Dialogue Concerning the Two Chief World Systems

by Galileo Galilei

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Title Page

GALILÆUS

Galilæus Lyncæus,

HIS

SYSTEME

OF THE

WORLD.

Dialogue I. Dialogue II. Dialogue III. Dialogue IV.

The First Dialogue

The First Dialogue.

INTERLOCVTORS.

Salviatus, Sagredus, and Simplicius.

SALVIATUS.

T was our yesterdayes resolution, and agreement, that we should to day discourse the most distinctly, and particularly we could possible, of the natural reasons, and their efficacy that have been hitherto alledged on the one or other part, by the

maintainers of the Positions, Aristotelian, and Ptolomaique; and by the followers of the Copernican Systeme: And because Copernicus Copernicus reputeth the Earth a Globe like to a Planet.placing the Earth among the moveable Bodies of Heaven, comes to constitute a Globe for the same like to a Planet; it would be good that we began our disputation with the examination of what, and how great the energy of the Peripateticks arguments is, when they demonstrate, that this Hypothesis is impossible: Since that it is necessary to introduce in Nature,Cœlestial substances that are inalterable, and Elementary that be alterable, are necessary in the opinion of Aristotle. substances different betwixt themselves, that is, the Cœlestial, and Elementary; that impassible and immortal, this alterable and corruptible. Which argument Aristotle handleth in his book De Cœlo, insinuating it first, by some discourses dependent on certain general assumptions, and afterwards confirming it with experiments and perticular demonstrations: following the same method, I will propound, and freely speak my judgement, submitting my self to your censure, and particularly to Simplicius, a Stout Champion and contender for the Aristotelian Doctrine.

Aristotle maketh the World perfect, because it hath the threefold demension.And the first Step of the Peripatetick arguments is that, where Aristotle proveth the integrity and perfection of the World, telling us, that it is not a simple line, nor a bare superficies, but a body adorned with Longitude, Latitude, and Profundity; and because there are no more dimensions but these three; The World having them, hath all, and having all, is to be concluded perfect. And again, that by simple length, that magnitude is constituted, which is called a Line, to which adding breadth, there is framed the Superficies, and yet further adding the altitude or profoundity, there results the Body, and after these three dimensions there is no passing farther, so that in these three the integrity, and to so speak, totality is terminated, which I might but with justice have required Aristotle to have proved to me by necessary consequences, the rather in regard he was able to do it very plainly, and speedily.

Simpl.What say you to the excellent demonstrations in the 2. 3. and 4. Texts,Aristotles demonstrations to prove the dimensions to be three and no more. after the definition of Continual? have you it not first there proved, that there is no more but three dimensions, for that those three are all things, and that they are every where? And is not this confirmed by the Doctrine and Authority of the Pythagorians,The number three celebrated amongst the Pythagorians who say that all things are determined by three, beginning, middle, and end, which is the number of All? And where leave you that reason, namely, that as it were by the law of Nature, this number is used in the sacrifices of the Gods? And why being so dictated by nature, do we atribute to those things that are three, and not to lesse, the title of all? why of two is it said both, and not all, unless they be three? And all this Doctrine you have in the second Text. Afterwards in the third, Ad pleniorem scientiam, we read that All, the Whole, and Perfect,Omne, Totum & Perfectum. are formally one and the same; and that therefore onely the Body, amongst magnitudes is perfect: because it is determined by three, which is All, and being divisible three manner of waies, it is every way divisible; but of the others, some are dividible in one manner, and some in two, because according to the number affixed, they have their division and continuity, and thus one magnitude is continuate one way,Or Solid. another two, a third, namely the Body, every way. Moreover in the fourth Text; doth he not after some other Doctrines, prove it by another demonstration? Scilicet, That no transition is made but according to some defect (and so there is a transition or passing from the line to the superficies, because the line is defective in breadth) and that it is impossible for the perfect to want any thing, it being every way so; therefore there is no transition from the Solid or Body to any other magnitude. Now think you not that by all these places he hath sufficiently proved, how that there's no going beyond the three dimensions, Length, Breadth, and Thickness, and that therefore the body or solid, which hath them all, is perfect?

Salv.To tell you true, I think not my self bound by all these reasons to grant any

more but onely this, That that which hath beginning, middle, and end, may, and ought to be called perfect: But that then, because beginning, middle, and end, are Three, the number Three is a perfect number, and hath a faculty of conferring Perfection on those things that have the same, I find no inducement to grant; neither do I understand, nor believe that, for example, of feet, the number three is more perfect then four or two, nor do I conceive the number four to be any imperfection to the Elements: and that they would be more perfect if they were three. Better therefore it had been to have left these subtleties to the Rhetoricians, and to have proved his intent, by necessary demonstration; for so it behoves to do in demonstrative sciences.

Simpl.You seem to scorn these reasons, and yet it is all the Doctrine of the Pythagorians, who attribute so much to numbers; and you that be a Mathematician, and believe many opinions in the Pythagorick Philosophy, seem now to contemn their Mysteries.

Salv.That the Pythagorians had the science of numbers in high esteem, and that Plato himself admired humane understanding, Plato held that humane understanding partook of divinity, because it understood numbers.and thought that it pertook of Divinity, for that it understood the nature of numbers, I know very well, nor should I be far from being of the same opinion: But that the Mysteries for which Pythagoras and his sect, had the Science of numbers in such veneration, are the follies that abound in the mouths and writings of the vulgar,The Mystery of Pythagorick numbers fabulous. I no waies credit: but rather because I know that they, to the end admirable things might not be exposed to the contempt, and scorne of the vulgar, censured as sacrilegious, the publishing of the abstruce properties of Numbers,De Papyrio prætextato, Gellius 1. 2. 3. and incommensurable and irrational quantities, by them investigated; and divulged, that he who discovered them, was tormented in the other World: I believe that some one of them to deter the common sort, and free himself from their inquisitiveness, told them that the mysteries of numbers were

those trifles, which afterwards did so spread amongst the vulgar; and this with a discretion and subtlety resembling that of the prudent young man, that to be freed from the importunity of his inquisitive Mother or Wife, I know not whether, who pressed him to impart the secrets of the Senate, contrived that story, which afterwards brought her and many other women to be derided and laught at by the same Senate.

Simpl.I will not be of the number of those who are over curious about the Pythagorick mysteries; but adhering to the point in hand; I reply, that the reasons produced by Aristotle to prove the dimensions to be no more than three, seem to me concludent, and I believe, That had there been any more evident demonstrations thereof, Aristotle would not have omitted them.

Sagr.Put in at least, if he had known, or remembred any more. But you Salviatus would do me a great pleasure to alledge unto me some arguments that may be evident, and clear enough for me to comprehend.

Salv.I will; and they shall be such as are not onely to be apprehended by you, but even by Simplicius himself: nor onely to be comprehended, but are also already known, although haply unobserved; and for the more easie understanding thereof, we will take this Pen and Ink, which I see already prepared for such occasions,A Geometrical demonstration of the triple dimension. and describe a few figures. And first we will note [Fig. 1. at the end of this Dialog.] these two points A B, and draw from the one to the other the curved lines, A C B, and A D B, and the right line A B, I demand of you which of them, in your mind, is that which determines the distance between the terms A B, & why?

Sagr.I should say the right line, and not the crooked, as well because the right is shorter, as because it is one, sole, and determinate, whereas the others are infinit, unequal, and longer; and my determination is grounded upon that, That it is one, and certain.

Salv.We have then the right line to determine the length between the two terms; let us add another right line and parallel to A B, which let be C D, [Fig. 2.] so that there is put between them a superficies, of which I desire you to assign me the breadth, therefore departing from the point A, tell me how, and which way you will go, to end in the line C D, and so to point me out the breadth comprehended between those lines; let me know whether you will terminate it according to the quantity of the curved line A E, or the right line A F, or any other.

Simpl.According to the right A F, and not according to the crooked, that being already excluded from such an use.

Sagr.But I would take neither of them, seeing the right line A F runs obliquely; But would draw a line, perpendicular to C D, for this should seem to me the shortest, and the properest of infinite that are greater, and unequal to one another, which may be produced from the term A to any other part of the opposite line C D.

Salv.Your choice, and the reason you bring for it in my judgment is most excellent; so that by this time we have proved that the first dimension is determined by a right line, the second namely the breadth with another line right also, and not onely right, but withall, at right-angles to the other that determineth the length, and thus we have the two dimensions of length and breadth, definite and certain. But were you to bound or terminate a height, as for example, how high this Roof is from the pavement, that we tread on, being that from any point in the Roof, we may draw infinite lines, both curved, and right, and all of diverse lengths to infinite points of the pavement, which of all these lines would you make use of?

Sagr.I would fasten a line to the Seeling, and with a plummet that should hang at it, would let it freely distend it self till it should reach well near to the pavement, and the length of such a thread being the streightest and shortest of all the lines, that could possibly be drawn from the same point to the pavement, I would say was the true height of this Room.

Salv.Very well, And when from the point noted in the pavement by this pendent thread (taking the pavement to be levell and not declining) you should produce two other right lines, one for the length, and the other for the breadth of the superficies of the said pavement, what angles should they make with the said thread?

Sagr.They would doubtless meet at right angles, the said lines falling perpendicular, and the pavement being very plain and levell.

Salv.Therefore if you assign any point, for the term from whence to begin your measure; and from thence do draw a right line, as the terminator of the first measure, namely of the length, it will follow of necessity, that that which is to design out the largeness or breadth, toucheth the first at right-angles, and that that which is to denote the altitude, which is the third dimension, going from the same point formeth also with the other two, not oblique but right angles, and thus by the three perpendiculars, as by three lines, one, certain, and as short as is possible, you have the three dimensions A B length, A C breadth, and A D height; and because, clear it is, that there cannot concurre any more lines in the said point, so as to make therewith right-angles, and the dimensions ought to be determined by the sole right lines, which make between themselves right-angles; therefore the dimensions are no more but three, and that which hath three hath all, and that which hath all, is divisible on all sides, and that which is so, is perfect, &c.

Simpl.And who saith that I cannot draw other lines? why may not I protract another line underneath, unto the point A, that may be perpendicular to the rest?

Salv.You can doubtless, at one and the same point, make no more than three right lines concurre, that constitute right angles between themselves.

Sagr.I see what Simplicius means, namely, that should the said DA be prolonged downward, then by that means there might be drawn two others, but they would be the same with the first three, differing onely in this, that whereas now they onely touch, then they would intersect, but not produce new dimensions.

Simpl.I will not say that this your argument may not be concludent; but yet this I say with Aristotle, that in things natural it is not alwaies necessary, to bring Mathematical demonstrations.

Sagr.Grant that it were so where such proofs cannot be had, yet if this case admit of them, why do not you use them? But it would be good we spent no more words on this particular, for I think that Salviatus will yield, both to Aristotle, and you, without farther demonstration, that the World is a body, and perfect, yea most perfect, as being the greatest work of God.

Salv.So really it is, therefore leaving the general contemplation of the whole, let us descend to the consideration of its parts, which Aristotle, in his first division, makes two, and they very different and almost contrary to one another; namely the Coelestial, and Elementary: that ingenerable, incorruptible, unalterable, unpassible, &c. and this exposed to a continual alteration, mutation, &c. Which difference, as from its original principle, he derives from the diversity of local motions, and in this method he proceeds.

Leaving the sensible, if I may so speak, and retiring into the Ideal world, he begins Architectonically to consider that nature being the principle of motion, it followeth that natural bodies be indued with local motion. Next he declares local motion to be of three kinds, namely, circular, right, and mixt of right and circular: and the two first he calleth simple, for that of all lines the circular, and right are onely simple; and here somewhat restraining himself, he defineth anew, of simple motions, one to be circular, namely that which is made about the medium, and the other namely the right, upwards, and downwards; upwards, that which moveth from the medium; downwards, that which goeth towards the medium. And from hence he infers, as he may by and necessary consequence, that all simple motions are confined to these three kinds, namely, to the medium, from the medium, and about the medium; the which corresponds saith he, with what hath been said before of a body, that it also is

perfected by three things, and so is its motion. Having confirmed these motions, he proceeds saying, that of natural bodies some being simple, and some composed of them (and he calleth simple bodies those, that have a principle of motion from nature, as the Fire and Earth) it follows that simple motions belong to simple bodies, and mixt to the compound; yet in such sort, that the compounded incline to the part predominant in the composition.

Sagr.Pray you hold a little Salviatus, for I find so many doubts to spring up on all sides in this discourse, that I shall be constrained, either to communicate them if I would attentively hearken to what you shall add, or to take off my attention from the things spoken, if I would remember objections.

Salv.I will very willingly stay, for that I also run the same hazard, and am ready at every step to lose my self whilst I sail between Rocks, and boisterous Waves, that make me, as they say, to lose my Compass; therefore before I make them more, propound your difficulties.

Sagr.You and Aristotle together would at first take me a little out of the sensible World, to tell me of the Architecture, wherewith it ought to be fabricated; and very appositly begin to tell me, that a natural body is by nature moveable, nature being (as elsewhere it is defined) the principle of motion. But here I am somewhat doubtfull why Aristotle said not that of natural bodies, some are moveable by nature, and others immoveable, for that in the definition, nature is said to be the principle of Motion, and Rest; for if natural bodies have all a principle of motion, either he might have omitted the mention of Rest, in the definition of nature: or not have introduced such a definition in this place. Next, as to the declaration of what Aristotle intends by simple motions, and how by Spaces he determines them, calling those simple, that are made by simple lines, which are onely the right, and circular, I entertain it willingly; nor do I desire to tenter the instance of the Helix, about the Cylinder; which in that it is in every part like to it self, might seemingly be numbred among

simple lines. But herein I cannot concurre, that he should so restrain simple motions (whilst he seems to go about to repeat the same definition in other words) as to call one of them the motion about the medium, the others Sursum & Deorsum, namely upwards and downward; which terms are not to be used, out of the World fabricated, but imply it not onely made, but already inhabited by us; for if the right motion be simple, by the simplicity of the right line, and if the simple motion be natural, it is made on every side, to wit, upwards, downwards, backwards, forwards, to the right, to the left, and if any other way can be imagined, provided it be straight, it shall agree to any simple natural body; or if not so, then the supposion of Aristotle is defective. It appears moreover that Aristotle hinteth but one circular motion alone to be in the World, and consequently but one onely Center, to which alone the motions of upwards and downwards, refer. All which are apparent proofs, that Aristotles aim is, to make white black, and to accommodate Architecture to the building, and not to modle the building according to the precepts of Arthitecture: for if I should say that Nature in Universal may have a thousand Circular Motions, and by consequence a thousand Centers, there would be also a thousand motions upwards, and downwards. Again he makes as hath been said, a simple motion, and a mixt motion, calling simple, the circular and right; and mixt, the compound of them two: of natural bodies he calls some simple (namely those that have a natural principle to simple motion) and others compound: and simple motions he attributes to simple bodies, and the compounded to the compound; but by compound motion he doth no longer understand the mixt of right and circular, which may be in the World; but introduceth a mixt motion as impossible, as it is impossible to mixe opposite motions made in the same right line, so as to produce from them a motion partly upwards, partly downwards; and, to moderate such an absurdity, and impossibility, he asserts that such mixt bodies move according to the simple part predominant: which necessitates others to say, that even the motion made by the same right line is sometimes simple, and sometimes also compound: so that the simplicity of the

motion, is no longer dependent onely on the simplicity of the line.

Simpl.How? Is it not difference sufficient, that the simple and absolute are more swift than that which proceeds from predominion? and how much faster doth a piece of pure Earth descend, than a piece of Wood?

Sagr.Well, Simplicius; But put case the simplicity for this cause was changed, besides that there would be a hundred thousand mixt motions, you would not be able to determine the simple; nay farther, if the greater or lesse velocity be able to alter the simplicity of the motion, no simple body should move with a simple motion; since that in all natural right motions, the velocity is ever encreasing, and by consequence still changing the simplicity, which as it is simplicity, ought of consequence to be immutable, and that which more importeth, you charge Aristotle with another thing, that in the definition of motions compounded, he hath not made mention of tardity nor velocity, which you now insert for a necessary and essential point. Again you can draw no advantage from this rule, for that there will be amongst the mixt bodies some, (and that not a few) that will move swiftly, and others more slowly than the simple; as for example, Lead, and Wood, in comparison of earth; and therefore amongst these motions, which call you the simple, and which the mixt?

Simpl.I would call that simple motion, which is made by a simple body, and mixt, that of a compound body.

Sagr.Very well, and yet Simplicius a little before you said, that the simple, and compound motions, discovered which were mixt, and which were simple bodies; now you will have me by simple and mixt bodies, come to know which is the simple, and which is the compound motion: an excellent way to keep us ignorant, both of motions and bodies. Moreover, you have also a little above declared, how that a greater velocity did not suffice, but you seek a third condition for the definement of simple motion, for which Aristotle contented himself with one alone,

namely, of the simplicity of the Space, or Medium: But now according to you, the simple motion, shall be that which is made upon a simple line, with a certain determinate velocity, by a body simply moveable. Now be it as you please, and let us return to Aristotle, who defineth the mixt motion to be that compounded of the right, and circular, but produceth not any body, which naturally moveth with such a motion.

Salv.I come again to Aristotle, who having very well, and Methodically begun his discourse, but having a greater aim to rest at, and hit a marke, predesigned in his minde, then that to which his method lead him, digressing from the purpose, he comes to assert, as a thing known and manifest, that as to the motions directly upwards or downwards, they naturally agree to Fire, and Earth; and that therefore it is necessary, that besides these bodies, which are neer unto us, there must be in nature another, to which the circular motion may agree: which shall be so much the more excellent by how much the circular motion is more perfect, then the streight, but how much more pefect that is than this, he determines from the greatness of the circular lines perfection above the right line;The circular line perfect, according to Aristotle, and but the right imperfect, and why. calling that perfect, and this imperfect; imperfect, because if infinite it wanteth a termination, and end: and if it be finite, there is yet something beyond which it may be prolonged. This is the basis, ground work, and master-stone of all the Fabrick of the Aristotelian World, upon which they superstruct all their other properties, of neither heavy nor light, of ingenerable incorruptible, exemption from all motions, some onely the local, &c. And all these passions he affirmeth to be proper to a simple body that is moved circularly; and the contrary qualities of gravity, levity, corruptibility, &c. he assigns to bodies naturally moveable in a streight line, for that if we have already discovered defects in the foundation, we may rationally question what soever may farther built thereon. I deny not, that this which Aristotle hitherto hath introduced, with a general discourse dependent upon universal primary principles, hath been since in process of

time, re-inforced with particular reasons, and experiments; all which it would be necessary distinctly to consider and weigh; but because what hath been said hitherto presents to such as consider the same many and no small difficulties, (and yet it would be necessary, that the primary principles and fundamentals, were certain, firm, and established, that so they might with more confidence be built upon) it would not be amiss, before we farther multiply doubts, to see if haply (as I conjecture) betaking our selves to other waies, we may not light upon a more direct and secure method; and with better considered principles of Architecture lay our primary fundamentals. Therefore suspending for the present the method of Aristotle, (which we will re-assume again in its proper place, and particularly examine;*) I say, that in the things hitherto affirmed by him, I agree with him, and admit that the World is a body enjoying all dimensions, and therefore most perfect; and I add, that as such, it is necessarily most ordinate, that is, having parts between themselves, with exquisite and most perfect order disposed; which assumption I think is not to be denied, neither by you or any other.

Simpl.Who can deny it? the first particular (of the worlds dimensions) is taken from Aristotle himself, and its denomination of ordinate seems onely to be assumed from the order which it most exactly keeps.

Salv.This principle then established, one may immediately conclude, that if the entire parts of the World should be by their nature moveable, it is impossible that their motions should be right, or other than circular; and the reason is sufficiently easie, and manifest; for that whatsoever moveth with a right motion, changeth place; and continuing to move, doth by degrees more and more remove from the term from whence it departed, and from all the places thorow which it successively passed; and if such motion naturally suited with it, then it was not at the beginning in its proper place; and so the parts of the World were not disposed with perfect order. But we suppose them to be perfectly ordinate, therefore as such, it is impossible that they should by nature change place, and consequently move in a right motion. Again, the

right motion being by nature infinite, for that the right line is infinite and indeterminate, it is impossible that any moveable can have a natural principle of moving in a right line; namely toward the place whither it is impossible to arrive, there being no prae-finite term; and nature, as Aristotle himself saith well, never attempts to do that which can never be done, nor essaies to move whither it is impossible to arrive. And if any one should yet object, that albeit the right line, and consequently the motion by it is producible in infinitum, that is to say, is interminate; yet nevertheless Nature, as one may say, arbitrarily hath assigned them some terms, and given natural instincts to its natural bodies to move unto the same; I will reply, that this might perhaps be fabled to have come to pass in the first Chaos, where indistinct matters confusedly and inordinately wandered; to regulate which, Nature very appositely made use of right motions, by which, like as the well-constituted, moving, disorder themselves, so were they which were before depravedly disposed by this motion ranged in order: but after their exquisite distribution and collocation, it is impossible that there should remain natural inclinations in them of longer moving in a right motion, from which now would ensue their removal from their proper and natural place, that is to say, their disordination; we may therefore say that the right motion serves to conduct the matter to erect the work; but once erected, that it is to rest immoveable, or if moveable, to move it self onely circularly. Unless we will say with Plato, that these mundane bodies, after they had been made and finished, were for a certain time moved by their Maker, in a right motion, but that after their attainment to certain and determinate places, they were revolved one by one in Spheres, passing from the right to the circular motion, wherein they have been ever since kept and maintained. A sublime conceipt, and worthy indeed of Plato: upon which, I remember to have heard our common friend the*Lyncean Academick discourse in this manner, if I have not forgot it. Every body for any reason constituted in a state of rest, but which is by nature moveable, being set at liberty doth move; provided withal, that it have

an inclination to some particular place; for should it stand indifferently affected to all, it would remain in its rest, not having greater inducement to move one way than another. From the having of this inclination necessarily proceeds, that it in its moving shall continually increase its acceleration, and beginning with a most slow motion, it shall not acquire any degree of velocity, before it shall have passed thorow all the degrees of less velocity, or greater tardity: for passing from the state of quiet (which is the infinite degree of tardity of motion) there is no reason by which it should enter into such a determinate degree of velocity, before it shall have entred into a less, and into yet a less, before it entred into that: but rather it stands with reason, to pass first by those degrees nearest to that from which it departed, and from those to the more remote; but the degree from whence the moveable began to move, is that of extreme tardity, namely of rest. Now this acceleration of motion is never made,The moveable doth not accelerate, save only as it approaheth nearer to its term. but when the moveable in moving acquireth it; nor is its acquist other than an approaching to the place desired, to wit, whither its natural inclination attracts it, and thither it tendeth by the shortest way; namely, by a right line. We may upon good grounds therefore say, That Nature, to confer upon a moveable first constituted in rest a determinate velocity, useth to make it move according to a certain time and space with a right motion.Nature, to introduce in the moveable a certain degree of velocity, made it move in a right line. This presupposed, let us imagine God to have created the Orb v. g. of Jupiter, on which he had determined to confer such a certain velocity, which it ought afterwards to retain perpetually uniform; we may with Plato say, that he gave it at the beginning a right and accelerate motion, and that it afterwards being arrived to that intended degree of velocity,Uniform velocity convenient to the circular motion. he converted its right, into a circular motion, the velocity of which came afterwards naturally to be uniform.

Sagr.I hearken to this Discourse with great delight; and I believe the content I take therein will be greater, when you have satisfied me in a doubt: that is, (which I do

not very well comprehend) how it of necessity ensues, that a moveable departing from its rest,Betwixt rest, and any assigned degree of velocity, infinite degrees of less velocity interpose. and entring into a motion to which it had a natural inclination, it passeth thorow all the precedent degrees of tardity, comprehended between any assigned degree of velocity, and the state of rest, which degrees are infinite? so that Nature was not able to confer them upon the body of Jupiter, his circular motion being instantly created with such and such velocity.

Salv.I neither did,Nature doth not immediately confer a determinate degree of velocity, howbeit she could. nor dare say, that it was impossible for God or Nature to confer that velocity which you speak of, immediately; but this I say, that de facto she did not do it; so that the doing it would be a work extra-natural, and by consequence miraculous

Sagr.Then you believe, that a stone leaving its rest, and entring into its natural motion towards the centre of the Earth, passeth thorow all the degrees of tardity inferiour to any degree of velocity?

Salv.I do believe it, nay am certain of it; and so certain, that I am able to make you also very well satisfied with the truth thereof.

Sagr.Though by all this daies discourse I should gain no more but such a knowledge, I should think my time very well bestowed.

Salv.By what I collect from our discourse, a great part of your scruple lieth in that it should in a time, and that very short, pass thorow those infinite degrees of tardity precedent to any velocity, acquired by the moveable in that time: and therefore before we go any farther, I will seek to remove this difficulty, which shall be an easie task; for I reply, that the moveable passeth by the aforesaid degrees,The moveable departing from rest passeth thorow all degrees of velocity without staying in any. but the passage is made without staying in any of them; so that the passage requiring but one sole instant of time, and every small time containing infinite

instants, we shall not want enough of them to assign its own to each of the infinite degrees of tardity; although the time were never so short.

Sagr.Hither to I apprehend you; nevertheless it is very much that that Ball shot from a Cannon (for such I conceive the cadent moveable) which yet we see to fall with such a precipice, that in less than ten pulses it will pass two hundred yards of altitude; should in its motion be found conjoyned with so small a degree of velocity, that, should it have continued to have moved at that rate without farther acceleration, it would not have past the same in a day.

Salv.You may say, nor yet in a year, nor in ten, no nor in a thousand; as I will endeavour to shew you, and also happily without your contradiction, to some sufficiently simple questions that I will propound to you. Therefore tell me if you make any question of granting that, that that ball in descending goeth increasing its impetus and velocity.

Sagr.I am most certain it doth.

Salv.And if I should say that the impetus acquired in any place of its motion, is so much, that it would suffice to re-carry it to that place from which it came, would you grant it?

Sagr.I should consent to it without contradiction, provided alwaies, that it might imploy without impediment its whole impetus in that sole work of re-conducting it self, or another equal to it, to that self-same height as it would do,The ponderous mover descending acquireth impetus sufficient to re-carry it to the like height. in case the Earth were bored thorow the centre, and the Bullet fell a thousand yards from the said centre, for I verily believe it would pass beyond the centre, ascending as much as it had descended; and this I see plainly in the experiment of a plummet hanging at a line, which removed from the perpendicular, which is its state of rest, and afterwards let go, falleth towards the said perpendicular, and goes as far beyond it; or onely so much less, as the opposition of the air, and line, or other accidents

have hindred it. The like I see in the water, which descending thorow a pipe, re-mounts as much as it had descended.

Salv.You argue very well. And for that I know you will not scruple to grant that the acquist of the impetus is by means of the receding from the term whence the moveable departed, and its approach to the centre, whither it motion tendeth; will you stick to yeeld, that two equal moveables, though descending by divers lines, without any impediment, acquire equal impetus, provided that the approaches to the centre be equal?

Sagr.I do not very well understand the question.

Salv.I will express it better by drawing a Figure: therefore I will suppose the line A B [in Fig. 3.] parallel to the Horizon, and upon the point B, I will erect a perpendicular B C; and after that I adde this slaunt line C A. Understanding now the line C A to be an inclining plain exquisitely polished, and hard, upon which descendeth a ball perfectly round and of very hard matter, and such another I suppose freely to descend by the perpendicular C B: will you now confess that the impetus of that which descends by the plain C A, being arrived to the point A, may be equal to the impetus acquired by the other in the point B, after the descent by the perpendicular C B?

Sagr.I resolutely believe so:The impetuosity of moveables equally approaching to the centre, are equal. for in effect they have both the same proximity to the centre, and by that, which I have already granted, their impetuosities would be equally sufficient to re-carry them to the same height.

Salv.Tell me now what you believe the same ball would do put upon the Horizontal plane A B?

Sagr.It would lie still,Upon an horizontal plane the moveable lieth still. the said plane having no declination.

Salv.But on the inclining plane C A it would descend, but with a gentler motion than

by the perpendicular C B?

Sagr.I may confidently answer in the affirmative, it seeming to me necessary that the motion by the perpendicular C B should be more swift, than by the inclining plane CA; yet nevertheless, if this be, how can the Cadent by the inclination arrived to the point A, have as much impetus, that is, the same degree of velocity, that the Cadent by the perpendicular shall have in the point B? these two Propositions seem contradictory.

Salv.Then you would think it much more false,The velocity by the inclining plane equal to the velocity by the perpendicular, and the motion by the perpendicular swifter than by the inclination. should I say, that the velocity of the Cadents by the perpendicular, and inclination, are absolutely equal: and yet this is a Proposition most true, as is also this that the Cadent moveth more swiftly by the perpendicular, than by the inclination.

Sagr.These Propositions to my ears sound very harsh: and I believe to yours Simplicius?

Simpl.I have the same sense of them.

Salv.I conceit you jest with me, pretending not to comprehend what you know better than my self: therefore tell me Simplicius, when you imagine a moveable more swift than another, what conceit do you fancy in your mind?

Simpl.I fancie one to pass in the same time a greater space than the other, or to move equal spaces, but in lesser time.

Salv.Very well: and for moveables equally swift, what's your conceit of them?

Simpl.I fancie that they pass equal spaces in equal times.

Salv.And have you no other conceit thereof than this?

Simpl.This I think to be the proper definition of equal motions.

Sagr.We will add moreover this other:Velocities are said to be equal, when the

spaces passed are proportionate to their time. and call that equal velocity, when the spaces passed have the same proportion, as the times wherein they are past, and it is a more universal definition.

Salv.It is so: for it comprehendeth the equal spaces past in equal times, and also the unequal past in times unequal, but proportionate to those spaces. Take now the same Figure, and applying the conceipt that you had of the more hastie motion, tell me why you think the velocity of the Cadent by C B, is greater than the velocity of the Descendent by C A?

Simpl.I think so; because in the same time that the Cadent shall pass all C B, the Descendent shall pass in C A, a part less than C B.

Salv.True; and thus it is proved, that the moveable moves more swiftly by the perpendicular, than by the inclination. Now consider, if in this same Figure one may any way evince the other conceipt, and finde that the moveables were equally swift by both the lines C A and C B.

Simpl.I see no such thing; nay rather it seems to contradict what was said before.

Salv.And what say you, Sagredus? I would not teach you what you knew before, and that of which but just now you produced me the definition.

Sagr.The definition I gave you, was, that moveables may be called equally swift, when the spaces passed are proportional to the times in which they passed; therefore to apply the definition to the present case, it will be requisite, that the time of descent by C A, to the time of falling by C B, should have the same proportion that the line C A hath to the line C B; but I understand not how that can be, for that the motion by C B is swifter than by C A.

Salv.And yet you must of necessity know it. Tell me a little, do not these motions go continually accelerating?

Sagr.They do; but more in the perpendicular than in the inclination.

Salv.But this acceleration in the perpendicular, is it yet notwithstanding such in comparison of that of the inclined, that two equal parts being taken in any place of the said perpendicular and inclining lines, the motion in the parts of the perpendicular is alwaies more swift, than in the part of the inclination?

Sagr.I say not so: but I could take a space in the inclination, in which the velocity shall be far greater than in the like space taken in the perpendicular; and this shall be, if the space in the perpendicular should be taken near to the end C, and in the inclination, far from it.

Salv.You see then, that the Proposition which saith, that the motion by the perpendicular is more swift than by the inclination, holds not true universally, but onely of the motions, which begin from the extremity, namely from the point of rest: without which restriction, the Proposition would be so deficient, that its very direct contrary might be true; namely, that the motion in the inclining plane is swifter than in the perpendicular: for it is certain, that in the said inclination, we may take a space past by the moveable in less time, than the like space past in the perpendicular. Now because the motion in the inclination is in some places more, in some less, than in the perpendicular; therefore in some places of the inclination, the time of motion of the moveable, shall have a greater proportion to the time of the motion of the moveable, by some places of the perpendicular, than the space passed, to the space passed: and in other places, the proportion of the time to the time, shall be less than that of the space to the space. As for example: two moveables departing from their quiescence, namely, from the point C, one by the perpendicular C B, [in Fig. 4.] and the other by the inclination C A, in the time that, in the perpendicular, the moveable shall have past all C B, the other shall have past C T lesser. And therefore the time by C T, to the time by C B (which is equal) shall have a greater proportion than the line C T to C B, being that the same to the less, hath a greater proportion than to the greater. And on the contrary, if in C A, prolonged as much as is requisite, one should take a part equal to C B, but past in a shorter time; the time in the inclination shall

have a less proportion to the time in the perpendicular, than the space to the space. If therefore in the inclination and perpendicular, we may suppose such spaces and velocities, that the proportion between the said spaces be greater and less than the proportion of the times; we may easily grant, that there are also spaces, by which the times of the motions retain the same proportion as the spaces.

Sagr.I am already freed from my greatest doubt, and conceive that to be not onely possible, but necessary, which I but now thought a contradiction: but nevertheless I understand not as yet, that this whereof we now are speaking, is one of these possible or necessary cases; so as that it should be true, that the time of descent by C A, to the time of the fall by C B, hath the same proportion that the line C A hath to C B; whence it may without contradiction be affirmed, that the velocity by the inclination C A, and by the perpendicular C B, are equal.

Salv.Content your self for this time, that I have removed your incredulity; but for the knowledge of this, expect it at some other time, namely, when you shall see the matters concerning local motion demonstrated by our Academick; at which time you shall find it proved, that in the time that the one moveable falls all the space C B, the other descendeth by C A as far as the point T, in which falls the perpendicular drawn from the point B: and to find where the same Cadent by the perpendicular would be when the other arriveth at the point A, draw from A the perpendicular unto C A, continuing it, and C B unto the interfection, and that shall be the point sought. Whereby you see how it is true, that the motion by C B is swifter than by the inclination C A (supposing the term C for the beginning of the motions compared) because the line C B is greater than C T, and the other from C unto the intersection of the perpendicular drawn from A, unto the line C A, is greater than C A, and therefore the motion by it is swifter than by C A. But when we compare the motion made by all C A, not with all the motion made in the same time by the perpendicular continued, but with that made in part of the time, by the sole part C B, it hinders not, that the motion by C A, continuing to descend beyond, may arrive to A in such a

time as is in proportion to the other time, as the line C A is to the line C B. Now returning to our first purpose; which was to shew, that the grave moveable leaving its quiescence, passeth descending by all the degrees of tardity, precedent to any whatsoever degree of velocity that it acquireth, re-assuming the same Figure which we used before, let us remember that we did agree, that the Descendent by the inclination C A, and the Cadent by the perpendicular C B, were found to have acquired equal degrees of velocity in the terms B and A: now to proceed, I suppose you will not scruple to grant, that upon another plane less steep than A C; as for example, A D [in Fig. 5.] the motion of the descendent would be yet more flow than in the plane A C. So that it is not any whit dubitable, but that there may be planes so little elevated above the Horizon A B, that the moveable, namely the same ball, in any the longest time may reach the point A, which being to move by the plane A B, an infinite time would not suffice: and the motion is made always more slowly, by how much the declination is less. It must be therefore confest, that there may be a point taken upon the term B, so near to the said B, that drawing from thence to the point A a plane, the ball would not pass it in a whole year. It is requisite next for you to know, that the impetus, namely the degree of velocity the ball is found to have acquired when it arriveth at the point A, is such, that should it continue to move with this self-same degree uniformly, that is to say, without accelerating or retarding; in as much more time as it was in coming by the inclining plane, it would pass double the space of the plane inclined: namely (for example) if the ball had past the plane D A in an hour, continuing to move uniformly with that degree of velocity which it is found to have in its arriving at the term A, it shall pass in an hour a space double the length D A; and because (as we have said) the degrees of velocity acquired in the points B and A, by the moveables that depart from any point taken in the perpendicular C B, and that descend, the one by the inclined plane, the other by the said perpendicular, are always equal: therefore the cadent by the perpendicular may depart from a term so near to B, that the degree of velocity acquired in B, would not

suffice (still maintaining the same) to conduct the moveable by a space double the length of the plane inclined in a year, nor in ten, no nor in a hundred. We may therefore conclude, that if it be true, that according to the ordinary course of nature a moveable, all external and accidental impediments removed, moves upon an inclining plane with greater and greater tardity, according as the inclination shall be less; so that in the end the tardity comes to be infinite, which is, when the inclination concludeth in, and joyneth to the horizontal plane; and if it be true likewise, that the degree of velocity acquired in some point of the inclined plane, is equal to that degree of velocity which is found to be in the moveable that descends by the perpendicular, in the point cut by a parallel to the Horizon, which passeth by that point of the inclining plane; it must of necessity be granted, that the cadent departing from rest, passeth thorow all the infinite degrees of tardity, and that consequently, to acquire a determinate degree of velocity, it is necessary that it move first by right lines, descending by a short or long space, according as the velocity to be acquired, ought to be either less or greater, and according as the plane on which it descendeth is more or less inclined; so that a plane may be given with so small inclination, that to acquire in it the assigned degree of velocity, it must first move in a very great space, and take a very long time; whereupon in the horizontal plane, any how little soever velocity, would never be naturally acquired, since that the moveable in this case will never move: but the motion by the horizontal line,The circular motion is never acquired naturally, without right motion precede it.Circular motion perpetually uniform. which is neither declined or inclined, is a circular motion about the centre: therefore the circular motion is never acquired naturally, without the right motion precede it; but being once acquired, it will continue perpetually with uniform velocity. I could with other discourses evince and demonstrate the same truth, but I will not by so great a digression interrupt our principal argument: but rather will return to it upon some other occasion; especially since we not assumed the same, not to serve for a necessary demonstration, but to adorn a Platonick Conceit; to which I

will add another particular observation of our Academick, which hath in it something of admirable. Let us suppose amongst the decrees of the divine Architect, a purpose of creating in the World these Globes, which we behold continually moving round, and of assigning the centre of their conversions; and that in it he had placed the Sun immoveable, and had afterwards made all the said Globes in the same place, and with the intended inclinations of moving towards the Centre, till they had acquired those degrees of velocity, which at first seemed good to the same Divine Minde; the which being acquired, we lastly suppose that they were turned round, each in his Sphere retaining the said acquired velocity: it is now demanded, in what altitude and distance from the Sun the place was where the said Orbs were primarily created; and whether it be possible that they might all be created in the same place? To make this investigation, we must take from the most skilfull Astronomers the magnitude of the Spheres in which the Planets revolve, and likewise the time of their revolutions: from which two cognitions is gathered how much (for example) Jupiter is swifter than Saturne; and being found (as indeed it is) that Jupiter moves more swiftly, it is requisite, that departing from the same altitude, Jupiter be descended more than Saturne, as we really know it is, its Orbe being inferiour to that of Saturne. But by proceeding forwards, from the proportions of the two velocities of Jupiter and Saturne, and from the distance between their Orbs, and from the proportion of acceleration of natural motion, one may finde in what altitude and distance from the centre of their revolutions,The magnitude of the Orbs, and the velocity of the motion of the Planets, answer proportionably, as if descended from the same place. was the place from whence they first departed. This found out, and agreed upon, it is to be sought, whether Mars descending from thence to his Orb, the magnitude of the Orb, and the velocity of the motion, agree with that which is found by calculation; and let the like be done of the Earth, of Venus, and of Mercury; the greatness of which Spheres, and the velocity of their motions, agree so nearly to what computation gives, that it is very admirable.

Sagr.I have hearkened to this conceit with extreme delight; and, but that I believe the making of these calculations truly would be a long and painfull task, and perhaps too hard for me to comprehend, I would make a trial of them.

Salv.The operation indeed is long and difficult; nor could I be certain to finde it so readily; therefore we shall refer it to another time, and for the present we will return to our first proposal, going on there where we made digression; which, if I well remember, was about the proving the motion by a right line of no use, in the ordinate parts of the World; and we did proceed to say, that it was not so in circular motions, of which that which is made by the moveable in it self,Finite and terminate circular motions disorder not the parts of the World. still retains it in the same place, and that which carrieth the moveable by the circumference of a circle about its fixed centre, neither puts it self, nor those about it in disorder; for that such a motion primarily is finite and terminate (though not yet finished and determined) but there is no point in the circumference,In the circular motion, every point in the circumference is the begining and end. that is not the first and last term in the circulation; and continuing it in the circumference assigned it, it leaveth all the rest, within and without that, free for the use of others, without ever impeding or disordering them. This being a motion that makes the moveable continually leave, and continually arrive at the end;Circular motion onely is uniform. it alone therefore can primarily be uniform; for that acceleration of motion is made in the moveable, when it goeth towards the term, to which it hath inclination; and the retardation happens by the repugnance that it hath to leave and part from the same term; and because in circular motion, the moveable continually leaves the natural term, and continually moveth towards the same, therefor, in it, the repugnance and inclination are always of equal force: from which equality results a velocity, neither retarded nor accelerated, i.e. an uniformity in motion. From this conformity, and from the being terminate,Circular motion may be continued perpetually. may follow the perpetual continuation by successively reiterating the circulations; which in an undeterminated line, and in a motion

continually retarded or accelerated, cannot naturally be.Right motion cannot naturally be perpetual. I say, naturally; because the right motion which is retarded, is the violent, which cannot be perpetual; and the accelerate arriveth necessarily at the term, if one there be; and if there be none, it cannot be moved to it, because nature moves not whether it is impossible to attain. I conclude therefore, that the circular motion can onely naturally consist with natural bodies, parts of the universe, and constituted in an excellent disposure; and that the right, at the most that can be said for it, is assigned by nature to its bodies,Right motion assigned to natural bodies, to reduce them to perfect order, when removed from their places. and their parts, at such time as they shall be out of their proper places, constituted in a depraved disposition, and for that cause needing to be redurcd by the shortest way to their natural state. Hence, me thinks, it may rationally be concluded, that for maintenance of perfect order amongst the parts of the World, it is necessary to say, that moveables are moveable onely circularly; and if there be any that move not circularly,Rest onely, and circular motion are apt to conserve order. these of necessity are immoveable: there being nothing but rest and circular motion apt to the conservation of order. And I do not a little wonder with my self, that Aristotle, who held that the Terrestrial globe was placed in the centre of the World, and there remained immoveable, should not say, that of natural bodies some are moveable by nature, and others immoveable; especially having before defined Nature, to be the principle of Motion and Rest.

Simpl.Aristotle, though of a very perspicacious wit, would not strain it further than needed:Sensible experiments are to be preferred before humane argumentations. holding in all his argumentations, that sensible experiments were to be preferred before any reasons founded upon strength of wit, and said those which should deny the testimony of sense deserved to be punished with the loss of that sense;He who denies sense, deserves to be deprived of it. Sense sheweth that things grave move to the medium, and the light to the concave. now who is so blind, that sees not the parts

of the Earth and Water to move, as being grave, naturally downwards, namely; towards the centre of the Universe, assigned by nature her self for the end and term of right motion deorsùm; and doth not likewise see the Fire and Air to move right upwards towards the Concave of the Lunar Orb, as to the natural end of motion sursùm? And this being so manifestly seen, and we being certain, that eadem est ratio totius & partium, why may we not assert it for a true and manifest proposition, that the natural motion of the Earth is the right motion ad medium, and that of the Fire, the right à medio?

Salv.The most that you can pretend from this your Discourse, were it granted to be true, is that, like as the parts of the Earth removed from the whole, namely, from the place where they naturally rest, that is in short reduced to a depraved and disordered disposure, return to their place spontaneously, and therefore naturally in a right motion, (it being granted, that eadem sit ratio totius & partium) so it may be inferred, that the Terrestrial Globe removed violently from the place assigned it by nature,It is questionable whether descending weights move in a right line. it would return by a right line. This, as I have said, is the most that can be granted you, and that onely for want of examination; but he that shall with exactness revise these things, will first deny, that the parts of the Earth, in returning to its whole, move in a right line, and not by a circular or mixt; and really you would have enough to do to demonstrate the contrary, as you shall plainly see in the answers to the particular reasons and experiments alledged by Ptolomey and Aristotle. Secondly, If another should say that the parts of the Earth, go not in their motion towards the Centre of the World, but to unite with its Whole, and that for that reason they naturally incline towards the centre of the Terrestrial Globe, by which inclination they conspire to form and preserve it, what other All, or what other Centre would you find for the World,The Earth sperical by the conspiration of its parts to its Centre. to which the whole Terrene Globe, being thence removed, would seek to return, that so the reason of the Whole might be like to that of its parts? It may be added, That neither

Aristotle, nor you can ever prove, that the Earth de facto is in the centre of the Universe; but if any Centre may be assigned to the Universe,The Sun more probably in the centre of the Vniverse, than the Earth. we shall rather find the Sun placed in it, as by the sequel you shall understand.

Now, like as from the consentaneous conspiration of all the parts of the Earth to form its whole, doth follow, that they with equal inclination concurr thither from all parts;Natural inclination of the parts of all the globes of the World to go to their centre. and to unite themselves as much as is possible together, they there spherically adapt themselves; why may we not believe that the Sun, Moon, and other mundane Bodies, be also of a round figure, not by other than a concordant instinct, and natural concourse of all the parts composing them? Of which, if any, at any time, by any violence were separated from the whole, is it not reasonable to think, that they would spontaneously and by natural instinct return? and in this manner to infer, that the right motion agreeth with all mundane bodies alike.

Simpl.Certainly, if you in this manner deny not onely the Principles of Sciences, but manifest Experience, and the Senses themselves, you can never be convinced or removed from any opinion which you once conceit, therefore I will choose rather to be silent (for, contra negantes principia non est disputandum) than contend with you. And insisting on the things alledged by you even now (since you question so much as whether grave moveables have a right motion or no) how can you ever rationally deny,The right motion of grave bodies manifest to sense. that the parts of the Earth; or, if you will, that ponderous matters descend towards the Centre, with a right motion; whenas, if from a very high Tower, whose walls are very upright and perpendicular, you let them fall, they shall descend gliding and sliding by the Tower to the Earth, exactly in that very place where a plummet would fall, being hanged by a line fastned above, just there, whence the said weights were let fall? is not this a more than evident argument of the motions being right, and towards the Centre?Arguments of Aristotle, to prove that grave bodies move with an inclination

to arrive at the centre of the Vniverse. In the second place you call in doubt, whether the parts of the Earth are moved, as Aristotle affirms, towards the Centre of the World; as if he had not rationally demonstrated it by contrary motions, whilst he thus argueth; The motion of heavie bodies is contrary to that of the light: but the motion of the light is manifest to be directly upwards, namely, towards the circumference of the World, therefore the motion of the heavie is directly towards the Centre of the World: and it happens per accidens,Heavie bodies move towards the centre of the Earth per accidens. that it be towards the centre of the Earth, for that this striveth to be united to that. The seeking in the next place, what a part of the Globe of the Sun or Moon would do, were it separated from its whole, is vanity; because that thereby that is sought,To seek what would follow upon an impossibility, is folly. which would be the consequence of an impossibility; in regard that, as Aristotle also demonstrates, the cœlestial bodies are impassible, impenetrable, and infrangible; so that such a case can never happen:Cœlestial bodies neither heavie nor light, according to Aristotle. and though it should, and that the separated part should return to its whole, it would not return as grave or light, for that the same Aristotle proveth, that the Cœlestial Bodies are neither heavie nor light.

Salv.With what reason I doubt, whether grave bodies move by a right and perpendicular line, you shall hear, as I said before, when I shall examine this particular argument. Touching the second point, I wonder that you should need to discover the Paralogism of Aristotle, being of it self so manifest; and that you perceive not, that Aristotle supposeth that which is in question: therefore take notice.

Simpl.Pray Salviatus speak with more respect of Aristotle: for who can you ever perswade, that he who was the first, only, and admirable explainer of the Syllogistick forms of demonstration,Aristotle cannot equivocate, being the inventer of Logick. of Elenchs, of the manner of discovering Sophisms, Paralogisms, and in short, of all the parts of Logick, should afterwards so notoriously equivocate in

imposing that for known, which is in question? It would be better, my Masters, first perfectly to understand him, and then to try, if you have a minde, to oppose him.

Salv.Simplicius, we are here familiarly discoursing among our selves, to investigate some truth; I shall not be displeased that you discover my errors; and if I do not follow the mind of Aristotle, freely reprehend me, and I shall take it in good part. Onely give me leave to expound my doubts, and to reply something to your last words, telling you, that Logick, as it is well understood, is the Organe with which we philosophate; but as it may be possible, that an Artist may be excellent in making Organs, but unlearned in playing on them, thus he might be a great Logician, but unexpert in making use of Logick; like as we have many that theorically understand the whole Art of Poetry, and yet are unfortunate in composing but meer four Verses; others enjoy all the precepts of Vinci**A famous Italian Painter., and yet know not how to paint a Stoole. The playing on the Organs is not taught by them who know how to make Organs, but by him that knows how to play on them: Poetry is learnt by continual reading of Poets: Limning is learnt by continual painting and designing: Demonstration from the reading of Books full of demonstrations, which are the Mathematical onely, and not the Logical. Now returning to our purpose, I say, that that which Aristotle seeth of the motion of light bodies, is the departing of the Fire from any part of the Superficies of the Terrestrial Globe, and directly retreating from it, mounting upwards; and this indeed is to move towards a circumference greater than that of the Earth; yea, the same Aristotle makes it to move to the concave of the Moon, but that this circumference is that of the World, or concentrick to it, so that to move towards this, is a moving towards that of the World, that he cannot affirm, unless he supposeth, That the Centre of the Earth,Paralogism of Aristotle, in proving the Earth to be in the Centre of the World. from which we see these light ascendent bodies to depart, be the same with the Centre of the World; which is as much as to say, that the terrestrial Globe is constituted in the midst of the World: which is yet that of which we were in doubt, and which Aristotle intended to prove. And do you

say that this is not a manifest Paralogism?The Paralogisme of Aristotle another way discovered.

Sagr.This Argument of Aristotle appeared to me deficient also, and non-concludent for another respect; though it were granted, that that Circumference, to which the Fire directly moveth, be that which includeth the World: for that in a circle, not onely the centre, but any other point being taken, every moveable which departing thence, shall move in a right line, and towards any whatsoever part, shall without any doubt go towards the circumference, and continuing the motion, shall also arrive thither; so that we may truly say, that it moveth towards the circumference: but yet it doth not follow, that that which moveth by the same line with a contrary motion, would go towards the centre, unless when the point taken were the centre it self, or that the motion were made by that onely line, which produced from the point assigned, passeth thorow the centre. So that to say, that Fire moving in a right line, goeth towards the circumference of the World, therefore the parts of the Earth which by the same lines move with a contrary motion, go towards the centre of the World, concludeth not, unless then when it is presupposed, that the lines of the Fire prolonged pass by the centre of the World; and because we know certainly of them, that they pass by the centre of the Terrestrial Globe (being perpendicular to its superficies, and not inclined) therefore to conclude, it must be supposed, that the centre of the Earth is the same with the centre of the World; or at least, that the parts of the Fire and Earth descend not, save onely by one sole line which passeth by the centre of the World. Which nevertheless is false, and repugnant to experience, which sheweth us, that the parts of Fire, not by one line onely, but by infinite, produced from the centre of the Earth towards all the parts of the World, ascend always by lines perpendicular to the Superficies of the Terrestrial Globe.

Salv.You do very ingeniously lead Aristotle to the same inconvenience, Sagredus, shewing his manifest equivoke; but withal you add another inconsistency. We see the Earth to be spherical, and therefore are certain that it hath its centre, to which we

see all its parts are moved; for so we must say, whilst their motions are all perpendicular to the Superficies of the Earth; we mean, that as they move to the centre of the Earth, they move to their Whole, and to their Universal Mother: and we are still farther so free, that we will suffer our selves to be perswaded, that their natural instinct is,Grave bodies may more rationally be affirmed to tend to the Centre of the Earth, than of the Universe. not to go towards the centre of the Earth, but towards that of the Universe; which we know not where to find, or whether it be or no; and were it granted to be, it is but an imaginary point, and a nothing without any quality. As to what Simplicius said last, that the contending whether the parts of the Sun, Moon, or other cœlestial Body, separated from their Whole, should naturally return to it, is a vanity, for that the case is impossible; it being clear by the Demonstrations of Aristotle, that the cœlestial Bodies are impassible,The conditions and attributes which differ the cœlestial bodies from Elementary, depend on the motions assigned them by Arist. impenetrable, unpartable, &c. I answer, that none of the conditions, whereby Aristotle distinguisheth the Cœlestial Bodies from Elementary, hath other foundation than what he deduceth from the diversity of the natural motion of those and these; insomuch that it being denied, that the circular motion is peculiar to Cœlestial Bodies, and affirmed, that it is agreeable to all Bodies naturally moveable, it is behoofull upon necessary consequence to say, either that the attributes of generable, or ingenerable, alterable, or unalterable, partable, or unpartable, &c. equally and commonly agree with all worldly bodies, namely, as well to the Cœlestial as to the Elementary; or that Aristotle hath badly and erroneously deduced those from the circular motion, which he hath assigned to Cœlestial Bodies.

Simpl.This manner of argumentation tends to the subversion of all Natural Philosophy, and to the disorder and subversion of Heaven and Earth, and the whole Universe; but I believe the Fundamentals of the Peripateticks are such, that we need not fear that new Sciences can be erected upon their ruines.

Salv.Take no thought in this place for Heaven or the Earth, neither fear their subversion, or the ruine of Philosophy. As to Heaven, your fears are vain for that which you your self hold unalterable and impassible; as for the Earth, we strive to enoble and perfect it, whilst we make it like to the Cœlestial Bodies, and as it were place it in Heaven, whence your Philosophers have exiled it.The disputes and contradictions of Philosophers may conduce to the benefit of Philosophy. Philosophy it self cannot but receive benefit from our Disputes, for if our conceptions prove true, new Discoveries will be made; if false, the first Doctrine will be more confirmed. Rather bestow your care upon some Philosophers, and help and defend them; for as to the Science it self, it cannot but improve. And that we may return to our purpose, be pleased freely to produce what presents it self to you in confirmation of that great difference which Aristotle puts between the Cœlestial Bodies, and the Elementary parts of the World, in making those ingenerable, incorruptible, unalterable, &c. and this corruptible, alterable, &c.

Simpl.I see not yet any need that Aristotle hath of help, standing as he doth stoutly and strongly on his feet; yea not being yet assaulted, much less foiled by you. And what ward will you choose in this combate for this first blow?Aristotles discourse to prove the incorruptibility of Heaven. Aristotle writeth, that whatever is generated, is made out of a contrary in some subject, and likewise is corrupted in some certain subject from a contrary into a contrary;Generation & corruption is onely amongst contraries, according to Arist. so that (observe) corruption and generation is never but onely in contraries; If therefore to a Cœlestial Body no contrary can be assigned, for that to the circular motion no other motion is contrary,To the circular motion no other motion is contrary. then Nature hath done very well to make that exempt from contraries, which was to be ingenerable and incorruptible, This fundamental first confirmed, it immediately followeth of consequence, that it is inaugmentable, inalterable, impassible, and finally eternal, and a proportionate habitation to the immortal Deities,Heaven an habitation for the immortal Gods. conformable to the

opinion even of all men that have any conceit of the Gods. He afterwards confirmeth the same by sense;Immutability of Heaven evident to sense. in regard, that in all times past, according to memory or tradition, we see nothing removed, according to the whole outward Heaven, nor any of its proper parts. Next, as to the circular motion,He proveth that the circular motion hath no contrary. that no other is contrary to it, Aristotle proveth many ways; but without reciting them all, it is sufficiently demonstrated, since simple motions are but three, to the medium, from the medium, and about the medium, of which the two right, sursum and deorsum, are manifestly contrary; and because one onely hath onely one for contrary, therefore there rests no other motion which may be contrary to the circular. You see the subtle and most concluding discourse of Aristotle, whereby he proveth the incorruptibility of Heaven.

Salv.This is nothing more, save the pure progress of Aristotle, by me hinted before; wherein, besides that I affirm, that the motion which you attribute to the Cœlestial Bodies agreeth also to the Earth, its illation proves nothing. I tell you therefore, that that circular motion which you assign to Cœlestial Bodies, suiteth also to the Earth, from which, supposing that the rest of your discourse were concludent, will follow one of these three things, as I told you a little before, and shall repeat; namely, either that the Earth it self is also ingenerable, and incorruptible, as the Cœlestial bodies; or that the Cœlestial bodies are, like as the Elementary generable, alterable &c. or that this difference of motion hath nothing to do with Generation and Corruption. The discourse of Aristotle, and yours also contain many Propositions not to be lightly admitted, and the better to examine them, it will be convenient to reduce them to the most abstracted and distinct that can be possible; and excuse me Sagredus, if haply with some tediousness you hear me oft repeat the same things, and fancie that you see me reassume my argument in the publick circle of Disputations. You say Generation and Corruption are onely made where there are contraries; contraries are onely amongst simple natural bodies, moveable with contrary motions; contrary

motions are onely those which are made by a right line between contrary terms; and these are onely two, that is to say, from the medium, and towards the medium; and such motions belong to no other natural bodies, but to the Earth, the Fire, and the other two Elements: therefore Generation and Corruption is onely amongst the Elements. And because the third simple motion, namely, the circular about the medium, hath no contrary, (for that the other two are contraries, and one onely, hath but onely one contrary) therefore that natural body with which such motion agreeth, wants a contrary; and having no contrary is ingenerable and incorruptible, &c. Because where there is no contrariety, there is no generation or corruption, &c. But such motion agreeth onely with the Cœlestial bodies; therefore onely these are ingenerable,Its easier to prove the Earth to move, than that corruption is made by contraries. incorruptible, &c. And to begin, I think it a more easie thing, and sooner done to resolve, whether the Earth (a most vast Body, and for its vicinity to us, most tractable) moveth with a speedy motion, such as its revolution about its own axis in twenty four hours would be, than it is to understand and resolve, whether Generation and Corruption ariseth from contrariety, or else whether there be such things as generation, corruption and contrariety in nature. And if you, Simplicius, can tell me what method Nature observes in working, when she in a very short time begets an infinite number of flies from a little vapour of the Must of wine, and can shew me which are there the contraries you speak of, what it is that corrupteth, and how; I should think you would do more than I can; for I profess I cannot comprehend these things. Besides, I would very gladly understand how, and why these corruptive contraries are so favourable to Daws, and so cruel to Doves; so indulgent to Stags, and so hasty to Horses, that they do grant to them many more years of life, that is, of incorruptibility, than weeks to these. Peaches and Olives are planted in the same soil, exposed to the same heat and cold, to the same wind and rains, and, in a word, to the same contrarieties; and yet those decay in a short time, and these live many hundred years. Furthermore, I never was thorowly satisfied about this substantial

transmutation (still keeping within pure natural bounds) whereby a matter becometh so transform'd, that it should be necessarily said to be destroy'd, so that nothing remaineth of its first being, and that another body quite differing there-from should be thence produced;Bare transposition of parts may represent bodies under diverse aspects. and if I fancy to my self a body under one aspect, and by and by under another very different, I cannot think it impossible but that it may happen by a simple transposition of parts, without corrupting or ingendring any thing a-new; for we see such kinds of Metamorphoses dayly: so that to return to my purpose, I answer you, that inasmuch as you go about to perswade me that the Earth can not move circularly by way of corruptibility and generability, you have undertook a much harder task than I, that with arguments more difficult indeed, but no less concluding, will prove the contrary.

Sagr.Pardon me, Salviatus, if I interrupt your discourse, which, as it delights me much, for that I also am gravel'd with the same doubts; so I fear that you can never conclude the same, without altogether digressing from your chief design: therefore if it be permitted to proceed in our first argument, I should think that it were convenient to remit this question of generation and corruption to another distinct and single conference; as also, if it shall please you and Simplicius, we may do by other particular questions which may fall in the way of our discourse; which I will keep in my mind to propose, and exactly discuss them some other time. Now as for the present, since you say, that if Aristotle deny circular motion to the Earth in common with other bodies Cœlestial, it thence will follow, that the same which befalleth the Earth, as to its being generable, alterable, &c. will hold also of Heaven, let us enquire no further if there be such things in nature, as generation and corruption, or not; but let us return to enquire what the Globe of the Earth doth.

Simpl.I cannot suffer my ears to hear it question'd, whether generation and corruption be in rerum naturâ, it being a thing which we have continually before our eyes,By denying Principles in the Sciences, any Paradox may be maintained. and

whereof Aristotle hath written two whole Books. But if you go about to deny the Principles of Sciences, and question things most manifest, who knows not, but that you may prove what you will, and maintain any Paradox? And if you do not dayly see herbs, plants, animals to generate and corrupt, what is it that you do see? Also, do you not continually behold contrarieties contend together, and the Earth change into Water, the Water turn to Air, the Air into Fire, and again the Air to condense into Clouds, Rains, Hails and Storms?

Sagr.Yes, we see these things indeed, and therefore will grant you the discourse of Aristotle, as to this part of generation and corruption made by contraries; but if I shall conclude by virtue of the same propositions which are granted to Aristotle, that the Cœlestial bodies themselves are also generable and corruptible, aswell as the Elementary, what will you say then?

Simpl.I will say you have done that which is impossible to be done.

Sagr.Go to; tell me, Simplicius, are not these affections contrary to one another?

Simpl.Which?

Sagr.Why these; Alterable, unalterable; passible,*Or, Impatible. *impassible; generable, ingenerable; corruptible, incorruptible?

Simpl.They are most contrary.

Sagr.Well then, if this be true, and it be also granted, that Cœlestial Bodies are ingenerable and incorruptible; I prove that of necessity Cœlestial Bodies must be generable and corruptible.

Simpl.This must needs be a Sophism.

Sagr.Hear my Argument,Cœlestial Bodies are generable and corruptible, because they are ingenerable and incorruptible. and then censure and resolve it. Cœlestial Bodies, for that they are ingenerable and incorruptible, have in Nature their contraries, which are those Bodies that be generable and corruptible; but where there

is contrariety, there is also generation and corruption; therefore Cœlestial Bodies are generable and corruptible.

Simpl.Did I not say it could be no other than a Sophism? This is one of those forked Arguments called Soritæ:The forked Syllogism cal'd Σωρόιτης. like that of the Cretan, who said that all Cretans were lyars; but he as being a Cretan, had told a lye, in saying that the Cretans were lyars; it followed therefore, that the Cretans were no lyars, and consequently that he, as being a Cretan, had spoke truth: And yet in saying the Cretans were lyars, he had said true, and comprehending himself as a Cretan, he must consequently be a lyar. And thus in these kinds of Sophisms a man may dwell to eternity, and never come to any conclusion.

Sagr.You have hitherto censured it, it remaineth now that you answer it, shewing the fallacie.

Simpl.As to the resolving of it, and finding out its fallacie, do you not in the first place see a manifest contradiction in it? Cœlestial Bodies are ingenerable and incorruptible; Ergo, Cœlestial Bodies are generable and corruptible.Amongst Cœlestial Bodies there is no contrariety. And again, the contrariety is not betwixt the Cœlestial Bodies, but betwixt the Elements, which have the contrariety of the Motions, sursùm and deorsùm, and of levity and gravity; But the Heavens which move circularly, to which motion no other motion is contrary, want contrariety, and therefore they are incorruptible.

Sagr.Fair and softly, Simplicius; this contrariety whereby you say some simple Bodies become corruptible, resides it in the same Body which is corrupted, or else hath it relation to some other? I say, if, for example, humidity by which a piece of Earth is corrupted, resides it in the same Earth or in some other bodie, which must either be the Air or Water? I believe you will grant, that like as the Motions upwards and downwards, and gravity and levity, which you make the first contraries, cannot be in the same Subject, so neither can moist and dry, hot and cold: you must

therefore consequently acknowledg that when a bodie corrupteth, Contraries which are the causes of corruption, reside not in the same body that corrupteth.it is occasioned by some quality residing in another contrary to its own: therefore to make the Cœlestial Body become corruptible, it sufficeth that there are in Nature, bodies that have a contrariety to that Cœlestial body; and such are the Elements, if it be true that corruptibility be contrary to incorruptibility.

Simpl.This sufficeth not, Sir; The Elements alter and corrupt, because they are intermixed, and are joyn'd to one another, and so may exercise their contrariety;Cœlestial Bodies touch, but are not touched by the Elements. but Cœlestial bodies are separated from the Elements, by which they are not so much as toucht, though indeed they have an influence upon the Elements. It is requisite, if you will prove generation and corruption in Cœlestial bodies, that you shew, that there resides contrarieties between them.

Sagr.See how I will find those contrarieties between them. The first fountain from whence you derive the contrariety of the Elements, is the contrariety of their motions upwards and downwards: it therefore is necessary that those Principles be in like manner contraries to each other,Gravity & levity, varity and density, are contrary qualities. upon which those motions depend: and because that is moveable upwards by lightness, and this downwards by gravity, it is necessary that lightness and gravity are contrary to each other: no less are we to believe those other Principles to be contraries, which are the causes that this is heavy, and that light: but by your own confession, levity and gravity follow as consequents of rarity and density; therefore rarity and density shall be contraries:The stars infinitely surpass the substance of the rest of Heaven in density. the which conditions or affections are so amply found in Cœlestial bodies, that you esteem the stars to be onely more dense parts of their Heaven: and if this be so, it followeth that the density of the stars exceeds that of the rest of Heaven, by almost infinite degrees: which is manifest, in that Heaven is infinitely transparent, and the stars extremely opacous; and for that there are there

above no other qualities, but more and less density and rarity, which may be causes of the greater or less transparency. There being then such contrariety between the Cœlestial bodies, it is necessary that they also be generable and corruptible, in the same manner as the Elementary bodies are; or else that contrariety is not the cause of corruptibility,Rarity & density in Cœlestial bodies, is different from the rarity & density of the elements. &c.

Simpl.There is no necessity either of one or the other, for that density and rarity in Cœlestial bodies, are not contraries to each other, as in Elementary bodies; for that they depend not on the primary qualities, cold and heat, which are contraries; but on the more or less matter in proportion to quantity: now much and little, speak onely a relative opposition, that is, the least of oppositions, and which hath nothing to do with generation and corruption.

Sagr.Therefore affirming, that density and rarity, which amongst the Elements should be the cause of gravity and levity, which may be the causes of contrary motions sursum and deorsùm, on which, again, dependeth the contrarieties for generation and corruption; it sufficeth not that they be those densnesses and rarenesses which under the same quantity, or (if you will) mass contain much or little matter, but it is necessary that they be densnesses and rarenesses caused by the primary qualities, hot and cold, otherwise they would operate nothing at all: but if this be so,Aristotle defective in assigning the causes why the elements are generable & corruptible. Aristotle hath deceived us, for that he should have told it us at first, and so have left written that those simple bodies are generable and corruptible, that are moveable with simple motions upwards and downwards, dependent on levity and gravity, caused by rarity and density, made by much or little matter, by reason of heat and cold; and not to have staid at the simple motion sursum and deorsùm: for I assure you that to the making of bodies heavy or light, whereby they come to be moved with contrary motions, any kind of density and rarity sufficeth, whether it proceed from heat and cold, or what else you please; for heat and cold have nothing

to do in this affair: and you shall upon experiment find, that a red iron, which you must grant to have heat, weigheth as much, and moves in the same manner as when it is cold. But to overpass this also, how know you but that Cœlestial rarity and density depend on heat and cold?

Simpl.I know it, because those qualities are not amongst Cœlestial bodies, which are neither hot nor cold.

Salv.I see we are again going about to engulph our selves in a bottomless ocean, where there is no getting to shore; for this is a Navigation without Compass, Stars, or Rudder: so that it will follow either that we be forced to pass from Shelf to Shelf, or run on ground, or to sail continually in danger of being lost. Therefore, if according to your advice we shall proceed in our main design, we must of necessity for the present overpass this general consideration, whether direct motion be necessary in Nature, and agree with some bodies; and come to the particular demonstrations, observations and experiments; propounding in the first place all those that have been hitherto alledged by Aristotle, Ptolomey, and others, to prove the stability of the Earth, endeavouring in the next place to answer them: and producing in the last place, those, by which others may be perswaded, that the Earth is no less than the Moon, or any other Planet to be numbered amongst natural bodies that move circularly.

Sagr.I shall the more willingly incline to this, in that I am better satisfied with your Architectonical and general discourse, than with that of Aristotle, for yours convinceth me without the least scruple, and the other at every step crosseth my way with some block. And I see no reason why Simplicius should not be presently satisfied with the Argument you alledg, to prove that there can be no such thing in nature as a motion by a right line, if we do but presuppose that the parts of the Universe are disposed in an excellent constitution and perfect order.

Salv.Stay a little, good Sagredus, for just now a way comes into my mind, how I

may give Simplicius satisfaction, provided that he will not be so strictly wedded to every expression of Aristotle, as to hold it heresie to recede in any thing from him. Nor is there any question to be made, but that if we grant the excellent disposition and perfect order of the parts of the Universe, as to local scituation, that then there is no other but the circular motion, and rest; for as to the motion by a right line, I see not how it can be of use for any thing, but to reduce to their natural constitution, some integral bodies, that by some accident were remov'd and separated from their whole, as we said above.

Let us now consider the whole Terrestrial Globe, and enquire the best we can, whether it, and the other Mundane bodies are to conserve themselves in their perfect and natural disposition. It is necessary to say, either that it rests and keeps perpetually immoveable in its place; or else that continuing always in its place, it revolves in its self; or that it turneth about a Centre, moving by the circumference of a circle.Arist. & Ptolomey make the Terrestrial Globe immoveable. Of which accidents, both Aristotle and Ptolomey, and all their followers say, that it hath ever observed, and shall continually keep the first, that is, a perpetual rest in the same place.It is better to say, that the Terrestrial Globe naturally resteth, than that it moveth directly downwards. Now, why, I pray you, ought they not to have said, that its natural affection is to rest immoveable, rather than to make natural unto it the motion * downwards, with which motion it never did or shall move? And as to the motion by a right line, they must grant us that Nature maketh use of it to reduce the * The word is, all' ingiù, which the Latine version rendreth sursùm, which is quite contrary to the Authors sense. small parts of the Earth, Water, Air, Fire, and every other integral Mundane body to their Whole, when any of them by chance are separated, and so transported out of their proper place; if also haply, some circular motion might not be found to be more convenient to make this restitution. In my judgment, this primary position answers much better, even according to Aristotles own method, to all the other consequences, than to attribute the straight motion to be

an intrinsick and natural principle of the Elements. Which is manifest, for that if I aske the Peripatetick, if, being of opinion that Cœlestial bodies are incorruptibe and eternal, he believeth that the Terrestial Globe is not so, but corruptible and mortal, so that there shall come a time, when the Sun and Moon and other Stars, continuing their beings and operations, the Earth shall not be found in the World, but shall with the rest of the Elements be destroyed and annihilated, I am certain that he would answer me, no: therefore generation and corruption is in the parts and not in the whole;Right Motion with more reason attributed to the parts, than to the whole Elements. and in the parts very small and superficial, which are, as it were, incensible in comparison of the whole masse. And because Aristotle deduceth generation and corruption from the contrariety of streight motions, let us remit such motions to the parts, which onely change and decay, and to the whole Globe and Sphere of the Elements, let us ascribe either the circular motion, or a perpetual consistance in its proper place: the only affections apt for perpetuation, and maintaining of perfect order. This which is spoken of the Earth, may be said with the same reason of Fire, and of the greatest part of the Air; to which Elements,The Peripateticks improperly assign those motious to the Elements for Natural, with which they never were moved, and those for Preternatural with which they alwayes are moved. the Peripateticks are forced to ascribe for intrinsical and natural, a motion wherewith they were never yet moved, nor never shall be; and to call that motion preternatural to them, wherewith, if they move at all, they do and ever shall move. This I say, because they assign to the Air and Fire the motion upwards, wherewith those Elements were never moved, but only some parts of them, and those were so moved onely in order to the recovery of their perfect constitution, when they were out of their natural places; and on the contrary they call the circular motion preternatural to them, though they are thereby incessantly moved: forgeting, as it seemeth, what Aristotle oft inculcateth, that nothing violent can be permanent.

Simpl.To all these we have very pertinent answers,Sensible experiments to be

preferred to humane Arguments. which I for this time omit, that we may come to the more particular reasons, and sensible experiments, which ought in conclusion to be opposed, as Aristotle saith well, to whatever humane reason can present us with.

Sagr.What hath been spoken hitherto, serves to clear up unto us which of the two general discourses carrieth with it most of probability, I mean that of Aristotle, which would perswade us, that the sublunary bodies are by nature generable, and corruptible, &c. and therefore most different from the essence of Cœlestial bodies, which are impassible, ingenerable, incorruptible, &c. drawn from the diversity of simple motions; or else this of Salviatus, who supposing the integral parts of the World to be disposed in a perfect constitution, excludes by necessary consequence the right or straight motion of simple natural bodies, as being of no use in nature, and esteems the Earth it self also to be one of the Cœlestial bodies adorn'd with all the prerogatives that agree with them; which last discourse is hitherto much more likely, in my judgment, than that other. Therefore resolve, Simplicius, to produce all the particular reasons, experiments and observations, as well Natural as Astronomical, that may serve to perswade us that the Earth differeth from the Cœlestial bodies, is immoveable, and situated in the Centre of the World, and what ever else excludes its moving like to the Planets, as Jupiter or the Moon, &c. And Salviatus will be pleased to be so civil as to answer to them one by one.

Simpl.See here for a begining, two most convincing Arguments to demonstrate the Earth to be most different from the Cœlestial bodies. First, the bodies that are generable, corruptible, alterable, &c. are quite different from those that are ingenerable, incorruptible, unalterable, &c. But the Earth is generable, corruptible, alterable, &c. and the Cœlestial bodies ingenerable, incorruptible, unalterable, &c. Therefore the Earth is quite different from the Cœlestial bodies.

Sagr.By your first Argument you spread the Table with the same Viands, which but just now with much adoe were voided.

Simpl.Hold a little, Sir, and take the rest along with you, and then tell me if this be not different from what you had before. In the former, the Minor was proved à priori, & now you see it proved à posteriori: Judg then if it be the same. I prove the Minor, therefore (the Major being most manifest) by sensible experience, which shews us that in the Earth there are made continual generations, corruptions, alterations, &c. which neither our senses, nor the traditions or memories of our Ancestors, ever saw an instance of in Heaven; therefore Heaven is unalterable, &c. and the Earth alterable,Heaven immutable, because there never was any mutation seen in it. &c. and therefore different from Heaven. I take my second Argument from a principal and essential accident, and it is this. That body which is by its nature obscure and deprived of light,Bodies naturally lucid, are different from those which are by nature obscure. is divers from the luminous and shining bodies; but the Earth is obscure and void of light, and the Cœlestial bodies splendid, and full of light; Ergo, &c. Answer to these Arguments first, that we may not heap up too many, and then I will alledge others.

Salv.As to the first, the stresse whereof you lay upon experience, I desire that you would a little more distinctly produce me the alteration which you see made in the Earth, and not in Heaven; upon which you call the Earth alterable, and the Heavens not so.

Simpl.I see in the Earth, plants and animals continually generating and decaying; winds, rains, tempests, storms arising; and in a word, the aspect of the Earth to be perpetually metamorphosing; none of which mutations are to be discern'd in the Cœlestial bodies; the constitution and figuration of which is most punctually conformable to that they ever were time out of mind; without the generation of any thing that is new, or corruption of any thing that was old.

Salv.But if you content your self with these visible, or to say better, seen experiments, you must consequently account China and America Cœlestial bodies,

for doubtlesse you never be held in them these alterations which you see here in Italy, and that therefore according to your apprehension they are inalterable.

Simpl.Though I never did see these alterations sensibly in those places, the relations of them are not to be questioned; besides that, cum eadem sit ratio totius, & partium, those Countreys being a part of the Earth, as well as ours, they must of necessity be alterable as these are.

Salv.And why have you not, without being put to believe other mens relations, examined and observed those alterations with your own eyes?

Simpl.Because those places, besides that they are not exposed to our eyes, are so remote, that our sight cannot reach to comprehend therein such like mutations.

Salv.See now, how you have unawares discovered the fallacy of your Argument; for, if you say that the alterations that are seen on the Earth neer at hand, cannot, by reason of the too great distance, be seen in America, much lesse can you see them in the Moon, which is so many hundred times more remote: And if you believe the alterations in Mexico upon the report of those that come from thence, what intelligence have you from the Moon, to assure you that there is no such alterations in it? Therefore, from your not seeing any alterations in Heaven, whereas, if there were any such, you could not see them by reason of their too great distance, and from your not having intelligence thereof, in regard that it cannot be had, you ought not to argue, that there are no such alterations; howbeit, from the seeing and observing of them on Earth, you well argue that therein such there are.

Simpl.I will shew so great mutations that have befaln on the Earth; that if any such had happened in the Moon, they might very well have been observed here below.The Mediterranian Sea made by the separation of Abila and Calpen. We find in very antient records, that heretofore at the Streights of Gibraltar, the two great Mountains Abila, and Calpen, were continued together by certain other lesse Mountains, which there gave check to the Ocean: but those Hills, being by some

cause or other separated, and a way being opened for the Sea to break in, it made such an inundation, that it gave occasion to the calling of it since the Mid-land Sea: the greatness whereof considered, and the divers aspects the surfaces of the Water and Earth then made, had it been beheld afar off, there is no doubt but so great a change might have been discerned by one that was then in the Moon; as also to us inhabitants of the Earth, the like alterations would be perceived in the Moon; but we find not in antiquity, that ever there was such a thing seen; therefore we have no cause to say, that any of the Cœlestial bodies are alterable, &c.

Salv.That so great alterations have hapned in the Moon, I dare not say, but for all that, I am not yet certain but that such changes might occur; and because such a mutation could onely represent unto us some kind of variation between the more clear, and more obscure parts of the Moon, I know not whether we have had on Earth observant Selenographers, who have for any considerable number of years, instructed us with so exact Selenography, as that we should confidently conclude, that there hath no such change hapned in the face of the Moon; of the figuration of which I find no more particular description, than the saying of some, that it represents an humane face; of others, that it is like the muzle of a Lyon; and of others, that it is Cain with a bundle of thorns on his back: therefore, to say Heaven is unalterable, because that in the Moon, or other Cœlestial bodies, no such alterations are seen, as discover themselves on Earth, is a bad illation, and concludeth nothing.

Sagr.And there is another odd kind of scruple in this Argument of Simplicius, running in my mind, which I would gladly have answered; therefore I demand of him, whether the Earth before the Mediterranian inundation was generable and corruptible, or else began then so to be?

Simpl.It was doubtless generable and corruptible also before that time; but that was so vast a mutation, that it might have been observed as far as the Moon.

Sagr.Go to; if the Earth was generable and corruptible before that Inundation, why

may not the Moon be so likewise without such a change? Or why should that be necessary in the Moon, which importeth nothing on Earth?

Salv.It is a shrewd question: But I am doubtfull that Simplicius a little altereth the Text of Aristotle, and the other Peripateticks, who say, they hold the Heavens unalterable, for that they see therein no one star generate or corrupt, which is probably a less part of Heaven, than a City is of the Earth, and yet innumerable of these have been destroyed, so as that no mark of them hath remain'd.

Sagr.I verily believed otherwise, and conceited that Simplicius dissembled this exposition of the Text, that he might not charge his Master and Consectators, with a notion more absurd than the former. And what a folly it is to say the Cœlestial part is unalterable, because no stars do generate or corrupt therein? What then? hath any one seen a Terrestrial Globe corrupt, and another regenerate in its place? And yet is it not on all hands granted by Philosophers, that there are very few stars in Heaven less than the Earth,Its no leß impossible for a star to corrupt, than for the whole Terrestrial Globe. but very many that are much bigger? So that for a star in Heaven to corrupt, would be no less than if the whole Terrestrial Globe should be destroy'd. Therefore, if for the true proof of generation and corruption in the Universe, it be necessary that so vast bodies as a star, must corrupt and regenerate, you may satisfie your self and cease your opinion; for I assure you, that you shall never see the Terrestrial Globe or any other integral body of the World, to corrupt or decay so, that having been beheld by us for so many years past, they should so dissolve, as not to leave any footsteps of them.

Salv.But to give Simplicius yet fuller satisfaction, and to reclaim him,Aristotle would change his opinion, did he see the novelties of our age. if possible, from his error; I affirm, that we have in our age new accidents and observations, and such, that I question not in the least, but if Aristotle were now alive, they would make him change his opinion; which may be easily collected from the very manner of his

discoursing: For when he writeth that he esteemeth the Heavens inalterable, &c. because no new thing was seen to be begot therein, or any old to be dissolved, he seems implicitely to hint unto us, that when he should see any such accident, he would hold the contrary: and confront, as indeed it is meet, sensible experiments to natural reason: for had he not made any reckoning of the senses, he would not then from the not seeing of any sensible mutation, have argued immutability.

Simpl.Aristotle deduceth his principal Argument à priori, shewing the necessity of the inalterability of Heaven by natural, manifest and clear principles; and then stablisheth the same à posteriori, by sense, and the traditions of the antients.

Salv.This you speak of is the Method he hath observed in delivering his Doctrine, but I do not bethink it yet to be that wherewith he invented it; for I do believe for certain, that he first procured by help of the senses, such experiments and observations as he could,The certainty of the conclusion helpeth by a resolutive method to find the demonstration. to assure him as much as it was possible, of the conclusion, and that he afterwards sought out the means how to demonstrate it: For this is the usual course in demonstrative Sciences, and the reason thereof is, because when the conclusion is true, by help of resolutive Method, one may hit upon some proposition before demonstrated, or come to some principle known per se; but if the conclusion be false, a man may proceed in infinitum, and never meet with any truth already known; but very oft he shall meet with some impossibility or manifest absurdity. Pythagoras offered an Hecatomb for a Geometrical demonstration which he found. Nor need you question but that Pythagoras along time before he found the demonstration for which he offered the Hecatomb, had been certain, that the square of the side subtending the right angle in a rectangle triangle, was equal to the square of the other two sides: and the certainty of the conclusion conduced not a little to the investigating of the demonstration, understanding me alwayes to mean in demonstrative Sciences. But what ever was the method of Aristotle, and whether his arguing à priori preceded sense à posteriori, or the contrary; it sufficeth that the

same Aristotle preferreth (as hath been oft said) sensible experiments before all discourses; besides, as to the Arguments à priori their force hath been already examined. Now returning to my purposed matter, I say, that the things in our times discovered in the Heavens, are, and have been such, that they may give absolute satisfaction to all Philosophers; forasmuch as in the particular bodies, and in the universal expansion of Heaven, there have been, and are continually, seen just such accidents as we call generations and corruptions, being that excellent Astronomers have observed many Comets generated and dissolved in parts higher than the Lunar Orb, besides the two new Stars, Anno 1572,New stars discovered in Heaven. and Anno 1604, without contradiction much higher than all the Planets; and in the face of the Sun it self, by help of the Telescope,Spots generate and dissolve in the face of the Sun. certain dense and obscure substances, in semblance very like to the foggs about the Earth, are seen to be produced and dissolved; and many of these are so vast, that they far exceed not only the Mediterranian Streight, but all Affrica and Asia also.Solar spots are bigger than all Asia and Affrick. Now if Aristotle had seen these things, what think you he would have said, and done Simplicius?

Simpl.I know not what Aristotle would have done or said, that was the great Master of all the Sciences, but yet I know in part, what his Sectators do and say, and ought to do and say, unlesse they would deprive themselves of their guide, leader, and Prince in Philosophy. As to the Comets, are not those Modern Astronomers, who would make them Cœlestial, convinced by the * Astronomers confuted by Anti-Tycho* Anti-Tycho, yea, and overcome with their own weapons, I mean by way of Paralaxes and Calculations, every way tryed, concluding at the last in favour of Aristotle, that they are all Elementary? And this being overthrown, which was as it were their foundation, have these Novellists any thing more wherewith to maintain their assertion?

Salv.Hold a little, good Simplicius, this modern Author, what saith he to the new Stars, Anno 1572, and 1604, and to the Solar spots? for as to the Comets, I for my

own particular little care to make them generated under or above the Moon; nor did I ever put much stresse on the loquacity of Tycho; nor am I hard to believe that their matter is Elementary, and that they may elevate (sublimate) themselves at their pleasure, without meeting with any obstacle from the impenetrability of the Peripatetick Heaven, which I hold to be far more thin, yielding, and subtil than our Air; and as to the calculations of the Parallaxes, first, the uncertainty whether Comets are subject to such accidents, and next, the inconstancy of the observations, upon which the computations are made, make me equally suspect both those opinions:Anti-Tycho wresteth Astronomical observations to his own purpose. and the rather, for that I see him you call Anti-Tycho, sometimes stretch to his purpose, or else reject those observations which interfere with his design.

Simpl.As to the new Stars, Anti-Tycho extricates himself finely in three or four words; saying, That those modern new Stars are no certain parts of the Cœlestial bodies, and that the adversaries, if they will prove alteration and generation in those superior bodies, must shew some mutations that have been made in the Stars described so many ages past, of which there is no doubt but that they be Cœlestial bodies, which they can never be able to do: Next, as to those matters which some affirm, to generate and dissipate in the face of the Sun, he makes no mention thereof; wherefore I conclude, that he believed them fictious, or the illusions of the Tube, or at most, some petty effects caused by the Air, and in brief, any thing rather than matters Cœlestial.

Salv.But you, Simplicius, what answer could you give to the opposition of these importunate spots which are started up to disturb the Heavens, and more than that, the Peripatetick Philosophy? It cannot be but that you, who are so resolute a Champion of it, have found some reply or solution for the same, of which you ought not to deprive us.

Simpl.I have heard sundry opinions about this particular. One saith: "They are Stars

which in their proper Orbs,Sundry opinions touching the Solar spots. like as Venus and Mercury, revolve about the Sun, and in passing under it, represent themselves to us obscure; and for that they are many, they oft happen to aggregate their parts together, and afterwards seperate again. Others believe them to be äerial impressions; others, the illusions of the chrystals; and others, other things: But I incline to think, yea am verily perswaded, That they are an aggregate of many several opacous bodies, as it were casually concurrent among themselves. And therefore we often see, that in one of those spots one may number ten or more such small bodies, which are of irregular figures, and seem to us like flakes of snow, or flocks of wooll, or moaths flying: they vary fire amongst themselves, and one while sever, another while meet, and most of all beneath the Sun, about which, as about their Centre, they continually move. But yet, must we not therefore grant, that they are generated or dissolved, but that at sometimes they are hid behind the body of the Sun, and at other times, though remote from it, yet are they not seen for the vicinity of the immeasurable light of the Sun; in regard that in the eccentrick Orb of the Sun, there is constituted, as it were, an Onion, composed of many folds one within another, each of which, being * The Original saith [tempestata si muove] which the Latine Translation, (Mistaking Tempestata, a word in Heraldry, for Tempestato,) rendereth [incitata movetur] which signifieth a violent transportmeut, as in a storm, that of a Ship. * studded with certain small spots, doth move; and albeit their motion at first seemeth inconstant and irregular, yet neverthelesse, it is said at last, to be observed that the very same spots, as before, do within a determinate time return again." This seemeth to me the fittest answer that hath been found to assigne a reason of that same appearance, and withal to maintain the incorruptability and ingenerability of the Heavens; and if this doth not suffice; there wants not more elevated wits, which will give you other more convincing.

Salv.If this of which we dispute, were some point of Law, or other part of the Studies called Humanity,In natural Sciences, the art of Oratory is of no force.

wherein there is neither truth nor falshood, if we will give sufficient credit to the acutenesse of the wit, readinesse of answers, and the general practice of Writers, then he who most aboundeth in these, makes his reason more probable and plausible; but in Natural Sciences, the conclusions of which are true and necessary, and wherewith the judgment of men hath nothing to do, one is to be more cautious how he goeth about to maintain any thing that is false; for a man but of an ordinary wit, if it be his good fortune to be of the right side, may lay a thousand Demosthenes and a thousand Aristotles at his feet. Therefore reject those hopes and conceits, wherewith you flatter your self, that there can be any men so much more learned, read, and versed in Authors, than we, that in despite of nature, they should be able to make that become true, which is false. And seeing that of all the opinions that have been hitherto alledged touching the essence of these Solar spots, this instanced in by you, is in your judgment the truest, it followeth (if this be so) that all the rest are false; and to deliver you from this also, which doubtlesse is a most false Chimæra, over-passing infinite other improbabilities that are therein,An Argument that necessarily proveth the Solar spots to generate and dissolve. I shall propose against it onely two experiments; one is, that many of those spots are seen to arise in the midst of the Solar ring, and many likewise to dissolve and vanish at a great distance from the circumference of the Sun; a necessary Argument that they generate and dissolve; for if without generating or corrrupting, they should appear there by onely local motion, they would all be seen to enter,A conclusive demonstration, that the spots are contiguous to the body of the Sun. and pass out by extreme circumference. The other observation to such as are not situate in the lowest degree of ignorance in Perspective, by the mutation of the appearing figures, and by the apparent mutations of the velocity of motion is necessarily concluding, that the spots are contiguous to the body of the Sun, and that touching its superficies, they move either with it or upon it, and that they in no wise move in circles remote from the same.The motion of the spots towards the circumference of the Sun appears slow. The motion proves

it, which towards the circumference of the Solar Circle, appeareth very slow, and towards the midst, more swift; the figures of the spots confirmeth it,The figure of the spots appears narrow towards the circumference of the Suns discus, & why. which towards the circumference appear exceeding narrow in comparison of that which they seem to be in the parts nearer the middle; and this because in the midst they are seen in their full luster, and as they truly be; and towards the circumference by reason of the convexity of the globous superficies, they seem more compress'd: And both these diminutions of figure and motion, to such as know how to observe and calculate them exactly, precisely answer to that which should appear, the spots being contiguous to the Sun, and differ irreconcileably from a motion in circles remote, though but for smal intervalls from the body of the Sun; as hath been diffusely demonstrated by our* Under this word Friend, as also that of Academick, & Common Friend, Galilœus modestly conceals himself throughout these Dialogues. * Friend, in his Letters about the Solar spots, to Marcus Velserus. It may be gathered from the same mutation of figure, that none of them are stars, or other bodies of spherical figure; for that amongst all figures the sphere never appeareth compressed, nor can ever be represented but onely perfectly round; and thus in case any particular spot were a round body, as all the stars are held to be, the said roundness would as well appear in the midst of the Solar ring, as when the spot is near the extreme: whereas, its so great compression, and shewing its self so small towards the extreme, and contrariwise, spatious and large towards the middle, assureth us,The Solar spots are not spherical, but flat like thin plates. that these spots are flat plates of small thickness or depth, in comparison of their length and breadth. Lastly, whereas you say that the spots after their determinate periods are observed to return to their former aspect, believe it not, Simplicius, for he that told you so, will deceive you; and that I speak the truth, you may observe them to be hid in the face of the Sun far from the circumference; nor hath your Observator told you a word of that compression, which necessarily argueth them to be contiguous to the Sun. That

which he tells you of the return of the said spots, is nothing else but what is read in the forementioned Letters, namely, that some of them may sometimes so happen that are of so long a duration, that they cannot be dissipated by one sole conversion about the Sun, which is accomplished in less than a moneth.

Simpl.I, for my part, have not made either so long, or so exact observations, as to enable me to boast my self Master of the Quod est of this matter: but I will more accurately consider the same, and make tryal my self for my own satisfaction, whether I can reconcile that which experience shews us, with that which Aristotle teacheth us; for it's a certain Maxim, that two Truths cannot be contrary to one another.

Salv. If you would reconcile that which sense shewed you, with the solider Doctrines of Aristotle,One cannot (saith Aristotle) speak confidently of Heaven, by reason of its great distance. you will find no great difficulty in the undertaking; and that so it is, doth not Aristotle say, that one cannot treat confidently of the things of Heaven, by reason of their great remoteness?

Simpl.He expresly saith so.

Salv.And doth he not likewise affirm,Aristotle prefers sense before ratiocination. that we ought to prefer that which sense demonstrates, before all Arguments, though in appearance never so well grounded? and saith he not this without the least doubt or haesitation?

Simpl.He doth so.

Salv.Why then, the second of these propositions, which are both the doctrine of Aristotle,Its a doctrine more agreeing with Aristotle, to say the Heavens are alterable, than that which affirms them inalterable. that saith, that sense is to take place of Logick, is a doctrine much more solid and undoubted, than that other which holdeth the Heavens to be unalterable; and therefore you shall argue more Aristotelically, saying, the Heavens are alterable, for that so my sense telleth me,

than if you should say, the Heavens are ualterable, for that Logick so perswaded Aristotle.We may by help of the Telescope discourse better of cœlestial matters, than Aristot. himself. Furthermore, we may discourse of Cœlestial matters much better than Aristotle; because, he confessing the knowledg thereof to be difficult to him, by reason of their remoteness from the senses, he thereby acknowledgeth, that one to whom the senses can better represent the same, may philosophate upon them with more certainty. Now we by help of the Telescope, are brought thirty or forty times nearer to the Heavens, than ever Aristotle came; so that we may discover in them an hundred things, which he could not see, and amongst the rest, these spots in the Sun, which were to him absolutely invisible; therefore we may discourse of the Heavens and Sun, with more certainty than Aristolte.

Sagr.I see into the heart of Simplicius, and know that he is much moved at the strength of these so convincing Arguments; but on the other side, when he considereth the great authority which Aristotle hath won with all men, and remembreth the great number of famous Interpreters, which have made it their business to explain his sense; and seeth other Sciences, so necessary and profitable to the publick, to build a great part of their esteem and reputation on the credit of Aristotle he is much puzzled and perplexed:The Declamation of Simplicius. and methinks I hear him say, To whom then should we repair for the decision of our controversies, if Aristotle were removed from the chair? What other Author should we follow in the Schools, Academies and Studies? What Philosopher hath writ all the parts of Natural Philosophy, and that so methodically without omitting so much as one single conclusion? Shall we then overthrow that Fabrick under which so many passengers find shelter? Shall we destroy that Asylum, that Prytaneum, wherein so many Students meet with commodious harbour, where without exposing themselves to the injuries of the air, with the onely turning over of a few leaves, one may learn all the secrets of Nature? Shall we dismantle that fort in which we are safe from all hostile assaults? But I pitie him no more than I do that Gentleman who with

great expence of time and treasure, and the help of many hundred artists, erects a very sumptuous Pallace, and afterwards beholds it ready to fall, by reason of the bad foundation; but being extremely unwilling to see the Walls stript which are adorned with so many beautifull Pictures; or to suffer the columns to fall, that uphold the stately Galleries; or the gilded roofs, chimney-pieces, the freizes, the cornishes of marble, with so much cost erected, to be ruined; goeth about with girders, props, shoars, butterasses, to prevent their subversion.

Salv.But alass, Simplicius as yet fears no such fall, and I would undertake to secure him from that mischief at a far less charge.Peripatetick Philosophy unchangeable. There is no danger that so great a multitude of subtle and wise Philosophers, should suffer themselves to be Hector'd by one or two, who make a little blustering; nay, they will rather, without ever turning the points of their pens against them, by their silence onely render them the object of universal scorn and contempt. It is a fond conceit for any one to think to introduce new Philosophy, by reproving this or that Author: it will be first necessary to new-mold the brains of men, and make them apt to distinguish truth from falshood. A thing which onely God can do. But from one discourse to another whither are we stray'd? your memory must help to guide me into the way again.

Simpl.I remember very well where we left. We were upon the answer of Anti-Tycho, to the objections against the immutability of the Heavens, among which you inserted this of the Solar spots, not spoke of by him; and I believe you intended to examine his answer to the instance of the New Stars. Salv.Now I remember the rest, and to proceed, Methinks there are some things in the answer to Anti-Tycho, worthy of reprehension. And first, if the two New Stars, which he can do no less than place in the uppermost parts of the Heavens, and which were of a long duration, but finally vanished, give him no obstruction in maintaining the inalterability of Heaven, in that they were not certain parts thereof, nor mutations made in the antient Stars, why doth he set himself so vigorously and earnestly against the Comets, to

banish them by all ways from the Cœlestial Regions? Was it not enough that he could say of them the same which he spoke of the New stars? to wit, that in regard they were no certain parts of Heaven, nor mutations made in any of the Stars, they could no wise prejudice either Heaven, or the Doctrine of Aristotle? Secondly, I am not very well satisfied of his meaning; when he saith that the alterations that should be granted to be made in the Stars, would be destructive to the prerogative of Heaven; namely, its incorruptibility, &c. and this, because the Stars are Cœlestial substances, as is manifest by the consent of every one; and yet is nothing troubled that the same alterations should be made * Extra Stellas.* without the Stars in the rest of the Cœlestial expansion. Doth he think that Heaven is no Cœlestial substance? I, for my part, did believe that the Stars were called Cœlestial bodies, by reason that they were in Heaven, or for that they were made of the substance of Heaven; and yet I thought that Heaven was more Cœlestial than they; in like sort, as nothing can be said to be more Terrestrial, or more fiery than the Earth or Fire themselves. And again, in that he never made any mention of the Solar spots, which have been evidently demonstrated to be produced, and dissolved, and to be neer the Sun, and to turn either with, or about the same, I have reason to think that this Author probably did write more for others pleasure, than for his own satisfaction; and this I affirm, forasmuch as he having shewn himself to be skilful in the Mathematicks, it is impossible but that he should have been convinced by Demonstrations, that those substances are of necessity contiguous with the body of the Sun, and are so great generations and corruptions, that none comparable to them, ever happen in the Earth: And if such, so many, and so frequent be made in the very Globe of the Sun, which may with reason be held one of the noblest parts of Heaven, what should make us think that others may not happen in the other Orbs.

Sagr.I cannot without great admiration,Generability and alteration is a greater perfection in the Worlds bodies than the contrary qualities. nay more, denial of my understanding, hear it to be attributed to natural bodies, for a great honour and

perfection that they are * Impatible.* impassible, immutable, inalterable, &c. And on the contrary, to hear it to be esteemed a great imperfection to be alterable, generable, mutable, &c.The Earth very noble, by reason of the many mutations made therein. It is my opinion that the Earth is very noble and admirable, by reason of so many and so different alterations, mutations, generations, &c. which are incessantly made therein; and if without being subject to any alteration, it had been all one vast heap of sand, or a masse of Jasper, or that in the time of the Deluge, the waters freezing which covered it, it had continued an immense Globe of Christal,The Earth unprofitable and full of idlenesse, its alterations taken away wherein nothing had ever grown, altered, or changed, I should have esteemed it a lump of no benefit to the World, full of idlenesse, and in a word superfluous, and as if it had never been in nature; and should make the same difference in it, as between a living and dead creature: The like I say of the Moon, Jupiter, and all the other Globes of the World. But the more I dive into the consideration of the vanity of popular discourses, the more empty and simple I find them. And what greater folly can there be imagined, than to call Jems, Silver and Gold pretious; and Earth and dirt vile?The Earth more noble than Gold and Jewels. For do not these persons consider, that if there should be as great a scarcity of Earth, as there is of Jewels and pretious metals, there would be no Prince, but would gladly give a heap of Diamonds and Rubies, and many Wedges of Gold, to purchase onely so much Earth as should suffice to plant a Gessemine in a little pot, or to set therein a China Orange, that he might see it sprout, grow up, and bring forth so goodly leaves, so odiriferous flowers,Scarcity and plenty enhanse and debase the price of things. and so delicate fruit? It is therefore scarcity and plenty that make things esteemed and contemned by the vulgar; who will say that same is a most beautiful Diamond, for that it resembleth a cleer water, and yet will not part with it for ten Tun of water:Incorruptibility esteemed by the vulgar out of their fear of death. These men that so extol incorruptibility, inalterability, &c. speak thus I believe out of the great

desire they have to live long, and for fear of death; not considering, that if men had been immortal, they should have had nothing to do in the World.The disparagers of corruptibility deserve to be turned into Statua's. These deserve to meet with a Medusa's head, that would transform them into Statues of Dimond and Jasper, that so they might become more perfect than they are.

Salv.And it may be such a Metamorphosis would not be altogether unprofitable to them; for I am of opinion that it is better not to discourse at all, than to argue erroniously.

Simpl.There is not the least question to be made, but that the Earth is much more perfect, being as it is alterable, mutable, &c. than if it had been a masse of stone; yea although it were one entire Diamond,The Cœlestial bodies designed to serve the Earth, need no more but motion and light. most hard and impassile. But look how much these qualifications enoble the Earth, they render the Heavenly bodies again on the other side so much the more imperfect, in which, such conditions would be superfluous; in regard that the Cœlestial bodies, namely, the Sun, Moon, and the other Stars, which are ordained for no other use but to serve the Earth, need no other qualities for attaining of that end, save onely those of light and motion.

Sagr.How? Will you affirm that nature hath produced and designed so many vast perfect and noble Cœlestial bodies, impassible, immortal, and divine, to no other use but to serve the passible, frail, and mortal Earth? to serve that which you call the drosse of the World, and sink of all uncleannesse? To what purpose were the Cœlestial bodies made immortal, &c. to serve a frail, &c. Take away this subserviency to the Earth, and the innumerable multitude of Cœlestial bodies become wholly unuseful, Celestial bodies want an interchangeable operation upon each other.and superfluous, since they neither have nor can have any mutual operation betwixt themselves; because they are all unalterable, immutable, impassible: For if, for Example, the Moon be impassible, what influence can the Sun

or any other Star have upon her? it would doubtlesse have far lesse effect upon her, than that of one who would with his looks or imagination, lignifie a piece of Gold. Moreover, it seemeth to me, that whilst the Cœlestial bodies concurre to the generation and alteration of the Earth, they themselves are also of necessity alterable; for otherwise I cannot understand how the application of the Sun or Moon to the Earth, to effect production, should be any other than to lay a marble Statue by a Womans side, and from that conjunction to expect children.

Simpl.Corruptibility,Alterability, &c. are not in the whole Terrestrial Globe, but in some of its parts. alteration, mutation, &c. are not in the whole Terrestrial Globe, which as to its whole, is no lesse eternal than the Sun or Moon, but it is generable and corruptible as to its external parts; but yet it is also true that likewise in them generation and corruption are perpetual, and as such require the heavenly eternal operations; and therefore it is necessary that the Cœlestial bodies be eternal.

Sagr.All this is right; but if the corruptibility of the superficial parts of the Earth be nowise prejudicial to the eternity of its whole Globe, yea, if their being generable, corruptible, alterable, &c. gain them great ornament and perfection; why cannot,Cœlestial bodies alterable in their outward parts. and ought not you to admit alteration, generation, &c. likewise in the external parts of the Cœlestial Globes, adding to them ornament, without taking from them perfection, or bereaving them of action; yea rather encreasing their effects, by granting not onely that they all operate on the Earth, but that they mutually operate upon each other, and the Earth also upon them all?

Simpl.This cannot be, because the generations, mutations, &c. which we should suppose v. g. in the Moon; would be vain and uselesse, & natura nihil frustra facit.

Sagr.And why should they be vain and uselesse?

Simpl.Because we cleerly see,The generations & mutations happening in the Earth, are all for the good of Man. and feel with our hands, that all generations,

corruptions, &c. made in the Earth, are all either mediately or immediately directed to the use, convenience, and benefit of man; for the use of man are horses brought forth, for the feeding of horses, the Earth produceth grasse, and the Clouds water it; for the use and nourishment of man, herbs, corn, fruits, beasts, birds, fishes, are brought forth; and in sum, if we should one by one dilligently examine and resolve all these things, we should find the end to which they are all directed, to be the necessity, use, convenience, and delight of man. Now of what use could the generations which we suppose to be made in the Moon or other Planets, ever be to mankind? unlesse you should say that there were also men in the Moon, that might enjoy the benefit thereof; a conceit either fabulous or impious.

Sagr.That in the Moon or other Planets,The Moon hath no generatings of things, like as we have, nor is it inhabited by men. there are generated either herbs, or plants, or animals, like to ours, or that there are rains, winds, or thunders there, as about the Earth, I neither know, nor believe, and much lesse, that it is inhabited by men: but yet I understand not, because there are not generated things like to ours, that therefore it necessarily followeth, that no alteration is wrought therein, or that there may not be other things that change,In the Moon may be a generation of things different from ours. generate, and dissolve, which are not onely different from ours, but exceedingly beyond our imagination, and in a word, not to be thought of by us. And if, as I am certain, that one born and brought up in a spatious Forrest, amongst beasts and birds, and that hath no knowledg at all of the Element of Water,He that had not heard of the Element of Water, could never fancy to himself Ships and Fishes. could never come to imagine another World to be in Nature, different from the Eatth, full of living creatures, which without legs or wings swiftly move, and not upon the surface onely, as beasts do upon the Earth, but in the very bowels thereof; and not onely move, but also stay themselves and cease to move at their pleasure, which birds cannot do in the air; and that moreover men live therein, and build Palaces and Cities, and have so great convenience in travailing, that without the least

trouble, they can go with their Family, House, and whole Cities, to places far remote, like as I say, I am certain, such a person, though of never so piercing an imagination, could never fancy to himself Fishes, the Ocean, Ships, Fleets, Armado's at Sea; thus, and much more easily, may it happn, that in the Moon, remote from us by so great a space, and of a substance perchance very different from the Earth, there may be matters, and operations, not only wide off, but altogether beyond all our imaginations, as being such as have no resemblance to ours, and therefore wholly inexcogitable, in regard, that what we imagine to our selves, must necessarily be either a thing already seen, or a composition of things, or parts of things seen at another time; for such are the Sphinxes, Sirenes, Chimaera's, Centaurs, &c.

Salv.I have very often let my fancy ruminate upon these speculations, and in the end, have thought that I had found some things that neither are nor can be in the Moon; but yet I have not found therein any of those which I believe are, and may be there, save onely in a very general acceptation, namely, things that adorn it by operating, moving and living; and perhaps in a way very different from ours;There may be substances in the Moon very different from ours. beholding and admiring the greatness and beauty of the World, and of its Maker and Ruler, and with continual Encomiums singing his prayses; and in summe (which is that which I intend) doing what sacred Writers so frequently affirm, to wit, all the creatures making it their perpetual imployment to laud God.

Sagr.These are the things, which speaking in general terms, may be there; but I would gladly hear you instance in such as you believe neither are nor can be there; which perchance may be more particularly named.

Salv.Take notice Sagredus that this will be the third time that we have unawares by running from one thing to another, lost our principal subject; and if we continue these digressions, it will be long ere we come to a conclusion of our discourse;

therefore I should judg it better to remit this, as also such other points, to be decided on a particular occasion.

Sagr.Since we are now got into the Moon, if you please, let us dispatch such things as concern her, that so we be not forced to such another tedious journey.

Salv.It shall be as you would have it. And to begin with things more general, I believe that the Lunar Globe is far different from the Terrestrial, though in some things they agree. I will recount first their resemblances, and next their differences. The Moon is manifestly like to the Earth in figure,The First resemblance between the Moon and Earth; which is that of figure; is proved by the manner of being illuminated by the Sun. which undoubtedly is spherical, as may be necessarily concluded from the aspect of its surface, which is perfectly Orbicular, and the manner of its receiving the light of the Sun, from which, if its surface were flat, it would come to be all in one and the same time illuminated, and likewise again in another instant of time obscured, and not those parts first, which are situate towards the Sun, and the rest successively, so that in its opposition, and not till then, its whole apparent circumference is enlightned; which would happen quite contrary, if the visible surface were concave; namely, the illumination would begin from the parts opposite or averse to the Sun.The Second conformity is the Moons being opacous as the Earth. Secondly she is as the Earth, in her self obscure and opacous, by which opacity it is enabled to receive, and reflect the light of the Sun;Thirdly, The matter of the Moon is dense and montanous as the Earth. which were it not so, it could not do. Thirdly, I hold its matter to be most dense and solid as the Earth is, which I clearly argue from the unevenness of its superficies in most places, by means of the many eminencies and cavities discovered therein by help of the Telescope: of which eminencies there are many all over it, directly resembling our most sharp and craggy mountains, of which you shall there perceive some extend and run in ledges of an hundred miles long; others are contracted into rounder forms; and there are also many craggy, solitary, steep and cliffy rocks. But that of which

there are frequentest appearances, are certain Banks (I use this word, because I cannot thing of another that better expresseth them) pretty high raised, which environ and inclose fields of several bignesses, and from sundry figures, but for the most part circular; many of which have in the midst a mount raised pretty high, and some few are replenished with a matter somewhat obscure, to wit, like to the great spots discerned by the bare eye, and these are of the greatest magnitude; the number moreover of those that are lesser and lesser is very great, and yet almost all circular. Fourthly,Fourthly, The Moon is distinguished into two different parts for clarity and obscurity, as the Terrestrial Globe into Sea and Land. like as the surface of our Globe is distinguished into two principal parts, namely, into the Terrestrial and Aquatick: so in the Lunar surface we discern a great distinction of some great fields more resplendant, and some less: whose aspect makes me believe, that that of the Earth would seem very like it, The surface of the Sea would shew at a distance more obscure than that of the Earth.beheld by any one from the Moon, or any other the like distance, to be illuminated by the Sun: and the surface of the sea would appear more obscure, and that of the Earth more bright. Fifthly, like as we from the Earth behold the Moon, one while all illuminated, another while half;Fiftly, Mutation of figures in the Earth, like to those of the Moon, and made with the same periods. sometimes more, sometimes less; sometimes horned, sometimes wholly invisibly; namely, when its just under the Sun beams; so that the parts which look towards the Earth are dark: Thus in every respect, one standing in the Moon would see the illumination of the Earths surface by the Sun, with the same periods to an hair, and under the same changes of figures. Sixtly,———

Sagr.Stay a little, Salviatus; That the illumination of the Earth, as to the several figures, would represent it self to a person placed in the Moon, like in all things to that which we discover in the Moon, I understand very well, but yet I cannot conceive how it shall appear to be done in the same period; seeing that that which the Suns illumination doth in the Lunar superficies in a month, it doth in the

Terrestrial in twenty four hours.

Salv.Its true, the effect of the Sun about the illuminating these two bodies, and replenishing with its splendor their whole surfaces, is dispatch'd in the Earth in a Natural day, and in the Moon in a Month; but the variation of the figures in which the illuminated parts of the Terrestrial superficies appear beheld from the Moon, depends not on this alone, but on the divers aspects which the Moon is still changing with the Sun; so that, if for instance, the Moon punctually followed the motion of the Sun, and stood, for example, always in a direct line between it and the Earth, in that aspect which we call Conjunction, it looking always to the same Hemisphere of the Earth which the Sun looks unto, she would behold the same all light: as on the contrary, if it should always stay in Opposition to the Sun, it would never behold the Earth, of which the dark part would be continually turn'd towards the Moon, and therefore invisible. But when the Moon is in Quadrature of the Sun, that half of the Terrestrial Hemisphere exposed to the sight of the Moon which is towards the Sun, is luminous; and the other towards the contrary is obscure: and therefore the illuminated part of the Earth would represent it self to the Moon in a semi-circular figure.

Sagr.I clearly perceive all this, and understand very well, that the Moon departing from its Opposition to the Sun, where it saw no part of the illumination of the Terrestrial superficies, and approaching day by day nearer the Sun, she begins by little and little to discover some part of the face of the illuminated Earth; and that which appeareth of it shall resemble a thin sickle, in regard the figure of the Earth is round: and the Moon thus acquiring by its motion day by day greater proximity to the Sun, successively discovers more and more of the Terrestrial Hemisphere enlightned, so that at the Quadrature there is just half of it visible, insomuch that we may see the other part of her: continuing next to proceed towards the Conjunction, it successively discovers more and more of its surface to be illuminated, and in fine, at the time of Conjunction seeth the whole Hemisphere enlightned. And in short, I very

well conceive, that what befalls the Inhabitants of the Earth, in beholding the changes of the Moon, would happen to him that from the Moon should observe the Earth; but in a contrary order, namely, that when the Moon is to us at her full, and in Opposition to the Sun, then the Earth would be in Conjunction with the Sun, and wholly obscure and invisible; on the contrary, that position which is to us a Conjunction of the Moon with the Sun, and for that cause a Moon silent and unseen, would be there an Opposition of the Earth to the Sun, and, to so speak, Full Earth, to wit, all enlightned. And lastly, look what part of the Lunar surface appears to us from time to time illuminated, so much of the Earth in the same time shall you behold from the Moon to be obscured: and look how much of the Moon is to us deprived of light, so much of the Earth is to the Moon illuminated. In one thing yet these mutual operations in my judgment seem to differ, and it is, that it being supposed, and not granted, that some one being placed in the Moon to observe the Earth, he would every day see the whole Terrestrial superficies, by means of the Moons going about the Earth in twenty four or twenty five hours; but we never see but half of the Moon, since it revolves not in it self, as it must do to be seen in every part of it.

Salv.So that this, befals not contrarily, namely, that her revolving in her self, is the cause that we see not the other half of her, for so it would be necessary it should be, if she had the Epicycle. But what other difference have you behind, to exchange for this which you have named?

Sagr.Let me see; Well for the present I cannot think of any other.

Salv.And what if the Earth (as you have well noted) seeth no more than halfAll the Earth seeth half onely of the Moon, & the half onely of the Moon seeth all the Earth. the Moon, whereas from the Moon one may see all the Earth; and on the contrary, all the Earth seeth the Moon, and but onely half of it seeth the Earth? For the inhabitants, to so speak, of the superior Hemisphere of the Moon, which is to us

invisible, are deprived of the sight of the Earth: and these haply are the Anticthones. But here I remember a particular accident, newly observed by our Academian,From the Earth we see more than half the Lunar Globe. in the Moon, from whch are gathered two necessary consequences; one is, that we see somewhat more than half of the Moon; and the other is, that the motion of the Moon hath exact concentricity with the Earth: and thus he finds the Phœnomenonand observation. When the Moon hath a correspondence and natural sympathy with the Earth, towards which it hath its aspect in such a determinate part, it is necessary that the right line which conjoyns their centers, do passe ever by the same point of the Moons superficies; so that, who so shall from the center of the Earth behold the same, shall alwayes see the same Discus or Face of the Moon punctually determined by one and the same circumference; But if a man be placed upon the Terrestrial surface, the ray which from his eye passeth to the centre of the Lunar Globe, will not pass by the same point of its superficies, by which the line passeth that is drawn from the centre of the Earth to that of the Moon, save onely when it is vertical to him: but the Moon being placed in the East, or in the West, the point of incidence of the visual ray, is higher than that of the line which conjoyns the centres; and therefore the observer may discern some part of the Lunar Hemisphere towards the upper circumference, and alike part of the other is invisible: they are discernable and undiscernable, in respect of the Hemisphere beheld from the true centre of the Earth: and because the part of the Moons circumference, which is superiour in its rising, is nethermost in its setting; therefore the difference of the said superiour and inferiour our parts must needs be very observable; certain spots and other notable things in those parts, being one while discernable, and another while not. A like variation may also be observed towards the North and South extremities of the same Discus (or Surface) according as the Moons position is in its greatest North or South Latitude; For, if it be North, some of its parts towards the North are hid, and some of those parts towards the South are discovered, and so on the contrary. Now that these consequences are

really true,Two spots in the Moon, by which it is perceived that she hath respect to the centre of the Earth in her motion. is verified by the Telescope, for there be in the Moon two remarkable spots, one of which, when the Moon is in the meridian, is situate to the Northwest, and the other is almost diametrically opposite unto it; and the first of these is visible even without the Telescope; but the other is not. That towards the Northwest is a reasonable great spot of oval figure, separated from the other great ones; the opposite one is lesse, and also severed from the biggest, and situate in a very cleer field; in both these we may manifestly discern the foresaid variations, and see them one after another; now neer the edge or limb of the Lunar Discus, and anon remote, with so great difference that the distance betwixt the Northwest and the circumference of the Discus is more than twice as great at one time, as at the other; and as to the second spot (because it is neerer to the circumference) such mutation importeth more, than twice so much in the former. Hence its manifest, that the Moon, as if it were drawn by a magnetick vertue, constantly beholds the Terrestrial Globe with one and the same aspect, never deviating from the same.

Sagr.Oh! when will there be an end put to the new observations and discoveries of this admirable Instrument?

Salv.If this succeed according to the progresse of other great inventions, it is to be hoped, that in processe of time, one may arrive to the sight of things, to us at present not to be imagined. But returning to our first discourse,Sixthly, The Earth and Moon interchangeably do illuminate. I say for the sixth resemblance betwixt the Moon and Earth, that as the Moon for a great part of time, supplies the want of the Suns light, and makes the nights, by the reflection of its own, reasonable clear; so the Earth, in recompence, affordeth it when it stands in most need, by reflecting the Solar rayes, a very cleer illumination, and so much, in my opinion, greater than that which cometh from her to us, by how much the superficies of the Earth is greater than that of the Moon.

Sagr.Hold there, Salviatus hold there, and permit me the pleasure of relating to you, how at this first hint I have penetrated the cause of an accident, which I have a thousand times thought upon,Light reflected from the Earth into the Moon. but could never find out. You would say, that the imperfect light which is seen in the Moon, especially when it is horned, comes from the reflection of the light of the Sun on the Superficies of the Earth and Sea; and that light is more clear, by how much the horns are lesse, for then the luminous part of the Earth, beheld by the Moon, is greater, according to that which was a little before proved; to wit, that the luminous part of the Earth, exposed to the Moon, is alway as great as the obscure part of the Moon, that is visible to the Earth; whereupon, at such time as the Moon is sharp-forked, and consequently its tenebrous part great, great also is the illuminated part of the Earth beheld from the Moon, and its reflection of light so much the more potent.

Salv.This is exactly the same with what I was about to say. In a word, it is a great pleasure to speak with persons judicious and apprehensive, and the rather to me, for that whilest others converse and discourse touching Axiomatical truths, I have many times creeping into my brain such arduous Paradoxes, that though I have a thousand times rehearsed this which you at the very first, have of your self apprehended, yet could I never beat it into mens brains.

Simpl.If you mean by your not being able to perswade them to it, that you could not make them understand the same, I much wonder thereat, and am very confident that if they did not understand it by your demonstration (your way of expression, being, in my judgment, very plain) they would very hardly have apprehended it upon the explication of any other man; but if you mean you have not perswaded them, so as to make them believe it, I wonder not, in the least, at this; for I confesse my self to be one of those who understand your discourses, but am not satisfied therewith; for there are in this, and some of the other six congruities, or resemblances, many difficulties, which I shall instance in, when you have gone through them all.

Salv.The desire I have to find out any truth, in the acquist whereof the objections of intelligent persons (such as your self) may much assist me, will cause me to be very brief in dispatching that which remains.Seventhly, The Earth and Moon do mutually eclipse. For a seventh conformity, take their reciprocal responsion as well to injuries, as favours; whereby the Moon, which very often in the height of its illumination, by the interposure of the Earth betwixt it and the Sun, is deprived of light, and eclipsed, doth by way of revenge, in like manner, interpose it self between the Earth and the Sun, and with its shadow obscureth the Earth; and although the revenge be not answerable to the injury, for that the Moon often continueth, and that for a reasonable long time, wholly immersed in the Earths shadow, but never was the Earth wholly, nor for any long time, eclipsed by the Moon; yet, neverthelesse, having respect to the smalnesse of the body of this, in comparision to the magnitude of the other, it cannot be denied but that the will and as it were valour of this, is very great. Thus much for their congruities or resemblances. It should next follow that we discourse touching their disparity; but because Simplicius will favour us with his objections against the former, its necessary that we hear and examine them, before we proceed any farther.

Sagr.And the rather, because it is to be supposed that Simplicius will not any wayes oppose the disparities, and incongruities betwixt the Earth and Moon, since that he accounts their substances extremely different.

Simpl.Amongst the resemblances by you recited, in the parallel you make betwixt the Earth and Moon, I find that I can admit none confidently save onely the first, and two others; I grant the first, namely, the spherical figure; howbeit, even in this there is some kind of difference, for that I hold that of the Moon to be very smooth and even, as a looking-glasse, whereas, we find and feel this of the Earth to be extraordinary montuous and rugged; but this belonging to the inequality of superficies, it shall be anon considered, in another of those Resemblances by you alledged; I shall therefore reserve what I have to say thereof, till I come to the

consideration of that. Of what you affirm next, that the Moon seemeth, as you say in your second Resemblance, opacous and obscure in its self, like the Earth; I admit not any more than the first attribute of opacity, of which the Eclipses of the Sun assure me. For were the Moon transparent, the air in the total obscuration of the Sun, would not become so duskish, as at such a time it is, but by means of the transparency of the body of the Moon, a refracted light would passe through it, as we see it doth through the thickest clouds. But as to the obscurity, I believe not that the Moon is wholly deprived of light, as the Earth; nay, that clarity which is seen in the remainder ot its Discus, over and the above the small crescent enlightened by the Sun, I repute to be its proper and natural light, and not a reflection of the Earth,The second clarity of the Moon esteemed to be its native light. which I esteem unable, by reason of its asperity (cragginesse) and obscurity, to reflect the raies of the Sun. In the third Parallel I assent unto you in one part,The Earth unable to reflect the Suns raies. and dissent in another: I agree in judging the body of the Moon to be most solid and hard, like the Earth, yea much more; for if from Aristotle we receive that the Heavens are impenetrable,The substance of the Heavens impenetrable, according to Aristotle. and the Stars the most dense parts of Heaven, it must necessarily follow, that they are most solid and most impenetrable.

Sagr.What excellent matter would the Heavens afford us for to make Pallaces of, if we could procure a substance so hard and so transparent? Salv.Rather how improper, for being by its transparence, wholly invisible, a man would not be able without stumbling at the thresholds, and breaking his head against the Walls, to pass from room to room.

Sagr.This danger would not befall him,The substance of Heaven intangible. if it be true, as some Peripateticks say, that it is intangible: and if one cannot touch it, much less can it hurt him.

Salv.This would not serve the turn, for though the matter of the Heavens cannot be

touch, as wanting tangible qualities: yet may it easily touch the elementary bodies; and to offend us it is as sufficient that it strike us, nay worse, than if we should strike it. But let us leave these Pallaces, or, to say better, these Castles in the air, and not interrupt Simplicius.

Simpl.The question which you have so casually started, is one of the most difficulty that is disputed in Philosophy; and I have on that subject most excellent conceits of a very learned Doctor of Padoua, but it is not now time to enter upon them. Therefore returning to our purpose, I say that the Moon, in my opinion, is much more solid than the Earth, but do not infer the same, as you do,The superficies of the Moon more sleek than any Looking-glaß. from the cragginess and montuousity of its superficies; but rather from the contrary, namely, from its aptitude to receive (as we see it experimented in the hardest stones) a polish and lustre exceeding that of the smoothest glass, for such necessarily must its superficies be, to render it apt to make so lively reflection of the Suns rays. And for those appearances which you mention, of Mountains, Cliffs, Hills, Valleys, &c. they are all illusions: and I have been present at certain publick disputes, where I have heard it strongly maintained against these introducers of novelties,The eminencies and cavities in the Moon are illusions of its opacous and perspicuous parts. that such appearances proceed from nothing else, but from the unequal distribution of the opacous and perspicuous parts, of which the Moon is inwardly and outwardly composed: as we see it often fall out in chrystal, amber, and many other precious stones of perfect lustre; in which by reason of the opacity of some parts, and the transparency of others, there doth appear several concavities and prominencies. In the fourth resemblance, I grant, that the superficies of Terrestrial Globe beheld from afar, would make two different appearances, namely, one more clear, the other more dark; but I believe that such diversity would succeed quite contrary to what you say; that is, I hold that the surface of the water would appear lucid, because that it is smooth and transparent; and that of the Earth would appear obscure, by reason of its opacity and scabrosity,

ill accommodated for reflecting the light of the Sun. Concerning the fifth comparison, I grant it wholly, and am able, in case the Earth did shine as the Moon, to show the same to any one that should from thence above behold it, represented by figures answerable to those which we see in the Moon: I comprehend also, how the period of its illumination and variation of figure, would be monthly, albeit the Sun revolves round about it in twenty four hours: and lastly, I do not scruple to admit, that the half onely of the Moon seeth all the Earth, and that all the Earth seeth but onely half of the Moon. For what remains, I repute it most false, that the Moon can receive light from the Earth, which is most obscure, opacous, and utterly unapt to reflect the Suns light, as the Moon doth reflect it to us: and as I have said, I hold that that light which we see in the remainder of the Moons face (the splendid crescents subducted) by the illumination, is the proper and natural light of the Moon, and no easie matter would induce me to believe otherwise. The seventh, touching the mutual Eclipses, may be also admitted; howbeit that is wont to be called the eclipse of the Sun, which you are pleased to phrase the eclipse of the Earth. And this is what I have at this time to say in opposition to your seven congruities or resemblances, to which objections, if you are minded to make any reply, I shall willingly hear you.

Salv.If I have well apprehended what you have answered, it seems to me, that there still remains in controversie between us, certain conditions, which I made common betwixt the Moon & Earth, and they are these; You esteem the Moon to be smooth and polisht, as a Looking-glass, and as such, able to reflect the Suns light; and contrarily, the Earth, by reason of its montuosity, unable to make such reflection: You yield the Moon to be solid and hard, and that you argue from its being smooth and polite, and not from its being montuous; and for its appearing montuous, you assign as the cause, that it consists of parts more and less opacous and perspicuous. And lastly, you esteem that secondary light, to be proper to the Moon, and not reflected from the Earth; howbeit you seem not to deny the sea, as being of a smooth surface, some kind of reflection. As to the convincing you of that error, that the

reflection of the Moon is made, as it were, like that of a Looking-glass, I have small hope, whilst I see, that what hath been read in the * Il Saggiatore, & Lettere Solari, two Treatises of Galilæus.* Saggiator and in the Solar Letters of our Common Friend, hath profited nothing in your judgment, if haply you have attentively read what he hath there written on this subject.

Simpl.I have perused the same so superficially, according to the small time of leasure allowed me from more solid studies; therefore, if you think you can, either by repeating some of those reasons, or by alledging others, resolve me these doubts, I will hearken to them attentively.

Salv.I will tell you what comes into my mind upon the instant, and its possible it may be a commixtion of my own conceipts, and those which I have sometime read in the fore-said Books, by which I well remember, that I was then perfectly satisfied, although the conclusions, at first sight seem'd unto me strange Paradoxes. We enquire Simplicius, whether to the making a reflection of light, like that which we receive from the Moon, it be necessary that the superficies from whence the reflection commeth, be so smooth and polite, as the face of a Looking-Glasse, or whether a superficies not smooth or polisht, but rough and uneven, be more apt for such a purpose. Now supposing two reflections should come unto us, one more bright, the other lesse, from two superficies opposite unto us, I demand of you, which of the two superficies you think would represent it self to our sight, to be the clearest, and which the obscurest.

Simpl.I am very confident, that that same, which most forcibly reflected the light upon me, would shew its self in its aspect the clearer, and the other darker.

Salv.Be pleased to take that Glasse which hangs on yonder Wall,It is proved at large that the Moons surface is sharp. and let us go out into the Court-yard. Come Sagredus. Now hang the glasse yonder, against that same Wall, on which the Sun shines, and now let us with-draw our selves into the shade. See yonder two

superficies beaten by the Sun, namely, the Wall and the Glasse. Tell me now which appears clearest unto you, that of the Wall or that of the Glasse? Why do you not answer me?

Sagr.I leave the reply to Simplicius, who made the question; but I, for my own part, am perswaded upon this small beginning of the experiment, that the Moon must be of a very unpolisht surface.

Salv.What say you Simplicius, if you were to depaint that Wall, and that Glasse fastened unto it, where would you use your darkest colours, in designing the Wall, or else in painting the Looking-Glasse.

Simpl.Much the darker in depainting the Glasse.

Salv.Now if from the superficies, which represents it self more clear, there proceedeth a more powerful reflection of light, the Wall will more forcibly reflect the raies of the Sun, than the Glasse.

Simpl.Very well, Sir, have you ever a better experiment than this? you have placed us where the Glasses doth not reverberate upon us; but come along with me a little this way; how, will you not stir?

Sagr.You perhaps seek the place of the reflection, which the Glasse maketh.

Simpl.I do so.

Sagr.Why look you, there it is upon the opposite Wall, just as big as the Glasse, and little lesse bright than if the Sun had directly shined upon it.

Simpl.Come hither therefore, and see from hence the surface of the Glasse, and tell me whether you think it more obscure than that of the Wall.

Sagr.Look on it your self, for I have no mind at this time, to dazle my eyes; and I know very well, without seeing it, that it there appears as splendid and bright as the Sun it self, or little lesse.

Simpl.What say you therefore, is the reflection of a Glasse lesse powerful than that

of a Wall? I see, that in this opposite Wall, where the reflection of the other illuminated Wall comes, together with that of the Glasse, this of the Glasse is much clearer; and I see likewise, that, from this place where I stand, the glasse it self appears with much more lustre than the Wall.

Salv.You have prevented me with your subtlety; for I stood in need of this very observation to demonstrate what remains. You see then the difference which happens betwixt the two reflections made by the two superficies of the Wall and Glasse, percu•t in the self-same manner, by the rayes of the Sun; and you see, how the reflection which comes from the Wall, diffuseth it self towards all the parts opposite to it, but that of the Glasse goeth towards one part onely, not at all bigger than the Glasse it self: you see likewise, how the superficies of the Wall, beheld from what part soever, alwayes shews it self of one and the same cleernesse, and every way, much clearer than that of the Glasse, excepting only in that little place, on which the Glasses reflection reverberates, for from thence indeed the Glasse appears much more lucid than the Wall. By these so sensible, and palpable experiments, my thinks one may soon come to know, whether the reflection which the Moon sends upon us, proceed as from a Glasse, or else, as from a Wall, that is, from a smooth superficies, or a rugged.

Sagr.If I were in the Moon it self, I think I could not with my hands more plainly feel the unevennesse of its superficies, than I do now perceive it, by apprehending your discourse. The Moon beheld in any posture, in respect of the Sun and us, sheweth us its superficies, touch't by the Suns rayes, alwayes equally clear; an effect, which answers to an hair that of the Wall, which beheld from what place soever, appeareth equally bright, and differeth from the Glasse, which from one place onely appeareth lucid, and from all others obscure. Moreover, the light which cometh to me from the reflection of the Wall, is tollerable, and weak, in comparison of that of the Glasse, which is little lesse forcible and offensive to the sight, than that primary and direct light of the Sun. And thus without trouble do we behold the face of the

Moon; which were it as a Glasse, it appearing to us by reason of its vicinity, as big as the Sun it self, its splendor would be absolutely intollerable, and would seem as if we beheld another Sun.

Salv.Ascribe not, I beseech you Sagredus, more to my demonstration, than it produceth. I will oppose you with an instance, which I see not well how you can easily resolve. You insist upon it as a grand difference between the Moon and Glasse, that it emits its reflection towards all parts equally, as doth the Wall; whereas the Glasse casts it upon one onely determinate place; and from hence you conclude the Moon to be like to the Wall, and not to the Glasse:Flat Looking-glasses cast forth the reflection towards but one place, but the spherical every way. But I must tell you, that that same Glasse casts its reflection on one place onely, because its surface is flat, and the reflex rayes being to depart at angles equal to those of the rayes of incidence, it must follow that from a plane or flat superficies, they do depart unitedly towards the same place; but in regard that the superficies of the Moon is not plain, but spherical, and the incident rayes upon such a superficies, being to reflect themselves at angles equal to those of the incidence towards all parts, by means of the infinity of the inclinations which compose the spherical superficies, therefore the Moon may send forth its reflection every way; and there is no necessity for its repercussion upon one place onely, as that Glasse which is flat.

Simpl.This is one of the very same objections, which I intended to have made against him.

Sagr.If this be one, you had need have more of them; yet I tell you, that as to this first, it seems to me to make more against you, than for you.

Simpl.You have pronounced as a thing manifest, that the reflection made by that Wall, is as cleer and lucid as that which the Moon sends forth, and I esteem it nothing in comparison thereto. For, in this businesse of the illumination, its requisite to respect, and to distinguish the Sphere of Activity;The sphere of Activity greater in

the Cœlestial bodies than in Elementary. and who questions but the Cœlestial bodies have greater Spheres of activity, than these our elementary, frail, and mortal ones? and that Wall, finally, what else is it but a little obscure Earth, unapt to shine?

Sagr.And here also I believe, that you very much deceive your felf. But I come to the first objection moved by Salviatus; and I consider, that to make a body appear unto us luminous, it sufficeth not that the rayes of the illuminating body fall upon it, but it is moreover requisite that the reflex rayes arrive to our eye; as is manifestly seen in the example of that Glasse, upon which, without question, the illuminating rayes of the Sun do come; yet neverthelesse, it appears not to us bright and shining, unlesse we set our eye in that particular place, where the reflection arriveth. Now let us consider what would succeed, were the glasse of a spherical figure; for without doubt, we should find, that of the reflection made by the whole surface illuminated, that to be but a very small part, which arriveth to the eye of a particular beholder; by reason that that is but an inconsiderable particle of the whole spherical superficies, the inclination of which casts the ray to the particular place of the eye; whence the part of the spherical superficies, which shews it self shining to the eye, must needs be very small; all the rest being represented obscure. So that were the Moon smooth, as a Looking-glasse,The Moon if it were smooth, like a spherical glasse, would be invisible. a very small part would be seen by any particular eye to be illustrated by the Sun, although its whole Hemisphere were exposed to the Suns rayes; and the rest would appear to the eye of the beholder as not illuminated, and therefore invisible; and finally, the whole Moon would be likewise invisible, for so much as that particle, whence the reflection should come, by reason of its smalnesse and remotenesse, would be lost. And as it would be invisible to the eye, so would it not afford any light; for it is altogether impossible, that a bright body should take away our darknesse by its splendor, and we not to see it.

Salv.Stay good Sagredus, for I see some emotions in the face and eyes of Simplicius, which are to me as indices that he is not either very apprehensive of, or

satisfied with this which you, with admirable proof, and absolute truth have spoken. And yet I now call to mind, that I can by another experiment remove all scruple. I have seen above in a Chamber, a great spherical Looking-glasse; let us send for it hither, and whilest it is in bringing, let Simplicius return to consider, how great the clarity is which cometh to the Wall here, under the penthouse, from the reflection of the flat glasse.

Simpl.I see it is little lesse shining, than if the Sun had directly beat upon it.

Salv.So indeed it is. Now tell me, if taking away that small flat glasse, we should put that great spherical one in the same place, what effect (think you) would its reflection have upon the same Wall?

Simpl.I believe that it would eject upon it a far greater and more diffused light.

Salv.But if the illumination should be nothing, or so small, that you would scarse discern it, what would you say then?

Simpl.When I have seen the effect, I will bethink my self of an answer.

Salv.See here is the glasse, which I would have to be placed close to the other. But first let us go yonder towards the reflection of that flat one, and attentively observe its clarity; see how bright it is here where it shines, and how distinctly one may discern these small unevennesses in the Wall.

Simpl.I have seen and very well observed the same, now place the other glasse by the side of the first.

Salv.See where it is. It was placed there assoon as you began to look upon the Walls small unevennesses, and you perceived it not, so great was the encrease of the light all over the rest of the Wall. Now take away the flat glasse. Behold now all reflection removed, though the great convex glasse still remaineth. Remove this also, and place it there again if you please, and you shall see no alteration of light in all the Wall. See here then demonstrated to sense, that the reflection of the Sun, made upon a spherical convex glasse, doth not sensibly illuminate the places neer

unto it. Now what say you to this experiment?

Simpl.I am afraid that there may be some Leigerdemain, used in this affair; yet in beholding that glasse I see it dart forth a great splendor, which dazleth my eyes; and that which imports most of all, I see it from what place soever I look upon it; and I see it go changing situation upon the superficies of the glasse, which way soever I place my self to look upon it; a necessary argument, that the light is livelily reflected towards every side, and consequently, as strongly upon all that Wall, as upon my eye.

Salv.Now you see how cautiously and reservedly you ought to proceed in lending your assent to that, which discourse alone representeth to you. There is no doubt but that this which you say, carrieth with it probability enough, yet you may see, how sensible experience proves the contrary.

Simpl.How then doth this come to pass?

Salv.I will deliver you my thoughts thereof, but I cannot tell how you may be pleas'd therewith. And first, that lively splendor which you see upon the glass, and which you think occupieth a good part thereof, is nothing near so great, nay is very exceeding small; but its liveliness occasioneth in your eye, (by means of the reflection made on the humidity of the extream parts of the eye-brows, which distendeth upon the pupil) an adventitious irradiation, like to that blaze which we think we see about the flame of a candle placed at some distance; or if you will, you may resemble it to the adventitious splendor of a star;The small body of the stars fringed round about with rays, appeareth very much bigger than plain and naked, and in its native clarity. for if you should compare the small body v. g. of the Canicula, seen in the day time with the Telescope, when it is seen without such irradiation, with the same seen by night by the eye it self, you will doubtless comprehend that being irradiated, it appeareth above a thousand times bigger than the naked and real body: and a like or greater augmentation doth the image of the

Sun make, which you see in that glass. I say greater, for that it is more lively than the star, as is manifest from our being able to behold the star with much less offence, than this reflection of the glass. The reverberation therefore which is to dispere it self all over this wall, cometh from a small part of that glass, and that which even now came from the whole flat glass dispersed and restrain'd it self to a very small part of the said wall. What wonder is it then, that the first reflection very lively illuminates, and that this other is almost imperceptible?

Simpl.I find my self more perplexed than ever, and there presents it self unto me the other difficulty, how it can be that that wall, being of a matter so obscure, and of a superficies so unpolish'd, should be able to dart from it greater light, than a glass very smooth and polite.

Salv.Greater light it is not, but more universal; for as to the degree of brightness, you see that the reflection of that small flat glass, where it beamed forth yonder under the shadow of the penthouse, illuminateth very much; and the rest of the wall which receiveth the reflection of the wall on which the glass is placed, is not in any great measure illuminated, as was the small part on which the reflection of the glass fell. And if you would understand the whole of this business, you must consider that the superficies of that wall's being rough,The reflex light of uneven bodies, is more universal than that of the smooth, & why. is the same as if it were composed of innumerable small superficies, disposed according to innumerable diversities of inclinations: amongst which it necessarily happens, that there are many disposed to send forth their reflex rays from them into such a place, many others into another: and in sum, there is not any place to which there comes not very many rays, reflected from very many small superficies, dispersed throughout the whole superficies of the rugged body, upon which the rays of the Sun fall. From which it necessarily followeth, That upon any, whatsoever, part of any superficies, opposed to that which receiveth the primary incident rays, there is produced reflex rays, and consequently illumination. There doth also follow thereupon, That the same body

upon which the illuminating rays fall, beheld from whatsoever place, appeareth all illuminated and shining: and therefore the Moon, as being of a superficies rugged and not smooth,The Moon, if it were smooth and sleek, would be invisible. beameth forth the light of the Sun on every side, and to all beholders appeareth equally lucid. But if the surface of it, being spherical, were also smooth as a glass, it would become wholly invisible; forasmuch as that small part, from which the image of the Sun should be reflected unto the eye of a particular person, by reason of its great distance would be invisible, as I have said before.

Simpl.I am very apprehensive of your discourse; yet methinks I am able to resolve the same with very little trouble; and easily to maintain, that the Moon is rotund and polite, and that it reflects the Suns light unto us in manner of a glass; nor therefore ought the image of the Sun to be seen in the middle of it, "forasmuch as the species of the Sun it self admits not its small figure to be seen at so great a distance, but the light produced by the Sun may help us to conceive that it illuminateth the whole Lunar Body: a like effect we may see in a plate gilded and well pollish'd, which touch't by a luminous body, appeareth to him that beholds it at some distance to be all shining; and onely near at hand one may discover in the middle of it the small image of the luminous body".

Salv.Ingenuously confessing my dullness of apprehension, I must tell you, that I understand not any thing of this your discourse, save onely what concerns the gilt plate: and if you permit me to speak freely, I have a great conceit that you also understand not the same, but have learnt by heart those words written by some one out of a desire of contradiction, and to shew himself more intelligent than his adversary; but it must be to those, which to appear also more wise, applaud that which they do not understand, and entertain a greater conceit of persons, the less they are by them understood: and the writer himself may be one of those (of which there are many) who write what they do not understand,Some write what they understand not, and therefore understand not what they write. and consequently

understand not what they write. Therefore, omitting the rest, I reply, as to the gilt plate, that if it be flat and not very big, it may appear at a distance very bright, whilst a great light beameth upon it, but yet it must be when the eye is in a determinate line, namely in that of the reflex rays: and it will appear the more shining, if it were v. g. of silver, by means of its being burnished, and apt through the great density of the metal, to receive a perfect polish. And though its superficies, being very well brightned, were not exactly plain, but should have various inclinations, yet then also would its splendor be seen many ways; namely, from as many places as the various reflections, made by the several superficies,Diamonds ground to divers sides, & why. do reach: for therefore are Diamonds ground to many sides, that so their pleasing lustre might be beheld from many places. But if the Plate were very big, though it should be all plain, yet would it not at a distance appear all over shining: and the better to express my self, Let us suppose a very large gilt plate exposed to the Sun, it will shew to an eye far distant, the image of the Sun, to occupy no more but a certain part of the said plate; to wit, that from whence the reflection of the incident solar rays come: but it is true that by the vivacity of the light, the said image will appear fringed about with many rays, and so will seem to occupie a far greater part of the plate, than really it doth. And to shew that this is true, when you have noted the particular place of the plate from whence the reflection cometh, and conceived likewise how great the shining place appeared to you, cover the greater part of that same space, leaving it only visible about the midst; and all this shall not any whit diminish the apparent splendor to one that beholds it from afar; but you shall see it largely dispers'd upon the cloth or other matter, wherewith you covered it. If therefore any one, by seeing from a good distance a small gilt plate to be all over shining, should imagine that the same would also even in a plate as broad as the Moon, he is no less deceived, than if he should believe the Moon to be no bigger than the bottom of a tub. If again the plate were turn'd into a spherical superficies, the reflection would be seen strong in but one sole particle of it; but yet by reason of

its liveliness, it will appear fringed about with many glittering rays: the rest of the Ball would appear according as it was burnished;Silver burnished appears more obscure, than the not burnished, & why. and this also onely then when it was not very much polished, for should it be perfectly brightned, it would appear obscure. An example of this we have dayly before our eyes in silver vessels, which whilst they are only boyl'd in the Argol and Salt, they are all as white as snow, and do not reflect any image; but if they be in any part burnish'd, they become in that place presently obscure: and in them one may see the representation of any thing as in Looking-glasses. And that chanto obscurity, proceeds from nothing else but the smoothing and plaining of a fine grain, which made the superficies of the silver rough, and yet such, as that it reflected the light into all parts, whereby it seemed from all parts equally illuminated: which small unevennesses, when they come to be exquisitely plained by the burnish, so that the reflection of the rays of incidence are all directed unto one determinate place; then, from that same place, the burnish'd part shall shew much more bright and shining than the rest which is onely whitened by boyling; but from all other places it looks very obscure. And note, that the diversity of sights of looking upon burnish'd superficies,Burnish'd Steel beheld from one place appears very bright, and from another, very obscure. occasioneth such difference in appearances, that to imitate and represent in picture, v. g. a polish'd Cuirace, one must couple black plains with white, one sideways to the other, in those parts of the arms where the light falleth equally.

Sagr.If therefore these great Philosophers would acquiese in granting, that the Moon, Venus and the other Planets, were not of so bright and smooth a surface as a Looking-glass, but wanted some small matter of it, namely, were as a silver plate, onely boyled white, but not burnished; would this yet suffice to the making of it visible, and apt for darting forth the light of the Sun?

Salv.It would suffice in part; but would not give a light so strong, as it doth being mountainous, and in sum, full of eminencies and great cavities. But these

Philosophers will never yield it to be lesse polite than a glasse; but far more, if more it can be imagined; for they esteeming that to perfect bodies perfect figures are most sutable; it is necessary, that the sphericity of those Cœlestial Globes be most exact; besides, that if they should grant me some inequality, though never so small, I would not scruple to take any other greater; for that such perfection consisting in indivisibles, an hair doth as much detract from its perfection as a mountain.

Sagr.Here I meet with two difficulties, one is to know the reason why the greater inequality of superficies maketh the stronger reflection of light; the other is, why these Peripatetick Gentlemen are for this exact figure.

Salv.I will answer to the first;The more rough superficies make greater reflection of light, than the less rough. and leave to Simplicius the care of making reply to the second. You must know therefore, that the same superficies happen to be by the same light more or less illuminated, according as the rayes of illumination fall upon them more or lesse obliquely;Perpendicular rays illuminate more than the oblique, and why. so that the greatest illumination is where the rayes are perpendicular. And see, how I will prove it to your sense. I bend this paper, so, that one part of it makes an angle upon the other: and exposing both these parts to the reflection of the light of that opposite Wall, you see how this side which receiveth the rayes obliquely, is lesse shining than this other, where the reflection fals at right angles; and observe, that as I by degrees receive the illumination more obliquely, it groweth weaker.

Sagr.I see the effect, but comprehend not the cause.

Salv.If you thought upon it but a minute of an hour, you would find it; but that I may not waste the time, see a kind of demonstration thereof in Fig. 7.

Sagr.The bare sight of this Figure hath fully satisfied me, therefore proceed.

Simpl.Pray you let me hear you out, for I am not of so quick an apprehension.

Salv.Fancie to your self, that all the paralel lines, which you see to depart from the terms A. B. are the rays which fall upon the line C. D. at right angles:The more

oblique Rayes illuminate leß, and why. then incline the said C. D. till it hang as D. O. now do not you see that a great part of those rays which peirce C. D. pass by without touching D. O? If therefore D. O. be illuminated by fewer rays, it is very reasonable, that the light received by it be more weak. Let us return now to the Moon, which being of a spherical figure, if its superficies were smooth, as this paper, the parts of its hemisphere illuminated by the Sun, which are towards its extremity, would receive much less light, than the middle parts; the rays falling upon them most obliquely, and upon these at right angles; whereupon at the time of full Moon, when we see almost its whole Hemisphere illuminated, the parts towards the midst, would shew themselves to us with more splendor, than those others towards the circumference: which is not so in effect. Now the face of the Moon being represented to me full of indifferent high mountains, do not you see how their tops and continuate ridges, being elevated above the convexity of the perfect spherical superficies, come to be exposed to the view of the Sun, and accommodated to receive its rays much less obliquely, and consequently to appear as luminous as the rest?

Sagr.All this I well perceive: and if there are such mountains, its true, the Sun will dart upon them much more directly than it would do upon the inclination of a polite superficies: but it is also true, that betwixt those mountains all the valleys would become obscure, by reason of the vast shadows, which in that time would be cast from the mountains, whereas the parts towards the middle, though full of valleys and hills, by reason they have the Sun elevated, would appear without shadow, and therefore more lucid by far than the extreme parts, which are no less diffused with shadow than light, and yet we can perceive no such difference.

Simpl.I was ruminating upon the like difficulty.

Salv.How much readier is Simplicius to apprehend the objections which favour the opinions of Aristotle, than their solutions? I have a kind of suspition, that he strives

also sometimes to dissemble them; and in the present case, he being of himself able to hit upon the doubt, which yet is very ingenious, I cannot believe but that he also was advis'd of the answer; wherefore I will attempt to wrest the same (as they say) out of his mouth. Therefore tell me, Simplicius, do you think there can be any shadow, where the rays of the Sun do shine?

Simpl.I believe, nay I am certain that there cannot; for that it being the grand luminary, which with its rays driveth away darkness, it is impossible any tenebrosity should remain where it cometh; moreover, we have the definition, that Tenebræ sunt privatio luminis.

Salv.Therefore the Sun, beholding the Earth, Moon or other opacous body, never seeth any of its shady parts, it not having any other eyes to see with, save its rays, the conveyers of light: and consequently, one standing in the Sun would never see any thing of umbrage, forasmuch as his visive rays would ever go accompanied with those illuminating beams of the Sun.

Simpl.This is true, without any contradiction.

Salv.But when the Moon is opposite to the Sun, what difference is there between the tract of the rayes of your sight, and that motion which the Suns rayes make?

Simpl.Now I understand you; for you would say, that the rayes of the sight and those of the Sun, moving by the same lines, we cannot perceive any of the obscure valleys of the Moon. Be pleased to change this your opinion, that I have either simulation or dissimulation in me; for I protest unto you, as I am a Gentleman, that I did not guesse at this solution, nor should I have thought upon it, without your help, or without long study.

Sagr.The resolutions, which between you two have been alledged touching this last doubt, hath, to speak the truth, satisfied me also. But at the same time this consideration of the visible rayes accompanying the rayes of the Sun, hath begotten in me another scruple, about the other part, but I know not whether I can expresse it

right, or no: for it but just now comming into my mind, I have not yet methodized it to my mind: but let us see if we can, all together, make it intelligible. There is no question, but that the parts towards the circumference of that polish't, but not burnish't Hemisphere, which is illuminated by the Sun, receiving the rayes obliquely, receive much fewer thereof, than the middlemost parts, which receive them directly. And its possible, that a tract or space of v. g. twenty degrees in breadth, and which is towards the extremity of the Hemisphere, may not receive more rays than another towards the middle parts, of but four degree broad: so that that doubtless will be much more obscure than this; and such it will appear to whoever shall behold them both in the face, or (as I may say) in their full magnitude. But if the eye of the beholder were constituted in such a place, that the breadth of the twenty degrees of the obscure space, appeared not to it longer than one of four degrees, placed in the midst of the Hemisphere, I hold it not impossible for it to appear to the said beholder equally clear and lucid with the other; because, finally, between two equal angles, to wit, of four degrees apiece, there come to the eye the reflections of two equal numbers of rayes: namely, those which are reflected from the middlemost space, four degrees in breadth, and those reflected from the other of twenty degrees, but seen by compression, under the quantity of four degrees: and such a situation shall the eye obtain, when it is placed between the said Hemisphere, and the body which illuminates it; for then the sight and rayes move in the same lines. It seemeth not impossible therefore, but that the Moon may be of a very equal superficies; and that neverthelesse, it may appear when it is at the full, no less light in the extremities, than in the middle parts.

Salv.The doubt is ingenious and worthy of consideration; and as it but just now came into your mind unawares, so I will like wise answer with what first comes into my thoughts, and it may happily fall out, that by thinking more upon it, I may stumble upon a better reply. But before, that I labyrinth my self any farther, it would be necessary, that we assure our selves by some experiment, whether your objection

prove in effect, what it seemeth to conclude in appearance; and therefore taking once more the same paper, and making it to incline, by bending a little part thereof upon the remainder, let us try whether exposing it to the Sun, so that the rayes of light fall upon the lesser part directly, and upon the other obliquely; this which receiveth the rayes directly appeareth more lucid; and see here by manifest experience, that it is notably more clear. Now if your objection be conclusive, it will follow, that stooping with our eye so, that in beholding the other greater part, less illuminated, in compression or fore-shortning, it appear unto us no bigger than the other, more shining; and that consequently, it be not beheld at a greater angle than that; it will necessarily ensue, I say, that its light be encreased, so that it do seem to us as bright as the other. See how I behold, and look upon it so obliquely, that it appeareth to me narrower than the other; but yet, notwithstanding its obscurity, doth not to my perceiving, at all grow clearer. Try now if the same succeed to you.

Sagr.I have look't upon it, and though I have stooped with my eye, yet cannot I see the said superficies encrease in light or clarity; nay me thinks it rather grows more dusky.

Salv.We are hitherto confident of the invalidity of the objection; In the next place, as to the solution, I believe, that, by reason the Superficies of this paper is little lesse than smooth, the rayes are very few, which be reflected towards the point of incidence, in comparison of the multitude, which are reflected towards the opposite parts; and that of those few more and more are lost, the nearer the visive rayes approach to those lucid rayes of incidence; and because it is not the incident rayes, but those which are reflected to the eye, that make the object appear luminous; therefore, in stooping the eye, there is more lost than got, as you your self confesse to have seen in looking upon the obscurer part of the paper.

Sagr.I rest satisfied with this experiment and reason: It remains now, that Simplicius answer to my other question, and tell me what moves the Peripateticks to require

this so exact rotundity in the Cœlestial bodies.

Simpl.The Cœlestial bodies being ingenerable, inalterable, impassible, immortal,&c.Perfect sphericity why ascribed to Cœlestial bodies, by the Peripateticks. they must needs be absolutely perfect; and their being absolute perfect, necessarily implies that there is in them all kinds of perfection; and consequently, that their figure be also perfect, that is to say, spherical; and absolutely and perfectly spherical, and not rough and irregular.

Salv.And this incorruptibility, from whence do you prove it?

Simpl.Immediately by its freedom from contraries, and mediately, by its simple circular motion.

Salv.So that;The Figure is not the cause of incorruptibility, but of longer duration. by what I gather from your discourse, in making the essence of the Cœlestial bodies to be incorruptible, inalterable, &c, there is no need of rotundity as a cause, or requisite; for if this should cause inalterability, we might at our pleasure make wood, wax, and other Elementary matters, incorruptible, by reducing them to a spherical figure.

Simpl.And is it not manifest that a ball of Wood will better and longer be preserved, than an oblong, or other angular figure, made of a like quantity of the same wood.

Salv.This is most certain, but yet it doth not of corruptible become incorruptible, but still remains corruptible, though of a much longer duration.Corruptibility admits of more or lesse; so doth not incorruptibiliiy. Therefore you must note, that a thing corruptible, is capable of being more or lesse such, and we may properly say this is lesse corruptible than that; as for example, the Jasper, than the Pietra Sirena; but incorruptibility admits not of more, or lesse, so as that it may be said this is more incorruptible than that,The perfection of figure, operateth in corruptible bodies, but not in the eternal. if both be incorruptible and eternal. The diversity of figure therefore cannot operate: save onely in matters capable of more or lesse duration;

but in the eternal, which cannot be other than equally eternal, the operation of figure ceaseth. And therefore, since the Cœlestial matter is not incorruptible by figure, but otherwayes no man needs to be so solicitous for this perfect sphericity; for if the matter be incorruptible, let it have what figure it will, it shall be alwayes such.

Sagr.But I am considering another thing,If the spherical figure conferreth eternity, all bodies would be eternal. and say, that if we should grant the spherical figure a faculty of conferring incorruptibility, all bodies of whatsoever figure, would be incorruptible; forasmuch as if the rotund body be incorruptible, corruptibility would then subsist in those parts which alter the perfect rotundity; as for instance, there is in a Die a body perfectly round, and, as such, incorruptible; therefore it remaineth that those angles be corruptible which cover and hide the rotundity; so that the most that could happen, would be, that those angles, and (to so speak) excrescencies, would corrupt. But if we proceed to a more inward consideration, that in those parts also towards the angles, there are comprised other lesser bals of the same matter; and therefore they also, as being round, must be also incorruptible; and likewise in the remainders, which environ these eight lesser Spheres, a man may understand that there are others: so that in the end, resolving the whole Die into innumerable balls, it must necessarily be granted incorruptible. And the same discourse and resolution may be made in all other figures.

Salv.Your method in making the conclusion, for if v. g. a round Chrystal were, by reason of its figure, incorruptible; namely, received from thence a faculy of resisting all internal and external alterations, we should not find, that the joyning to it other Chrystal, and reducing it v. g. into a Cube, would any whit alter it within, or without; so as that it would thereupon become lesse apt to resist the new ambient, made of the same matter, than it was to resist the other, of a matter different; and especially, if it be true, that corruption is generated by contraries, as Aristotle saith; and with what can you enclose that ball of Crystal, that is lesse contrary to it, than Crystal it self? But we are not aware how time flies away; and it will be too late

before we come to an end of our dispute, if we should make so long discourses, upon every particular; besides our memories are so confounded in the multiplicity of notions, that I can very hardly recal to mind the Propotsiions, which I proposed in order to Simplicius, for our consideration.

Simpl.I very well remember them: And as to this particular question of the montuosity of the Moon, there yet remains unanswered that which I have alledged, as the cause, (and which may very well serve for a solution) of that Phænomenon, saying, that it is an illusion proceeding from the parts of the Moon, being unequally opacous, and perspicuous.

Sagr.Even now, when Simplicius ascribed the apparent Protnberancies or unevennesses of the Moon (according to the opinion of a certain Peripatetick his friend) to the diversly opacous, and perspicuous parts of the said Moon,Mother of Pearl accommodated to imitate the apparent unevennesses of the Moons surface. conformable to which the like illusions are seen in Crystal, and Jems of divers kinds, I bethought my self of a matter much more commodious for the representing such effects; which is such, that I verily believe, that that Philosopher would give any price for it; and it is the mother of Pearl, which is wrought into divers figures, and though it be brought to an extreme evennesse, yet it seemeth to the eye in several parts, so variously hollow and knotty, that we can scarce credit our feeling of their evennesse.

Salv.This invention is truly ingenious; and that which hath not been done already, may be done in time to come; and if there have been produced other Jems, and Crystals, which have nothing to do with the illusions of the mother of Pearl, these may be produced also; in the mean time, that I may not prevent any one, I will suppresse the answer which might be given, and onely for this time betake my self to satisfie the objections brought by Simplicius. I say therefore, that this reason of yours is too general, and as you apply it not to all the appearances one by one; which

are seen in the Moon, and for which my self and others are induced to hold it mountainous, I believe you will not find any one that will be satisfied with such a doctrine; nor can I think, that either you, or the Author himself, find in it any greater quietude,The apparent unevennesses of the Moon cannot be imitated by way of more and less opacity & perspicuity. than in any other thing wide from the purpose. Of the very many several appearances which are seen night by night in the course of Moon, you cannot imitate so much as one, by making a Ball at your choice, more or less opacous and perspicuous, and that is of a polite superficies;The various aspects of the Moon, imitable with any opacous matter. whereas on the contrary, one may make Balls of any solid matter whatsoever, that is not transparent, which onely with eminencies and cavities, and by receiving the illumination several ways, shall represent the same appearances and mutations to an hair,Various appearances from which the Moons montuosity is argued. which from hour to hour are discovered in the Moon. In them you shall see the ledges of Hills exposed to the Suns light, to be very shining, and after them the projections of their shadows very obscure; you shall see them greater and less, according as the said eminencies shall be more or less distant from the confines which distinguish the parts of the Moon illuminated, from the obscure: you shall see the same term and confine, not equally distended, as it would be if the Ball were polish'd, but craggie and rugged. You shall see beyond the same term, in the dark parts of the Moon many bright prominencies, and distinct from the rest of the illuminations: you shall see the shadows aforesaid, according as the illumination gradually riseth, to deminish by degrees, till they wholly disappear; nor are there any of them to be seen when the whole Hemisphere is enlightned. Again on the contrary, in the lights passage towards the other Hemisphere of the Moon, you shall again observe the same eminencies that were marked, and you shall see the projections of their shadows to be made a contrary way, and to decrease by degrees: of which things, once more I say, you cannot shew me so much as one in yours that are opacous and perspicuous.

Sagr.One of them certainly he may imitate, namely, that of the Full-Moon, when by reason of its being all illuminated, there is not to be seen either shadow, or other thing, which receiveth any alteration from its eminencies and cavities. But I beseech you, Salviatus, let us spend no more time on this Argument, for a person that hath had but the patience to make observation of but one or two Lunations, and is not satisfied with this most sensible truth, may well be adjudged void of all judgment; and upon such why should we throw away our time and breath in vain?

Simpl.I must confess I have not made the observations, for that I never had so much curiosity, or the Instruments proper for the business; but I will not fail to do it. In the mean time, we may leave this question in suspense, and pass to that point which follows, producing the motives inducing you to think that the Earth may reflect the light of the Sun no less forceably than the Moon, for it seems to me so obscure and opacous, that I judg such an effect altogether impossible.

Salv.The cause for which you repute the Earth unapt for illumination, may rather evince the contrary: And would it not be strange, Simplicius, if I should apprehend your discourses better than you your self?

Simpl.Whether I argue well or ill, it may be, that you may better understand the same than I; but be it ill or well that I discourse, I shall never believe that you can penetrate what I mean better than I my self.

Salv.Well, I will make you believe the same presently. Tell me a little, when the Moon is near the Full, so that it may be seen by day, and also at midnight, at what do you think it more splendid, by day or by night?

Simpl.By night,The Moon beheld in the day time, is like to a little cloud. without all comparison. And methinks the Moon resembleth that pillar of Clouds and pillar of Fire, which guided the Israelites; which at the presence of the Sun, appeared like a Cloud, but in the night was very glorious. Thus I have by day observed the Moon amidst certain small Clouds,The Moon appears brighter by night than by day. just as

if one of them had been coloured white, but by night it shines with much splendor.

Salv.So that if you had never happened to see the Moon, save onely in the day time, you would not have thought it more shining than one of those Clouds.

Simpl.I verily believe I should not.

Salv.Tell me now; do you believe that the Moon is really more shining in the night than day, or that by some accident it seemeth so?

Simpl.I am of opinion, that it resplends in it self as much in the day as night, but that its light appears greater by night, because we behold it in the dark mantle of Heaven; and in the day time, the whole Atmosphere being very clear, so that she little exceedeth it in lustre, she seems to us much less bright.

Salv.Now tell me; have you ever at midnight seen the Terrestrial Globe illuminated by the Sun?

Simpl.This seemeth to me a question not to be ask'd, unless in jest, or of some person known to be altogether void of sense.

Salv.No, no; I esteem you to be a very rational man, and do ask the question seriously; and therefore answer me: and if afterwards you shall think that I speak impertinently, I will be content to be the senseless man: for he is much more a fool who interrogates simply, than he to whom the question is put.

Simpl.If then you do not think me altogether simple, take it for granted that I have answered you already, and said, that it is impossible, that one that is upon the Earth, as we are, should see by night that part of the Earth where it is day, namely, that is illuminated by the Sun.

Salv.Therefore you have never seen the Earth enlightned, save onely by day; but you see the Moon to shine also in the dead of night. And this is the cause, Simplicius, which makes you believe that the Earth doth not shine like the Moon; but if you could see the Earth illuminated, whilst you were in some dark place, like our night,

you would see it shine brighter than the Moon. Now if you desire that the comparison may proceed well, you must compare the light of the Earth, with that of the Moon seen in the day time, and not with the same by night: for it is not in our power to see the Earth illuminated, save onely in the day. Is it not so?

Simpl.So it ought to be.

Salv.And forasmuch as you your self have already confessed to have seen the Moon by day among some little white Clouds, and very nearly, as to its aspect, resembling one of them; you did thereby grant,Clouds are no less apt than the Moon to be illuminated by the Sun. that those Clouds, which yet are Elementary matters, are as apt to receive illumination, as the Moon, yea more, if you will but call to mind that you have sometimes seen some Clouds of vast greatness, and as perfect white as the Snow; and there is no question, but that if such a Cloud could be continued so luminous in the deep of night, it would illuminate the places near about it, more than an hundred Moons. If therefore we were assured that the Earth is illuminated by the Sun, like one of those Clouds, it would be undubitable, but that it would be no less shining than the Moon. But of this there is no question to be made, in regard we see those very Clouds in the absence of the Sun, to remain by night, as obscure as the Earth: and that which is more, there is not any one of us, but hath seen many times some such Clouds low, and far off, and questioned whether they were Clouds or Mountains: an evident sign that the Mountains are no less luminous than those Clouds.A wall illuminated by the Sun, compared to the Moon shineth no less than it.

Sagr.But what needs more discourse? See yonder the Moon is risen, and more than half of it illuminated; see there that wall, on which the Sun shineth; retire a little this way, so that you see the Moon sideways with the wall: look now; which of them shews more lucid? Do not you see, that if there is any advantage, the wall hath it? The Sun shineth on that wall; from thence it is reverberated upon the wall of the Hall,The third reflection of a Wall illuminates more than the first of the Moon. from

thence it's reflected upon that chamber, so that it falls on it at the third reflection: and I am very certain, that there is in that place more light, than if the Moons light had directly faln upon it.

Simpl.But this I cannot believe; for the illumination of the Moon, especially when it is at the full, is very great.

Sagr.It seemeth great by reason of the circumjacent dark places;The light of the Moon weaker than that of the twilight. but absolutely it is not much, and is less than that of the twilight half an hour after the Sun is set; which is manifest, because you see not the shadows of the bodies illuminated by the Moon till then, to begin to be distinguished on the Earth. Whether, again, that third reflection upon that chamber, illuminates more than the first of the Moon, may be known by going thether, and reading a Book, and afterwards standing there in the night by the Moons light, which will shew by which of them lights one may read more or less plainly, but I believe without further tryal, that one should see less distinctly by this later.

Salv.Now, Simplicius, (if haply you be satisfied) you may conceive, as you your self know very well, that the Earth doth shine no less than the Moon; and the only remembring you of some things, which you knew of your self, and learn'd not of me, hath assured you thereof: for I taught you not that the Moon shews lighter by night than by day, but you understood it of your self; as also you could tell me that a little Cloud appeareth as lucid as the Moon: you knew also, that the illumination of the Earth cannot be seen by night; and in a word, you knew all this, without knowing that you knew it. So that you have no reason to be scrupulous of granting, that the dark part of the Earth may illuminate the dark part of the Moon, with no less a light than that wherewith the Moon illuminates the obscurities of the night, yea rather so much the greater, inasmuch as the Earth is forty times bigger than the Moon.

Simpl.I must confess that I did believe, that that secondary light had been the natural light of the Moon.

Salv.And this also you know of your self, and perceive not that you know it. Tell me, do not you know without teaching, that the Moon shews it self more bright by night than by day,Luminous bodies appear the brighter in an obscurer ambient. in respect of the obscurity of the space of the ambient? and consequently, do you not know in genere, that every bright body shews the clearer, by how much the ambient is obscurer?

Simpl.This I know very well.

Salv.When the Moon is horned, and that secondary light seemeth to you very bright, is it not ever nigh the Sun, and consequently, in the light of the crepusculum, (twilight?)

Simpl.It is so; and I have oftentimes wish'd that the Air would grow thicker, that I might be able to see that same light more plainly; but it ever disappeared before dark night.

Salv.You know then very certainly, that in the depth of night, that light would be more conspicuous.

Simpl.I do so; and also more than that, if one could but take away the great light of the crescent illuminated by the Sun, the presence of which much obscureth the other lesser.

Salv.Why, doth it not sometimes come to pass, that one may in a very dark night see the whole face of the Moon, without being at all illuminated by the Sun?

Simpl.I know not whether this ever happeneth, save onely in the total Ecclipses of the Moon.

Salv.Why, at that time this its light would appear very clear, being in a most obscure medium, and not darkned by the clarity of the luminous crescents: but in that position, how light did it appear to you?

Simpl.I have sometimes seen it of the colour of brass, and a little whitish; but at

other times it hath been so obscure, that I have wholly lost the sight of it.

Salv.How then can that light be so natural, which you see so cleer in the close of the twilight, notwithstanding the impediment of the great and contiguous splendor of the crescents; and which again, in the more obscure time of night, all other light removed, appears not at all?

Simpl.I have heard of some that believed that same light to be participated to these crescents from the other Stars, and in particular from Venus, the Moons neighbour.

Salv.And this likewise is a vanity; because in the time of its total obscuration, it ought to appear more shining than ever; for you cannot say, that the shadow of the Earth intercepts the sight of Venus, or the other Stars. But to say true, it is not at that instant wholly deprived thereof, for that the Terrestrial Hemisphere, which in that time looketh towards the Moon, is that where it is night, that is, an intire privation of the light of the Sun. And if you but diligently observe, you will very sensibly perceive, that like as the Moon, when it is sharp-horned, doth give very little light to the Earth; and according as in her the parts illuminated by the Suns light do encrease: so likewise the splendor to our seeming encreaseth, which from her is reflected towards us; thus the Moon, whilst it is sharp-forked, and that by being between the Sun and the Earth, it discovereth a very great part of the Terrestrial Hemisphere illuminated, appeareth very clear: and departing from the Sun, and passing towards the * By the Moons two Quadratures you are to understand its first and last quarters, as Astrologers call them*Quadrature, you may see the said light by degrees to grow dim; and after the Quadrature, the same appears very weak, because it continually loseth more and more of the view of the luminous part of the Earth: and yet it should succeed quite contrary, if that light were its own, or communicated to it from the Stars; for then we should see it in the depth of night, and in so very dark an ambient.

Simpl.Stay a little; for I just now remember, that I have read in a little modern tract,

full of many novelties; "That this secondary light is not derived from the Stars, nor innate in the Moon, and least of all communicated by the Earth, but that it is received from the same illumination of the Sun,The secondary light of the Moon caused by the Sun, according to some. which, the substance of the Lunar Globe being somewhat transparent, penetrateth thorow all its body; but more livelily illuminateth the superficies of the Hemisphere exposed to the rays of the Sun: and its profundity imbuing, and (as I may say) swallowing that light, after the manner of a cloud or chrystal, transmits it, and renders it visibly lucid. And this (if I remember aright) he proveth by Authority, Experience and Reason; citing Cleomedes, Vitellion, Macrobius, and a certain other modern Author: and adding, That it is seen by experience to shine most in the days nearest the Conjunction, that is, when it is horned, and is chiefly bright about its limb. And he farther writes, That in the Solar Ecclipses, when it is under the Discus of the Sun, it may be seen translucid, and more especially towards its utmost Circle. And in the next place, for Arguments, as I think, he saith, That it not being able to derive that light either from the Earth, or from the Stars, or from it self, it necessarily follows, that it cometh from the Sun. Besides that, if you do but grant this supposition, one may easily give convenient reasons for all the particulars that occur. For the reason why that secundary light shews more lively towards the outmost limb, is, the shortness of the space that the Suns rays hath to penetrate, in regard that of the lines which pass through a circle, the greatest is that which passeth through the centre, and of the rest, those which are farthest from it, are always less than those that are nearer. From the same principle, he saith, may be shewn why the said light doth not much diminish. And lastly, by this way the cause is assigned whence it comes, that that same more shining circle about the utmost edge of the Moon, is seen at the time of the Solar Ecclipse, in that part which lyeth just under the Discus of the Sun, but not in that which is beside the Discus: which happeneth because the rays of the Sun pass directly to our eye, through the parts of the Moon underneath: but as for the parts which are besides it,

they fall besides the eye."

Salv.If this Philosopher had been the first Author of this opinion, I would not wonder that he should be so affectionate to it, as to have received it for truth; but borrowing it from others, I cannot find any reason sufficient to excuse him for not perceiving its fallacies; and especially after he had heard the true cause of that effect, and had it in his power to satisfie himself by a thousand experiments, and manifest circumstances, that the same proceeded from the reflection of the Earth, and from nothing else: and the more this speculation makes something to be desired, in the judgment of this Author, and of all those who give no credit to it: so much the more doth their not having understood and remembred it, excuse those more recess Antients, who, I am very certain, did they now understand it, would without the least repugnance admit thereof. And if I may freely tell you what I think, I cannot believe but that this Modern doth in his heart believe it; but I rather think, that the conceit he should not be the first Author thereof, did a little move him to endeavour to suppresse it, or to disparage it at least amongst the simple, whose number we know to be very great; and many there are, who much more affect the numerous applauds of the people, than the approbation of a few not vulgar judgments.

Sagr.Hold good Salviatus, for me thinks, I see that you go not the way to hit the true mark in this your discourse, for these that* Tendono le parete al commune. * confound all propriety, know also how to make themselves Authors of others Inventions, provided they be not so stale, and publick in the Schools and Market-places, as that they are more then notorious to every one.

Salv.Ha! well aimed, you blame me for roving from the point in hand; but what have you to do with Schools and Markets? Its all one whether opinions be new to men, or men new to opinions. Is it not all one whether opinions and inventions be new to men, or the men new to them? If you* Contestare falsly rendered in the Latine Translation contentare. *contend about the esteem of the Founders of Sciences,

which in all times do start up, you may make your self their inventor, even to the Alphabet it self, and so gain admiration amongst that illiterate rabble; and though in processe of time your craft should be perceived, that would but little prejudice your designe; for that others would succeed them in maintaining the number of your fautors; but let us return to prove to Simplicius the invalidity of the reasons of his modern Author, in which there are several falsities, inconsequencies,The secondary light of the Moon appears in form of a Ring, that is to say, bright in the extreme circumference, and not in the midst, and why. and incredible Paradoxes. And first, it is false that this secondary light is clearer about the utmost limb than in the middle parts, so as to form, as it were, a ring or circle more bright than the rest of its space or contence. True it is, indeed, that looking on the Moon at the time of twilight, at first sight there is the resemblance of such a circle, but by an illusion arising from the diversity of confines that bound the Moons Discus, which are confused by means of this secondary light; forasmuch as on the part towards the Sun it is bounded by the lucid horns of the Moon, and on the other part, its confining term is the obscure tract of the twilight; whose relation makes us think the candor of the Moons Discus to be so much the clearer; the which happens to be obfuscated in the opposite part, by the greater clarity of the crescents; but if this modern Author had essaied to make an interposition between the eye and the primary splendor,The way to observe the secondary light of the Moon. by the ridg of some house, or some other screen, so as to have left visible only the grose of the Moon, the horns excluded, he might have seen it all alike luminous.

Simpl, I think, now I remember, that he writes of his making use of such another Artifice, to hide from us the false lucidum.

Salv.Oh! how is this (as I believed) inadvertency of his, changed into a lie, bordering on rashnesse; for that every one may frequently make proof of the contrary. That in the next place,The Moons Discus in a solar Eclipse can be seen onely by privation. at the Suns Eclipse, the Moons Discus is seen otherwayes than

by privation, I much doubt, and specially when the Eclipse is not total, as those must necessarily have been, which were observed by the Author; but if also he should have discovered somewhat of light, this contradicts not, rather favoureth our opinion; for that at such a time, the whole Terrestrial Hemisphere illuminated by the Sun, is opposite to the Moon, so that although the Moons shadow doth obscure a part thereof, yet this is very small in comparison of that which remains illuminated. That which he farther adds, that in this case, the part of the limb, lying under the Sun, doth appear very lucid, but that which lyeth besides it, not so; and that to proceed from the coming of the solar rayes directly through that part to the eye, but not through this, is really one of those fopperies, which discover the other fictions, of him which relates them: For if it be requisite to the making a secondary light visible in the lunar Discus, that the rayes of the Sun came directly through it to our eyes, doth not this pitiful Philosopher perceive, that we should never see this same secondary light, save onely at the Eclipse of the Sun? And if a part onely of the Moon, far lesse than half a degree, by being remote from the Suns Discus, can deflect or deviate the rayes of the Sun, so that they arrive not at our eye; what shall it do when it is distant twenty or thirty degrees, as it is at its first apparition? and what course shall the rayes of the Sun keep, which are to passe thorow the body of the Moon, that they may find out our eye?The Author of the Book of conclusions, accommodates the things to his purposes, and not his purposes to the things. This man doth go successively considering what things ought to be, that they may serve his purpose, but doth not gradually proceed, accommodating his conceits to the things, as really they are. As for instance, to make the light of the Sun capable to penetrate the substance of the Moon, he makes her in part diaphanous, as is v. g. the transparence of a cloud, or crystal: but I know not what he would think of such a transparency, in case the solar rayes were to passe a depth of clouds of above two thousand miles; but let it be supposed that he should boldly answer, that might well be in the Cœlestial, which are quite other things from these our Elementary, impure,

and feculent bodies; and let us convict his error by such wayes, as admit him no reply, or (to say better) subter-fuge. If he will maintain, that the substance of the Moon is diaphanous, he must say that it is so, whilest that the rayes of the Sun are to penetrate its whole profundity, that is, more than two thousand miles; but that if you oppose unto them onely one mile, or lesse, they should no more penetrate that, than they penetrate one of our mountains.

Sagr.You put me in mind of a man,A jest put upon one that would sell a certain secret for holding correspondency with a person a thousand miles off. who would have sold me a secret how to correspond, by means of a certain sympathy of magnetick needles, with one, that should be two or three thousand miles distant; and I telling him, that I would willingly buy the same, but that I desired first to see the experiment thereof, and that it did suffice me to make it, I being in one Chamber, and he in the next, he answered me, that in so small a distance one could not so well perceive the operation; whereupon I turn'd him going, telling him, that I had no mind, at that time, to take a journey unto Grand Cairo, or to Muscovy, to make the experiment; but that, if he would go himself, I would perform the other part, staying in Venice. But let us hear whither the deduction of our Author tendeth, and what necessity there is, that he must grant the matter of the Moon to be most perforable by the rayes of the Sun, in a depth of two thousand miles, but more opacous than one of our mountains, in a thicknesse of one mile onely.

Salv.The very mountains of the Moon themselves are a proof thereof, which percussed on one side of the Sun, do cast on the contrary side very dark shadows, terminate, and more distinct by much, than the shadows of ours; but had these mountains been diaphanous, we could never have come to the knowledg of any unevennesse in the superficies of the Moon, not have seen those luminous montuosities distinguished by the terms which separate the lucid parts from the dark: much lesse, should we see this same term so distinct, if it were true, that the Suns light did penetrate the whole thicknesse of the Moon; yea rather, according to the

Authors own words, we should of necessity discern the passage, and confine, between the part of the Sun seen, and the part not seen, to be very confused, and mixt with light and darknesse; for that that matter which admits the passage of the Suns rayes thorow a space of two thousand miles, must needs be so transparent, that it would very weakly resist them in a hundredth, or lesser part of that thicknesse; neverthelesse, the term which separateth the part illuminated from the obscure, is incident, and as distinct, as white is distinct from black; and especially where the Section passeth through the part of the Moon, that is naturally more clear and montanous; but where the old spots do part, which are certain plains, that by means of their spherical inclination, receive the rayes of the Sun obliquely, there the term is not so distinct, by reason of the more dimme illumination. That, lastly, which he saith, how that the secondary light doth not diminish and languish, according as the Moon encreaseth, but conserveth it self continually in the same efficacy; is most false; nay it is hardly seen in the quadrature, when, on the contrary, it should appear more splendid, and be visible after the crepusculum in the dark of night. Let us conclude therefore, that the Earths reflection is very strong upon the Moon; and that, which you ought more to esteem, we may deduce from thence another admirable congruity between the Moon and Earth; namely, The Earth may reciprocally operate upon Cœlestial bodies, with its light. that if it be true, the Planets operate upon the Earth by their motion and light, the Earth may probably be no lesse potent in operating reciprocally upon them with the same light, and peradventure, motion also. And though it should not move, yet may it retain the same operation; because, as it hath been proved already, the action of the light is the self same, I mean of the light of the Sun reflected; and motion doth nothing, save only vary the aspects, which fall out in the same manner, whether we make the Earth move, and the Sun stand still, or the contrary.

Simpl.None of the Philosophers are found to have said, that these inferiour bodies operate on the Cœlestial, nay, Aristotle affirmes the direct contrary.

Salv.Aristotle and the rest, who knew not that the Earth and Moon mutually illuminated each other, are to be excused; but they would justly deserve our censure, if whilest they desire that we should grant and believe with them, that the Moon operateth upon the Earth with light, they should deny to us, who have taught them that the Earth illuminates the Moon, the operation the Earth hath on the Moon.

Simpl.In short, I find in my self a great unwillingnesse to admit this commerce, which you would perswade me to be betwixt the Earth and Moon, placing it, as we say, amongst the number of the Stars; for if there were nothing else, the great separation and distance between it and the Cœlestial bodies, doth in my opinion necessarily conclude a vast disparity between them.

Salv.See Simplicius what an inveterate affection and radicated opinion can do, since it is so powerful, that it makes you think that those very things favour you, which you produce against your self. For if separation and distance are accidents sufficient to perswade with you a great diversity of natures, it must follow that proximity and contiguity import similitude.Affinity between he Earth & Moon in respect of their vicinity. Now how much more neerer is the Moon to the Earth, than to any other of the Cœlestial Orbs? You must acknowledg therefore, according to your own concession (and you shall have other Philosophers bear you company) that there is a very great affinity betwixt the Earth and Moon. Now let us proceed, and see whether any thing remains to be considered, touching those objections which you made against the resemblances that are between these two bodies.

Simpl.It rests, that we say something touching the solidity of the Moon, which I argued from its being exquisite smooth and polite, and you from its montuosity. There is another scruple also comes into my mind, from an opinion which I have, that the Seas reflection ought by the equality of its surface, to be rendered stronger than that of the Earth, whose superficies is so rough and opacous.

Salv.As to the first objection; I say, that like as among the parts of the Earth,Solidity

of the Lunar Globe argued from its being montainous. which all by their gravity strive to approach the nearest they can possible to the center, some of them alwayes are more remote from it than the rest, as the mountains more than the valleys, and that by reason of their solidity and firmnesse (for if they were of fluid, they would be even) so the seeing some parts of the Moon to be elevated above the sphericity of the lower parts, argueth their hardnesse; for it is probable that the matter of the Moon is reduced into a spherical form by the harmonious conspiration of all its parts to the same sentense. Touching the second doubt, my thinks that the particulars already observed to happen in the Looking-glasses, may very well assure us, that the reflection of light comming from the Sea,The Seas reflection of light much weaker than that of the Earth. is far weaker than that which cometh from Land; understanding it alwayes of the universal reflection; for as to that particular, on which the water being calm, casteth upon a determinate place, there is no doubt, but that he who shall stand in that place, shall see a very great reflection in the water, but every way else he shall see the surface of the Water more obscure than that of the Land;An experiment to prove the reflection of the Water lesse clear than that of the Land. and to prove it to your senses, let us go into yonder Hall, and power forth a little water upon the Pavement. Tell me now, doth not this wet brick shew more dull than the other dry ones? Doubtlesse it doth, and will so appear, from what place soever you behold it, except one onely, and this is that way which the light cometh, that entereth in at yonder window; go backwards therefore by a little and a little.

Simpl.Here I see the west part shine more than all the rest of the pavement, and I see that it so hapneth, because the reflection of the light which entereth in at the window, cometh towards me.

Salv.That moisture hath done no more but filled those little cavities which are in the brick with water, and reduced its superficies to an exact evenesse; whereupon the reflex rayes issue unitedly towards one and the same place; but the rest of the pavement which is dry, hath its protuberances, that is, an innumerable variety of

inclinations in its smallest particles; whereupon the reflections of the light scatter towards all parts, but more weakly than if they had gone all united together; and therefore, the same sheweth almost all alike, beheld several wayes, but far lesse clear than the moistned brick. I conclude therefore, that the surface of the Sea, beheld from the Moon, in like manner, as it would appear most equal, (the Islands and Rocks deducted) so it would shew lesse clear than that of the Earth, which is montanous and uneven. And but that I would not seem, as the saying is, to harp too much on one string, I could tell you that I have observed in the Moon that secondary light which I told you came to her from the reflection of the Terrestrial Globe, to be notably more clear two or three dayes before the conjunction,The secondary light of the Moon clearer before the conjunction, than after. than after, that is, when we see it before break of day in the East, than when it is seen at night after Sun-set in the West; of which difference the cause is, that the Terrestrial Hemisphere, which looks towards the Eastern Moon, hath little Sea, and much Land, to wit, all Asia, whereas, when it is in the West, it beholds very great Seas, that is, the whole Atlantick Ocean as far as America: An Argument sufficiently probable that the surface of the water appears lesse splendid than that of the Earth.

Simpl.So that perhaps you believe, those great spots discovered in the face of the Moon, to be Seas, and the other clearer parts to be Land, or some such thing?

Salv.This which you ask me, is the beginning of those incongruities which I esteem to be between the Moon and the Earth, out of which it is time to dis-ingage our selves, for we have stayed too long in the Moon. I say therefore, that if there were in nature but one way onely, to make two superficies illustrated by the Sun, to appear one more clear than the other, and that this were by the being of the one Earth, and the other Water; it would be necessary to say that the surface of the Moon were part earthy and part aquatick; but because we know many wayes to produce the same effect (and others there may be which we know not of;) therefore I dare not affirm the Moon to consist of one thing more than another: It hath been seen already that a

silver plate boiled, being toucht with the Burnisher, becometh of white obscure; that the moist part of the Earth shews more obscure than the dry; that in the tops of Hills, the woody parts appear more gloomy than the naked and barren; which hapneth because there falleth very much shadow among the Trees, but the open places are illuminated all over by the Sun. And this mixtion of shadow hath such operation, that in tufted velvet, the silk which is cut, is of a far darker colour than that which is not cut, by means of the shadows diffused betwixt thred and thred, and a plain velvet shews much blacker than a Taffata, made of the same silk. So that if there were in the Moon things which should look like great Woods, their aspect might represent unto us the spots which we discover; alike difference would be occasioned, if there were Seas in her: and lastly, nothing hindreth, but that those spots may really be of an obscurer colour than the rest; for thus the snow makes the mountains shew brighter.The obscurer parts of the Moon are plains, and the more bright mountainous. That which is plainly observed in the Moon is, that its most obscure parts are all plains, with few rises and bancks in them; though some there be; the rest which is of a brighter colour, is all full of rocks, mountains, hillocks of spherical and other figures; and in particular, round about the spots are very great ledges of mountains.Long ledges of mountains about the spots of the Moon. That the spots be plain superficies, we have assured proof, in that we see, how that the term which distinguisheth the part illuminated from the obscure, in crossing the spots makes the intersection even, but in the clear parts it shews all craggy and shagged. But I know not as yet whether this evennesse of superficies may be sufficient of it self alone, to make the obscurity appear, and I rather think not. Besides, I account the Moon exceeding different from the Earth; for although I imagine to my self that those are not idle and dead Regions,There are not generated in the Moon things like to ours, but if there be any productions, they are very different. yet I affirm not, that there are in them motion and life, much less that there are bred plants, animals or other things like to ours; but, if such there be, they should nevertheless be very different, and

remote from our imagination. And I am induced so to think, because in the first place, I esteem that the matter of the Lunar Globe consists not of Earth and Water; and this alone sufficeth to take away the generations and alterations resembling ours:The Moon not composed of Water and Earth. but now supposing that there were in the Moon, Water and Earth, yet would they not produce plants and animals like to ours;Those aspects of the Sun necessary for our generations, are not so in the Moon. and this for two principal reasons: The first is, that unto our productions there are required so many variable aspects of the Sun, that without them they would all miscarry: now the habitudes of the Sun towards the Earth are far different from those towards the Moon. We as to the diurnal illumination, have, in the greater part of the Earth, every twenty four hours part day, and part night, which effect in the Moon is monethly: and that annual declination and elevation of the Sun in the Zodiack,Natural dayes in the Moon are of a Moneth long. by which it produceth diversity of Seasons, and inequality of dayes and nights, are finished in the Moon in a moneth; and whereas the Sun to us riseth and declineth so much,To the Moon the Sun ascendeth and declineth with a difference of ten degrees, and to the Earth of forty seven degrees. that from the greatest to the least altitude, there is a difference of almost 47 degrees, for so much is the distance from one to the other Tropick; this is in the Moon but ten degrees only, or little more; namely, as much as the greatest Latitudes of the Dragon on each side the Ecliptick. Now consider what effect the Sun would have in the torrid Zone, should it continually for fifteen dayes together beam forth its Rayes upon it; which without all question would destroy plants, herbs, and living creatures: and if it should chance that there were any production, it would be of herbs, plants, and creatures very different from those which are now there.There are no rains in the Moon. Secondly, I verily believe that in the Moon there are no rains, for if Clouds should gather in any part thereof, as they do about the Earth, they would thereupon hide from our sight some of those things, which we with the Telescope behold in the Moon, and in a word, would some way or other

change its Phænomenon, an effect which I could never by long and diligent observations discover; but alwayes beheld it in a even and pure serenity.

Sagr.To this may be answered, either that there might be great mists, or that it might rain in the time of their night, that is, when the Sun doth not illuminate it.

Salv.If other passages did but assure us, that there were generations in it like to ours, and that there was onely wanting the concourse of rains, we might find out this, or some other temperament to serve instead thereof, as it happens in Egypt by the inundation of Nile: but not meeting with any accident, which corresponds with ours, of many that have been sought out for the production of the like effects, we need not trouble our selves to introduce one alone; and that also, not because we have certain observation of it, but for a bare non-repugnance that we find therein. Moreover, if I was demanded what my first apprehension, and pure natural reason dictated to me concerning the production of things like or unlike there above, I would alwayes reply, that they are most different, and to us altogether unimaginable, for so me thinks the riches of Nature, and the omnipotence of our Creator and Governour, do require.

Sagr.I ever accounted extraordinary madnesse that of those, who would make humane comprehension the measure of what nature hath a power or knowledge to effect; whereas on the contrary there is not any the least effect in Nature,The having a perfect knowledg of nothing, maketh some believe they understand all things. which can be fully understood by the most speculative wits in the world. This their so vain presumption of knowing all, can take beginning from nothing, unlesse from their never having known any thing; for if one hath but once onely experienced the perfect knowledg of one onely thing, and but truly tasted what it is to know, he shall perceive that of infinite other conclusions, he understands not so much as one.

Salv.Your discourse is very concluding; in confirmation of which we have the example of those who understand, or have known some thing, which the more

knowing they are, the more they know, and freely confesse that they know little; nay, the wisest man in all Greece, and for such pronounced by the Oracle, openly professed to know that he knew nothing.

Simpl.It must be granted therefore, either that Socrates or that the Oracle it self was a lyar, that declaring him to be most wise, and he confessing that he knew himself to be most ignorant.

Salv.Neither one nor the other doth follow,The answer of the Oracle true in judging Socrates the wisest of his time. for that both the assertions may be true. The Oracle adjudged Socrates the wisest of all men, whose knowledg is limited; Socrates acknowledgeth that he knew nothing in relation to absolute wisdome, which is infinite; and because of infinite, much is the same part, as is little, and as is nothing (for to arrive v. g. to the infinite number, it is all one to accumulate thousands, tens, or ciphers,) therefore Socrates well perceived his wisdom to be nothing, in comparison of the infinite knowledg which he wanted. But yet, because there is some knowledg found amongst men, and this not equally shared to all, Socrates might have a greater share thereof than others, and therefore verified the answer of the Oracle.

Sagr.I think I very well understand this particular amongst men, Simplicius there is a power of operating, but not equally dispensed to all; and it is without question, that the power of an Emperor is far greater than that of a private person; but, both this and that are nothing in comparison of the Divine Omnipotence. Amongst men, there are some that better understand Agriculture than many others; but the knowledg of planting a Vine in a trench, what hath it to do with the knowledg of making it to sprout forth, to attract nourishment, to select this good part from that other, for to make thereof leaves, another to make sprouts, another to make grapes, another to make raisins, another to make the huskes of them, which are the works of most wise Nature? This is one only particular act of the innumerable, which Nature

doth,Divine Wisdom infinitely infinite. and in it alone is discovered an infinite wisdom, so that Divine Wisdom may be concluded to be infinitely infinite.

Salv.Take hereof another example. Do we not say that the judicious discovering of a most lovely Statua in a piece of Marble, hath sublimated the wit of Buonarruotti far above the vulgar wits of other men?Buonarruotti, a statuary of admirable ingenuity. And yet this work is onely the imitation of a meer aptitude and disposition of exteriour and superficial members of an immoveable man; but what is it in comparison of a man made by nature, composed of as many exteriour and interiour members, of so many muscles, tendons, nerves, bones, which serve to so many and sundry motions? but what shall we say of the senses, and of the powers of the soul, and lastly, of the understanding? May we not say, and that with reason, that the structure of a Statue fals far short of the formation of a living man, yea more of a contemptible worm?

Sagr.And what difference think you, was there betwixt the Dove of Architas, and one made by Nature?

Simpl.Either I am none of these knowing men, or else there is a manifest contradiction in this your discourse. You account understanding amongst the greatest (if you make it not the chief of the) Encomiums ascribed to man made by Nature, and a little before you said with Socrates, that he had no knowledg at all; therefore you must say, that neither did Nature understand how to make an understanding that understandeth.

Salv.You argue very cunningly, but to reply to your objection I must have recourse to a Philosophical distinction, and say that the understanding is to be taken too ways,Man understandeth very well intensivè, but little extensivè that is intensivè, or extensivè; and that extensivè, that is, as to the multitude of intelligibles, which are infinite, the understanding of man is as nothing, though he should understand a thousand propositions; for that a thousand, in respect of infinity is but as a cypher:

but taking the understanding intensive, (in as much as that term imports) intensively, that is, perfectly some propositions, I say, that humane wisdom understandeth some propositions so perfectly, and is as absolutely certain thereof, as Nature her self; and such are the pure Mathematical sciences, to wit, Geometry and Arithmetick: in which Divine Wisdom knows infinite more propositions, because it knows them all; but I believe that the knowledge of those few comprehended by humane understanding, equalleth the divine, as to the certainty objectivè, for that it arriveth to comprehend the necessity thereof, than which there can be no greater certainty.

Simpl.This seemeth to me a very bold and rash expression.

Salv.These are common notions, and far from all umbrage of temerity, or boldness, and detract not in the least from the Majesty of divine wisdom; as it nothing diminisheth the omnipotence thereof to say, that God cannot make what is once done, to be undone: but I doubt, Simplicius, that your scruple ariseth from an opinion you have, that my words are somewhat equivocal; therefore the better to express my self I say, that as to the truth, of which Mathematical demonstrations give us the knowledge, it is the same, which the divine wisdom knoweth; but this I must grant you,Gods manner of knowing different from that of men. that the manner whereby God knoweth the infinite propositions, of which we understand some few, is highly more excellent than ours,Humane understanding done by raciocination. which proceedeth by ratiocination, and passeth from conclusion to conclusion, whereas his is done at one single thought or intuition; and whereas we, for example, to attain the knowledg of some passion of the Circle, which hath infinite, beginning from one of the most simple, and taking that for its definition, do proceed with argumentation to another, and from that to a third, and then to a fourth, &c. the Divine Wisdom, by the apprehension of its essence comprehends, without temporary raciocination, all these infinite passions; which notwithstanding, are in effect virtually comprised in the definitions of all things;Definitions contein virtually all the passions of the things defined. and, to conclude, as being infinite, perhaps are but

one alone in their nature, and in the Divine Mind; the which neither is wholly unknown to humane understanding,Infinite Passions are perhaps but one onely. but onely be-clouded with thick and grosse mists; which come in part to be dissipated and clarified, when we are made Masters of any conclusions, firmly demonstrated, and so perfectly made ours, as that we can speedily run through them; for in sum, what other, is that proposition, that the square of the side subtending the right angle in any triangle, is equal to the squares of the other two, which include it, but onely the Paralellograms being upon common bases, and between parallels equal amongst themselves? and this, lastly, is it not the same, as to say that those two superficies are equal, of which equal parts applyed to equal parts,The discourses which humane reason makes in a certain time, the Divine Wisdom resolveth in a moment; that is, hath them alwayes present. possesse equal place? Now these inferences, which our intellect apprehendeth with time and a gradual motion, the Divine Wisdom, like light, penetrateth in an instant, which is the same as to say, hath them alwayes present: I conclude therefore, that our understanding, both as to the manner and the multitude of the things comprehended by us, is infinitely surpast by the Divine Wisdom; but yet I do not so vilifie it, as to repute it absolutely nothing; yea rather, when I consider how many and how great misteries men have understood, discovered, and contrived, I very plainly know and understand the mind of man to be one of the works, yea one of the most excellent works of God.

Sagr.I have oft times considered with my self,The wit of man admirably acute. in pursuance of that which you speak of, how great the wit of man is; and whil'st I run thorow such and so many admirable inventions found out by him, as well in the Arts, as Sciences; and again reflecting upon my own wit, so far from promising me the discovery of any thing new, that I despair of comprehending what is already discovered, confounded with wonder, and surprised with desperation, I account my self little lesse than miserable. If I behold a Statue of some excellent Master, I say with my self; When wilt thou know how to chizzle away the refuse of a piece of

Marble, and discover so lovely a figure, as lyeth hid therein? When wilt thou mix and spread so many different colours upon a Cloth, or Wall, and represent therewith all visible objects, like a Michael Angelo, a Raphaello, or a Tizvano? If I behold what inventions men have in comparting Musical intervals, in establishing Precepts and Rules for the management thereof with admirable delight to the ear: When shall I cease my astonishment? What shall I say of such and so various Instruments of that Art? The reading of excellent Poets, with what admiration doth it swell any one that attentively considereth the invention of conceits, and their explanation? What shall we say of Architecture? What of Navigation?The invention of writing stupendious above all others. But, above all other stupendious inventions, what sublimity of mind was that in him, that imagined to himself to find out a way to communicate his most secret thoughts to any other person, though very far distant from him either in time, or place, speaking with those that are in the India's; speaking to those that are not yet born, nor shall be this thousand, or ten thousand years? and with how much facility? but by the various collocation of* For of so many only the Italian Alphabet consists. * twenty little letters upon a paper? Let this be the Seal of all the admirable inventions of man, and the close of our Discourse for this day: For the warmer hours being past, I suppose that Salviatus hath a desire to go and take the air in his Gondelo; but too morrow we will both wait upon you, to continue the Discourses we have begun, &c.

The Second Dialogue

The Second Dialogue.

INTERLOCUTORS.

Salviatus, Sagredus, and Simplicius.

SALV.

He yester-dayes diversions which led us out of the path of our principal discourse, were such and so many, that I know not how I can without your assistance recover the track in which I am to proceed.

Sagr.I wonder not, that you, who have your fancy charged and laden with both what hath been, and is to be spoken, do find your self in some confusion; but I, who as being onely an Auditor, have nothing to burthen my memory withal, but such things as I have heard, may haply by a succinct rehearsal of them, recover the first thred of our Discourse. As far therefore as my memory serves me, the sum of yester-dayes conferences were an examination of the Principles of Ptolomy and Copernicus, and which of their opinions is the more probable and rational; that, which affirmeth the substance of the Cœlestial bodies to be ingenerable, incorruptible, unalterable, impassible, and in a word, exempt from all kind of change, save that of local, and therefore to be a fifth essence, quite different from this of our Elementary bodies, which are generable, corruptible, alterable, &c. or else the other, which taking away such deformity from the parts of the World, holdeth the Earth to enjoy the same perfections as the other integral bodies of the universe; and esteemeth it a moveable and erratick Globe, no lesse than the Moon, Jupiter, Venus, or any other Planet: And lastly, maketh many particular parallels betwixt the Earth and Moon; and more with the Moon, than with any other Planet; haply by reason we have greater and more certain notice of it, as being lesse distant from us. And having, lastly, concluded this second opinion to have more of probability with it than the first, I should think it best in the subsequent discourses to begin to examine whether the Earth be esteemed immoveable, as it hath been till now believed by most men, or else moveable, as some ancient Philosophers held, and others of not very recesse times, were of opinion; and if it be moveable, to enquire of what kind its motion may be?

Salv.I see already what way I am to take; but before we offer to proceed any farther, I am to say something to you touching those last words which you spake, how that the opinion which holds the Earth to be endued with the same conditions that the

Cœlestial bodies enjoy, seems to be more true than the contrary; for that I affirmed no such thing, nor would I have any of the Propositions in controversie, be made to speak to any definitive sense: but I onely intended to produce on either part, those reasons and answers, arguments and solutions, which have been hitherto thought upon by others, together with certain others, which I have stumbled upon in my long searching thereinto, alwayes remitting the decision thereof to the judgment of others.

Sagr.I was unawares transported by my own sense of the thing; and believing that others ought to judg as I did, I made that conclusion universal, which should have been particular; and therefore confesse I have erred, and the rather, in that I know not what Simplicius his judgment is in this particular.

Simpl.I must confesse, that I have been ruminating all this night of what past yesterday, and to say the truth, I meet therein with many acute, new, aud plausible notions; yet nevertheless, I find my self over-perswaded by the authority of so many great Writers, and in particular ——— &c. I see you shake your head Sagredus, and smile to your self, as if I had uttered some great absurdity.

Sagr.I not onely smile, but to tell you true, am ready to burst with holding in my self from laughing outright, for you have put me in mind of a very pretty passage, that I was a witnesse of, not many years since, together with some others of my worthy friends, which I could yet name unto you.

Salv.It would be well that you told us what it was, that so Simplicius may not still think that he gave you the occasion of laughter.

Sagr.I am content. I found one day, at home in his house, at Venice, a famous Phisician, to whom some flockt for their studies, and others out of curiosity, sometimes came thither to see certain Anatomies diffected by the hand of a no lesse learned, than careful and experienced Anatomist.The original of the Nerves, according to Aristotle, and according to Phisicians. It chanced upon that day, when I was there, that he was in search of the original and rise of the Nerves, about which

there is a famous controversie between the Galenists and Peripateticks; and the Anatomist shewing, how that the great number of Nerves departing from the Brain, as their root, and passing by the nape of the Neck, distend themselves afterwards along by the Back-bone, and branch themselves thorow all the Body; and that a very small filament, as fine as a thred went to the Heart; he turned to a Gentleman whom he knew to be a Peripatetick Philosopher, and for whose sake he had with extraordinary exactnesse, discovered and proved every thing, and demanded of him, if he was at length satisfied and perswaded that the original of the Nerves proceeded from the Brain, and not from the Heart?The ridiculous answer of a Philosopher, determining the original of the Nerves. To which the Philosopher, after he had stood musing a while, answered; you have made me to see this businesse so plainly and sensibly, that did not the Text of Aristotle assert the contrary, which positively affirmeth the Nerves to proceed from the Heart, I should be constrained to confesse your opinion to be true.

Simpl.I would have you know my Masters, that this controversie about the original of the Nerves is not yet so proved and decided, as some may perhaps perswade themselves.

Sagr.Nor questionlesse ever shall it be, if it find such like contradictors; but that which you say, doth not at all lessen the extravagance of the answer of that Peripatetick, who against such sensible experience produced not other experiments, or reasons of Aristotle, but his bare authority and pure ipse dixit.

Simpl.Aristotle had not gained so great authority, but for the force of his Demonstrations, and the profoundnesse of his arguments; but it is requisite that we understand him, and not onely understand him, but have so great familiarity with his Books, that we form a perfect Idea thereof in our minds, so as that every saying of his may be alwayes as it were, present in our memory for he did not write to the vulgar, nor is he obliged to spin out his Sillogismes with the trivial method of

disputes; nay rather, using a freedome, he hath sometimes placed the proof of one Proposition amongst Texts, which seem to treat of quite another point;Requisites to fit a man to philosophate well after the manner of Aristotle. and therefore it is requisite to be master of all that vast Idea, and to learn how to connect this passage with that, and to combine this Text with another far remote from it; for it is not to be questioned but that he who hath thus studied him, knows how to gather from his Books the demonstrations of every knowable deduction, for that they contein all things.

Sagr.But good Simplicius, like as the things scattered here and there in Aristotle, give you no trouble in collecting them, but that you perswade your self to be able by comparing and connecting several small sentences to extract thence the juice of some desired conclusion,A cunning way to gather Philosophy out of any book whatsoever. so this, which you and other egregious Philosophers do with the Text of Aristotle, I could do by the verses of Virgil, or of Ovid, composing thereof* A word signifying works composed of many fragments of verses collected out of the Poets. * Centones, and therewith explaining all the affairs of men, and secrets of Nature. But what talk I of Virgil, or any other Poet? I have a little Book much shorter than Aristotle and Ovid, in which are conteined all the Sciences, and with very little study, one may gather out of it a most perfect Idea, and this is the Alphabet; and there is no doubt but that he who knows how to couple and dispose aright this and that vowel, with those, or those other consonants, may gather thence the infallible answers to all doubts, and deduce from them the principles of all Sciences and Arts, just in the same manner as the Painter from divers simple colours, laid severally upon his Pallate, proceedeth by mixing a little of this and a little of that, with a little of a third, to represent to the life men, plants, buildings, birds, fishes, and in a word, counterfeiting what ever object is visible, though there be not on the Pallate all the while, either eyes, or feathers, or fins, or leaves, or stones. Nay, farther, it is necessary, that none of the things to be imitated, or any part of them, be actually

among colours, if you would be able therewith to represent all things; for should there be amongst them v. gr. feathers, these would serve to represent nothing save birds, and plumed creatures.

Salv.And there are certain Gentlemen yet living, and in health, who were present, when a Doctor, that was Professor in a famous Academy,Invention of the Telescope taken from Aristotle. hearing the description of the Telescope, by him not seen as then, said, that the invention was taken from Aristotle, and causing his works to be fetch't, he turned to a place where the Philosopher gives the reason, whence it commeth, that from the bottom of a very deep Well, one may see the stars in Heaven, at noon day; and, addressing himself to the company, see here, saith he, the Well, which representeth the Tube, see here the gross vapours, from whence is taken the invention of the Crystals, and see here lastly the sight fortified by the passage of the rays through a diaphanous, but more dense and obscure medium.

Sagr.This is a way to comprehend all things knowable, much like to that wherewith a piece of marble conteineth in it one, yea, a thousand very beautiful Statua's, but the difficulty lieth in being able to discover them; or we may say, that it is like to the prophesies of Abbot Joachim, or the answers of the Heathen Oracles, which are not to be understood, till after the things fore-told are come to passe.

Salv.And why do you not adde the predictions of the Genethliacks, which are with like cleernesse seen after the event, in their Horoscopes, or, if you will, Configurations of the Heavens.

Sagr.In this manner the Chymists find,Chymists interpret the Fables of the Poets to be secrets for making of Gold. being led by their melancholly humour, that all the sublimest wits of the World have writ of nothing else in reality, than of the way to make Gold; but, that they might transmit the secret to posterity without discovering it to the vulgar, they contrived some one way, and some another how to conceal the same under several maskes; and it would make one merry to hear their comments

upon the ancient Poets, finding out the important misteries, which lie hid under their Fables; and the signification of the Loves of the Moon, and her descending to the Earth for Endimion; her displeasure against Acteon, and what was meant by Jupiters turning himself into a showre of Gold; and into flames of fire; and what great secrets of Art are conteined in that Mercury the Interpreter; in those thefts of Pluto; and in those Branches of Gold.

Simpl.I believe, and in part know, that there want not in the World very extravagant heads, the vanities of whom ought not to redound to the prejudice of Aristotle, of whom my thinks you speak sometimes with too little respect, and the onely antiquity and bare name that he hath acquired in the opinions of so many famous men, should suffice to render him honourable with all that professe themselves learned.

Salv.You state not the matter rightly, Simplicius; There are some of his followers that fear before they are in danger, who give us occasion, or, to say better, would give us cause to esteem him lesse,Some of Aristotles Sectators impare the reputation of their Master, in going about to enhanse it. should we consent to applaud their Capricio's. And you, pray you tell me, are you for your part so simple, as not to know that had Aristotle been present, to have heard the Doctor that would have made him Author of the Telescope, he would have been much more displeased with him, than with those, who laught at the Doctor and his Comments? Do you question whether Aristotle, had he but seen the novelties discovered in Heaven, would not have changed his opinion, amended his Books, and embraced the more sensible Doctrine; rejecting those silly Gulls, which too scrupulously go about to defend what ever he hath said; not considering, that if Aristotle were such a one as they fancy him to themselves, he would be a man of an untractable wit, an obstinate mind, a barbarous soul, a stubborn will, that accounting all men else but as silly sheep, would have his Oracles preferred before the Senses, Experience, and Nature her self? They are the Sectators of Aristotle that have given him this Authority, and not he that hath usurped or taken it upon him; and because it is more easie for a man

to sculk under anothers shield than to shew himself openly, they tremble, and are affraid to stir one step from him; and rather than they will admit some alterations in the Heaven of Aristotle, they will impertinently deny those they behold in the Heaven of Nature.

Sagr.These kind of Drolleries put me in mind of that Statuary which having reduced a great piece of Marble to the Image of an Hercules,A ridiculous passage of a certain Statuary. or a thundring Jupiter, I know not whether, and given it with admirable Art such a vivacity and threatning fury, that it moved terror in as many as beheld it; he himself began also to be affraid thereof, though all its sprightfulnesse, and life was his own workmanship; and his affrightment was such, that he had no longer the courage to affront it with his Chizzels and Mallet.

Salv.I have many times wondered how these nice maintainers of what ever fell from Aristotle, are not aware how great a prejudice they are to his reputation and credit; and how that the more they go about to encrease his Authority, the more they diminish it; for whilest I see them obstinate in their attempts to maintain those Propositions which I palpably discover to be manifestly false; and in their desires to perswade me that so to do, is the part of a Philosopher; and that Aristotle himself would do the same, it much abates in me of the opinion that he hath rightly philosophated about other conclusions, to me more abstruse: for if I could see them concede and change opinion in a manifest truth, I would believe, that in those in which they should persist, they may have some solid demonstrations to me unknown, and unheard of.

Sagr.Or when they should be made to see that they have hazarded too much of their own and Aristotle's repuatation in confessing, that they had not understood this or that conclusion found out by some other man; would it not be a less evil for them to seek for it amongst his Texts, by laying many of them together, according to the art intimated to us by Simplicius? for if his works contain all things knowable, it must

follow also that they may be therein discovered.

Salv.Good Sagredus, make no jest of this advice, which me thinks you rehearse in too Ironical a way; for it is not long since that a very eminent Philosopher having composed a Book de animà, wherein, citing the opinion of Aristotle, about its being or not being immortal, he alledged many Texts, (not any of those heretofore quoted by Alexander ab Alexandro: for in those he said, that Aristotle had not so much as treated of that matter, much less determined any thing pertaining to the same, but others) by himself found out in other more abstruse places, which tended to an erroneous sense: and being advised, that he would find it an hard matter to get a Licence from the Inquisitors,A brave resolution of a certain Peripatetick Philosopher. he writ back unto his friend, that he would notwithstanding, with all expedition procure the same, for that if no other obstacle should interpose, he would not much scruple to change the Doctrine of Aristotle, and with other expositions, and other Texts to maintain the contrary opinion, which yet should be also agreeable to the sense of Aristotle.

Sagr.Oh most profound Doctor, this! that can command me that I stir not a step from Aristotle, but will himself lead him by the nose, and make him speak as he pleaseth. See how much it importeth to learn to take Time by the Fore-top. Nor is it seasonable to have to do with Hercules, whil'st he is enraged, and amongst the Furies, but when he is telling merry tales amongst the Meonion Damosels.The servile spirit of some of Aristotles followers. Ah, unheard of sordidnesse of servile souls! to make themselves willing slaves to other mens opinions; to receive them for inviolable Decrees, to engage themselves to seem satisfied and convinced by arguments, of such efficacy, and so manifestly concludent, that they themselves cannot certainly resolve whether they were really writ to that purpose, or serve to prove that assumption in hand, or the contrary. But, which is a greater madnesse, they are at variance amongst themselves, whether the Author himself hath held the affirmative part, or the negative. What is this, but to make an Oracle of a Log, and to

run to that for answers, to fear that, to reverence and adore that?

Simpl.But in case we should recede from Aristotle, who have we to be our Guid in Philosophy? Name you some Author.

Salv.We need a Guid in unknown and uncouth wayes, but in champion places, and open plains, the blind only stand in need of a Leader; and for such, it is better that they stay at home. But he that hath eyes in his head, and in his mind, him should a man choose for his Guid.Too close adhering to Aristotle is blameable. Yet mistake me not, thinking that I speak this, for that I am against hearing of Aristotle; for on the contrary, I commend the reading, and diligently studying of him; and onely blame the servile giving ones self up a slave unto him, so, as blindly to subscribe to what ever he delivers, and without search of any farther reason thereof, to receive the same for an inviolable decree. Which is an abuse, that carrieth with it another great inconvenience, to wit, that others will no longer take pains to understand the validity of his Demonstrations. And what is more shameful, than in the middest of publique disputes, whilest one person is treating of demonstrable conclusions, to hear another interpose with a passage of Aristotle, and not seldome writ to quite another purpose, and with that to stop the mouth of his opponent? But if you will continue to study in this manner, I would have you lay aside the name of Philosophers; and call your selves either Historians or Doctors of Memory,It is not just, that those who never philosophate, should usurp the title of Philosophers. for it is not fit, that those who never philosophate, should usurp the honourable title of Philosophers. But it is best for us to return to shore, and not lanch farther into a boundlesse Gulph, out of which we shall not be able to get before night. Therefore Simplicius, come either with arguments and demonstrations of your own, or of Aristotle, and bring us no more Texts and naked authorities,The Sensible World. for our disputes are about the Sensible World, and not one of Paper. And forasmuch as in our discourses yesterday, we retriev'd the Earth from darknesse, and exposed it to the open skie, shewing, that the attempt to enumerate it amongst those which we call

Cœlestial bodies, was not a position so foil'd, and vanquish't, as that it had no life left in it; it followeth next, that we proceed to examine what probability there is for holding of it fixt, and wholly immoveable, scilicet as to its entire Globe, what likelihood there is for making it moveable with some motion, and of what kind that may be. And forasmuch as in this same question I am ambiguous, and Simplicius is resolute, as likewise Aristotle for the opinion of its immobility, he shall one by one produce the arguments in favour of their opinion, and I will alledge the answers and reasons on the contrary part; and next Sagredus shall tell us his thoughts, and to which side he finds himself inclined.

Sagr.Content; provided alwayes that I may reserve the liberty to my self of alledging what pure natural reason shall sometimes dictate to me.

Salv.Nay more, it is that which I particularly beg of you; for, amongst the more easie, and, to so speak, material considerations, I believe there are but few of them that have been omitted by Writers, so that onely some of the more subtle, and remote can be desired, or wanting; and to investigate these, what other ingenuity can be more fit than that of the most acute and piercing wit of Sagredus? Sagr.I am what ever pleaseth Salviatus, but I pray you, let us not sally out into another kind of digression complemental; for at this time I am a Philosopher, and in the Schools, not in the Court.

Salv.Let our contemplation begin therefore with this consideration, that whatsoever motion may be ascribed to the Earth, it is necessary that it be to us, (as inhabitants upon it, and consequently partakers of the same) altogether imperceptible, and as if it were not at all, so long as we have regard onely to terrestrial things;The motions of the Earth are imperceptible to its inhabitants. but yet it is on the contrary, as necessary that the same motion do seem common to all other bodies, and visible objects, that being separated from the Earth, participate not of the same. So that the true method to find whether any kind of motion may be ascribed to the Earth, and

that found, to know what it is, is to consider and observe if in bodies separated from the Earth,The Earth can have no other motions, than those which to us appear commune to all the rest of the Vniverse, the Earth excepted. one may discover any appearance of motion, which equally suiteth to all the rest; for a motion that is onely seen, v. gr. in the Moon, and that hath nothing to do with Venus or Jupiter, or any other Stars, cannot any way belong to the Earth, or to any other save the Moon alone. Now there is a most general and grand motion above all others, and it is that by which the Sun, the Moon,The Diurnal Motion, seemeth commune to all the Universe, save onely the Earth excepted. the other Planets, and the Fixed Stars, and in a word, the whole Universe, the Earth onely excepted, appeareth in our thinking to move from the East towards the West, in the space of twenty four hours; and this, as to this first appearance, hath no obstacle to hinder it, that it may not belong to the Earth alone, as well as to all the World besides, the Earth excepted; for the same aspects will appear in the one position, as in the other. Hence it is that Aristotle and Ptolomy,Aristotle and Ptolomy argue against the Diurnal Motion attributed to the Earth. as having hit upon this consideration, in going about to prove the Earth to be immoveable, argue not against any other than this Diurnal Motion; save onely that Aristotle hinteth something in obscure terms against another Motion ascribed to it by an Ancient, of which we shall speak in its place.

Sagr.I very well perceive the necessity of your illation: but I meet with a doubt which I know not how to free my self from, and this it is, That Copernicus assigning to the Earth another motion beside the Diurnal, which, according to the rule even now laid down, ought to be to us, as to appearance, imperceptible in the Earth, but visible in all the rest of the World; me thinks I may necessarily infer, either that he hath manifestly erred in assigning the Earth a motion, to which there appears not a general correspondence in Heaven; or else that if there be such a congruity therein, Ptolomy on the other hand hath been deficient in not confuting this, as he hath done the other.

Salv.You have good cause for your doubt: and when we come to treat of the other Motion, you shall see how far Copernicus excelled Ptolomey in clearness and sublimity of wit, in that he saw what the other did not, I mean the admirable harmony wherein that Motion agreed with all the other Cœlestial Bodies. But for the present we will suspend this particular, and return to our first consideration; touching which I will proceed to propose (begining with things more general) those reasons which seem to favour the mobility of the Earth,Why the diurnal motion more probably should belong to the Earth, than to the rest of the Universe. and then wait the answers which Simplicius shall make thereto. And first, if we consider onely the immense magnitude of the Starry Sphere, compared to the smalness of the Terrestrial Globe, contained therein so many millions of times; and moreover weigh the velocity of the motion which must in a day and night make an entire revolution thereof, I cannot perswade my self, that there is any man who believes it more reasonable and credible, that the Cœlestial Sphere turneth round, and the Terrestrial Globe stands still.

Sagr.If from the universality of effects, which may in nature have dependence upon such like motions, there should indifferently follow all the same consequences to an hair, aswell in one Hypothesis as in the other; yet I for my part, as to my first and general apprehension, would esteem, that he which should hold it more rational to make the whole Universe move, and thereby to salve the Earths mobility, is more unreasonable than he that being got to the top of your Turret, should desire, to the end onely that he might behold the City, and the Fields about it, that the whole Country might turn round, that so he might not be put to the trouble to stir his head. And yet doubtless the advantages would be many and great which the Copernican Hypothesis is attended with, above those of the Ptolomaique, which in my opinion resembleth, nay surpasseth that other folly; so that all this makes me think that far more probable than this. But haply Aristotle, Ptolomey, and Simplicius may find the advantages of their Systeme, which they would do well to communicate to us also, if

any such there be; or else declare to me, that there neither are or can be any such things.

Salv.For my part, as I have not been able, as much as I have thought upon it, to find any diversity therein; so I think I have found, that no such diversity can be in them: in so much that I esteem it to no purpose to seek farther after it.Motion, as to the things that equally move thereby, is as if it never were, & so far operates as it hath relation to things deprived of motion. Therefore observe: Motion is so far Motion, and as Motion operateth, by how far it hath relation to things which want Motion: but in those things which all equally partake thereof it hath nothing to do, and is as if it never were. And thus the Merchandises with which a ship is laden, so far move, by how far leaving London, they pass by France, Spain, Italy, and sail to Aleppo, which London, France, Spain &c. stand still, not moving with the ship: but as to the Chests, Bales and other Parcels, wherewith the ship is stow'd and and laden, and in respect of the ship it self, the Motion from London to Syria is as much as nothing; and nothing-altereth the relation which is between them: and this, because it is common to all, and is participated by all alike: and of the Cargo which is in the ship, if a Bale were romag'd from a Chest but one inch onely, this alone would be in that Cargo, a greater Motion in respect of the Chest, than the whole Voyage of above three thousand miles, made by them as they were stived together.

Simpl.This Doctrine is good, sound, and altogether Peripatetick.

Salv.I hold it to be much more antient:A proposition taken by Aristotle from the Antients, but somewhat altered by him. and suspect that Aristotle in receiving it from some good School, did not fully understand it, and that therefore, having delivered it with some alteration, it hath been an occasion of confusion amongst those, who would defend whatever he saith. And when he writ, that whatsoever moveth, doth move upon something immoveable, I suppose that he equivocated, and meant, that whatever moveth, moveth in respect to something immoveable; which

proposition admitteth no doubt, and the other many.

Sagr.Pray you make no digression, but proceed in the dissertation you began.

Salv.It being therefore manifest,The first discourse to prove that the diurnal motion belongs to the Earth. that the motion which is common to many moveables, is idle, and as it were, null as to the relation of those moveables between themselves, because that among themselves they have made no change: and that it is operative onely in the relation that those moveables have to other things, which want that motion, among which the habitude is changed: and we having divided the Universe into two parts, one of which is necessarily moveable, and the other immoveable; for the obtaining of whatsoever may depend upon, or be required from such a motion, it may as well be done by making the Earth alone, as by making all the rest of the World to move: for that the operation of such a motion consists in nothing else, save in the relation or habitude which is between the Cœlestial Bodies, and the Earth, the which relation is all that is changed. Now if for the obtaining of the same effect ad unguem, it be all one whether the Earth alone moveth, the rest of the Universe standing still;Nature never doth that by many things, which may be done by a few. or that, the Earth onely standing still, the whole Universe moveth with one and the same motion; who would believe, that Nature (which by common consent, doth not that by many things, which may be done by few) hath chosen to make an innumerable number of most vast bodies move, and that with an unconceivable velocity, to perform that, which might be done by the moderate motion of one alone about its own Centre?

Simpl.I do not well understand, how this grand motion signifieth nothing as to the Sun, as to the Moon, as to the other Planets, and as to the innumerable multitude of fixed stars: or why you should say that it is to no purpose for the Sun to pass from one Meridian to another; to rise above this Horizon, to set beneath that other; to make it one while day, another while night: the like variations are made by the

Moon, the other Planets, and the fixed stars themselves.

Salv.All these alterations instanced by you, are nothing, save onely in relation to the Earth: and that this is true, do but imagine the Earth to move,The diurnal motion causeth no mutation amongst the Cœlestial Bodies, but all changes have relation to the Earth. and there will be no such thing in the World as the rising or setting of the Sun or Moon, nor Horizons, nor Meridians, nor days, nor nights; nor, in a word, will such a motion cause any mutation between the Moon and Sun, or any other star whatsoever, whether fixed or erratick; but all these changes have relation to the Earth: which all do yet in sum import no other than as if the Sun should shew it self now to China, anon to Persia, then to Egypt, Greece, France, Spain, America, &c. and the like holdeth in the Moon, and the rest of the Cœlestial Bodies: which self same effect falls out exactly in the same manner, if, without troubling so great a part of the Universe, the Terrestrial Globe be made to revolve in it self.A second confirmation that the diurnal motion belongs to the Earth. But we will augment the difficulty by the addition of this other, which is a very great one, namely, that if you will ascribe this Great Motion to Heaven, you must of necessity make it contrary to the particular motion of all the Orbs of the Planets, each of which without controversie hath its peculiar motion from the West towards the East, and this but very easie and moderate: and then you make them to be hurried to the contrary part, i. e. from East to West, by this most furious diurnal motion: whereas, on the contrary, making the Earth to move in it self, the contrariety of motions is taken away, and the onely motion from West to East is accommodated to all appearances, and exactly satisfieth every Phœnomenon.

Simpl.As to the contrariety of Motions it would import little,Circular motions are not contrary, according to Aristotle. for Aristotle demonstrateth, that circular motions, are not contrary to one another; and that theirs cannot be truly called contrariety.

Salv.Doth Aristotle demonstrate this, or doth he not rather barely affirm it, as serving to some certain design of his? If contraries be those things, that destroy one another, as he himself affirmeth, I do not see how two moveables that encounter each other in a circular line, should lesse prejudice one another, than if they interfered in a right line.

Sagr.Hold a little, I pray you. Tell me Simplicius, when two Knights encounter each other, tilting in open field, or when two whole Squadrons, or two Fleets at Sea, make up to grapple, and are broken and sunk, do you call these encounters contrary to one another?

Simpl.Yes, we say they are contrary.

Sagr.How then, is there no contrariety in circular motions. These motions, being made upon the superficies of the Earth or Water, which are, as you know, spherical, come to be circular. Can you tell, Simplicius, which those circular motions be, that are not contrary to each other? They are (if I mistake not) those of two circles, which touching one another without, one thereof being turn'd round, naturally maketh the other move the contrary ** As you see in a Mill, wherein the implicated cogs set the wheels on moving. way; but if one of them shall be within the other, it is impossible that their motion being made towards different points, they should not justle one another.

Salv.But be they contrary, or not contrary, these are but alterations of words; and I know, that upon the matter, it would be far more proper and agreeable with Nature, if we could salve all with one motion onely, than to introduce two that are (if you will not call them contrary) opposite; yet do I not censure this introduction (of contrary motions) as impossible; nor pretend I from the denial thereof, to inferre a necessary Demonstration, but onely a greater probability,A third confirmation of the same Doctrine. of the other. A third reason which maketh the Ptolomaique Hypothesis lesse probable is, that it most unreasonably confoundeth the order, which

we assuredly see to be amongst those Cœlestial Bodies, the circumgyration of which is not questionable,The greater Orbs make their conversions in greater times. but most certain. And that Order is, that according as an Orb is greater, it finisheth its revolution in a longer time, and the lesser, in shorter. And thus Saturn describing a greater Circle than all the other Planets, compleateth the same in thirty yeares: Jupiter finisheth his; that is lesse, in twelve years: Mars in two: The Moon runneth thorow hers, so much lesse than the rest, in a Moneth onely. Nor do we lesse sensibly see that of the Medicean Stars,The times of the Medicean Planets conversions. which is nearest to Jupiter, to make its revolution in a very short time, that is, in four and forty hours, or thereabouts, the next to that in three dayes and an half, the third in seven dayes, and the most remote in sixteen. And this rate holdeth well enough, nor will it at all alter, whilest we assign the motion of 24 hours to the Terrestrial Globe, for it to move round its own center in that time; but if you would have the Earth immoveable, it is necessary, that when you have past from the short period of the Moon, to the others successively bigger, until you come to that of Mars in two years, and from thence to that of the bigger Sphere of Jupiter in twelve years, and from this to the other yet bigger of Saturn, whose period is of thirty years, it is necessary, I say, that you passe to another Sphere incomparably greater still than that, and make this to accomplish an entire revolution in twenty four hours.The motion of 24 hours ascribed to the highest Sphere disorders the period of the inferiour. And this yet is the least disorder that can follow. For if any one should passe from the Sphere of Saturn to the Starry Orb, and make it so much bigger than that of Saturn, as proportion would require, in respect of its very slow motion, of many thousands of years, then it must needs be a Salt much more absurd, to skip from this to another bigger, and to make it convertible in twenty four hours. But the motion of the Earth being granted, the order of the periods will be exactly observed, and from the very slow Sphere of Saturn, we come to the fixed Stars, which are wholly immoveable, The fourth Confirmation. and so avoid a fourth difficulty,

which we must of necessity admit, if the Starry Sphere be supposed moveable, and that is the immense disparity between the motions of those stars themselves;Great disparity amongst the motions of the particular fixed stars, if their Sphere be moveable. of which some would come to move most swiftly in most vast circles, others most slowly in circles very small, according as those or these should be found nearer, or more remote from the Poles; which still is accompanied with an inconvenience, as well because we see those, of whose motion there is no question to be made, to move all in very immense circles; as also, because it seems to be an act done with no good consideration, to constitute bodies, that are designed to move circularly, at immense distances from the centre, and afterwards to make them move in very small circles. And not onely the magnitudes of the circles, and consequently the velocity of the motions of these Stars, shall be most different from the circles and motions of those others,The fifth Confirmation. but (which shall be the fifth inconvenience) the self-same Stars shall successively vary its circles and velocities:The motions of the fixed stars would accelerate and grow slow in divers times, if the starry Sphere were moveable. For that those, which two thousand years since were in the Equinoctial, and consequently did with their motion describe very vast circles, being in our dayes many degrees distant from thence, must of necessity become more slow of motion, and be reduced to move in lesser circles, and it is not altogether impossible but that a time may come, in which some of them which in aforetime had continually moved, shall be reduced by uniting with the Pole, to a state of rest, and then after some time of cessation, shall return to their motion again; whereas the other Stars, touching whose motion none stand in doubt, do all describe, as hath been said, the great circle of their Orb, and in that maintain themselves without any variation.The sixth Confirmation. The absurdity is farther enlarged (which let be the sixth inconvenience) to him that more seriously examineth the thing, in that no thought can comprehend what ought to be the solidity of that immense Sphere, whose depth so stedfastly holdeth fast such a multitude of Stars,

which without ever changing site among themselves, are with so much concord carried about, with so great disparity of motions. Or else, supposing the Heavens to be fluid, as we are with more reason to believe, so as that every Star wandereth to and fro in it, by wayes of its own, what rules shall regulate their motions, and to what purpose, so, as that being beheld from the Earth, they appear as if they were made by one onely Sphere? It is my opinion, that they might so much more easily do that, and in a more commodious manner, by being constituted immoveable, than by being made errant, by how much more facile it is to number the quarries in the Pavement of a Piazza, than the rout of boyes which run up and down upon them.The Seventh Confirmation. And lastly, which is the seventh instance, if we attribute the Diurnal Motion to the highest Heaven, it must be constituted of such a force and efficacy, as to carry along with it the innumerable multitude of fixed Stars, Bodies all of vast magnitude, and far bigger than the Earth; and moreover all the Spheres of the Planets; notwithstanding that both these and those of their own nature move the contrary way. And besides all this, it must be granted, that also the Element of Fire, and the greater part of the Air, are likewise forcibly hurried along with the rest, and that the sole little Globe of the Earth pertinaciously stands still, and unmoved against such an impulse; a thing, which in my thinking, is very difficult; nor can I see how the Earth, a pendent body,The Earth a pendent Body, and equilibrated in a fluid Medium seems unable to resist the rapture of the Diurnal Motion. and equilibrated upon its centre, exposed indifferently to either motion or rest, and environed with a liquid ambient, should not yield also as the rest, and be carried about. But we find none of these obstacles in making the Earth to move; a small body, and insensible, compared to the Universe, and therefore unable to offer it any violence.

Sagr.I find my fancy disturbed with certain conjectures so confusedly sprung from your later discourses; that, if I would be enabled to apply my self with atention to what followeth, I must of necessity attempt whether I can better methodize them, and gather thence their true construction, if haply any can be made of them; and

peradventure, the proceeding by interrogations may help me the more easily to expresse my self. Therefore I demand first of Simplicius, whether he believeth, that divers motions may naturally agree to one and the same moveable body, or else that it be requisite its natural and proper motion be onely one.

Simpl.To one single moveable,A single moveable hath but onely one natural motion, and all the rest are by participation. there can naturally agree but one sole motion, and no more; the rest all happen accidentally and by participation; like as to him that walketh upon the Deck of a Ship, his proper motion is that of his walk, his motion by participation that which carrieth him to his Port, whither he would never with his walking have arrived, if the Ship with its motion had not wafted him thither.

Sagr.Tell me secondly. That motion, which is communicated to any moveable by participation, whilest it moveth by it self, with another motion different from the participated, is it necessary, that it do reside in some certain subject by it self, or else can it subsist in nature alone, without other support.

Simpl.Aristotle giveth you an answer to all these questions,Motion cannot be made without its moveable subject. and tels you, that as of one sole moveable the motion is but one; so of one sole motion the moveable is but one; and consequently, that without the inherence in its subject, no motion can either subsist, or be imagined.

Sagr.I would have you tell me in the third place, whether you beblieve that the Moon and the other Planets and Cœlestial bodies, have their proper motions, and what they are.

Simpl.They have so, and they be those according to which they run through the Zodiack, the Moon in a Moneth, the Sun in a Year, Mars in two, the Starry Sphere in those so many thousand. And these are their proper, or natural motions.

Sagr.But that motion wherewith I see the fixed Stars, and with them all the Planets go unitedly from East to West, and return round to the East again in twenty four hours, how doth it agree with them?

Simpl.It suiteth with them by participation.

Sagr.This then resides not in them, and not residing in them, nor being able to subsist without some subject in which it is resident, it must of force be the proper and natural motion of some other Sphere.

Simpl.For this purpose Astronomers, and Philosophers have found another high Sphere, above all the rest, without Stars, to which Natural agreeth the Diurnal Motion; and this they call the Primum mobile; the which carrieth along with it all the inferiour Spheres, contributing and imparting its motion to them.

Sagr.But when, without introducing other Spheres unknown and hugely vast, without other motions or communicated raptures, with leaving to each Sphere its sole and simple motion, without intermixing contrary motions, but making all turn one way, as it is necessary that they do, depending all upon one sole principle, all things proceed orderly, and correspond with most perfect harmony, why do we reject this Phœnomenon, and give our assent to those prodigious and laborious conditions?

Simpl.The difficulty lyeth in finding out this so natural and expeditous way.

Sagr.In my judgment this is found. Make the Earth the Primum mobile, that is, make it turn round its own axis in twenty four hours, and towards the same point with all the other Spheres; and without participating this same motion to any other Planet or Star, all shall have their risings, settings, and in a word, all their other appearances.

Simpl.The business is, to be able to make the Earth move without a thousand inconveniences.

Salv.All the inconveniences shall be removed as fast as you propound them: and the things spoken hitherto are onely the primary and more general inducements which give us to believe that the diurnal conversion may not altogether without probability be applyed to the Earth, rather than to all the rest of the Universe: the which inducements I impose not upon you as inviolable Axioms, but as hints, which carry

with them somewhat of likelihood.One single experiment, or sound demonstration battereth down all arguments meerly probable. And in regard I know very well, that one sole experiment, or concludent demonstration, produced on the contrary part, sufficeth to batter to the ground these and a thousand other probable Arguments; therefore it is not fit to stay here, but proceed forwards and hear what Simplicius answereth, and what greater probabilities, or stronger arguments he alledgeth on the contrary.

Simpl.I will first say something in general upon all these considerations together, and then I will descend to some particulars. It seems that you universally bottom all you say upon the greater simplicity and facility of producing the same effects, whilst you hold, that as to the causing of them, the motion of the Earth alone, serveth as well as that of all the rest of the World, the Earth deducted: but as to the operations, you esteem that much easier than this. To which I reply, that I am also of the same opinion, so long as I regard my own not onely finite, but feeble power; but having a respect to the strength of the Mover, which is infinite, its no lesse easie to move the Universe, than the Earth, yea than a straw. And if his power be infinite,Of an infinite power one would think a greater part should rather be imploy'd than a lesse. why should he not rather exercise a greater part thereof than a lesse? Therefore, I hold that your discourse in general is not convincing.

Salv.If I had at any time said, that the Universe moved not for want of power in the Mover, I should have erred, and your reproof would have been seasonable; and I grant you, that to an infinite power, it is as easie to move an hundred thousand, as one. But that which I did say, concerns not the Mover, but onely hath respect to the Moveables; and in them, not onely to their resistance, which doubtlesse is lesser in the Earth, than in the Universe; but to the many other particulars, but even now considered. As to what you say in the next place, that of an infinite power it is better to exercise a great part than a small: I answer, that of infinite one part is not greater than another, since both are infinite;Of infinity, one part is no bigger than another,

although they are comparatively unequal. nor can it be said, that of the infinite number, an hundred thousand is a greater part than two, though that be fifty thousand times greater than this; and if to the moving of the Universe there be required a finite power, though very great in comparison of that which sufficeth to move the Earth onely; yet is there not implied therein a greater part of the infinite power, nor is that part lesse infinite which remaineth unimploy'd. So that to apply unto a particular effect, a little more, or a little lesse power, importeth nothing; besides that the operation of such vertue, hath not for its bound or end the Diurnal Motion onely; but there are several other motions in the World, which we know of, and many others there may be, that are to us unknown. Therefore if we respect the Moveables, and granting it as out of question, that it is a shorter and easier way to move the Earth, than the Universe; and moreover, having an eye to the so many other abreviations, and facilities that onely this way are to be obtained, an infallible Maxime of Aristotle, which he teacheth us, that, frustra fit per plura, quod potest fieri per pauciora, rendereth it more probable that the Diurnal Motion belongs to the Earth alone, than to the Universe, the Earth subducted.

Simpl.In reciting that Axiom, you have omitted a small clause, which importeth as much as all the rest, especially in our case, that is to say, the words æquè bene. It is requisite therefore to examine whether this Hypothesis doth equally well satisfie in all particulars, as the other.

Salv.The knowledg whether both these positions do æquè bene, satisfie, may be comprehended from the particular examination of the appearances which they are to satisfie; for hitherto we have discoursed, and will continue to argue ex hypothesi, namely, supposing, that as to the satisfaction of the appearances, both the assumptions are equally accomodated.In the Axiome Frustra fit per plura, &c. the addition of æque benè, is superfluous. As to the clause which you say was omitted by me, I have more reason to suspect that it was superfluously inserted by you. For the expression æquè bene, is a relative that necessarily requireth two terms at least,

for a thing cannot have relation to its self, nor do we say, v. gr. rest to be equally good, as rest. And because, when we say, that is done in vain by many means, which may be done with fewer, we mean, that that which is to be done, ought to be the same thing, not two different ones; and because the same thing cannot be said to be done as well as its self; therefore, the addition of the Phrase æquè bene is superfluous, and a relation, that hath but one term onely.

Sagr.Unlesse you will have the same befal us, as did yesterday, let us return to our matter in hand; and let Simplicius begin to produce those difficulties that seem in his opinion, to thwart this new disposition of the World.

Simpl.That disposition is not new, but very old; and that you may see it is so, Aristotle confuteth it; and his confutations are these:Aristotles Arguments for the Earths quiessence. "First if the Earth moveth either in it self about its own Centre, or in an Excentrick Circle, it is necessary that that same motion be violent; for it is not its natural motion, for if it were, each of its parts would partake thereof; but each of them moveth in a right line towards its Centre. It being therefore violent and pteternatural, it could never be perpetual: But the order of the World is perpetual. Therefore, &c. Secondly, all the other moveables that move circularly, seem to* Restino indietzo, which is meant here of that motion which a bowl makes when its born by its byas to one side or other, and so hindered in its direct motion. * stay behind, and to move with more than one motion, the Primum Mobile excepted: Whence it would be necessary that the Earth also do move with two motions; and if that should be so, it would inevitably follow, that mutations should be made in the Fixed Stars, the which none do perceive; nay without any variation, the same Stars alwayes rise from towards the same places, and in the same places do set. Thirdly, the motion of the parts is the same with that of the whole, and naturally tendeth towards the Centre of the Universe; and for the same cause rest, being arrived thither. He thereupon moves the question whether the motion of the parts hath a tendency to centre of the Universe, or to the centre of the Earth; and concludeth that

it goeth by proper instinct to the centre of the Universe, and per accidence to that of the Earth; of which point we largely discoursed yesterday. He lastly confirmeth the same with a fourth argument taken from the experiment of grave bodies, which faling from on high, descend perpendicularly unto the Earths surface; and in the same manner Projections shot perpendicularly upwards, do by the same lines return perpendicularly down again, though they were shot to a very great height. All which arguments necessarily prove their motion to be towards the Centre of the Earth, which without moving at all waits for, and receiveth them. He intimateth in the last place that the Astronomers alledg other reasons in confirmation of the same conclusions, I mean of the Earths being in the Centre of the Universe, and immoveable; and instanceth onely in one of them, to wit, that all the Phænomena or appearances that are seen in the motions of the Stars, perfectly agree with the position of the Earth in the Centre; which would not be so, were the Earth seated otherwise. The rest produced by Ptolomy and the other Astronomers, I can give you now if you please, or after you have spoken what you have to say in answer to these of Aristotle."

Salv.The arguments which are brought upon this occasion are of two kinds:Two kindes of Arguments touching the Earths motion or rest. some have respect to the accidents Terrestrial, without any relation to the Stars, and others are taken from the Phænomena and observations of things Cœlestial. The arguments of Aristotle are for the most part taken from things neer at hand, and he leaveth the others to Astronomers; and therefore it is the best way, if you like of it, to examine these taken from experiments touching the Earth, and then proceed to those of the other kind.Arguments of Ptolomy and Tycho, and other persons, over and above those of Aristotle. And because Ptolomy, Tycho, and the other Astronomers and Philosophers, besides the arguments of Aristotle by them assumed, confirmed, and made good, do produce certain others; we will put them all together, that so we may not answer twice to the same, or the like objections. Therefore Simplicius, choose

whether you will recite them your self, or cause me to ease you of this task, for I am ready to serve you.

Simpl.It is better that you quote them, because, as having taken more pains in the study of them, you can produce them with more readinesse, and in greater number.

Salv.All,The first argument taken from grave bodies falling from on high to the ground. for the strongest reason, alledge that of grave bodies, which falling downwards from on high, move by a right line, that is perpendicular to the surface of the Earth, an argument which is held undeniably to prove that the Earth is immoveable: for in case it should have the diurnal motion, a Tower, from the top of which a stone is let fall, being carried along by the conversion of the Earth, in the time that the stone spends in falling, would be transported many hundred yards Eastward, and so far distant from the Towers foot would the stone come to ground. The which effect they back with another experiment;Which is confirmed by the experiment of a body let fall from the round top of a Ship. to wit, by letting a bullet of lead fall from the round top of a Ship, that lieth at anchor, and observing the mark it makes where it lights, which they find to be neer the ** That is, at the foot of the Mast, upon the upper deck. partners of the Mast; but if the same bullet be let fall from the same place when the ship is under sail, it shall light as far from the former place, as the ship hath run in the time of the leads descent; and this for no other reason, than because the natural motion of the ball being at liberty is by a right line towards the centre of the Earth.The second argument taken from a Projection shot very high. They fortifie this argument with the experiment of a projection shot on high at a very great distance; as for example, a ball sent out of a Cannon, erected perpendicular to the horizon, the which spendeth so much time in ascending and falling, that in our parallel the Cannon and we both should be carried by the Earth many miles towards the East, so that the ball in its return could never come neer the Peece, but would fall as far West,The third argument taken from the shots of a Cannon, towards the East, and towards the West. as the Earth had run East. They

againe adde a third, and very evident experiment, scilicet, that shooting a bullet point blank (or as Gunners say, neither above nor under metal) out of a Culverin towards the East, and afterwards another, with the same charge, and at the same elevation or disport towards the West, the range towards the West should be very much greater then the other towards the East: for that whil'st the ball goeth Westward, and the Peece is carried along by the Earth Eastward, the ball will fall from the Peece as far distant as is the aggregate of the two motions, one made by it self towards the West, and the other by the Peece carried about by the Earth towards the East; and on the contrary, from the range of the ball shot Eastward you are to substract the space the Peece moved, being carried after it. Now suppose, for example, that the range of the ball shot West were five miles, and that the Earth in the same parallel and in the time of the Bals ranging should remove three miles, the Ball in this case would fall eight miles distant from the Culverin, namely, its own five Westward, and the Culverins three miles Eastward: but the range of the shot towards the East would be but two miles long, for so much is the remainder, after you have substracted from the five miles of the range, the three miles which the Peece had moved towards the same part. But experience sheweth the Ranges to be equal, therefore the Culverin, and consequently the Earth are immoveable.This argument is confirmed by two shots towards the South and towards the North. And the stability of the Earth is no lesse confirmed by two other shots made North and South; for they would never hit the mark, but the Ranges would be alwayes wide, or towards the West, by meanes of the remove the mark would make, being carried along with the Earth towards the East, whil'st the ball is flying.And it is likewise confirmed by two shots towards the East, and towards the West. And not onely shots made by the Meridians, but also those aimed East or West would prove uncertain; for those aim'd East would be too high, and those directed West too low, although they were shot point blank, as I said. For the Range of the Ball in both the shots being made by the Tangent, that is, by a line parallel to the Horizon, and being that

in the diurnal motion, if it be of the Earth, the Horizon goeth continually descending towards the East, and rising from the West (therefore the Oriental Stars seem to rise, and the Occidental to decline) so that the Oriental mark would descend below the aime, and thereupon the shot would fly too high, and the ascending of the Western mark would make the shot aimed that way range too low; so that the Peece would never carry true towards any point; and for that experience telleth us the contrary, it is requisite to say, that the Earth is immoveable.

Simpl.These are solid reasons, and such as I believe no man can answer.

Salv.Perhaps they are new to you?

Simpl.Really they are; and now I see with how many admirable experiments Nature is pleased to favour us, wherewith to assist us in the knowledge of the Truth. Oh! how exactly one truth agreeth with another, and all conspire to render each other inexpugnable!

Sagr.What pity it is that Guns were not used in Aristotles age, he would with help of them have easily battered down ignorance, and spoke without hæsitation of these mundane points.

Salv.I am very glad that these reasons are new unto you, that so you may not rest in the opinion of the major part of Peripateticks, who believe, that if any one forsakes the Doctrine of Aristotle, it is because they did not understand or rightly apprehend his demonstrations.Copernicus his followers are not moved through ignorance of the arguments on the other part. But you may expect to hear of other Novelties, and you shall see the followers of this new Systeme produce against themselves observations, experiences, and reasons of farre greater force than those alledged by Aristotle, Ptolomy, and other opposers of the same conclusions, and by this means you shall come to ascertain your self that they were not induced through want of knowledge or experience to follow that opinion.

Sagr.It is requisite that upon this occasion I relate unto you some accidents that

befell me, so soon as I first began to hear speak of this new doctrine. Being very young, and having scarcely finished my course of Philosophy, which I left off, as being set upon other employments, there chanced to come into these parts a certain Foreigner of Rostock, whose name, as I remember, was Christianus Vurstitius,Christianus Vurstitius read certain Lectures touching the opinion of Copernicus, & what ensued thereupon. a follower of Copernicus, who in an Academy made two or three Lectures upon this point, to whom many flock't as Auditors; but I thinking they went more for the novelty of the subject than otherwise, did not go to hear him: for I had concluded with my self that that opinion could be no other than a solemn madnesse. And questioning some of those who had been there, I perceived they all made a jest thereof, execpt one, who told me that the businesse was not altogether to be laugh't at, and because this man was reputed by me to be very intelligent and wary, I repented that I was not there, and began from that time forward as oft as I met with any one of the Copernican perswasion, to demand of them, if they had been alwayes of the same judgment; and of as many as I examined, I found not so much as one, who told me not that he had been a long time of the contrary opinion, but to have changed it for this, as convinced by the strength of the reasons proving the same: and afterwards questioning them, one by one, to see whether they were well possest of the reasons of the other side, I found them all to be very ready and perfect in them;The followers of Copernicus were all first against that opinion, but the Sectators of Aristotle & Ptolomy, were never of the other side. so that I could not truly say, that they had took up this opinion out of ignorance, vanity, or to shew the acutenesse of their wits. On the contrary, of as many of the Peripateticks and Ptolomeans as I have asked (and out of curiosity I have talked with many) what pains they had taken in the Book of Copernicus, I found very few that had so much as superficially perused it; but of those whom, I thought, had understood the same, not one; and moreover, I have enquired amongst the followers of the Peripatetick Doctrine, if ever any of them had held the contrary

opinion, and likewise found none that had. Whereupon considering that there was no man who followed the opinion of Copernicus, that had not been first on the contrary side, and that was not very well acquainted with the reasons of Aristotle and Ptolomy; and, on the contrary, that there is not one of the followers of Ptolomy that had ever been of the judgment of Copernicus, and had left that, to imbrace this of Aristotle, considering, I say, these things, I began to think, that one, who leaveth an opinion imbued with his milk, and followed by very many, to take up another owned by very few, and denied by all the Schools, and that really seems a very great Paradox, must needs have been moved, not to say forced, by more powerful reasons. For this cause, I am become very curious to dive, as they say, into the bottom of this businesse, and account it my great good fortune that I have met you two, from whom I may without any trouble, hear all that hath been, and, haply, can be said on this argument, assuring my self that the strength of your reasons will resolve all scruples, and bring me to a certainty in this subject.

Simpl.But its possible your opinion and hopes may be disappointed, and that you may find your selves more at a losse in the end than you was at first.

Sagr.I am very confident that this can in no wise befal me.

Simpl.And why not? I have a manifest example in my self, that the farther I go, the more I am confounded.

Sagr.This is a sign that those reasons that hitherto seemed concluding unto you, and assured you in the truth of your opinion, begin to change countenance in your mind, and to let you by degrees, if not imbrace, at least look towards the contrary tenent; but I, that have been hitherto indifferent, do greatly hope to acquire rest and satisfaction by our future discourses, and you will not deny but I may, if you please but to hear what perswadeth me to this expectation.

Simpl.I will gladly hearken to the same, and should be no lesse glad that the like effect might be wrought in me.

Sagr.Favour me therefore with answering to what I shall ask you. And first, tell me, Simplicius, is not the conclusion, which we seek the truth of, Whether we ought to hold with Aristotle and Ptolomy, that the Earth onely abiding without motion in the Centre of the Universe, the Cœlestial bodies all move, or else, Whether the Starry Sphere and the Sun standing still in the Centre, the Earth is without the same, and owner of all those motions that in our seeming belong to the Sun and fixed Stars?

Simpl.These are the conclusions which are in dispute.

Sagr.And these two conclusions, are they not of such a nature, that one of them must necessarily be true, and the other false?

Simpl.They are so. We are in a Dilemma, one part of which must of necessity be true, and the other untrue; for between Motion and Rest, which are contradictories, there cannot be instanced a third, so as that one cannot say the Earth moves not, nor stands still; the Sun and Stars do not move, and yet stand not still.

Sagr.The Earth, the Sun, and Stars, what things are they in nature? are they petite things not worth our notice, or grand and worthy of consideration?

Simpl.They are principal, noble, integral bodies of the Universe, most vast and considerable.

Sagr.And Motion, and Rest, what accidents are they in Nature?

Simpl.So great and principal,Motion and rest principal accidents in nature. that Nature her self is defined by them.

Sagr.So that moving eternally, and the being wholly immoveable are two conditions very considerable in Nature, and indicate very great diversity; and especially when ascribed to the principal bodies of the Universe, from which can ensue none but very different events.

Simpl.Yea doubtlesse.

Sagr.Now answer me to another point. Do you believe that in Logick, Rhethorick,

the Physicks, Metaphysicks, Mathematicks, and finally, in the universality of Disputations there are arguments sufficient to perswade and demonstrate to a person the fallacious, no lesse then the true conclusions?

Simpl.No Sir;Untruths cannot be demonstrated, as Truths are. rather I am very confident and certain, that for the proving of a true and necessary conclusion, there are in nature not onely one,For proof of true conclusions, many solid arguments may be produced, but to prove a falsity, none. but many very powerfull demonstrations: and that one may discusse and handle the same divers and sundry wayes, without ever falling into any absurdity; and that the more any Sophist would disturb and muddy it, the more clear would its certainty appear: And that on the contrary to make a false position passe for true, and to perswade the belief thereof, there cannot be any thing produced but fallacies, Sophisms, Paralogismes, Equivocations, and Discourses vain, inconsistant, and full of repugnances and contradictions.

Sagr.Now if eternal motion, and eternal rest be so principal accidents of Nature, and so different, that there can depend on them only most different consequences, and especially when applyed to the Sun, and to the Earth, so vast and famous bodies of the Universe; and it being, moreover, impossible, that one of two contradictory Propositions, should not be true, and the other false; and that for proof of the false one, any thing can be produced but fallacies; but the true one being perswadeable by all kind of concluding and demonstrative arguments, why should you think that he, of you two, who shall be so fortunate as to maintain the true Proposition ought not to perswade me? You must suppose me to be of a stupid wit, perverse judgment, dull mind and intellect, and of a blind reason, that I should not be able to distinguish light from darknesse, jewels from coals, or truth from falshood.

Simpl.I tell you now, and have told you upon other occasions, that the best Master to teach us how to discern Sophismes, Paralogismes, and other fallacies, was Aristotle, who in this particular can never be deceived.

Sagr.You insist upon Aristotle, who cannot speak. Yet I tell you,Aristotle would either refute his adversaries arguments, or would alter his opinion. that if Aristotle were here, he would either yield himself to be perswaded by us, or refuting our arguments, convince us by better of his own. And you your self, when you heard the experiments of the Suns related, did you not acknowledg and admire them, and confesse them more concludent than those of Aristotle? Yet neverthelesse I cannot perceive that Salviatus, who hath produced them, examined them, and with exquisite care scan'd them, doth confesse himself perswaded by them; no nor by others of greater force, which he intimated that he was about to give us an account of. And I know not on what grounds you should censure Nature, as one that for many Ages hath been lazie, and forgetful to produce speculative wits; and that knoweth not how to make more such, unlesse they be such kind of men as slavishly giving up their judgments to Aristotle, do understand with his brain, and resent with his senses. But let us hear the residue of those reasons which favour his opinion, that we may thereupon proceed to speak to them; comparing and weighing them in the ballance of impartiality.

Salv.Before I proceed any farther, I must tell Sagredus, that in these our Disputations, I personate the Copernican, and imitate him, as if I were his Zany; but what hath been effected in my private thoughts by these arguments which I seem to alledg in his favour, I would not have you to judg by what I say, whil'st I am in the heat of acting my part in the Fable; but after I have laid by my disguise, for you may chance to find me different from what you see me upon the Stage. Now let us go on.

Ptolomy and his followers produce another experiment like to that of the Projections,An argument taken from the Clouds, and from Birds. and it is of things that being separated from the Earth, continue a good space of time in the Air, such as are the Clouds, Birds of flight; and as of them it cannot be said that they are rapt or transparted by the Earth, having no adhesion thereto, it seems not possible, that they should be able to keep pace with the velocity thereof; nay it should rather seem

to us, that they all swiftly move towards the West: And if being carried about by the Earth, passe our parallel in twenty four hours, which yet is at least sixteen thousand miles, how can Birds follow such a course or revolution? Whereas on the contrary, we see them fly as well towards the East, as towards the West,An argument taken from the air which we feel to beat upon us when we run a Horse at full speed. or any other part, without any sensible difference. Moreover, if when we run a Horse at his speed, we feel the air beat vehemently against our face, what an impetuous blast ought we perpetually to feel from the East, being carried with so rapid a course against the wind? and yet no such effect is perceived. Take another very ingenious argument inferred from the following experiment. An argument taken from the whirling of circular motion, which hath a faculty to extrude and dissipate. The circular motion hath a faculty to extrude and dissipate from its Centre the parts of the moving body, whensoever either the motion is not very slow, or those parts are not very well fastened together; and therefore, if v. g. we should turn one of those great wheels very fast about, wherein one or more men walking, crane up very great weights, as the huge massie stone, used by the Callander for pressing of Cloaths; or the fraighted Barks which being haled on shore, are hoisted out of one river into another; in case the parts of that same Wheel so swiftly turn'd round, be not very well joyn'd and pin'd together, they would all be shattered to pieces; and though many stones or other ponderous substances, should be very fast bound to its outward Rimme, yet could they not resist the impetuosity, which with great violence would hurl them every way far from the Wheel, and consequently from its Centre. So that if the Earth did move with such and so much greater velocity, what gravity, what tenacity of lime or plaister would keep together Stones, Buildings, and whole Cities, that they should not be tost into the Air by so precipitous a motion? And both men and beasts, which are not fastened to the Earth, how could they resist so great an impetus? Whereas, on the other side, we see both these, and far lesse resistances of pebles, sands, leaves rest quietly on the Earth, and to return to it in falling, though

with a very slow motion. See here, Simplicius, the most potent arguments, taken, to so speak, from things Terrestrial; there remain those of the other kind, namely, such as have relation to the appearances of Heaven, which reasons, to confesse the truth, tend more to prove the Earth to be in the centre of the Universe, and consequently, to deprive it of the annual motion about the same, ascribed unto it by Copernicus. Which arguments, as being of somewhat a different nature, may be produced, after we have examined the strength of these already propounded.

Sagr.What say you Simplicius? do you think that Salviatus is Master of, and knoweth how to unfold the Ptolomean and Aristotelian arguments? Or do you think that any Peripatetick is equally verst in the Copernican demonstrations?

Simpl.Were it not for the high esteem, that the past discourses have begot in me of the learning of Salviatus, and of the acutenesse of Sagredus, I would by their good leave have gone my way without staying for their answers; it seeming to me a thing impossible, that so palpable experiments should be contradicted; and would, without hearing them farther, confirm my self in my old perswasion; for though I should be made to see that it was erroneous, its being upheld by so many probable reasons, would render it excuseable. And if these are fallacies, what true demonstrations were ever so fair?

Sagr.Yet its good that we hear the responsions of Salviatus; which if they be true, must of necessity be more fair, and that by infinite degrees; and those must be deformed, yea most deformed, if the Metaphysical Axiome hold,True and fair are one and the same, as also false and deformed. That true and fair are one and the same thing; as also false and deformed. Therefore Salviatus let's no longer lose time.

Salv.The first Argument alledged by Simplicius, if I well remember it, was this. The Earth cannot move circularly, because such motion would be violent to the same, and therefore not perpetual: that it is violent, the reason was: Because, that had it been natural, its parts would likewise naturally move round, which is impossible, for

that it is natural for the parts thereof to move with a right motion downwards. To this my reply is, that I could gladly wish,The answer to Aristotles first argument. that Aristotle had more cleerly exprest himself, where he said; That its parts would likewise move circularly; for this moving circularly is to be understood two wayes, one is, that every particle or atome separated from its Whole would move circularly about its particular centre, describing its small Circulets; the other is, that the whole Globe moving about its centre in twenty four hours, the parts also would turn about the same centre in four and twenty hours. The first would be no lesse an impertinency, than if one should say, that every part of the circumference of a Circle ought to be a Circle; or because that the Earth is Spherical, that therefore every part thereof be a Globe, for so doth the Axiome require: Eadem est ratio totius, & partium. But if he took it in the other sense, to wit, that the parts in imitation of the Whole should move naturally round the Centre of the whole Globe in twenty four hours, I say, that they do so; and it concerns you, instead of Aristotle, to prove that they do not.

Simpl.This is proved by Aristotle in the same place, when he saith, that the natural motion of the parts is the right motion downwards to the centre of the Universe; so that the circular motion cannot naturally agree therewith.

Salv.But do not you see, that those very words carry in them a confutation of this solution?

Simpl.How? and where?

Salv.Doth not he say that the circular motion of the Earth would be violent? and therefore not eternal? and that this is absurd, for that the order of the World is eternal?

Simpl.He saith so.

Salv.But if that which is violent cannot be eternal,That which is violent, cannot be eternal, and that which cannot be eternal, cannot be natural. then by conversion, that

which cannot be eternal, cannot be natural: but the motion of the Earth downwards cannot be otherwise eternal; therefore much lesse can it be natural: nor can any other motion be natural to it, save onely that which is eternal. But if we make the Earth move with a circular motion, this may be eternal to it, and to its parts, and therefore natural.

Simpl.The right motion is most natural to the parts of the Earth, and is to them eternal; nor shall it ever happen that they move not with a right motion; alwayes provided that the impediments be removed.

Salv.You equivocate Simplicius; and I will try to free you from the equivoke. Tell me, therefore, do you think that a Ship which should sail from the Strait of Gibralter towards Palestina can eternally move towards that Coast? keeping alwayes an equal course?

Simpl.No doubtlesse.

Salv.And why not?

Simpl.Because that Voyage is bounded and terminated between the Herculean Pillars, and the shore of the Holy-land; and the distance being limited, it is past in a finite time, unlesse one by returning back should with a contrary motion begin the same Voyage anew; but this would be an interrupted and no continued motion.

Salv.Very true. But the Navigation from the Strait of Magalanes by the Pacifick Ocean, the Moluccha's, the Cape di buona Speranza, and from thence by the same Strait, and then again by the Pacifick Ocean, &c. do you believe that it may be perpetuated?

Simpl.It may; for this being a circumgyration, which returneth about its self, with infinite replications, it may be perpetuated without any interruption.

Salv.A Ship then may in this Voyage continue sailing eternally.

Simpl.It may, in case the Ship were incorruptible, but the Ship decaying, the

Navigation must of necessity come to an end.

Salv.But in the Mediterrane, though the Vessel were incorruptible, yet could she not sail perpetually towards Palestina, that Voyage being determined.Two things requisite to the end a motion may perpetuate it self; an unlimited space, and an incorruptible moveable. Two things then are required, to the end a moveable may without intermission move perpetually; the one is, that the motion may of its own nature be indeterminate and infinite; the other, that the moveable be likewise incorruptible and eternal.

Simpl.All this is necessary.

Salv.Therefore you may see how of your own accord you have confessed it impossible that any moveable should move eternally in a right line,Right motion cannot be eternal, and consequently cannot be natural to the Earth. in regard that right motion, whether it be upwards, or downwards, is by you your self bounded by the circumference and centre; so that if a Moveable, as suppose the Earth be eternal, yet forasmuch as the right motion is not of its own nature eternall, but most ** Terminatissimo terminate, it cannot naturally suit with the Earth. Nay, as was said ** By this expression he every where means the preceding Dialogue, or Giornata. yesterday, Aristotle himself is constrained to make the Terrestrial Globe eternally immoveable. When again you say, that the parts of the Earth evermore move downwards, all impediments being removed, you egregiously equivocate; for then, on the other side they must be impeded, contraried, and forced, if you would have them move; for, when they are once fallen to the ground, they must be violently thrown upwards, that they may a second time fall; and as to the impediments, these only hinder its arrival at the centre; but if there were a Well, that did passe thorow and beyond the centre, yet would not a cold of Earth passe beyond it, unlesse inasmuch as being transported by its impetus, it should passe the same to return thither again, and in the end there to rest. As therefore to the defending, that the

motion by a right line doth or can agree naturally neither to the Earth, nor to any other moveable, whil'st the Universe retaineth its perfect order, I would have you take no further paines about it, but (unlesse you will grant them the circular motion) your best way will be to defend and maintain their immobility.

Simpl.As to their immoveablenesse, the arguments of Aristotle, and moreover those alledged by your self seem in my opinion necessarily to conclude the same, as yet; and I conceive it will be a hard matter to refute them.

Salv.Come we therefore to the second Argument, which was, That those bodies,The answer to the second argument. which we are assured do move circularly, have more than one motion, unlesse it be the Primum Mobile; and therefore, if the Earth did move circularly, it ought to have two motions; from which alterations would follow in the rising and setting of the Fixed Stars: Which effect is not perceived to ensue. Therefore, &c. The most proper and genuine answer to this Allegation is contained in the Argument it self; and even Aristotle puts it in our mouths, which it is impossible, Simplicius, that you should not have seen.

Simpl.I neither have seen it, nor do I yet apprehend it.

Salv.This cannot be, sure, the thing is so very plain.

Simpl.I will with your leave, cast an eye upon the Text.

Sagr.We will command the Text to be brought forthwith.

Simpl.I alwayes carry it about with me: See here it is, and I know the place perfectly well, which is in lib. 2. De Cœlo, cap. 16. Here it is, Text 97. Preterea omnia, quæ feruntur latione circulari subdeficere videntur, ac moveri pluribus una latione, præter primam Sphæram; quare & Terram necessariam est, sive circa medium, sive in medio posita feratur, duabus moveri lationibus. Si autem hoc acciderit, necessariam est fieri mutationes, ac conversiones fixorum astrorum. Hoc autem non videtur fieri, sed semper eadem, apud eadem loca ipsius, & oriuntur, & occidunt. [In English thus:] Furthermore all that are carried with circular motion, seem to ** Subdesicere.

foreslow, and to move with more than one motion, except the first Sphere; wherefore it is necessary that the Earth move with two motions, whether it be carried about the ** Or Centre. middle, or placed in the middle. But if it be so, there would of necessity be alterations and conversions made amongst the fixed Stars. But no such thing is seen to be done, but the same Star doth alwayes rise and set in the same place. In all this I find not any falacy, and my thinks the argument is very forcible.

Salv.And this new reading of the place hath confirmed me in the fallacy of the Sillogisme, and moreover, discovered another falsity. Therefore observe. The Positions, or if you will, Conclusions, which Aristotle endeavours to oppose, are two; one is that of those, who placing the Earth in the midst of the World, do make it move in it self about its own centre. The other is of those, who constituting it far from the middle, do make it revolve with a circular motion about the middle of the Universe. And both these Positions he conjointly impugneth with one and the same argument. Now I affirm that he is out in both the one and the other impugnation; and that his error against the first Position is an Equivoke or Paralogisme;Aristotles argument against the Earths motion, is defective in two things and his mistake touching the second is a false consequence. Let us begin with the first Assertion, which constituteth the Earth in the midst of the World, and maketh it move in it self about its own centre; and let us confront it with the objection of Aristotle; saying, All moveables, that move circularly, seem to ** The same word which a little above I tendred stay behind, as a bowle when it meets with rubs. foreslow, and move with more than one Byas, except the first Sphere (that is the primum mobile) therefore the Earth moving about its own centre, being placed in the middle, must of necessity have two byasses, and foreslow. But if this were so, it would follow, that there should be a variation in the rising and setting of the fixed Stars, which we do not perceive to be done: Therefore the Earth doth not move, &c. Here is the Paralogisme, and to discover it, I will argue with Aristotle in this manner. Thou

saist, oh Aristotle, that the Earth placed in the middle of the World, cannot move in it self (i. e. upon its own axis) for then it would be requisite to allow it two byasses; so that, if it should not be necessary to allow it more than one Byas onely, thou wouldest not then hold it impossible for it to move onely with that one; for thou would'st unnecessarily have confined the impossibility to the plurality of byasses, if in case it had no more but one, yet it could not move with that. And because that of all the moveables in the World, thou makest but one alone to move with one sole byas; and all the rest with more than one; and this same moveable thou affirmest to be the first Sphere, namely, that by which all the fixed and erratick Stars seem harmoniously to move from East to West, if in case the Earth may be that first Sphere, that by moving with one byas onely, may make the Stars appear to move from East to West, thou wilt not deny them it: But he that affirmeth, that the Earth being placed in the midst of the World, moveth about its own Axis, ascribes unto it no other motion, save that by which all the Stars appear to move from East to West; and so it cometh to be that first Sphere, which thou thy self acknowledgest to move with but one byas onely. It is therefore necessary, oh Aristotle, if thou wilt conclude any thing, that thou demonstrate, that the Earth being placed in the midst of the World, cannot move with so much as one byas onely; or else, that much lesse can the first Sphere have one sole motion; for otherwise thou doest in thy very Sillogisme both commit the falacy, and detect it, denying, and at that very time proving the same thing. I come now to the second Position, namely, of those who placing the Earth far from the midst of the Universe, make it moveable about the same; that is, make it a Planet and erratick Star; against which the argument is directed, and as to form is concludent, but faileth in matter. For it being granted, that the Earth doth in that manner move, and that with two byasses, yet doth it not necessarily follow that though it were so, it should make alterations in the risings and settings of the fixed Stars, as I shall in its proper place declare. And here I could gladly excuse Aristotle; rather I could highly applaud him for having light upon the

most subtil argument that could be produced against the Copernican Hypothesis; and if the objection be ingenious, and to outward appearance most powerful, you may see how much more acute and ingenious the solution must be, and not to be found by a wit lesse piercing than that of Copernicus; and again from the difficulty in understanding it, you may argue the so much greater difficulty in finding it. But let us for the present suspend our answer, which you shall understand in due time and place, after we have repeated the objection of Aristotle, and that in his favour, much strengthened. Now passe we to Aristotles third Argument,The answer to the third argument. touching which we need give no farther reply, it having been sufficiently answered betwixt the discourses of yesterday and to day: In as much as he urgeth, that the motion of grave bodies is naturally by a right line to the centre; and then enquireth, whether to the centre of the Earth, or to that of the Universe, and concludeth that they tend naturally to the centre of the Universe, but accidentally to that of the Earth. Therefore we may proceed to the fourth,The answer to the fourth argument. upon which its requisite that we stay some time, by reason it is founded upon that experiment, from whence the greater part of the remaining arguments derive all their strength. Aristotle saith therefore, that it is a most convincing argument of the Earths immobility, to see that projections thrown or shot upright, return perpendicularly by the same line unto the same place from whence they were shot or thrown. And this holdeth true, although the motion be of a very great height; which could never come to passe, did the Earth move: for in the time that the projected body is moving upwards and downwards in a state of separation from the Earth, the place from whence the motion of the projection began, would be past, by means of the Earths revolution, a great way towards the East, and look how great that space was, so far from that place would the projected body in its descent come to the ground. So that hither may be referred the argument taken from a bullet shot from a Canon directly upwards; as also that other used by Aristotle and Ptolomy, of the grave bodies that falling from on high, are observed to descend by a direct and

perpendicular line to the surface of the Earth. Now that I may begin to unite these knots, I demand of Simplicius that in case one should deny to Ptolomy and Aristotle that weights in falling freely from on high, descend by a right and perpendicular line, that is, directly to the centre, what means he would use to prove it?

Simpl.The means of the senses; the which assureth us, that that Tower or other altitude, is upright and perpendicular, and sheweth us that that stone, or other grave body, doth slide along the Wall, without inclining a hairs breadth to one side or another, and light at the foot thereof just under the place from whence it was let fall.

Salv.But if it should happen that the Terrestrial Globe did move round, and consequently carry the Tower also along with it, and that the stone did then also grate and slide along the side of the Tower, what must its motion be then?

Simpl.In this case we may rather say its motions: for it would have one wherewith to descend from the top of the Tower to the bottom, and should necessarily have another to follow the course of the said Tower.

Salv.So that its motion should be compounded of two, to wit, of that wherewith it measureth the Tower, and of that other wherewith it followeth the same: From which composition would follow, that the stone would no longer describe that simple right and perpendicular line, but one transverse, and perhaps not streight.

Simpl.I can say nothing of its non-rectitude, but this I know very well, that it would of necessity be transverse, and different from the other directly perpendicular, which it doth describe, the Earth standing still.

Salv.You see then, that upon the meer observing the falling stone to glide along the Tower, you cannot certainly affirm that it describeth a line which is streight and perpendicular, unless you first suppose that the Earth standeth still.

Simpl.True; for if the Earth should move, the stones motion would be transverse, and not perpendicular.

Salv.Behold then the Paralogism of Aristotle and Ptolomey to be evident and

manifest,The Paralogism of Aristotle and Ptolomey in supposing that for known, which is in question. and discovered by you your self, wherein that is supposed for known, which is intended to be demonstrated.

Simpl.How can that be? To me it appeareth that the Syllogism is rightly demonstrated without petitionem principii.

Salv.You shall see how it is; answer me a little. Doth he not lay down the conclusion as unknown?

Simpl.Unknown; why otherwise the demonstrating it would be superfluous.

Salv.But the middle term, ought not that to be known?

Simpl.Its necessary that it should; for otherwise it would be a proving ignotum per æquè ignotum.

Salv.Our conclusion which is to be proved, and which is unknown, is it not the stability of the Earth?

Simpl.It is the same.

Salv.The middle term, which ought to be known, is it not the streight and perpendicular descent of the stone?

Simpl.It is so.

Salv.But was it not just now concluded, that we can have no certain knowledg whether that same shall be direct and perpendicular, unless we first know that the Earth stands still? Therefore in your Syllogism the certainty of the middle term is assumed from the uncertainty of the conclusion. You may see then, what and how great the Paralogism is.

Sagr.I would, in favour of Simplicius, defend Aristotle if it were possible, or at least better satisfie my self concerning the strength of your illation. You say, that the seeing the stone rake along the Tower, is not sufficient to assure us, that its motion is perpendicular (which is the middle term of the Syllogism) unless it be presupposed,

that the Earth standeth still, which is the conclusion to be proved: For that if the Tower did move together with the Earth, and the stone did slide along the same, the motion of the stone would be transverse, and not perpendicular. But I shall answer, that should the Tower move, it would be impossible that the stone should fail gliding along the side of it; and therefore from its falling in that manner the stability of the Earth is inferred.

Simpl.It is so; for if you would have the stone in descending to grate upon the Tower, though it were carried round by the Earth, you must allow the stone two natural motions, to wit, the straight motion towards the Centre, and the circular about the Centre, the which is impossible.

Salv.Aristotles defense then consisteth in the impossibilitie, or at least in his esteeming it an impossibility, that the stone should move with a motion mixt of right and circular: for if he did not hold it impossible that the stone could move to the Centre, and about the Centre at once, he must have understood, that it might come to pass that the cadent stone might in its descent, race the Tower as well when it moved as when it stood still; and consequently he must have perceived, that from this grating nothing could be inferred touching the mobility or immobility of the Earth. But this doth not any way excuse Aristotle; aswell because he ought to have exprest it, if he had had such a conceit, it being so material a part of his Argument; as also because it can neither be said that such an effect is impossible, nor that Aristotle did esteem it so. The first cannot be affirmed, for that by and by I shall shew that it is not onely possible, but necessary: nor much less can the second be averred,Aristotle admitteth that the Fire moveth directly upwards by nature, and round about by participation. for that Aristotle himself granteth fire to move naturally upwards in a right line, and to move about with the diurnal motion, imparted by Heaven to the whole Element of Fire, and the greater part of the Air: If therefore he held it not impossible to mix the right motion upwards, with the circular communicated to the Fire and Air from the concave of the Moon, much less ought he to account

impossible the mixture of the right motion downwards of the stone, with the circular which we presuppose natural to the whole Terrestrial Globe, of which the stone is a part.

Simpl.I see no such thing: for if the element of Fire revolve round together with the Air, it is a very easie, yea a necessary thing, that a spark of fire which from the Earth mounts upwards, in passing thorow the moving air, should receive the same motion, being a body so thin, light, and easie to be moved: but that a very heavy stone, or a Canon bullet, that descendeth from on high, and that is at liberty to move whither it will, should suffer it self to be transported either by the air or any other thing, is altogether incredible. Besides that, we have the Experiment, which is so proper to our purpose, of the stone let fall from the round top of the Mast of a ship, which when the ship lyeth still, falleth at the Partners of the Mast; but when the ship saileth, falls so far distant from that place, by how far the ship in the time of the stones falling had run forward; which will not be a few fathoms, when the ships course is swift.

Salv.There is a great disparity between the case of the Ship and that of the Earth,The disparity between the fall of a stone from the round top of a ship, and from the top of a tower. if the Terrestrial Globe be supposed to have a diurnal motion. For it is a thing very manifest, that the motion of the Ship, as it is not natural to it, so the motion of all those things that are in it is accidental, whence it is no wonder that the stone which was retained in the round top, being left at liberty, descendeth downwards without any obligation to follow the motion of the Ship. But the diurnal conversion is ascribed to the Terrestrial Globe for its proper and natural motion, and consequently, it is so to all the parts of the said Globe; and, as being impress'd by nature, is indelible in them; and therefore that stone that is on the top of the Tower hath an intrinsick inclination of revolving about the Centre of its Whole in twenty four hours, and this same natural instinct it exerciseth eternally, be it placed in any state whatsoever. And to be assured of the truth of this, you have no more to do but

to alter an antiquated impression made in your mind; and to say, Like as in that I hitherto holding it to be the property of the Terrestrial Globe to rest immoveable about its Centre, did never doubt or question but that all whatsoever particles thereof do also naturally remain in the same state of rest: So it is reason, in case the Terrestrial Globe did move round by natural instinct in twenty four hours, that the intrinsick and natural inclination of all its parts should also be, not to stand still, but to follow the same revolution. And thus without running into any inconvenience, one may conclude, that in regard the motion conferred by the force of **That you may not suspect my translation, or wonder what Oars have to do with a ship, you are to know that the Author intends the Gallies used in the Mediterrane. Oars on the Ship, and by it on all the things that are contained within her, is not natural but forreign, it is very reasonable that that stone, it being separated from the ship, do reduce its self to its natural disposure, and return to exercise its pure simple instinct given it by nature.The part of the Air inferiour to the higher mountains doth follow the motion of the Earth. To this I add, that it's necessary, that at least that part of the Air which is beneath the greater heights of mountains, should be transported and carried round by the roughness of the Earths surface; or that, as being mixt with many Vapours, and terrene Exhalations, it do naturally follow the diurnal motion, which occurreth not in the Air about the ship rowed by Oars: So that your arguing from the ship to the Tower hath not the force of an illation; because that stone which falls from the round top of the Mast, entereth into a medium, which is unconcern'd in the motion of the ship: but that which departeth from the top of the Tower, finds a medium that hath a motion in common with the whole Terrestrial Globe; so that without being hindred, rather being assisted by the motion of the air, it may follow the universal course of the Earth.

Simpl.I cannot conceive that the air can imprint in a very great stone,The motion of the Air apt to carry with it light things but not heavy. or in a gross Globe of Wood or Ball of Lead, as suppose of two hundred weight, the motion wherewith its self is

moved, and which it doth perhaps communicate to feathers, snow, and other very light things: nay, I see that a weight of that nature, being exposed to any the most impetuous wind, is not thereby removed an inch from its place; now consider with your self whether the air will carry it along therewith.

Salv.There is great difference between your experiment and our case. You introduce the wind blowing against that stone, supposed in a state of rest, and we expose to the air, which already moveth, the stone which doth also move with the same velocity; so that the air is not to conferr a new motion upon it, but onely to maintain, or to speak better, not to hinder the motion already acquired: you would drive the stone with a strange and preternatural motion, and we desire to conserve it in its natural. If you would produce a more pertinent experiment, you should say, that it is observed, if not with the eye of the forehead, yet with that of the mind, what would evene, if an eagle that is carried by the course of the wind, should let a stone fall from its talons; which, in regard that at its being let go, it went along with the wind, and after it was let fall it entered into a medium that moved with equal velocity, I am very confident that it would not be seen to descend in its fall perpendicularly, but that following the course of the wind, and adding thereto that of its particular gravity, it would move with a transverse motion.

Simpl.But it would first be known how such an experiment may be made; and then one might judg according to the event. In the mean time the effect of the ship doth hitherto incline to favour our opinion.

Salv.Well said you hitherto, for perhaps it may anon change countenance. And that I may no longer hold you in suspense, tell me, Simplicius, do you really believe, that the Experiment of the ship squares so very well with our purpose, as that it ought to be believed, that that which we see happen in it, ought also to evene in the Terrestrial Globe?

Simpl.As yet I am of that opinion; and though you have alledged some small

disparities, I do not think them of so great moment, as that they should make me change my judgment.

Salv.I rather desire that you would continue therein, and hold for certain, that the effect of the Earth would exactly answer that of the ship: provided, that when it shall appear prejudicial to your cause, you would not be humorous and alter your thoughts. You may haply say, Forasmuch as when the ship stands still, the stone falls at the foot of the Mast, and when she is under sail, it lights far from thence, that therefore by conversion, from the stones falling at the foot is argued the ships standing still, and from its falling far from thence is argued her moving; and because that which occurreth to the ship, ought likewise to befall the Earth: that therefore from the falling of the stone at the foot of the Tower is necessarily inferred the immobility of the Terrestrial Globe. Is not this your argumentation?

Simpl.It is, and reduced into that conciseness, as that it is become most easie to be apprehended.

Salv.Now tell me; if the stone let fall from the Round-top, when the ship is in a swift course, should fall exactly in the same place of the ship, in which it falleth when the ship is at anchor, what service would these experiments do you, in order to the ascertaining whether the vessel doth stand still or move?

Simpl.Just none: Like as, for exemple, from the beating of the pulse one cannot know whether a person be asleep or awake, seeing that the pulse beateth after the same manner in sleeping as in waking.

Salv.Very well. Have you ever tryed the experiment of the Ship?

Simpl.I have not; but yet I believe that those Authors which alledg the same, have accurately observed it; besides that the cause of the disparity is so manifestly known, that it admits of no question.

Salv.That it is possible that those Authors instance in it, without having made tryal of it, you your self are a good testimony, that without having examined it, alledg it

as certain, and in a credulous way remit it to their authority; as it is now not onely possible, but very probable that they likewise did; I mean, did remit the same to their Predecessors, without ever arriving at one that had made the experiment: for whoever shall examine the same, shall find the event succeed quite contrary to what hath been written of it: that is, he shall see the stone fall at all times in the same place of the Ship, whether it stand still, or move with any whatsoever velocity.The stone falling from the Mast of a ship lights in the same place, whether the ship doth move or ly still. So that the same holding true in the Earth, as in the Ship, one cannot from the stones falling perpendicularly at the foot of the Tower, conclude any thing touching the motion or rest of the Earth.

Simpl.If you should refer me to any other means than to experience, I verily believe our Disputations would not come to an end in haste; for this seemeth to me a thing so remote from all humane reason, as that it leaveth not the least place for credulity or probability.

Salv.And yet it hath left place in me for both.

Simpl.How is this? You have not made an hundred, no nor one proof thereof, and do you so confidently affirm it for true? I for my part will return to my incredulity, and to the confidence I had that the Experiment hath been tried by the principal Authors who made use thereof, and that the event succeeded as they affirm.

Salv.I am assured that the effect will ensue as I tell you; for so it is necessary that it should: and I farther add, that you know your self that it cannot fall out otherwise, however you feign or seem to feign that you know it not. Yet I am so good at taming of wits, that I will make you confess the same whether you will or no. But Sagredus stands very mute, and yet, if I mistake not, I saw him make an offer to speak somewhat.

Sagr.I had an intent to say something, but to tell you true, I know not what it was; for the curiosity that you have moved in me, by promising that you would force

Simplicius to discover the knowledg which he would conceal from us, hath made me to depose all other thoughts: therefore I pray you to make good your vaunt.

Salv.Provided that Simplicius do consent to reply to what I shall ask him, I will not fail to do it.

Simpl.I will answer what I know, assured that I shall not be much put to it, for that of those things which I hold to be false, I think nothing can be known, in regard that Science respecteth truths and not falshoods.

Salv.I desire not that you should say or reply, that you know any thing, save that which you most assuredly know. Therefore tell me; If you had here a flat superficies as polite as a Looking-glass, and of a substance as hard as steel, and that it were not paralel to the Horizon, but somewhat inclining, and that upon it you did put a Ball perfectly spherical, and of a substance grave and hard, as suppose of brass; what think you it would do being let go? do not you believe (as for my part I do) that it would lie still?

Simpl.If that superficies were inclining?

Salv.Yes; for so I have already supposed.

Simpl.I cannot conceive how it should lie still: nay, I am confident that it would move towards the declivity with much propensness.

Salv.Take good heed what you say, Simplicius, for I am confident that it would lie still in what ever place you should lay it.

Simpl.So long as you make use of such suppositions, Salvictus, I shall cease to wonder if you inferr most absurd conclusions.

Salv.Are you assured, then, that it would freely move towards the declivity?

Simpl.Who doubts it?

Salv.And this you verily believe, not because I told you so, (for I endeavoured to perswade you to think the contrary) but of your self, and upon your natural

judgment.

Simpl.Now I see what you would be at; you spoke not this as really believing the same; but to try me, and to wrest matter out of my own mouth wherewith to condemn me.

Salv.You are in the right. And how long would that Ball move, and with what velocity? But take notice that I instanced in a Ball exactly round, and a plain exquisitely polished, that all external and accidental impediments might be taken away. And so would I have you remove all obstructions caused by the Airs resistance to division, and all other casual obstacles, if any other there can be.

Simpl.I very well understand your meaning, and as to your demand, I answer, that the Ball would continue to move in infinitum, if the inclination of the plain should so long last, and continually with an accelerating motion; for such is the nature of ponderous moveables, that vires acquirant eundo: and the greater the declivity was, the greater the velocity would be.

Salv.But if one should require that that Ball should move upwards on that same superficies, do you believe that it would so do?

Simpl.Not spontaneously; but being drawn, or violently thrown, it may.

Salv.And in case it were thrust forward by the impression of some violent impetus from without, what and how great would its motion be?

Simpl.The motion would go continually decreasing and retarding, as being contrary to nature; and would be longer or shorter, according to the greater or less impulse, and according to the greater or less acclivity.

Salv.It seems, then, that hitherto you have explained to me the accidents of a moveable upon two different Planes; and that in the inclining plane, the grave moveable doth spontaneously descend, and goeth continually accelerating, and that to retain it in rest, force must be used therein: but that on the ascending plane, there is required a force to thrust it forward, and also to stay it in rest, and that the motion

impressed goeth continually diminishing, till that in the end it cometh to nothing. You say yet farther, that in both the one and the other case, there do arise differences from the planes having a greater or less declivity or acclivity; so that the greater inclination is attended with the greater velocity; and contrariwise, upon the ascending plane, the same moveable thrown with the same force, moveth a greater distance, by how much the elevation is less. Now tell me, what would befall the same moveable upon a superficies that had neither acclivity nor declivity?

Simpl.Here you must give me a little time to consider of an answer. There being no declivity, there can be no natural inclination to motion: and there being no acclivity, there can be no resistance to being moved; so that there would arise an indifference between propension and resistance of motion; therefore, methinks it ought naturally to stand still. But I had forgot my self: it was but even now that Sagredus gave me to understand that it would so do.

Salv.So I think, provided one did lay it down gently: but if it had an impetus given it towards any part, what would follow?

Simpl.There would follow, that it should move towards that part.

Salv.But with what kind of motion? with the continually accelerated, as in declining planes; or with the successively retarded, as in those ascending.

Simpl.I cannot tell how to discover any cause of acceleration, or retardation, there being no declivity or acclivity.

Salv.Well: but if there be no cause of retardation, much less ought there to be any cause of rest. How long therefore would you have the moveable to move?

Simpl.As long as that superficies, neither inclined nor declined shall last.

Salv.Therefore if such a space were interminate, the motion upon the same would likewise have no termination, that is, would be perpetual.

Simpl.I think so, if so be the moveable be of a matter durable.

Salv.That hath been already supposed, when it was said, that all external and accidental impediments were removed, and the brittlenesse of the moveable in this our case, is one of those impediments accidental. Tell me now, what do you think is the cause that that same Ball moveth spontaneously upon the inclining plane, and not without violence upon the erected?

Simpl.Because the inclination of grave bodies is to move towards the centre of the Earth, and onely by violence upwards towards the circumference; and the inclining superficies is that which acquireth vicinity to the centre, and the ascending one, remotenesse.

Salv.Therefore a superficies, which should be neither declining nor ascending, ought in all its parts to be equally distant from the centre. But is there any such superficies in the World?

Simpl.There is no want thereof: Such is our Terrestrial Globe, if it were more even, and not as it is rough and montainous; but you have that of the Water, at such time as it is calm and still.

Salv.Then a ship which moveth in a calm at Sea, is one of those moveables, which run along one of those superficies that are neither declining nor ascending, and therefore disposed, in case all obstacles external and accidental were removed, to move with the impulse once imparted incessantly and uniformly.

Simpl.It should seem to be so.

Salv.And that stone which is on the round top, doth not it move, as being together with the ship carried about by the circumference of a Circle about the Centre; and therefore consequently by a motion in it indelible, if all extern obstacles be removed? And is not this motion as swift as that of the ship.

Simpl.Hitherto all is well. But what followeth?

Salv.Then in good time recant, I pray you, that your last conclusion, if you are satisfied with the truth of all the premises.

Simpl.By my last conclusion, you mean, That that same stone moving with a motion indelibly impressed upon it, is not to leave, nay rather is to follow the ship, and in the end to light in the self same place, where it falleth when the ship lyeth still; and so I also grant it would do, in case there were no outward impediments that might disturb the stones motion, after its being let go, the which impediments are two, the one is the moveables inability to break through the air with its meer impetus onely, it being deprived of that of the strength of Oars, of which it had been partaker, as part of the ship, at the time that it was upon the Mast; the other is the new motion of descent, which also must needs be an hinderance of that other progressive motion.

Salv.As to the impediment of the Air, I do not deny it you; and if the thing falling were a light matter, as a feather, or a lock of wool, the retardation would be very great, but in an heavy stone is very exceeding small. And you your self but even now did say, that the force of the most impetuous wind sufficeth not to stir a great stone from its place; now do but consider what the calmer air is able to do, being encountred by a stone no more swift than the whole ship. Neverthelesse, as I said before, I do allow you this small effect, that may depend upon such an impediment; like as I know, that you will grant to me, that if the air should move with the same velocity that the ship and stone hath, then the impediment would be nothing at all. As to the other of the additional motion downwards; in the first place it is manifest, that these two, I mean the circular, about the centre, and the streight, towards the centre, are not contraries, or destructive to one another, or incompatible. Because that as to the moveable, it hath no repugnance at all to such motions, for you your self have already confest the repugnance to be against the motion which removeth from the centre, and the inclination to be towards the motion which approacheth to the centre. Whence it doth of necessity follow, that the moveable hath neither repugnance, nor propension to the motion which neither approacheth, nor goeth from the centre, nor consequently is there any cause for the diminishing in it the faculty impressed. And forasmuch as the moving cause is not one alone, which it

hath attained by the new operation of retardation; but that they are two, distinct from each other, of which, the gravity attends only to the drawing of the moveable towards the centre, and the vertue impress't to the conducting it about the centre, there remaineth no occasion of impediment.

Simpl.Your argumentation, to give you your due, is very probable; but in reality it is invelloped with certain intricacies, that are not easie to be extricated. You have all along built upon a supposition,The project according to Aristotle, is not moved by vertue impressed, but by the medium. which the Peripatetick Schools will not easily grant you, as being directly contrary to Aristotle, and it is to take for known and manifest, That the project separated from the projicient, continueth the motion by vertue impressed on it by the said projicient, which vertue impressed is a thing as much detested in Peripatetick Philosophy, as the passage of any accident from one subject into another. Which doctrine doth hold, as I believe it is well known unto you, that the project is carried by the medium, which in our case happeneth to be the Air. And therefore if that stone let fall from the round top, ought to follow the motion of the ship, that effect should be ascribed to the Air, and not to the vertue impressed. But you presuppose that the Air doth not follow the motion of the ship, but is tranquil. Moreover, he that letteth it fall, is not to throw it, or to give it impetus with his arm, but ought barely to open his hand and let it go; and by this means, the stone, neither through the vertue impressed by the projicient, nor through the help of the Air, shall be able to follow the ships motion, and therefore shall be left behind.

Salv.I think then that you would say, that if the stone be not thrown by the arm of that person, it is no longer a projection.

Simpl.It cannot be properly called a motion of projection.

Salv.So then that which Aristotle speaks of the motion, the moveable, and the mover of the projects, hath nothing to do with the businesse in hand; and if it concern not our purpose, why do you alledg the same?

Simpl.I produce it on the oceasion of that impressed vertue, named and introduced by you, which having no being in the World, can be of no force; for non-entium nullae sunt operationes; and therefore not onely of projected, but of all other preternatural motions, the moving cause ought to be ascribed to the medium, of which there hath been no due consideration had; and therefore all that hath been said hitherto is to no purpose.

Salv.Go to now, in good time. But tell me, seeing that your instance is wholly grounded upon the nullity of the vertue impressed, if I shall demonstrate to you, that the medium hath nothing to do in the continuation of projects, after they are separated from the projicient, will you admit of the impressed vertue, or will you make another attempt to overthrow it?

Simpl.The operation of the medium being removed, I see not how one can have recourse to any thing else save the faculty impressed by the mover.

Salv.It would be well, for the removing, as much as is possible, the occasions of multiplying contentions, that you would explain with as much distinctnesse as may be, what is that operation of the medium in continuing the motion of the project.Operation of the medium in continuing the motion of the project.

Simpl.The projicient hath the stone in his hand, and with force and violence throws his arm, with which jactation the stone doth not move so much as the circumambient Air; so that when the stone at its being forsaken by the hand, findeth it self in the Air, which at the same time moveth with impetousity, it is thereby born away; for, if the air did not operate, the stone would fall at the foot of the projicient or thrower.

Salv.And was you so credulous,Many experiments, and reasons against the cause of the motion of projects, assigned by Aristotle. as to suffer your self to be perswaded to believe these fopperies, so long as you had your senses about you to confute them, and to understand the truth thereof? Therefore tell me, that great stone, and that Canon bullet, which but onely laid upon a table, did continue immoveable

against the most impetuous winds, according as you a little before did affirm, if it had been a ball of cork or other light stuffe, think you that the wind would have removed it from its place?

Simpl.Yes, and I am assured that it would have blown it quite away, and with so much more velocity, by how much the matter was lighter, for upon this reason we see the clouds to be transported with a velocity equal to that of the wind that drives them.

Salv.And what is the Wind?

Simpl.The Wind is defined to be nothing else but air moved.

Salv.Then the moved air doth carry light things more swiftly, and to a greater distance, then it doth heavy.

Simpl.Yes certainly.

Salv.But if you were to throw with your arm a stone, and a lock of cotton wool, which would move swiftest and farthest?

Simpl.The stone by much; nay the wool would fall at my feet.

Salv.But, if that which moveth the projected substance, after it is delivered from the hand, be no other than the air moved by the arm, and the moved air do more easily bear away light than grave matters, how cometh it that the project of wool flieth not farther, and swifter than that of stone? Certainly it argueth that the stone hath some other impulse besides the motion of the air. Furthermore, if two strings of equal length did hang at yonder beam, and at the end of one there was fastened a bullet of lead, and a ball of cotton wool at the other, and both were carried to an equal distance from the perpendicular, and then let go; it is not to be doubted, but that both the one and the other would move towards the perpendicular, and that being carried by their own impetus, they would go a certain space beyond it, and afterwards return thither again. But which of these two pendent Globes do you think, would continue longest in motion, before that it would come to rest in its perpendicularity?

Simpl.The ball of lead would swing to and again many times, and that of wool but two or three at the most.

Salv.So that the impetus and that mobility whatsoever is the cause thereof, would conserve its self longer in grave substances, than light; I proceed now to another particular, and demand of you, why the air doth not carry away that Lemon which is upon that same Table?

Simpl.Because that the air it self is not moved

Salv.It is requisite then, that the projicient do confer motion on the Air, with which it afterward moveth the project. But if such a motion cannot be impressed [i. e. imparted] it being impossible to make an accident passe out of one subject into another, how can it passe from the arm into the Air? Will you say that the Air is not a subject different from the arm?

Simpl.To this it is answered that the Air, in regard it is neither heavy nor light in its own Region, is disposed with facility to receive every impulse, and also to retain the same.

Salv.But if those penduli even now named, did prove unto us, that the moveable, the lesse it had of gravity, the lesse apt it was to conserve its motion, how can it be that the Air which in the Air hath no gravity at all, doth of it self alone retain the motion acquired? I believe, and know that you by this time are of the same opinion, that the arm doth not sooner return to rest, than doth the circumambient Air. Let's go into the Chamber, and with a towel let us agitate the Air as much as we can, and then holding the cloth still, let a little candle be brought, that was lighted in the next room, or in the same place let a leaf of beaten Gold be left at liberty to flie any way, and you shall by the calm vagation of them be assured that the Air is immediately reduced to tranquilty. I could alledg many other experiments to the same purpose, but if one of these should not suffice, I should think your folly altogether incurable.

Sagr.When an arrow is shot against the Wind, how incredible a thing is it, that that

same small filament of air, impelled by the bow-string, should in despite of fate go along with the arrow? But I would willingly know another particular of Aristotle, to which I intreat Simplicius would vouchsafe me an answer. Supposing that with the same Bow there were shot two arrows, one just after the usual manner, and the other side-wayes, placing it long-wayes upon the Bow-string, and then letting it flie, I would know which of them would go farthest. Favour me, I pray you with an answer, though the question may seem to you rather ridiculous than otherwise; and excuse me, for that I, who am, as you see, rather blockish, than not, can reach no higher with my speculative faculty.

Simpl.I have never seen an arrow shot in that manner, yet neverthelesse I believe, that it would not flie side-long, the twentieth part of the space that it goeth end-wayes.

Sagr.And for that I am of the same opinion, hence it is, that I have a doubt risen in me, whether Aristotle doth not contradict experience. For as to experience, if I lay two arrows upon this Table, in a time when a strong Wind bloweth, one towards the course of the wind, and the other sidelong, the wind will quickly carry away this later, and leave the other where it was; and the same to my seeming, ought to happen, if the Doctrine of Aristotle were true, of those two shot out of a Bow: forasmuch as the arrow shot sideways is driven by a great quantity of Air, moved by the bowstring, to wit by as much as the said string is long, whereas the other arrow receiveth no greater a quantity of air, than the small circle of the strings thickness. And I cannot imagine what may be the reason of such a difference, but would fain know the same.

Simpl.The cause seemeth to me sufficiently manifest; and it is, because the arrow shot endways, hath but a little quantity of air to penetrate, and the other is to make its way through a quantity as great as its whole length.

Salv.Then it seems the arrows shot, are to penetrate the air? but if the air goeth along

with them, yea, is that which carrieth them, what penetration can they make therein? Do you not see that, in this case, the arrow would of necessity move with greater velocity than the air? and this greater velocity, what doth confer it on the arrow? Will you say the air giveth them a velocity greater than its own? Know then, Simplicius, that the business proceeds quite contrary to that which Aristotle saith,The medium doth impede and not confer the motion of projects. and that the medium conferreth the motion on the project, is as false, as it is true, that it is the onely thing which procureth its obstruction; and having known this, you shall understand without finding any thing whereof to make question, that if the air be really moved, it doth much better carry the dart along with it longways, than endways, for that the air which impelleth it in that posture, is much, and in this very little. But shooting with the Bow, forasmuch as the air stands still, the transverse arrow, being to force its passage through much air, comes to be much impeded, and the other that was nock't easily overcometh the obstruction of the small quantity of air, which opposeth it self thereto.

Salv.How many Propositions have I observed in Aristotle, (meaning still in Natural Philosophy) that are not onely false, but false in such sort, that its diametrical contrary is true, as it happens in this case. But pursuing the point in hand, I think that Simplicius is perswaded, that, from seeing the stone always to fall in the same place, he cannot conjecture either the motion or stability of the Ship: and if what hath been hitherto spoken, should not suffice, there is the Experiment of the medium which may thorowly assure us thereof; in which experiment, the most that could be seen would be, that the cadent moveable might be left behind, if it were light, and that the air did not follow the motion of the ship: but in case the air should move with equal velocity, no imaginable diversity could be found either in this, or any other experiment whatsoever, as I am anon to tell you. Now if in this case there appeareth no difference at all, what can be pretended to be seen in the stone falling from the top of the Tower, where the motion in gyration is not adventitious, and accidental,

but natural and eternal; and where the air exactly followeth the motion of the Tower, and the Tower that of the Terrestrial Globe? have you any thing else to say, Simplicius, upon this particular?

Simpl.No more but this, that I see not the mobility of the Earth as yet proved.

Salv.Nor have I any intention at this time, but onely to shew, that nothing can be concluded from the experiments alledged by our adversaries for convincing Arguments: as I think I shall prove the others to be.

Sagr.I beseech you, Salviatus, before you proceed any farther, to permit me to start certain questions, which have been rouling in my fancy all the while that you with so much patience and equanimity, was minutely explaining to Simplicius the experiment of the Ship.

Salv.We are here met with a purpose to dispute, and it's fit that every one should move the difficulties that he mets withall; for this is the way to come to the knowledg of the truth. Therefore speak freely.

Sagr.If it be true, that the impetus wherewith the ship moves, doth remain indelibly impress'd in the stone, after it is let fall from the Mast; and if it be farther true, that this motion brings no impediment or retardment to the motion directly downwards, natural to the stone:An admirable accident in the motion of projects. it's necessary, that there do an effect ensue of a very wonderful nature. Let a Ship be supposed to stand still, and let the time of the falling of a stone from the Masts Round-top to the ground, be two beats of the pulse; let the Ship afterwards be under sail, and let the same stone depart from the same place, and it, according to what hath been premised, shall still take up the time of two pulses in its fall, in which time the ship will have run, suppose, twenty yards; so that the true motion of the stone will be a transverse line, considerably longer than the first straight and perpendicular line, which is the length of the ** By the length of the mast he means the distance between the upper-deck and Round-top. Mast, and yet nevertheless the ** La palla.

stone will have past it in the same time. Let it be farther supposed, that the Ships motion is much more accelerated, so that the stone in falling shall be to pass a transverse line much longer than the other; and in sum, increasing the Ships velocity as much as you will, the falling stone shall describe its transverse lines still longer and longer, and yet shall pass them all in those self same two pulses. And in this fashion, if a Canon were level'd on the top of a Tower, and shots were made therewith point blank, that is, paralel to the Horizon, let the Piece have a greater or less charge, so as that the ball may fall sometimes a thousand yards distant, sometimes four thousand, sometimes six, sometimes ten, &c. and all these shots shall curry or finish their ranges in times equal to each other, and every one equal to the time which the ball would take to pass from the mouth of the Piece to the ground, being left, without other impulse, to fall simply downwards in a perpendicular line. Now it seems a very admirable thing, that in the same short time of its falling perpendicularly down to the ground, from the height of, suppose, an hundred yards, the same ball, being thrust violently out of the Piece by the Fire, should be able to pass one while four hundred, another while a thousand, another while four, another while ten thousand yards, so as that the said ball in all shots made point blank, always continueth an equal time in the air.

Salv.The consideration for its novelty is very pretty, and if the effect be true, very admirable: and of the truth thereof, I make no question: and were it not for the accidental impediment of the air, I verily believe, that, if at the time of the balls going out of the Piece, another were let fall from the same height directly downwards, they would both come to the ground at the same instant, though that should have curried ten thousand miles in its range, and this but an hundred onely: presupposing the surface of the Earth to be equal, which to be assured of, the experiment may be made upon some lake. As for the impediment which might come from the air, it would consist in retarding the extreme swift motion of the shot. Now, if you think fit, we will proceed to the solution of the other Objections, seeing that

Simplicius (as far as I can see) is convinc'd of the nullity of this first, taken from things falling from on high downwards.

Simpl.I find not all my scruples removed, but it may be the fault is my own, as not being of so easie and quick an apprehension as Sagredus. And it seems to me, that if this motion, of which the stone did partake whilst it was on the Round-top of the Ships Mast, be, as you say, to conserve it self indelibly in the said stone, even after it is separated from the Ship, it would follow, that likewise in case any one, riding a horse that was upon his speed, should let a bowl drop out of his hand, that bowl being fallen to the ground would continue its motion and follow the horses steps, without tarrying behind him: the which effect, I believe, is not to be seen, unless when he that is upon the horse should throw it with violence that way towards which he runneth; but otherwise, I believe it will stay on the ground in the same place where it fell.

Salv.I believe that you very much deceive your self, and am certain, that experience will shew you the contrary, and that the ball being once arrived at the ground, will run together with the horse, not staying behind him, unless so far as the asperity and unevenness of the Earth shall hinder it. And the reason seems to me very manifest: for if you, standing still, throw the said ball along the ground, do you think it would not continue its motion even after you had delivered it out of your hand? and that for so much a greater space, by how much the superficies were more smooth, so that v. g. upon ice it would run a great way?

Simpl.There is no doubt of it, if I give it impetus with my arm; but in the other case it is supposed, that he who is upon the horse, onely drops it out of his hand.

Salv.So I desire that it should be: but when you throw it with your arm, what other remaineth to the ball being once gone out of your hand, than the motion received from your arm, which motion being conserved in the boul, it doth continue to carry it forward? Now, what doth it import, that that impetus be conferred on the ball

rather from the arm than from the horse? Whilst you were on horseback, did not your hand, and consequently the ball run as fast as the horse it self? Doubtless it did: therefore in onely opening of the hand, the ball departs with the motion already coceived, not from your arm, by your particular motion, but from the motion dependant on the said horse, which cometh to be communicated to you, to your arm, to your hand, and lastly to the ball. Nay, I will tell you farther, that if the rider upon his speed fling the ball with his arm to the part contrary to the course, it shall, after it is fallen to the ground, sometimes (albeit thrown to the contrary part) follow the course of the horse, and sometimes lie still on the ground; and shall onely move contrary to the said course, when the motion received from the arm, shall exceed that of the carrier in velocity. And it is a vanity, that of some, who say that a horseman is able to cast a javelin thorow the air, that way which the horse runs, and with the horse to follow and overtake the same; and lastly, to catch it again. It is, I say, a vanity, for that to make the project return into the hand, it is requisite to cast it upwards, in the same manner as if you stood still. For, let the carrier be never so swift, provided it be uniform, and the project not over-light, it shall always fall back again into the hand of the projicient, though never so high thrown.

Sagr.By this Doctrine I come to know some Problems very curious upon this subject of projections;Sundry curious Problems, touching the motions of projects. the first of which must seem very strange to Simplicius. And the Problem is this; I affirm it to be possible, that the ball being barely dropt or let fall, by one that any way runneth very swiftly, being arrived at the Earth, doth not onely follow the course of that person, but doth much out go him. Which Problem is connexed with this, that the moveable being thrown by the projicient above the plane of the Horizon, may acquire new velocity, greater by far than that confer'd upon it by the projicient. The which effect I have with admiration observed, in looking upon those who use the sport of tops, which, so soon as they are set out of the hand, are seen to move in the air with a certain velocity, the which they afterwards much encrease at their coming

to the ground; and if whipping them, they rub at any uneven place that makes them skip on high, they are seen to move very slowly through the air, and falling again to the Earth, they still come to move with a greater velocity: But that which is yet more strange, I have farther observed, that they not onely turn always more swiftly on the ground, than in the air, but of two spaces both upon the Earth, sometimes a motion in the second space is more swift than in the first. Now what would Simplicius say to this?

Simpl.He would say in the first place, that he had never made such an observation. Secondly, he would say, that he did not believe the same. He would say again, in the third place, that if you could assure him thereof, and demonstratively convince him of the same, he would account you a great Dæmon.

Sagr.I hope then that it is one of the Socratick, not infernal ones. But that I may make you understand this particular, you must know, that if a person apprehend not a truth of himself, it is impossible that others should make him understand it: I may indeed instruct you in those things which are neither true nor false; but the true, that is, the necessary, namely, such as it is impossible should be otherwise, every common capacity either comprehendeth them of himself, or else it is impossible he should ever know them. And of this opinion I am confident is Salviatus also: and therefore I tell you, that the reasons of the present Problems are known by you, but it may be, not apprehended.

Simpl.Let us, for the present, pass by that controversie, and permit me to plead ignorance of these things you speak of, and try whether you can make me capable of understanding these Problems.

Sagr.This first dependeth upon another, which is, Whence cometh it, that setting a top with the lash, it runneth farther, and consequently with greater force, than when its set with the fingers?

Simpl.Aristotle also makes certain Problems about these kinds of projects.

Salv.He doth so; and very ingenious they are: particularly, That, Whence it cometh to pass that round tops run better than the square?

Sagr.And cannot you, Simplicius, give a reason for this, without others prompting you?

Simpl.Very good, I can so; but leave your jeering.

Sagr.In like manner you do know the reason of this other also. Tell me therefore; know you that a thing which moveth, being impeded stands still?

Simpl.I know it doth, if the impediment be so great as to suffice.

Sagr.Do you know, that moving upon the Earth is a greater impediment to the moveable, than moving in the air, the Earth being rough and hard, and the air soft and yielding?

Simpl.And knowing this, I know that the top will turn faster in the air, than on the ground, so that my knowledg is quite contrary to what you think it.

Sagr.Fair and softly, Simplicius. You know that in the parts of a moveable, that turneth about its centre, there are found motions towards all sides; so that some ascend, others descend; some go forwards, others backwards?

Simpl.I know it, and Aristotle taught me the same.

Sagr.And with what demonstration, I pray you?

Simpl.With that of sense.

Sagr.Aristotle, then, hath made you see that which without him you would not have seen? Did he ever lend you his eyes? You would say, that Aristotle hath told, advertised, remembered you of the same; and not taught you it. When then a top, without changing place, turns round, (or in the childrens phrase, sleepeth) not paralel, but erect to the Horizon, some of its parts ascend, and the opposite descend; the superiour go one way, the inferiour another. Fancie now to your self, a top, that without changing place, swiftly turns round in that manner, and stands suspended in

the air, and that in that manner turning, it be let fall to the Earth perpendicularly, do you believe, that when it is arrived at the ground, it will continue to turn round in the same manner, without changing place, as before?

Simpl.No, Sir.

Sagr.What will it do then?

Simpl.It will run along the ground very fast.

Sagr.And towards what part?

Simpl.Towards that, whither its ** Vertigine. reeling carrieth it.

Sagr.In its reeling there are parts, that is the uppermost, which do move contrary to the inferiour; therefore you must instance which it shall obey: for as to the parts ascending and descending, the one kind will not yield to the other; nor will they all go downwards, being hindered by the Earth, nor upwards as being heavy.

Simpl.The top will run reeling along the floor towards that part whither its upper parts encline it.

Sagr.And why not whither the contrary parts tend, namely, those which touch the ground?

Simpl.Because those upon the ground happen to be impeded by the roughness of the touch, that is, by the floors unevenness; but the superiour, which are in the tenuous and flexible air, are hindred very little, if at all; and therefore the top will obey their inclination.

Sagr.So that that taction, if I may so say, of the neither parts on the floor, is the cause that they stay, and onely the upper parts spring the top forward.

Salv.And therefore, if the top should fall upon the ice, or other very smooth superficies, it would not so well run forward, but might peradventure continue to revolve in it self, (or sleep) without acquiring any progressive motion.

Sagr.It is an easie thing for it so to do; but yet nevertheless, it would not so speedily

come to sleep, as when it falleth on a superficies somewhat rugged. But tell me, Simplicius, when the top-turning round about it self, in that manner, is let fall, why doth it not move forwards in the air, as it doth afterwards when it is upon the ground?

Simpl.Because having air above it, and beneath, neither those parts, nor these have any where to touch, and not having more occasion to go forward than backward, it falls perpendicularly.

Sagr.So then the onely reeling about its self, without other impetus, can drive the top forward, being arrived at the ground, very nimbly. Now proceed we to what remains. That lash, which the driver tyeth to his Top-stick, and with which, winding it about the top, he sets it (i. e. makes it go) what effect hath it on the said top?

Simpl.It constrains it to turn round upon its toe, that so it may free it self from the Top-lash.

Sagr.So then, when the top arriveth at the ground, it cometh all the way turning about its self, by means of the lash. Hath it not reason then to move in it self more swiftly upon the ground, than it did whilst it was in the air?

Simpl.Yes doubtless; for in the air it had no other impulse than that of the arm of the projicient; and if it had also the reeling, this (as hath been said) in the air drives it not forward at all▪ but arriving at the floor, to the motion of the arm is added the progression of the reeling, whereby the velocity is redoubled. And I know already very well, that the top skipping from the ground, its velocity will deminish, because the help of its circulation is wanting; and returning to the Earth will get it again, and by that means move again faster, than in the air. It onely rests for me to understand, whether in this second motion on the Earth it move more swiftly, than in the first; for then it would move in infinitum, alwayes accelerating.

Sagr.I did not absolutely affirm, that this second motion is more swift than the first; but that it may happen so to be sometimes.

Simpl.This is that, which I apprehend not, and which I desire to know.

Sagr.And this also you know of your self. Therefore tell me: When you let the top fall out of your hand, without making it turn round (i. e. setting it) what will it do at its coming to the ground?

Simpl.Nothing, but there lie still.

Sagr.May it not chance, that in its fall to the ground it may acquire a motion? Think better on it.

Simpl.Unlesse we let it fall upon some inclining stone, as children do playing at ** A Game in Italy, which is, to glide bullets down an inclining stone, &c. Chiosa, and that falling side-wayes upon the same, it do acquire the motion of turning round upon its toe, wherewith it afterwards continueth to move progressively on the floor, I know not in what other manner it can do any thing but lie still where it falleth.

Sagr.You see then that in some case it may acquire a new revolution. When then the top jerked up from the ground, falleth down again, why may it not casually hit upon the declivity of some stone fixed in the floor, and that hath an inclination that way towards which it moveth, and acquiring by that slip a new whirle over and above that conferred by the lash, why may it not redouble its motion, and make it swifter than it was at its first lighting upon the ground?

Simpl.Now I see that the same may easily happen. And I am thinking that if the top should turn the contrary way, in arriving at the ground, it would work a contrary effect, that is, the motion of the accidental whirl would retard that of the projicient.

Sagr.And it would sometimes wholly retard and stop it, in case the revolution of the top were very swift. And from hence ariseth the resolution of that slight, which the more skilful Tennis Players use to their advantage; that is, to gull their adversary by cutting (for so is their Phrase) the Ball; which is, to return it with a side Rachet, in such a manner, that it doth thereby acquire a motion by it self contrary to the projected motion, and so by that means, at its coming to the ground, the rebound,

which if the ball did not turn in that manner, would be towards the adversary, giving him the usual time to tosse it back again, doth fail, and the ball runs tripping along the ground, or rebounds lesse than usual, and breaketh the time of the return. Hence it is that you see, those who play at **A Game in Italy, wherein they strive who shall trundle or throw a wooden bowle neerest to an assigned mark. Stool-ball, when they play in a stony way, or a place full of holes and rubs that make the ball trip an hundred several wayes, never suffering it to come neer the mark, to avoid them all, they do not trundle the ball upon the ground, but throw it, as if they were to pitch a quait. But because in throwing the ball, it issueth out of the hand with some roling conferred by the fingers, when ever the hand is under the ball, as it is most commonly held; whereupon the ball in its lighting on the ground neer to the mark, between the motion of the projicient and that of the roling, would run a great way from the same: To make the ball stay, they hold it artificially, with their hand uppermost, and it undermost, which in its delivery hath a contrary twirl or roling conferred upon it by the fingers, by means whereof in its coming to the ground neer the mark it stays there, or runs very very little forwards. But to return to our principal problem which gave occasion for starting these others; I say it is possible that a person carried very swiftly, may let a ball drop out of his hand, that being come to the Earth, shall not onely follow his motion, but also out-go it, moving with a greater velocity. And to see such an effect, I desire that the course may be that of a Chariot, to which on the out-side let a declining board be fastened; so as that the neither part may be towards the horses, and the upper towards the hind Wheel. Now, if in the Chariots full career, a man within it, let a ball fall gliding along the declivity of that board, it shall in roling downward acquire a particular vertigo or turning, the which added to the motion impressed by the Chariot, will carrie the ball along the ground much faster than the Chariot. And if one accommodate another declining board over against it, the motion of the Chariot may be qualified so, that the ball, gliding downwards along the board, in its coming to the ground shall rest

immoveable, and also shall sometimes run the contrary way to the Chariot. But we are strayed too far from the purpose, therefore if Simplicius be satisfied with the resolution of the first argnment against the Earths mobility, taken from things falling perpendicularly, we may passe to the rest.

Salv.The digressions made hitherto, are not so alienated from the matter in hand, as that one can say they are wholly strangers to it. Besides these argumentations depend on those things that start up in the fancy not of one person, but of three, that we are: And moreover we discourse for our pleasure, nor are we obliged to that strictnesse of one who ex professo treateth methodically of an argument, with an intent to publish the same. I will not consent that our Poem should be so confined to that unity, as not to leave us fields open for Epsody's, which every smalll connection should suffice to introduce; but with almost as much liberry as if we were met to tell stories, it shall be lawful for me to speak, what ever your discourse brings into my mind.

Sagr.I like this motion very well; and since we are at this liberty, let me take leave, before we passe any farther to ask of you Salviatus, whether you did ever consider what that line may be that is described by the grave moveable naturally falling down from the top of a Tower; and if you have reflected on it, be pleased to tell me what you think thereof.

Salv.I have sometimes considered of it, and make no question, that if one could be certain of the nature of that motion wherewith the grave body descendeth to approach the centre of the Terrestrial Globe, mixing it self afterwards with the common circular motion of the diurnal conversion; it might be exactly found what kind of line that is, that the centre of gravity of the moveable describeth in those two motions.

Sagr.Touching the simple motion towards the centre dependent on the gravity, I think that one may confidently, without error, believe that it is by a right line, as it

would be, were the Earth immoveable.

Salv.As to this particular, we may not onely believe it, but experience rendereth us certain of the same.

Sagr.But how doth experience assure us thereof, if we never see any motions but such as are composed of the two, circular and descending.

Salv.Nay rather Sagredus we onely see the simple motion of descent; since that other circular one common to the Earth, the Tower and our selves remains imperceptible, and as if it never were, and there remaineth perceptible to us that of the stone, onely not participated by us, and for this, sense demonstrateth that it is by a right line, ever parallel to the said Tower, which is built upright and perpendicular upon the Terrestrial surface.

Sagr.You are in the right; and this was but too plainly demonstrated to me even now, seeing that I could not remember so easie a thing; but this being so manifest, what more is it that you say you desire, for understanding the nature of this motion downwards?

Salv.It sufficeth not to know that it is streight, but its requisite to know whether it be uniform, or irregular; that is, whether it maintain alwayes one and the same velocity, or else goeth retarding or accelerating.

Sagr.It is already clear, that it goeth continually accellerating.

Salv.Neither doth this suffice, but its requisite to know according to what proportion such accelleration is made; a Problem, that I believe was never hitherto understood by any Philosopher or Mathematician; although Philosophers, and particularly the Peripateticks, have writ great and entire Volumes, touching motion.

Simpl.Philosophers principally busie themselves about universals; they find the definitions and more common symptomes, omitting certain subtilties and niceties, which are rather curiosities to the Mathematicians. And Aristotle did content himself to define excellently what motion was in general; and of the local, to shew the

principal qualities, to wit, that one is natural, another violent; one is simple, another compound; one is equal, another accellerate; and concerning the accelerate, contents himself to give the reason of acceleration, remitting the finding out of the proportion of such acceleration, and other particular accidents to the Mechanitian, or other inferiour Artist.

Sagr.Very well Simplicius. But you Salviatus, when you descend sometimes from the Throne of Peripatetick Majesty, have you ever thrown away any of your hours in studying to find this proportion of the acceleration of the motion of descending grave bodies?

Salv.There was no need that I should study for it, in regard that the Academick our common friend, heretofore shewed me a Treatise of hisThis is that excellent tract which we give the first place in our second Volume.De Motu, where this, and many other accidents were demonstrated. But it would be too great a digression, if for this particular, we should interrupt our present discourse, (which yet it self is also no better than a digression) and make as the Saying is, a Comedy within a Comedy.

Sagr.I am content to excuse you from this narration for the present, provided that this may be one of the Propositions reserved to be examined amongst the rest in another particular meeting, for that the knowledg thereof is by me very much desired; and in the mean time let us return to the line described by the grave body in its fall from the top of the Tower to its base.

Salv.If the right motion towards the centre of the Earth was uniforme, the circular towards the East being also uniforme, you would see composed of them both a motion by a spiral line, of that kind with those defined by Archimedes in his Book De Spiralibus; which are, when a point moveth uniformly upon a right line, whilest that line in the mean time turneth uniformly about one of its extreme points fixed, as the centre of his gyration. But because the right motion of grave bodies falling, is continually accelerated, it is necessary, that the line resulting of the composition of

the two motions do go alwayes receding with greater and greater proportion from the circumference of that circle, which the centre of the stones gravity would have designed, if it had alwayes staid upon the Tower; it followeth of necessity that this recession at the first be but little, yea very small, yea, more, as small as can be imagined, seeing that the descending grave body departing from rest, that is, from the privation of motion, towards the bottom and entring into the right motion downwards, it must needs passe through all the degrees of tardity, that are betwixt rest, and any assigned velocity; the which degrees are infinite; as already hath been at large discoursed and proved.

It being supposed therefore, that the progresse of the acceleration being after this manner, and it being moreover true, that the descending grave body goeth to terminate in the centre of the Earth,The line described by a moveable in its natural descent, the motion of the Earth about its own centre being presupposed, would probably be the circumference of a circle. it is necessary that the line of its mixt motion be such, that it go continually receding with greater and greater proportion from the top of the Tower, or to speak more properly, from the circumference of the circle described by the top of the Tower, by means of the Earths conversion; but that such recessions be lesser and lesser in infinitum; by how much the moveable finds it self to be lesse and lesse removed from the first term where it rested. Moreover it is necessary, that this line of the compounded motion do go to terminate in the centre of the Earth. Now having presupposed these two things, I come to describe about the centre A [in Fig. 1. of this second Dialogue;] with the semidiameter A B, the circle B I, representing to me the Terrestrial Globe, and prolonging the semidiameter A B to C, I have described the height of the Tower B C; the which being carried about by the Earth along the circumference B I, describeth with its top the arch C D: Dividing, in the next place, the line C A in the middle at E; upon the centre E, at the distance E C, I describe the semicircle C I A: In which, I now affirm, that it is very probable that a stone falling from the top of the Tower C, doth move, with a motion

mixt of the circular, which is in common, and of its peculiar right motion. If therefore in the circumference C D, certain equal parts C F, F G, G H, H L, be marked, and from the points F, G, H, L, right lines be drawn towards the centre A, the parts of them intercepted between the two circumferences C D and B I, shall represent unto us the same Tower C B, transported by the Terrestrial Globe towards D I; in which lines the points where they come to be intersected by the arch of the semicircle C I, are the places by which from time to time the falling stone doth passe; which points go continually with greater and greater proportion receding from the top of the Tower. And this is the cause why the right motion made along the side of the Tower apeareth to us more and more accelerate. It appeareth also, how by reason of the infinite acutenesse of the contact of those two circles D C, C I, the recession of the cadent moveable from the circumference C F D; namely, from the top of the Tower, is towards the beginning extream small, which is as much as if one said its motion downwards is very slow, and more and more slow in infinitum, according to its vicinity to the term C, that is to the state of rest. And lastly it is seen how in the end this same motion goeth to terminate in the centre of the Earth A.

Sagr.I understand all this very well, nor can I perswade my self that the falling moveable doth describe with the centre of its gravity any other line, but such an one as this.

Salv.But stay a little Sagredus, for I am to acquaint you also with three Observations of mine, that its possible will not displease you.A moveable falling from the top of the Tower, moveth in the circumference of a circle. The first of which is, that if we do well consider, the moveable moveth not really with any more than onely one motion simply circular, as when being placed upon the Tower, it moved with one single and circular motion. The second is yet more pleasant; for,It moveth neither more nor lesse, than if it had staid alwayes there. it moveth neither more nor lesse then if it had staid continually upon the Tower, being that to the arches C F, F G, G H, &c. that it would have passed continuing alwayes upon the Tower, the arches of

the circumference C I are exactly equal, answering under the same C F, F G, G H, &c. Whence followeth the third wonder,It moveth with an uniform, not an accelerate motion. That the true and real motion of the stone is never accelerated, but alwayes even and uniforme, since that all the equal arches noted in the circumference C D, and their respondent ones marked in the circumference C I, are past in equal times; so that we are left at liberty to seek new causes of acceleration, or of other motions, seeing that the moveable, as well standing upon the Tower, as descending thence, alwayes moveth in the same fashion, that is, circularly, with the same velocity, and with the same uniformity. Now tell me what you think of this my fantastical conjecture.

Sagr.I must tell you, that I cannot with words sufficiently expresse how admirable it seemeth to me; and for what at present offereth it self to my understanding, I cannot think that the business happeneth otherwise; and would to God that all the demonstrations of Philosophers were but half so probable as this. However for my perfect satisfaction I would gladly hear how you prove those arches to be equal.

Salv.The demonstration is most easie. Suppose to your self a line drawn from I to E. And the Semidiameter of the circle C D, that is, the line C A, being double the Semidiameter C E of the circle C I, the circumference shall be double to the circumference, and every arch of the greater circle double to every like arch of the lesser; and consequently, the half of the arch of the greater circle, equal to the whole arch of the lesse. And because the angle C E I made in the centre E of the lesser circle, and which insisteth upon the arch CI, is double the angle C A D, made in the centre A of the greater circle, to which the arch C D subtendeth; therefore the arch C D is half of the arch of the greater circle like to the arch C I, and therefore the two arches C D and C I are equal; and in the same manner we may demonstrate of all their parts. But that the business, as to the motion of descending grave bodies, proceedeth exactly thus, I will not at this time affirm; but this I will say, that if the line described by the cadent moveable be not exactly the same with this, it doth

extream neerly resemble the same.

Sagr.But I,Right motion seemeth wholly excluded in nature.Salviatus, am just now considering another particular very admirable; and this it is; That admitting these considerations, the right motion doth go wholly ** Vadia del tutto a monte, rendered in the Latine omnino pessum eat. mounting, and that Nature never makes use thereof, since that, even that that use, which was from the beginning granted to it, which was of reducing the parts of integral bodies to their place, when they were separated from their whole, and therefore constituted in a depraved disposition, is taken from it, and assigned to the circular motion.

Salv.This would necessarily follow, if it were concluded that the Terrestrial Globe moveth circularly; a thing, which I pretend not to be done, but have onely hitherto attempted, as I shall still, to examine the strength of those reasons, which have been alledged by Philosophers to prove the immobility of the Earth, of which this first taken from things falling perpendicularly, hath begat the doubts, that have been mentioned; which I know not of what force they may have seemed to Simplicius; and therefore before I passe to the examination of the remaining arguments, it would be convenient that he produce what he hath to reply to the contrary.

Simpl.As to this first, I confesse indeed that I have heard sundry pretty notions, which I never thought upon before, and in regard they are new unto me, I cannot have answers so ready for them, but this argument taken from things falling perpendicularly, I esteem it not one of the strongest proofs of the mobility of the Earth; and I know not what may happen touching the shots of great Guns, especially those aimed contrary to the diurnal motion.

Sagr.The flying of the birds as much puzzleth me as the objection of the Gun-shot, and all the other experiments above alledged. For these birds which at their pleasure flie forwards and backwards, and wind to and again in a thousand fashions, and, which more importeth, lie whole hours upon the wing, these I say do not a little pose

me, nor do I see, how amongst so many circumgyrations, they should not lose the motion of the Earth, and how they should be able to keep pace with so great a velocity as that which they so far exceed with their flight.

Salv.To speak the truth, your scruple is not without reason, and its possible Copernicus himself could not find an answer for it, that was to himself entirely satisfactory; and therefore haply past it over in silence; albeit he was, indeed, very brief in examining the other allegations of his adversaries, I believe through his height of wit, placed on greater aud sublimer contemplations, like as Lions are not much moved at the barking of little Dogs. We will therefore reserve the instance of birds to the last place, and for the present, see if we can give Simplicius satisfaction in the others, by shewing him in our wonted manner, that he himself hath their answers at hand, though upon first thoughts he doth not discover them. And to begin with the shots made at randome, with the self same piece, powder, and ball, the one towards the East, the other towards the West (if the diurnal conversion belonged to the Earth) ought to be much longer than that towards the East.

Simpl.I am moved so to think; because in the shot made towards the East,The reason why a Gun should seem to carry farther towards the West than towards the East. the ball whil'st it is out of the piece, is followed by the said piece, the which being carried round by the Earth, runneth also with much velocity towards the same part, whereupon the fall of the ball to the ground, cometh to be but little distant from the piece. On the contrary in the shot towards the West, before that the ball falleth to the ground, the piece is retired very far towards the East, by which means the space between the ball and the piece, that is Range, will appear longer than the other, by how much the piece, that is the Earth, had run in the time that both the bals were in the air.

Salv.I could wish, that we did know some way to make an experiment corresponding to the motion of these projects, as that of the ship doth to the motion

of things perpendicularly falling from on high; and I am thinking how it may be done.

Sagr.I believe, that it would be a very opposite proof, to take an open Chariot,The experiment of a running chariot to find out the difference of Ranges. and to accomodate therein a ** Balestrone da bolzoni. Stock-bow at half elevation, to the end the flight may prove the greatest that my be, and whil'st the horses shall run, to shoot first towards the part whither you drive, and then another backwards towards the contrary part, causing some one to mark diligently where the Chariot was in that moment f time when the shaft came to the ground, as well in the one shot as in the other: for thus you may see exactly how much one shaft flew farther than the other.

Simpl.In my thoughts this experiment is very proper: and I do not doubt but that the flight, that is, the space between the shaft and the place where the chariot was at the shafts fall, will be less by much when one shooteth towards the chariots course, than when one shooteth the contrary way. For an example, let the flight of it self be three hundred yards, and the course of the chariot in the time whilst the shaft stayeth in the air, an hundred yards, therefore shooting towards the course, of the three hundred yards of the flight, the chariot will have gone one hundred; so then at the shafts coming to the ground, the space between it and the chariot, shall be but two hundred yards onely; but on the contrary, in the other shoot, the chariot running contrary to the shaft, when the shaft shall have passed its three hundred yards, and the chariot its other hundred the contrary way, the distance interposing shall be found to be four hundred yards.

Salv.Is there any way to shoot so that these flights may be equal?

Simpl.I know no other way, unless by making the chariot to stand still.

Salv.This we know; but I mean when the chariot runneth in full carreer.

Simpl.In that case you are to draw the Bow higher in shooting forwards, and to slack it in shooting the contrary way.

Salv.Then you see that there is one way more. But how much is the bow to be drawn, and how much slackened?

Simpl.In our case, where we have supposed that the bow carried three hundred yards, it would be requisite to draw it so, as that it might carry four hundred, and in the other to slacken it so, as that it might carry no more than two hundred. For so each of the flights would be but three hundred in relation to the chariot, the which, with its course of an hundred yards which it substracts from the shoot of four hundred, and addeth to that of two hundred, would reduce them both to three hundred.

Salv.But what effect hath the greater or less intensness of the bow upon the shaft?

Simpl.The stiffer bow carrieth it with greater velocity, and the weaker with less; and the same shaft flieth so much farther at one time than another, with how much greater velocity it goeth out of the tiller at one time, than another.

Salv.So that to make the shaft shot either way, to flie at equal distance from the running chariot, it is requisite, that if in the first shoot of the precedent example, it goeth out of the tiller with v. g. four degrees of velocity, that then in the other shoot it depart but with two onely: but if the same bow be used, it always receiveth thence three degrees.

Simpl.It doth so; and for this reason, shooting with the same bow in the chariots course, the shoots cannot be equal.

Salv.I had forgot to ask, with what velocity it is supposed in this particular experiment, that the chariot runneth.

Simpl.The velocity of the chariot must be supposed to be one degree in comparison to that of the bow, which is three,

Salv.Very right, for so computation gives it. But tell me, when the chariot moveth, doth not all things in the same move with the same velocity?

Simpl.Yes doubtless.

Salv.Then so doth the shaft also, and the bow, and the string, upon which the shaft is nock't.

Simpl.They do so.

Salv.Why then, in discharging the shaft towards the course of the chariot, the bow impresseth its three degrees of velocity on a shaft that had one degree of velocity before, by means of the chariot which transported it so fast towards that part; so that in its going off it hath four degrees of velocity. On the contrary, in the other shoot, the same bow conferreth its same three degrees of velocity on a shaft that moveth the contrary way, with one degree; so that in its departing from the bow-string, it hath no more left but onely two degrees of velocity. But you your self have already said, that the way to make the shoots equal, is to cause that the shaft be let flie the first time with four degrees of velocity, and the second time with two. Therefore without changing the bow, the very course of the chariot is that which adjusteth the flights,The solution of the argument taken from great Guns shot towards the East & West. and the experiment doth so represent them to any one who is not either wilfully or naturally incapable of reason. Now apply this discourse to Gunnery, and you shall find, that whether the Earth move or stand still, the shots made with the same force, will always curry equal ranges, to what part soever aimed. The error of Aristotle, Ptolomey, Tycho, your self, and all the rest, is grounded upon that fixed and strong persuasion, that the Earth standeth still, which you have not judgment nor power to depose, no not when you have a desire to argue of that which would ensue, presupposing the Earth to move. And thus, in the other argument, not considering that whil'st the stone is upon the Tower, it doth, as to moving or not moving, the same that the Terrestrial Globe doth, because you have concluded with your self, that the Earth stands still, you always discourse touching the fall of the stone, as if it were to depart from rest: whereas it behooveth to say, that if the Earth standeth still,

the stone departeth from rest, and descendeth perpendicularly; but if the Earth do move, the stone likewise moveth with like velocity, nor doth it depart from rest, but from a motion equal to that of the Earth, wherewith it intermixeth the supervenient motion of descent, and of those two composeth a third which is transversal or side-ways.

Simpl.But for Gods sake, if it move transversly, how is it that I behold it to move directly and perpendicularly? This is no better than the denial of manifest sense; and if we may not believe sense, at what other door shall we enter into disquisitions of Philosophy?

Salv.In respect to the Earth, to the Tower, and to our selves, which all as one piece move with the diurnal motion together with the stone, the diurnal motion is as if it never had been, and becometh insensible, imperceptible, and without any action at all; and the onely motion which we can perceive, is that of which we partake not, that is the descent gliding along the side of the Tower: You are not the first that hath felt great repugnance in apprehending this non-operating of motion upon things to which it is common.

Sagr.Now I do remember a certain conceipt,A notable case of Sagredus, to shew the non-operating of common motion. that came one day into my fancy, whilst I sailed in my voyage to Aleppo, whither I went Consul for our Countrey, and possibly it may be of some use, for explaining this nullity of operation of common motion, and being as if it never were to all the partakers thereof. And if it stand with the good liking of Simplicius, I will reason with him upon that which then I thought of by my self alone.

Simpl.The novelty of the things which I hear, makes me not so much a patient, as a greedy and curious auditor: therefore go on.

Sagr.If the neb of a writing pen, that I carried along with me in the ship, through all my navigation from Venice to ** Alessandretta Scanderon, had had a facultie of

leaving visible marks of its whole voyage, what signs, what marks, what lines would it have left?

Simpl.It would have left a line distended from Venice thither, not perfectly streight, or to say better, distended in a perfect arch of a circle, but in some places more, in some less curved, according as the vessel had gone more or less fluctuating; but this its inflecting in some places a fathom or two to the right hand or to the left, upwards or downwards, in a length of many hundred miles, would have brought but little alteration to the intire tract of the line, so that it would have been hardly sensible; and without any considerable error, might have been called the part of a perfect arch.

Sagr.So that the true and most exact motion of the neb of my pen would have also been an arch of a perfect circle, if the vessels motion, the fluctuation of the billows ceasing, had been calm and tranquill. And if I had continually held that per in my hand, and had onely moved it sometimes an inch or two this way or that way, what alteration should I have made in that its principal, and very long tract or stroke?

Simpl.Less than that which the declining in several places from absolute rectitude, but the quantity of a flea's eye makes in a right line of a thousand yards long.

Sagr.If a Painter, then, at our launching from the Port, had began to design upon a paper with that pen, and continued his work till he came to Scanderon, he would have been able to have taken by its motion a perfect draught of all those figures perfectly interwoven and shadowed on several sides with countreys, buildings, living creatures, and other things; albeit all the true, real, and essential motion traced out by the neb of that pen, would have been no other than a very long, but simple line: and as to the proper operation of the Painter, he would have delineated the same to an hair, if the ship had stood still. That therefore of the huge long motion of the pen there doth remain no other marks, than those tracks drawn upon the paper, the reason thereof is because the grand motion from Venice to Scanderon, was common to the paper, the pen, and all that which was in the ship: but the petty

motions forwards and backwards, to the right, to the left, communicated by the fingers of the Painter unto the pen, and not to the paper, as being peculiar thereunto, might leave marks of it self upon the paper, which did not move with that motion. Thus it is likewise true, that the Earth moving, the motion of the stone in descending downwards, was really a long tract of many hundreds and thousands of yards, and if it could have been able to have delineated in a calm air, or other superficies, the track of its course, it would have left behind an huge long transverse line. But that part of all this motion which is common to the stone, the Tower, and our selves, is imperceptible to us, and as if it had never been, and that part onely remaineth observable, of which neither the Tower nor we are partakers, which is in fine, that wherewith the stone falling measureth the Tower.

Salv.A most witty conceipt to clear up this point, which was not a little difficult to many capacities. Now if Simplicius will make no farther reply, we may pass to the other experiments, the unfolding of which will receive no small facility from the things already declared.

Simpl.I have nothing more to say: and I was well-nigh transported with that delineation, and with thinking how those strokes drawn so many ways, hither, thither, upwards, downwards, forwards, backwards, and interwoven with thousands of turnings, are not essentially or really other, than small pieces of one sole line drawn all one way, and the same without any other alteration save the declining the direct rectitude, sometimes a very insensible matter towards one side or another, and the pens moving its neb one while softer, another while slower, but with very small inequality. And I think that it would in the same manner write a letter, and that those frollike penmen, who to shew their command of hand, without taking their pen from the paper in one sole stroke, with infinite turnings draw a pleasant knot, if they were in a boat that did tide it along swiftly they would convert the whole motion of the pen, which in reality is but one sole line, drawn all towards one and the same part, and very little curved, or declining from perfect rectitude, into a knot or flourish.

And I am much pleased that Sagredus hath helped me to this conceit: therefore let us go on, for the hope of meeting with more of them, will make me the stricter in my attention.

Sagr.If you have a curiosity to hear such like subtilties,Subtilties sufficiently insipid, ironically, spoken and taken from a certain Encyclopædia. which occurr not thus to every one, you will find no want of them, especially in this particular of Navigation; and do you not think that a witty conceit which I met with likewise in the same voyage, when I observed that the mast of the ship, without either breaking or bending, had made a greater voyage with its round-top, that is with its top-gallant, than with its foot; for the round top being more distant from the centre of the Earth than the foot is, it had described the arch of a circle bigger than the circle by which the foot had passed.

Simpl.And thus when a man walketh he goeth farther with his head than with his feet.

Sagr.You have found out the matter your self by help of your own mother-wit: But let us not interrupt Salviatus.

Salv.It pleaseth me to see Simplicius how he sootheth up himself in this conceit, if happly it be his own, and that he hath not borrowed it from a certain little pamphlet of conclusions, where there are a great many more such fancies no less pleasant & witty. It followeth that vve speak of the peice of Ordinance mounted perpendicular to the Horizon,An instance against the diurnal motion of the earth, taken from the shot of a Peece of Ordinance perpendicularly. that is, of a shot towards our vertical point, and to conclude, of the return of the ball by the same line unto the same peice, though that in the long time which it is separated from the peice, the earth hath transported it many miles towards the East; now it seemeth, that the ball ought to fall a like distance from the peice towards the West; the which doth not happen: therefore the peice without having been moved did stay expecting the same. The

answer is the same with that of the stone falling from the Tower;The answer to the objection, shewing the equivoke. and all the fallacy, and equivocation consisteth in supposing still for true, that which is in question; for the Opponent hath it still fixed in his conceit that the ball departs from its rest, being discharged by the fire from the piece; and the departing from the state of rest, cannot be, unlesse the immobility of the Terrestrial Globe be presupposed, which is the conclusion of that was in dispute; Therefore, I reply, that those who make the Earth moveable, answer, that the piece, and the ball that is in it, partake of the same motion with the Earth; nay that they have this together with her from nature; and that therefore the ball departs in no other manner from its quiescence, but conjoyned with its motion about the centre, the which by its projection upwards, is neither taken away, nor hindered; and in this manner following, the universal motion of the Earth towards the East, it alwayes keepeth perpendicular over the said piece, as well in its rise as in its return. And the same you see to ensue, in making the experiment in a ship with a bullet shot upwards perpendicularly with a Crosse-bow, which returneth to the same place whether the ship doth move, or stand still.

Sagr.This satisfieth very well to all;Another answer to the same objection. but because that I have seen that Simplicius taketh pleasure with certain subtilties to puzzle his companions, I will demand of him whether, supposing for this time that the Earth standeth still, and the piece erected upon it perpendicularly, directed to our Zenith, he do at all question that to be the true perpendicular shot, and that the ball in departing, and in its return is to go by the same right line, still supposing all external and accidental impediments to be removed?

Simpl.I understand that the matter ought to succeed exactly in that manner.

Sagr.But if the piece were placed, not perpendicularly, but inclining towards some place, what would the motion of the ball be? Would it go haply, as in the other shot, by the perpendicular line, and return again by the same?

Simpl.It would not so do; but issuing out of the piece, it would pursue its motion by a right line which prolongeth the erect perpendicularity of the concave cylinder of the piece, unlesse so far as its own weight would make it decline from that erection towards the Earth.

Sagr.So that the mounture of the cylinder is the regulator of the motion of the ball, nor doth it, or would it move out of that line, if its own gravity did not make it decline downwards. And therefore placing the cylinder perpendicularly,Projects continue their motion by the right line that followeth the direction of the motion, made together with the projicient, whil'st they were conjoin'd therewith. and shooting the ball upwards, it returneth by the same right line downwards; because the motion of the ball dependent on its gravity is downward, by the same perpendicular. The journey therefore of the ball out of the piece, continueth or prolongeth the rectitude or perpendicularity of that small part of the said journey, which it made within the said piece; is it not so?

Simpl.So it is, in my opinion.

Sagr.Now imagine the cylinder to be erected, and that the Earth doth revolve about with a diurnal motion, carrying the piece along with it, tell me what shall be the motion of the ball within the cylinder, having given fire?

Simpl.It shall be a streight and perpendicular motion, the cylinder being erected perpendicularly.

Sagr.Consider well what you say: for I believe that it will not be perpendicular. It would indeed be perpendicular, if the Earth stood still, for so the ball would have no other motion but that proceeding from the fire.The revolution of the Earth supposed, the ball in the piece erected perpendicularly, doth not move by a perpendicular, but an inclined line. But in case the Earth turns round, the ball that is in the piece, hath likewise a diurnal motion, so that there being added to the same the impulse of the fire, it moveth from the breech of the piece to the muzzle with two motions, from the

composition whereof it cometh to passe that the motion made by the centre of the balls gravity is an inclining line. And for your clearer understanding the same, let the piece AC [in Fig. 2.] be erected, and in it the ball B; it is manifest, that the piece standing immoveable, and fire being given to it, the ball will make its way out by the mouth A, and with its centre, passing thorow the the piece, shall have described the perpendicular line BA, and it shall pursue that rectitude when it is out of the piece, moving toward the Zenith. But in case the Earth should move round, and consequently carry the piece along with it, in the time that the ball driven out of the piece shall move along the cylinder, the piece being carried by the Earth, shall passe into the situation DE, and the ball B, in going off, would be at the cornish D, and the motion of the bals centre, would have been according to the line BD, no longer perpendicular, but inclining towards the East; and the ball (as hath been concluded) being to continue its motion through the air, according to the direction of the motion made in the piece, the said motion shall continue on according to the inclination of the line BD, and so shall no longer be perpendicular, but inclined towards the East, to which part the piece doth also move; whereupon the ball may follow the motion of the Earth, and of the piece. Now Simplicius, you see it demonstrated, that the Range which you took to be perpendicular, is not so.

Simpl.I do not very well understand this business; do you, Salviatus?

Salv.I apprehend it in part; but I have a certain kind of scruple, which I wish I knew how to express. It seems to me, that according to what hath been said, if the Piece be erected perpendicular, and the Earth do move, the ball would not be to fall, as Aristotle and Tycho will have it, far from the Piece towards the West, nor as you would have it, upon the Piece, but rather far distant towards the East. For according to your explanation, it would have two motions, the which would with one consent carry it thitherward, to wit, the common motion of the Earth, which carrieth the Piece and the ball from CA towards ED; and the fire which carrieth it by the inclined line BD, both motions towards the East, and therefore they are superiour to the

motion of the Earth.

Sagr.Not so, Sir. The motion which carrieth the ball towards the East, cometh all from the Earth, and the fire hath no part at all therein: the motion which mounteth the ball upwards, is wholly of fire, wherewith the Earth hath nothing to do. And that it is so, if you give not fire, the ball will never go out of the Piece, nor yet rise upwards a hairs breadth; as also if you make the Earth immoveable, and give fire, the ball without any inclination shall go perpendicularly upwards. The ball therefore having two motions, one upwards, and the other in gyration, of both which the transverse line BD is compounded, the impulse upward is wholly of fire, the circular cometh wholly from the Earth, and is equal to the Earths motion: and being equal to it, the ball maintaineth it self all the way directly over the mouth of the Piece, and at last falleth back into the same: and because it always observeth the erection of the Piece, it appeareth also continually over the head of him that is near the Piece, and therefore it appeareth to mount exactly perpendicular towards our Zenith, or vertical point.

Simpl.I have yet one doubt more remaining, and it is, that in regard the motion of the ball is very swift in the Piece, it seems not possible, that in that moment of time the transposition of the Piece from CA to AD should confer such an inclination upon the transverse line CD, that by means thereof, the ball when it cometh afterwards into the air should be able to follow the course of the Earth.

Sagr.You err upon many accounts; and first, the inclination of the transverse line CD, I believe it is much greater than you take it to be, for I verily think that the velocity of the Earths motion, not onely under the Equinoctial, but in our paralel also, is greater than that of the ball whilst it moveth in the Piece; so that the interval CE would be absolutely much bigger than the whole length of the Piece, and the inclination of the transverse line consequently bigger than half a right angle: but be the velocity of the Earth more, or be it less, in comparison of the velocity of the fire,

this imports nothing; for if the velocity of the Earth be small, and consequently the inclination of the transverse line be little also; there is then also need but of little inclination to make the ball suspend it self in its range directly over the Piece. And in a word, if you do but attentively consider, you will comprehend, that the motion of the Earth in transferring the Piece along with it from CA to ED, conferreth upon the transverse line CD, so much of little or great inclination, as is required to adjust the range to its perpendicularity. But you err, secondly, in that you referr the faculty of carrying the ball along with the Earth to the impulse of the fire, and you run into the same error, into which Salviatus, but even now seemed to have fallen; for the faculty of following the motion of the Earth, is the primary and perpetual motion, indelibly and inseparably imparted to the said ball, as to a thing terrestrial, and that of its own nature doth and ever shall possess the same.

Salv.Let us yield,The manner how Fowlers shoot birds flying. Simplicius, for the business is just as he saith. And now from this discourse let us come to understand the reason of a Venatorian Problem, of those Fowlers who with their guns shoot a bird flying; and because I did imagine, that in regard the bird flieth a great pace, therefore they should aim their shot far from the bird, anticipating its flight for a certain space, and more or less according to its velocity and the distance of the bird, that so the bullet hasting directly to the mark aimed at, it might come to arrive at the self same time in the same point with its motion, and the bird with its flight, and by that means one to encounter the other: and asking one of them, if their practise was not so to do; He told me, no; but that the slight was very easie and certain, and that they took aim just in the same manner as if they had shot at a bird that did sit still; that is, they made the flying bird their mark, and by moving their fowling-piece they followed her, keeping their aim still full upon her, till such time as they let fly, and in this manner shot her as they did others sitting still. It is necessary therefore that that motion, though slow, which the fowling-piece maketh in turning and following after the flight of the bird do communicate it self to the bullet also, and that it be

joyned with that of the fire; so that the ball hath from the fire the motion directly upwards, and from the concave Cylinder of the barrel the declination according to the flight of the Bird, just as was said before of the shot of a Canon; where the ball receiveth from the fire a virtue of mounting upwards towards the Zenith, and from the motion of the Earth its winding towards the East, and of both maketh a compound motion that followeth the course of the Earth, and that to the beholder seemeth onely to go directly upwards, and return again downwards by the same line. The holding therefore of the gun continually directed towards the mark, maketh the shoot hit right, and that you may keep your gun directed to the mark, in case the mark stands still, you must also hold your gun still; and if the mark shall move, the gun must be kept upon the mark by moving.The answer to the objection taken from the shots of great Guns made towards the North and South. And upon this dependeth the proper answer to the other argument taken from the shot of a Canon, at the mark placed towards the South or North: wherein is alledged, that if the Earth should move, the shots would all range Westward of the mark, because that in the time whilst the ball, being forc'd out of the Piece, goeth through the air to the mark, the said mark being carried toward the East, would leave the ball to the Westward. I answer therefore, demanding whether if the Canon be aimed true at the mark, and permitted so to continue, it will constantly hit the said mark, whether the Earth move or stand still? It must be replied, that the aim altereth not at all, for if the mark doth stand still, the Piece also doth stand still, and if it, being transported by the Earths motion, doth move, the Piece doth also move at the same rate, and, the aim maintained, the shot proveth always true, as by what hath been said above, is manifest.

Sagr.Stay a little, I entreat you, Salviatus, till I have propounded a certain conceit touching these shooters of birds flying, whose proceeding I believe to be the same which you relate, and believe the effect of hitting the bird doth likewise follow: but yet I cannot think that act altogether conformable to this of shooting in great Guns,

which ought to hit as well when the piece and mark moveth, as when they both stand still; and these, in my opinion, are the particulars in which they disagree. In shooting with a great Gun both it and the mark move with equal velocity, being both transported by the motion of the Terrestrial Globe: and albeit sometimes the piece being planted more towards the Pole, than the mark, and consequently its motion being somewhat flower than the motion of the mark, as being made in a lesser circle, such a difference is insensible, at that little distance of the piece from the mark: but in the shot of the Fowler the motion of the Fowling-piece wherewith it goeth following the bird, is very slow in comparison of the flight of the said bird; whence me thinks it should follow, that that small motion which the turning of the Birding-piece conferreth on the bullet that is within it, cannot, when it is once gone forth of it, multiply it self in the air, untill it come to equal the velocity of the birds flight, so as that the said bullet should always keep direct upon it: nay, me thinketh the bird would anticipate it and leave it behind. Let me add, that in this act, the air through which the bullet is to pass, partaketh not of the motion of the bird: whereas in the case of the Canon, both it, the mark, and the intermediate air, do equally partake of the common diurnal motion. So that the true cause of the Marks-man his hitting the mark, as it should seem, moreover and besides the following the birds flight with the piece, is his somewhat anticipating it, taking his aim before it; as also his shooting (as I believe) not with one bullet, but with many small balls (called shot) the which scattering in the air possess a great space; and also the extreme velocity wherewith these shot, being discharged from the Gun, go towards the bird.

Salv.See how far the winged wit of Sagredus anticipateth, and out-goeth the dulness of mine; which perhaps would have light upon these disparities,The answer to the Argument taken from the shots at point blanck towards the East & West. but not without long studie. Now turning to the matter in hand, there do remain to be considered by us the shots at point blank, towards the East and towards the West; the first of which, if the Earth did move, would always happen to be too high above the

mark, and the second too low; forasmuch as the parts of the Earth Eastward, by reason of the diurnal motion, do continually descend beneath the tangent paralel to the Horizon, whereupon the Eastern stars to us appear to ascend; and on the contrary, the parts Westward do more and more ascend, whereupon the Western stars do in our seeming descend: and therefore the ranges which are leveled according to the said tangent at the Oriental mark, (which whilst the ball passeth along by the tangent descendeth) should prove too high, and the Occidental too low by means of the elevation of the mark, whilst the ball passeth along the tangent. The answer is like to the rest: for as the Eastern mark goeth continually descending, by reason of the Earths motion, under a tangent that continueth immoveable; so likewise the piece for the same reason goeth continually inclining, and with its mounture pursuing the said mark: by which means the shot proveth true.

But here I think it a convenient opportunity to give notice of certain concessions,The followers of Copernicus too freely admit certain propositions for true, which are very doubtfull. which are granted perhaps over liberally by the followers of Copernicus unto their Adversaries: I mean of yielding to them certain experiments for sure and certain, which yet the Adversaries themselves had never made tryal of: as for example, that of things falling from the round-top of a ship whilst it is in motion, and many others; amongst which I verily believe, that this of experimenting whether the shot made by a Canon towards the East proveth too high, and the Western shot too low, is one: and because I believe that they have never made tryal thereof, I desire that they would tell me what difference they think ought to happen between the said shots, supposing the Earth moveable, or supposing it moveable; and let Simplicius for this time answer for them.

Simpl.I will not undertake to answer so confidently as another more intelligent perhaps might do; but shall speak what thus upon the sudden I think they would reply; which is in effect the same with that which hath been said already, namely, that in case the Earth should move, the shots made Eastward would prove too high,

&c. the ball, as it is probable, being to move along the tangent.

Salv.But if I should say, that so it falleth out upon triall, how would you censure me?

Simpl.It is necessary to proceed to experiments for the proving of it.

Salv.But do you think, that there is to be found a Gunner so skilful, as to hit the mark at every shoot, in a distance of v.g. five hundred paces?

Simpl.No Sir; nay I believe that there is no one, how good a marks-man soever that would promise to come within a pace of the mark,

Salv.How can we then, with shots so uncertain, assure our selves of that which is in dispute?

Simpl.We may be assured thereof two wayes; one, by making many shots; the other, because in respect of the great velocity of the Earths motion, the deviation from the mark would in my opinion be very great.

Salv.Very great, that is more than one pace; in regard that the varying so much, yea and more, is granted to happen ordinarily even in the Earths mobility.

Simpl.I verily believe the variation from the mark would be more than so.

Salv.Now I desire that for our satisfaction we do make thus in grosse a slight calculation,A Computation how much the ranges of great shot ought to vary from the marke, the Earths motion being granted. if you consent thereto, which will stand us in stead likewise (if the computation succeed as I expect) for a warning how we do in other occurrences suffer our selves, as the saying is, to be taken with the enemies shouts, and surrender up our belief to what ever first presents it self to our fancy. And now to give all advantages to the Peripateticks and Tychonicks, let us suppose our selves to be under the Equinoctial, there to shoot a piece of Ordinance point blank Eastwards at a mark five hundred paces off. First, let us see thus (as I said) in a level, what time the shot after it is gone out of the Piece taketh to arrive at

the mark; which we know to be very little, and is certainly no more than that wherein a travailer walketh two steps, which also is less than the second of a minute of an hour; for supposing that the travailer walketh three miles in an hour, which are nine thousand paces, being that an hour containes three thousand, six hundred second minutes, the travailer walketh two steps and an half in a second, a second therefore is more than the time of the balls motion. And for that the diurnal revolution is twenty four hours, the Western horizon riseth fifteen degrees in an hour, that is, fifteen first minutes of a degree, in one first minute of an hour; that is, fifteen seconds of a degree, in one second of an hour; and because one second is the time of the shot, therefore in this time the Western horizon riseth fifteen seconds of a degree, and so much likewise the mark; and therefore fifteen seconds of that circle, whose semidiameter is five hundred paces (for so much the distance of the mark from the Piece was supposed.) Now let us look in the table of Arches and Chords (see here is Copernicus his book) what part is the chord of fifteen seconds of the semidiameter, that is, five hundred paces. Here you see the chord (or subtense) of a first minute to be less than thirty of those parts, of which the semidiameter is an hundred thousand. Therefore the chord of a second minute shall be less then half of one of those parts, that is less than one of those parts, of which the semidiameter is two hundred thousand; and therefore the chord of fifteen conds shall be less than fifteen of those same two hundred thousand parts; but that which is less than (a)(a) That is, in plainer termes the fraction 15/200000, is more than the fraction 4/50000, for dividing the denominators by their nominators, and the first produceth 133331/3, the other but 12500. fifteen parts of two hundred thousand, is also more than that which is four centesmes of five hundred; therefore the ascent of the mark in the time of the balls motion is lesse than four centesmes, that is, than one twenty fifth part of a pace; it shall be therefore (b)(b) It shall be neer 22/5 inches, accounting the pace to be Geometrical, containing 5 foot. about two inches: And so much consequently shall be the variation of each Western shot, the Earth

being supposed to have a diurnal motion. Now if I shall tell you, that this variation (I mean of falling two inches short of what they would do in case the Earth did not move) upon triall doth happen in all shots, how will you convince me Simplicius, shewing me by an experiment that it is not so? Do you not see that it is impossible to confute me, unless you first find out a way to shoot at a mark with so much exactnesse, as never to misse an hairs bredth? For whilst the ranges of great shot consist of different numbers of paces, as de facto they do, I will affirm that in each of those variations there is contained that of two inches caused by the motion of the Earth.

Sagr.Pardon me,It is demonstrated with great subtilty, that the Earths motion supposed, Canon shot ought not to vary more than in rest. Salviatus, you are too liberal. For I would tell the Peripateticks, that though every shot should hit the very centre of the mark, that should not in the least disprove the motion of the Earth. For the Gunners are so constantly imployed in levelling the sight and gun to the mark, as that they can hit the same, notwithstanding the motion of the Earth. And I say, that if the Earth should stand still, the shots would not prove true; but the Occidental would be too low, and the Oriental too high: now let Simplicius disprove me if he can.

Salv.This is a subtilty worthy of Sagredus: But whether this variation be to be observed in the motion, or in the rest of the Earth, it must needs be very small, it must needs be swallowed up in those very great ones which sundry accidents continually produce. It is requisite to be very cautious in admitting experiments for true, to those who never tried them. And all this hath been spoken and granted on good grounds to Simplicius, and only with an intent to advertise him how much it importeth to be cautious in granting many experiments for true to those who never had tried them, but only eagerly alledged them just as they ought to be for the serving their purpose: This is spoken, I say, by way of surplussage and Corollary to Simplicius, for the real truth is,Experiments and arguments against the Earths motion seem so far concluding, as they lie hid under equivokes. that as concerning

these shots, the same ought exactly to befall aswell in the motion as in the rest of the Terrestrial Globe; as likewise it will happen in all the other experiments that either have been or can be produced, which have at first blush so much semblance of truth, as the antiquated opinion of the Earths motion hath of equivocation.

Sagr.As for my part I am fully satisfied, and very well understand that who so shall imprint in his fancy this general community of the diurnal conversion amongst all things Terrestrial, to all which it naturally agreeth, aswell as in the old conceit of its rest about the centre, shall doubtlesse discern the fallacy and equivoke which made the arguments produced seem eoncluding. There yet remains in me some hæsitancy (as I have hinted before) touching the flight of birds; the which having as it were an animate faculty of moving at their pleasure with a thousand motions, and to stay long in the Air separated from the Earth, and therein with most irregular windings to go fluttering to and again, I cannot conceive how amongst so great a confusion of motions, they should be able to retain the first commune motion; and in what manner, having once made any stay behind, they can get it up again, and overtake the same with flying, and keep pace with the Towers and trees which hurry with so precipitant a course towards the East; I say so precipitant, for in the great circle of the Globe it is little lesse than a thousand miles an hour, whereof the flight of the swallow I believe makes not fifty.

Salv.If the birds were to keep pace with the course of the trees by help of their wings, they would of necessity flie very fast; and if they were deprived of the universal conversion, they would lag as far behind; and their flight would seem as furious towards the West, and to him that could discern the same, it would much exceed the flight of an arrow; but I think we could not be able to perceive it, no more than we see a Canon bullet, whil'st driven by the fury of the fire, it flieth through the Air: But the truth is that the proper motion of birds, I mean of their flight, hath nothing to do with the universal motion, to which it is neither an help, nor an hinderance; and that which maintaineth the said motion unaltered in the birds,

is the Air it self, thorough which they flie, which naturally following the Vertigo of the Earth, like as it carrieth the clouds along with it, so it transporteth birds and every thing else which is pendent in the same; in so much that as to the businesse of keeping pace with the Earth, the birds need take no care thereof, but for that work might sleep perpetually.

Sagr.That the Air can carry the clouds along with it, as being matters easie for their lightnesse to be moved and deprived of all other contrary inclination, yea more, as being matters that partake also of the conditions and properties of the Earth; I comprehend without any difficulty; but that birds, which as having life, may move with a motion quite contrary to the diurnal, once having surceased the said motion, the Air should restore them to it, seems to me a little strange, and the rather for that they are solid and weighty bodies; and withal, we see; as hath been said, stones and other grave bodies to lie unmoved against the impetus of the air; and when they suffer themselves to be overcome thereby, they never acquire so much velocity as the wind which carrieth them.

Salv.We ascribe not so little force, Sagredus, to the moved Air, which is able to move and bear before it ships full fraught, to tear up trees by the roots, and overthrow Towers when it moveth swiftly; and yet we cannot say that the motion of the Air in these violent operations is neer so violent, as that of the diurnal revolution.

Simpl.You see then that the moved Air may also cotinue the motion of projects, according to the Doctrine of Aristotle; and it seemed to me very strange that he should have erred in this particular.

Salv.It may without doubt, in case it could continue it self, but lik as when the wind ceasing neither ships go on, nor trees are blown down, so the motion in the Air not continuing after the stone is gone out of the hand, and the Air ceasing to move, it followeth that it must be something else besides the Air that maketh the projects to move.

Simpl.But how upon the winds being laid, doth the ship cease to move? Nay you may see that when the wind is down, and the sails furl'd, the vessel continueth to run whole miles.

Salv.But this maketh against your self Simplicius, for that the wind being laid that filling the sails drove on the ship, yet neverthelesse doth it without help of the medium continue its course.

Simpl.It might be said that the water was the medium which carried forward the ship, and maintain'd it in motion.

Salv.It might indeed be so affirmed, if you would speak quite contrary to truth; for the truth is, that the water, by reason of its great resistance to the division made by the hull of the ship, doth with great noise resist the same; nor doth it permit it of a great while to acquire that velocity which the wind would confer upon it, were the obstacle of the water removed. Perhaps Simplicius you have never considered with what fury the water besets a bark, whil'st it forceth its way through a standing water by help of Oars or Sails: for if you had ever minded that effect, you would not now have produced such an absurdity. And I am thinking that you have hitherto been one of those who to find out how such things succeed, and to come to the knowledg of natural effects, do not betake themselves to a Ship, a Crosse-bow, or a piece of Ordinance, but retire into their studies, and turn over Indexes and Tables to see whether Aristotle hath spoken any thing thereof, and being assured of the true sense of the Text, neither desire nor care for knowing any more.

Sagr.This is a great felicity,The great felicity for which they are much to be envied who perswade themselves that they know every thing. and they are to be much envied for it. For if knowledg be desired by all, and if to be wise, be to think ones self so, they enjoy a very great happinesse, for that they may perswade themselves that they know and understand all things, in scorn of those who knowing, that they understand not what these think they understand, and consequently seeking that they

know not the very least particle of what is knowable, kill themselves with waking and studying, and consume their days in experiments and observations. But pray you let us return to our birds; touching which you have said, that the Air being moved with great velocity, might restore unto them that part of the diurnal motion which amongst the windings of their flight they might have lost; to which I reply, that the agitated Air seemeth unable to confer on a solid and grave body, so great a velocity as its own: And because that of the Air is as great as that of the Earth, I cannot think that the Air is able to make good the losse of the birds retardation in flight.

Salv.Your discourse hath in it much of probability, and to stick at trivial doubts is not for an acute wit; yet neverthelesse the probability being removed, I believed that it hath not a jot more force than the others already considered and resolved.

Sagr.It is most certain that if it be not necessarily concludent, its efficacy must needs be just nothing at all, for it is onely when the conclusion is necessary that the opponent hath nothing to alledg on the contrary.

Salv.Your making a greater scruple of this than of the other instances dependeth, if I mistake not, upon the birds being animated, and thereby enabled to use their strength at pleasure against the primary motion in-bred in terrene bodies: like as for example, we see them whil'st they are alive to fly upwards, a thing altogether impossible for them to do as they are grave bodies; whereas being dead they can onely fall downwards; and therefore you hold that the reasons that are of force in all the kinds of projects above named, cannot take place in birds: Now this is very true; and because it is so, Sagredus, that doth not appear to be done in those projects,The answer to the argument taken from the flight of birds contrary to the motion of the Earth. which we see the birds to do. For if from the top of a Tower you let fall a dead bird and a live one, the dead bird shall do the same that a stone doth, that is, it shall first follow the general motion diurnal, and then the motion of descent, as grave; but if the bird let fall, be a live, what shall hinder it, (there ever remaining in

it the diurnal motion) from soaring by help of its wings to what place of the Horizon it shall please? and this new motion, as being peculiar to the bird, and not participated by us, must of necessity be visible to us; and if it be moved by help of its wings towards the West, what shall hinder it from returning with a like help of its wings unto the Tower. And, because, in the last place, the bird swending its flight towards the West was no other than a withdrawing from the diurnal motion, (which hath, suppose ten degrees of velocity) one degree onely, there did thereupon remain to the bird whil'st it was in its flight nine degrees of velocity, and so soon as it did alight upon the the Earth, the ten common degrees returned to it, to which, by flying towards the East it might adde one, and with those eleven overtake the Tower. And in short, if we well consider, and more narrowly examine the effects of the flight of birds, they differ from the projects shot or thrown to any part of the World in nothing, save onely that the projects are moved by an external projicient,An experiment with which alone is shewn the nullity of all the objections produced against the motion of the Earth. and the birds by an internal principle. And here for a final proof of the nullity of all the experiments before illedged, I conceive it now a time and place convenient to demonstrate a way how to make an exact trial of them all. Shut your self up with some friend in the grand Cabbin between the decks of some large Ship, and there procure gnats, flies, and such other small winged creatures: get also a great tub (or other vessel) full of water, and within it put certain fishes; let also a certain bottle be hung up, which drop by drop letteth forth its water into another bottle placed underneath, having a narrow neck: and, the Ship lying still, observe diligently how those small winged animals fly with like velocity towards all parts of the Cabin; how the fishes swim indifferently towards all sides; and how the distilling drops all fall into the bottle placed underneath. And casting any thing towards your friend, you need not throw it with more force one way then another, provided the distances be equal: and leaping, as the saying is, with your feet closed, you will reach as far one way as another. Having observed all these

particulars, though no man doubteth that so long as the vessel stands still, they ought to succeed in this manner; make the Ship to move with what velocity you please; for (so long as the motion is uniforme, and not fluctuating this way and that way) you shall not discern any the least alteration in all the forenamed effects; nor can you gather by any of them whether the Ship doth move or stand still. In leaping you shall reach as far upon the floor, as before; nor for that the Ship moveth shall you make a greater leap towards the poop than towards the prow; howbeit in the time that you staid in the Air, the floor under your feet shall have run the contrary way to that of your jump; and throwing any thing to your companion you shall not need to cast it with more strength that it may reach him, if he shall be towards the prow, and you towards the poop, then if you stood in a contrary situation; the drops shall all distill as before into the inferiour bottle, and not so much as one shall fall towards the poop, albeit whil'st the drop is in the Air, the Ship shall have run many feet; the Fishes in their water shall not swim with more trouble towards the fore-part, than towards the hinder part of the tub; but shall with equal velocity make to the bait placed on any side of the tub; and lastly, the flies and gnats shall continue their flight indifferently towards all parts; nor shall they ever happen to be driven together towards the side of the Cabbin next the prow, as if they were wearied with following the swift course of the Ship, from which through their suspension in the Air, they had been long separated; and if burning a few graines of incense you make a little smoke, you shall see it ascend on high, and there in manner of a cloud suspend it self, and move indifferently, not inclining more to one side than another: and of this correspondence of effects the cause is for that the Ships motion is common to all the things contained in it, and to the Air also; I mean if those things be shut up in the Cabbin: but in case those things were above deck in the open Air, and not obliged to follow the course of the Ship, differences more or lesse notable would be observed in some of the fore-named effects, and there is no doubt but that the smoke would stay behind as much as the Air it self; the flies also, and the gnats being hindered by

the Air would not be able to follow the motion of the Ship, if they were separated at any distance from it. But keeping neer thereto, because the Ship it self as being an unfractuous Fabrick, carrieth along with it part of its neerest Air, they would follow the said Ship without any pains or difficulty. And for the like reason we see sometimes in riding post, that the troublesome flies and * Tafaris, horse-flyes.* hornets do follow the horses flying sometimes to one, sometimes to another part of the body, but in the falling drops the difference would be very small; and in the salts, and projections of grave bodies altogether imperceptible.

Sagr.Though it came not into my thoughts to make triall of these observations, when I was at Sea, yet am I confident that they will succeed in the same manner, as you have related; in confirmation of which I remember that being in my Cabbin I have asked an hundred times whether the Ship moved or stood still; and sometimes I have imagined that it moved one way, when it steered quite another way. I am therefore as hitherto satisfied and convinced of the nullity of all those experiments that have been produced in proof of the negative part. There now remains the objection founded upon that which experience shews us, namely, that a swift Vertigo or whirling about hath a faculty to extrude and disperse the matters adherent to the machine that turns round; whereupon many were of opinion, and Ptolomy amongst the rest, that if the Earth should turn round with so great velocity, the stones and creatures upon it should be tost into the Skie, and that there could not be a morter strong enough to fasten buildings so to their foundations, but that they would likewise suffer a like extrusion.

Salv.Before I come to answer this objection, I cannot but take notice of that which I have an hundred times observed, and not without laughter, to come into the minds of most men so soon as ever they hear mention made of this motion of the Earth, which is believed by them so fixt and immoveable, that they not only never doubted of that rest, but have ever strongly believed that all other men aswell as they, have held it to be created immoveable, and so to have continued through all succeeding ages:The

stupidity of some that think the Earth to have begun to move, when Pythagoras began to affirme that it did so. and being setled in this perswasion, they stand amazed to hear that any one should grant it motion, as if, after that he had held it to be immoveable, he had fondly thought it to commence its motion then (and not till then) when Pythagoras (or whoever else was the first hinter of its mobility) said that it did move. Now that such a foolish conceit (I mean of thinking that those who admit the motion of the Earth, have first thought it to stand still from its creation, untill the time of Pythagoras, and have onely made it moveable after that Pythagoras esteemed it so) findeth a place in the mindes of the vulgar, and men of shallow capacities, I do not much wonder; but that such persons as Aristotle and Ptolomy should also run into this childish mistake, is to my thinking a more admirable and unpardonable folly.

Sagr.You believe then, Salviatus, that Ptolomy thought, that in his Disputation he was to maintain the stability of the Earth against such persons, as granting it to have been immoveable, untill the time of Pythagoras, did affirm it to have been but then made moveable, when the said Pythagoras ascribed unto it motion.

Salv.We can think no other, if we do but consider the way he taketh to confute their assertion;Aristotle and Ptolomy seem to confute the mobility of the Earth against those who thought that it having a long time stood still, did begin to move in the time of Pythagoras the confutation of which consists in the demolition of buildings, and the tossing of stones, living creatures and men themselves up into the Air. And because such overthrows and extrusions cannot be made upon buildings and men, which were not before on the Earth, nor can men be placed, nor buildings erected upon the Earth, unlesse when it standeth still; hence therefore it is cleer, that Ptolomy argueth against those, who having granted the stability of the Earth for some time, that is, so long as living creatures, stones, and Masons were able to abide there, and to build Palaces and Cities, make it afterwards precipitately moveable to the overthrow and destructi- of Edifices, and living creatures, &c. For if he had

undertook to dispute against such as had ascribed that revolution to the Earth from its first creation, he would have confuted them by saying, that if the Earth had alwayes moved, there could never have been placed upon it either men or stones; much less could buildings have been erected, or Cities founded, &c.

Simpl.I do not well conceive these Aristotelick and Ptolomaick inconveniences.

Salv.Ptolomey either argueth against those who have esteemed the Earth always moveable; or against such as have held that it stood for some time still, and hath since been set on moving. If against the first, he ought to say, that the Earth did not always move, for that then there would never have been men, animals, or edifices on the Earth, its vertigo not permitting them to stay thereon. But in that he arguing, saith that the Earth doth not move, because that beasts, men, and houses before plac'd on the Earth would precipitate, he supposeth the Earth to have been once in such a state, as that it did admit men and beasts to stay, and build thereon; the which draweth on the consequence, that it did for some time stand still, to wit, was apt for the abode of animals and erection of buildings. Do you now conceive what I would say?

Simpl.I do, and I do not: but this little importeth to the merit of the cause; nor can a small mistake of Ptolomey, committed through inadvertencie be sufficient to move the Earth, when it is immoveable. But omitting cavils, let us come to the substance of the argument, which to me seems unanswerable.

Salv.And I, Simplicius, will drive it home, and re-inforce it, by shewing yet more sensibly, that it is true that grave bodies turn'd with velocity about a settled centre, do acquire an impetus of moving, and receding to a distance from that centre, even then when they are in a state of having a propension of moving naturally to the same. Tie a bottle that hath water in it, to the end of a cord, and holding the other end fast in your hand, and making the cord and your arm the semi-diameter, and the knitting of the shoulder the centre, swing the bottle very fast about, so as that it may

describe the circumference of a circle, which, whether it be parallel to the Horizon, or perpendicular to it, or any way inclined, it shall in all cases follow, that the water will not fall out of the bottle: nay, he that shall swing it, shall find the cord always draw, and strive to go farther from the shoulder. And if you bore a hole in the bottom of the bottle, you shall see the water spout forth no less upwards into the skie, than laterally, and downwards to the Earth; and if instead of water, you shall put little pebble stones into the bottle, and swing it in the same manner, you shall find that they will strive in the like manner against the cord. And lastly, we see boys throw stones a great way, by swinging round a piece of a stick, at the end of which the stone is let into a slit (which stick is called by them a sling;) all which are arguments of the truth of the conclusion, to wit, that the vertigo or swing conferreth upon the moveable, a motion towards the circumference, in case the motion be swift: and therefore if the Earth revolve about its own centre, the motion of the superficies, and especially towards the great circle, as being incomparably more swift than those before named, ought to extrude all things up into the air.

Simpl.The Argument seemeth to me very well proved and inforced; and I believe it would be an hard matter to answer and overthrow it.

Salv.Its solution dependeth upon certain notions no less known and believed by you, than by my self: but because they come not into your mind, therefore it is that you perceive not the answer; wherefore, without telling you it (for that you know the same already) I shall with onely assisting your memory, make you to refute this argument.

Simpl.I have often thought of your way of arguing, which hath made me almost think that you lean to that opinion of Plato,Our knowledg is a kind of reminiscence according to Plato. Quòd nostrum scire sit quoddam reminisci; therefore I intreat you to free me from this doubt, by letting me know your judgment.

Salv.What I think of the opinion of Plato, you may gather from my words and

actions. I have already in the precedent conferences expresly declared my self more than once; I will pursue the same style in the present case, which may hereafter serve you for an example, thereby the more easily to gather what my opinion is touching the attainment of knowledg, when a time shall offer upon some other day: but I would not have Sagredus offended at this digression.

Sagr.I am rather very much pleased with it, for that I remember that when I studied Logick, I could never comprehend that so much cry'd up and most potent demonstration of Aristotle.

Salv.Let us go on therefore; and let Simplicius, tell me what that motion is which the stone maketh that is held fast in the slit of the sling, when the boy swings it about to throw it a great way?

Simpl.The motion of the stone, so long as it is in the slit, is circular, that is, moveth by the arch of a circle, whose stedfast centre is the knitting of the shoulder, and its semi-diameter the arm and stick.

Salv.And when the stone leaveth the sling, what is its motion? Doth it continue to follow its former circle, or doth it go by another line?

Simpl.It will continue no longer to swing round, for then it would not go farther from the arm of the projicient, whereas we see it go a great way off.

Salv.With what motion doth it move then?

Simpl.Give me a little time to think thereof; For I have never considered it before.

Salv.Hark hither, Sagredus; this is the Quoddam reminisci in a subject well understood. You have paused a great while, Simplicius.

Simpl.As far as I can see, the motion received in going out of the sling, can be no other than by a right line; nay, it must necessarily be so, if we speak of the pure adventitious impetus. I was a little puzled to see it make an arch, but because that arch bended all the way upwards, and no other way, I conceive that that incurvation

cometh from the gravity of the stone,The motion impressed by the projicient is onely by a right line. which naturally draweth it downwards. The impressed impetus, I say, without respecting the natural, is by a right line.

Salv.But by what right line? Because infinite, and towards every side may be produced from the slit of the sling, and from the point of the stones separation from the sling.

Simpl.It moveth by that line which goeth directly from the motion which the stone made in the sling.

Salv.The motion of the stone whilst it was in the slit, you have affirmed already to be circular; now circularity opposeth directness, there not being in the circular line any part that is direct or streight.

Simpl.I mean not that the projected motion is direct in respect of the whole circle, but in reference to that ultimate point, where the circular motion determineth. I know what I would say, but do not well know how to express my self.

Salv.And I also perceive that you understand the business, but that you have not the proper terms, wherewith to express the same. Now these I can easily teach you; teach you, that is, as to the words, but not as to the truths, which are things. And that you may plainly see that you know the thing I ask you, and onely want language to express it, tell me, when you shoot a bullet out of a gun, towards what part is it, that its acquired impetus carrieth it?

Simpl.Its acquired impetus carrieth it in a right line, which continueth the rectitude of the barrel, that is, which inclineth neither to the right hand nor to the left, nor upwards nor downwards.

Salv.Which in short is asmuch as to say, it maketh no angle with the line of streight motion made by the sling.

Simpl.So I would have said.

Salv.If then the line of the projects motion be to continue without making an angle upon the circular line described by it, whilst it was with the projicient; and if from this circular motion it ought to pass to the right motion, what ought this right line to be?

Simpl.It must needs be that which toucheth the circle in the point of separation, for that all others, in my opinion, being prolonged would intersect the circumference, and by that means make some angle therewith.

Salv.You have argued very well, and shewn your self half a Geometrician. Keep in mind therefore, that your true opinion is exprest in these words, namely, That the project acquireth an impetus of moving by the Tangent, the arch described by the motion of the projicient, in the point of the said projects separation from the projicient.

Simpl.I understand you very well, and this is that which I would say.

Salv.Of a right line which toucheth a circle, which of its points is the nearest to the centre of that circle?

Simpl.That of the contact without doubt: for that is in the circumference of a circle, and the rest without: and the points of the circumference are all equidistant from the centre.

Salv.Therefore a moveable departing from the contact, and moving by the streight Tangent, goeth continually farther and farther from the contact, and also from the centre of the circle.

Simpl.It doth so doubtless.

Salv.Now if you have kept in mind the propositions, which you have told me, lay them together, and tell me what you gather from them.

Simpl.I think I am not so forgetful, but that I do remember them.The project moveth by the Tangent of the circle of the motion precedent in the point of separation. From

the things premised I gather that the project swiftly swinged round by the projicient, in its separating from it, doth retain an impetus of continuing its motion by the right line, which toucheth the circle described by the motion of the projicient in the point of separation, by which motion the project goeth continually receding from the centre of the circle described by the motion of the projicient.

Salv.You know then by this time the reason why grave bodies sticking to the rim of a wheele, swiftly moved, are extruded and thrown beyond the circumference to yet a farther distance from the centre.

Simpl.I think I understand this very well; but this new knowledg rather increaseth than lesseneth my incredulity that the Earth can turn round with so great velocity, without extruding up into the sky, stones, animals, &c.

Salv.In the same manner that you have understood all this, you shall, nay you do understand the rest: and with recollecting your self, you may remember the same without the help of others: but that we may lose no time, I will help your memory therein. You do already know of your self, that the circular motion of the projicient impresseth on the project an impetus of moving (when they come to separate) by the right Tangent, the circle of the motion in the point of separation, and continuing along by the same the motion ever goeth receding farther and farther from the projicient: and you have said, that the project would continue to move along by that right line, if there were not by its proper weight an inclination of descent added unto it; from which the incurvation of the line of motion is derived. It seems moreover that you knew of your self, that this incurvation always bended towards the centre of the Earth, for thither do all grave bodies tend. Now I proceed a little farther, and ask you, whether the moveable after its separation, in continuing the right motion goeth always equally receding from the centre, or if you will, from the circumference of that circle, of which the precedent motion was a part; which is as much as to say, Whether a moveable, that forsaking the point of a Tangent, and moving along by the

said Tangent, doth equally recede from the point of contact, and from the circumference of the circle?

Simpl.No, Sir: for the Tangent near to the point of contact, recedeth very little from the circumference, wherewith it keepeth a very narrow angle, but in its going farther and farther off, the distance always encreaseth with a greater proportion; so that in a circle that should have v. g. ten yards of diameter, a point of the Tangent that was distant from the contact but two palms, would be three or four times as far distant from the circumference of the circle, as a point that was distant from the contaction one palm, and the point that was distant half a palm, I likewise believe would fearse recede the fourth part of the distance of the second: so that within an inch or two of the contact, the separation of the Tangent from the circumference is scarse discernable.

Salv.So that the recession of the project from the circumference of the precedent circular motion is very small in the begining?

Simpl.Almost insensible.

Salv.Now tell me a little; the project, which from the motion of the projicient receiveth an impetus of moving along the Tangent in a right line, and that would keep unto the same, did not its own weight depress it downwards, how long is it after the separation, ere it begin to decline downwards.

Simpl.I believe that it beginneth presently; for it not having any thing to uphold it, its proper gravity cannot but operate. A grave project, as soon as it is separated from the projicient begineth to decline.

Salv.So that, if that same stone, which being extruded from that wheel turn'd about very fast, had as great a natural propension of moving towards the centre of the said wheel, as it hath to move towards the centre of the Earth, it would be an easie matter for it to return unto the wheel, or rather not to depart from it; in regard that upon the begining of the separation, the recession being so small, by reason of the infinite

acuteness of the angle of contact, every very little of inclination that draweth it back towards the centre of the wheel, would be sufficient to retain it upon the rim or circumference.

Simpl.I question not, but that if one suppose that which neither is, nor can be, to wit, that the inclination of those grave bodies was to go towards the centre of the wheel, they would never come to be extruded or shaken off.

Salv.But I neither do, nor need to suppose that which is not; for I will not deny but that the stones are extruded. Yet I speak this by way of supposition, to the end that you might grant me the rest. Now fancy to your self, that the Earth is that great wheel, which moved with so great velocity is to extrude the stones. You could tell me very well even now, that the motion of projection ought to be by that right line which toucheth the Earth in the point of separation: and this Tangent, how doth it notably recede from the superficies of the Terrestrial Globe?

Simpl.I believe, that in a thousand yards, it will not recede from the Earth an inch.

Salv.And did you not say, that the project being drawn by its own weight, declineth from the Tangent towards the centre of the Earth?

Simpl.I said so, and also confesse the rest: and do now plainly understand that the stone will not separate from the Earth, for that its recession in the beginning would be such, and so small, that it is a thousand times exceeded by the inclination which the stone hath to move towards the centre of the Earth, which centre in this case is also the centre of the wheel. And indeed it must be confessed that the stones, the living creatures, and the other grave bodies cannot be extruded; but here again the lighter things beget in me a new doubt, they having but a very weak propension of descent towards the centre; so that there being wanting in them that faculty of withdrawing from the superficies, I see not, but that they may be extruded; and you know the rule, that ad destruendum sufficit unum.

Savl.We will also give you satisfaction in this. Tell me therefore in the first place,

what you understand by light matters, that is, whether you thereby mean things really so light, as that they go upwards, or else not absolutely light, but of so small gravity, that though they descend downwards, it is but very slowly; for if you mean the absolutely light, I will be readier than your self to admit their extrusion.

Simpl.I speak of the other sort, such as are feathers, wool, cotton, and the like; to lift up which every small force sufficeth: yet neverthelesse we see they rest on the Earth very quietly.

Salv.This pen, as it hath a natural propension to descend towards the superficies of the Earth, though it be very small, yet I must tell you that it sufficeth to keep it from mounting upwards: and this again is not unknown to you your self; therefore tell me if the pen were extruded by the Vertigo of the Earth, by what line would it move?

Simpl.By the tangent in the point of separation.

Salv.And when it should be to return, and re-unite it self to the Earth, by what line would it then move?

Simpl.By that which goeth from it to the centre of the Earth.

Salv.So then here falls under our consideration two motions; one the motion of projection, which beginneth from the point of contact, and proceedeth along the tangent; and the other the motion of inclination downwards, which beginneth from the project it self, and goeth by the secant towards the centre; and if you desire that the projection follow, it is necessary that the impetus by the tangent overcome the inclination by the secant: is it not so?

Simpl.So it seemeth to me.

Salv.But what is it that you think necessary in the motion of the projicient, to make that it may prevail over that inclination, from which ensueth the separation and elongation of the pen from the Earth?

Simpl.I cannot tell.

Salv.How, do you not know that? The moveable is here the same, that is, the same pen; now how can the same moveable superate and exceed it self in motion?

Simpl.I do not see how it can overcome or yield to it self in motion, unlesse by moving one while faster, and another while slower.

Salv.You see then, that you do know it. If therefore the projection of the pen ought to follow, and its motion by the tangent be to overcome its motion by the secant, what is it requisite that their velocities should be?

Simpl.It is requisite that the motion by the tangent be greater than that other by the secant. But wretch that I am! Is it not only many thousand times greater than the descending motion of the pen, but than that of the stone? And yet like a simple fellow I had suffered my self to be perswaded, that stones could not be extruded by the revolution of the Earth. I do therefore revoke my former sentence, and say, that if the Earth should move, stones, Elephants, Towers, and whole Cities would of necessity be tost up into the Air; and because that that doth not evene, I conclude that the Earth doth not move.

Salv.Softly Simplicius, you go on so fast, that I begin to be more afraid for you, than for the pen. Rest a little, and observe what I am going to speap. If for the reteining of the stone or pen annexed to the Earths surface it were necessary that its motion of descent were greater, or as much as the motion made by the tangent; you would have had reason to say, that it ought of necessity to move as fast, or faster by the secant downwards, than by the tangent Eastwards: But did not you tell me even now, that a thousand yards of distance by the tangent from the contact, do remove hardly an inch from the circumference? It is not sufficient therefore that the motion by the tangent, which is the same with that of the diurnall Vertigo, (or hasty revolution) be simply more swift than the motion by the secant, which is the same with that of the pen in descending; but it is requisite that the same be so much more swift as that the time which sufficeth for the pen to move v. g. a thousand yards by the tangent, be

insufficient for it to move one sole inch by the secant. The which I tell you shall never be, though you should make that motion never so swift, and this never so slow.

Simpl.And why might not that by the tangent be so swift, as not to give the pen time to return to the surface of the Earth?

Salv.Try whether you can state the case in proper termes, and I will give you an answer. Tell me therefore, how much do you think sufficeth to make that motion swifter than this?

Simpl.I will say for example, that if that motion by the tangent were a million of times swifter than this by the secant, the pen, yea, and the stone also would come to be extruded.

Salv.You say so, and say that which is false, onely for want, not of Logick, Physicks, or Metaphysicks, but of Geometry; for if you did but understand its first elements, you would know, that from the centre of a circle a right line may be drawn to meet the tangent, which intersecteth it in such a manner, that the part of the tangent between the contact and the secant, may be one, two, or three millions of times greater than that part of the secant which lieth between the tangent and the circumference, and that the neerer and neerer the secant shall be to the contact, this proportion shall grow greater and greater in infinitum; so that it need not be feared, though the vertigo be swift, and the motion downwards slow, that the pen or other lighter matter can begin to rise upwards, for that the inclination downwards always exceedeth the velocity of the projection.

Sagr.I do not perfectly apprehend this businesse.

Salv.I will give you a most universal yet very easie demonstration thereof.A geometrical demonstration to prove the impossibility of extrusion by means of the terrestrial vertigo. Let a proportion be given between BA [in Fig. 3.] and C: And let BA be greater than C at pleasure. And let there be described a circle, whose centre is

D. From which it is required to draw a secant, in such manner, that the tangent may be in proportion to the said secant, as BA to C. Let AI be supposed a third proportional to BA and C. And as BI is to IA, so let the diameter FE be to EG; and from the point G, let there be drawn the tangent GH. I say that all this is done as was required; and as BA is to C, so is HG to GE. And in regard that as BI is to IA, so is FE to EG; therefore by composition, as BA is to AI; so shall FG be to GE. And because C is the middle proportion between BA and AI; and GH is a middle term between FG and GE; therefore, as BA is to C, so shall FG be to GH; that is HG to GE, which was to be demonstrated.

Sagr.I apprehend this demonstration; yet neverthelesse, I am not left wholly without haesitation; for I find certain confused scruples role to and again in my mind, which like thick and dark clouds, permit me not to discern the cleernesse and necessity of the conclusion with that perspicuity, which is usual in Mathematical Demonstrations. And that which I stick at is this. It is true that the spaces between the tangent and the circumference do gradually diminish in infinitum towards the contact; but it is also true on the contrary, that the propension of the moveable to descending groweth less & less in it, the nearer it is to the first term of its descent; that is, to the state of rest; as is manifest from that which you declare unto us, demonstrating that the descending grave body departing from rest, ought to passe thorow all the degrees of tardity comprehended between the said rest, & any assigned degree of velocity, the which grow less and in infinitum. To which may be added, that the said velocity and propension to motion, doth for another reason diminish to infinity; and it is because the gravity of the said moveable may infinitely diminish. So that the causes which diminish the propension of ascending, and consequently favour the projection, are two; that is, the levity of the moveable, and its vicinity to the state of rest; both which are augmentable in infinit. and these two on the contrary being to contract but with one sole cause of making the projection, I cannot conceive how it alone, although it also do admit of infinite augmentation,

should be able to remain invincible against the union & confederacy of the others, wch are two, and are in like manner capable of infinite augmentation.

Salv.This is a doubt worthy of Sagredus; and to explain it so as that we may more cleerly apprehend it, for that you say that you your self have but a confused Idea of it, we will distinguish of the same by reducing it into figure; which may also perhaps afford us some ease in resolving the same. Let us therefore [in Fig. 4.] draw a perpendicular line towards the centre, and let it be AC, and to it at right angles let there be drawn the Horizontal line AB, upon which the motion of the projection ought to be made; now the project would continue to move along the same with an even motion, if so be its gravity did not incline it downwards. Let us suppose from the point A a right line to be drawn, that may make any angle at pleasure with the line AB; which let be AE, and upon AB let us mark some equal spaces AF, FH, HK, and from them let us let fall the perpendiculars FG, HI, KL, as far as AE. And because, as already hath been said, the descending grave body departing from rest, goeth from time to time acquiring a greater degrees of velocity, according as the said time doth successively encrease; we may conceive the spaces AF, FH, HK, to represent unto us equal times; and the perpendiculars FG, HI, KL, degrees of velocity acquired in the said times; so that the degree of velocity acquired in the whole time AK, is as the line KL, in respect to the degree HI, acquired in the time AH, and the degree FG in the time AF; the which degrees KL, HI, FG, are (as is manifest) the same in proportion, as the times KA, HA, FA, and if other perpendiculars were drawn from the points marked at pleasure in the line FA, one might successively find degrees lesse and lesse in infinitum, proceeding towards the point A, representing the first instant of time, and the first state of rest. And this retreat towards A, representeth the first propension to the motion of descent, diminished in infinitum by the approach of the moveable to the first state of rest, which approximation is augmentable in infinitum. Now let us find the other diminution of velocity, which likewise may proceed to infinity, by the diminution of

the gravity of the moveable, and this shall be represented by drawing other lines from the point A, which contein angles lesse than the angle BAE, which would be this line AD, the which intersecting the parallels KL, HI, FG, in the points M, N, and O, represent unto us the degrees FO, HN, KM, acquired in the times AF, AH, AK, lesse than the other degrees FG, HI, KL, acquired in the same times; but these latter by a moveable more ponderous, and those other by a moveable more light. And it is manifest, that by the retreat of the line EA towards AB, contracting the angle EAB (the which may be done in infinitum, like as the gravity may in infinitum be diminished) the velocity of the cadent moveable may in like manner be diminished in infinitum, and so consequently the cause that impeded the projection; and therefore my thinks that the union of these two reasons against the projection, diminished to infinity, cannot be any impediment to the said projection. And couching the whole argument in its shortest terms, we will say, that by contracting the angle EAB, the degrees of velocity LK, IH, GF, are diminished; and moreover by the retreat of the parallels KL, HI, FG, towards the angle A, the same degrees are again diminished; and both these diminutions extend to infinity: Therefore the velocity of the motion of descent may very well diminish so much, (it admitting of a twofold diminution in infinitum) as that it may not suffice to restore the moveable to the circumference of the wheel, and thereupon may occasion the projection to be hindered and wholly obviated.

Again on the contrary, to impede the projection, it is necessary that the spaces by which the project is to descend for the reuniting it self to the Wheel, be made so short and close together, that though the descent of the moveable be retarded, yea more, diminished in infinitum, yet it sufficeth to reconduct it thither: and therefore it would be requisite, that you find out a diminution of the said spaces, not only produced to infinity, but to such an infinity, as that it may superate the double infinity that is made in the diminution of the velocity of the descending moveable. But how can a magnitude be diminished more than another, which hath a twofold

diminution in infinitum? Now let Simplicius observe how hard it is to philosophate well in nature, without Geometry. The degrees of velocity diminished in infinitum, as well by the diminution of the gravity of the moveable, as by the approxination to the first term of the motion, that is, to the state of rest, are alwayes determinate, and answer in proportion to the parallels comprehended between two right lines that concur in an angle, like to the angle BAE, or BAD, or any other infinitely more acute, alwayes provided it be rectilineall. But the diminution of the spaces thorow which the moveable is to be conducted along the circumference of the wheel, is proportionate to another kind of diminution, comprehended between lines that contain an angle infinitely more narrow and acute, than any rectilineal angle, how acute soever, which is that in our present case. Let any point be taken in the perpendicular AC, and making it the centre, describe at the distance CA, an arch AMP, the which shall intersect the parallels that determine the degrees of velocity, though they be very minute, and comprehended within a most acute rectilineal angle; of which parallels the parts that lie between the arch and the tangent AB, are the quantities of the spaces, and of the returns upon the wheel, alwayes lesser (and with greater proportion lesser, by how much neerer they approach to the contact) than the said parallels of which they are parts. The parallels comprehended between the right lines in retiring towards the angle diminish alwayes at the same rate, as v. g. AH being divided in two equal parts in F, the parallel HI shall be double to FG, and sub-dividing FA, in two equal parts, the parallel produced from the point of the division shall be the half of FG; and continuing the sub-division in infinitum, the subsequent parallels shall be alwayes half of the next preceding; but it doth not so fall out in the lines intercepted between the tangent and the circumference of the circle: For if the same sub-division be made in FA; and supposing for example, that the parallel which cometh from the point H, were double unto that which commeth from F, this shall be more then double to the next following, and continually the neerer we come towards the contact A, we shall find the precedent lines contein the

next following three, four, ten, an hundred, a thousand, an hundred thousand, an hundred millions of times, and more in infinitum. The brevity therefore of such lines is so reduced, that it far exceeds what is requisite to make the project, though never so light, return, nay more, continue unremoveable upon the circumference.

Sagr.I very well comprehend the whole discourse, and upon what it layeth all its stresse, yet neverthelesse methinks that he that would take pains to pursue it, might yet start some further questions, by saying, that of those two causes which render the descent of the moveable slower and slower in infinitum, it is manifest, that that which dependeth on the vicinity to the first term of the descent, increaseth alwayes in the same proportion, like as the parallels alwayes retain the same proportion to each other, &c. but that the diminution of the same velocity, dependent on the diminution of the gravity of the moveable (which vvas the second cause) doth also observe the same proportion, doth not so plainly appear, And vvho shall assure us that it doth not proceed according to the proportion of the lines intercepted between the secant, and the circumference; or vvhether vvith a greater proportion?

Salv.I have assumed for a truth, that the velocities of moveables descending naturally, will follow the proportion of their gravities, with the favour of Simplicius, and of Aristotle, who doth in many places affirm the same, as a proposition manifest: You, in favour of my adversary, bring the same into question, and say that its possible that the velocity increaseth with greater proportion, yea and greater in infinitum than that of the gravity; so that all that hath been said falleth to the ground: For maintaining whereof, I say, that the proportion of the velocities is much lesse than that of the gravities; and thereby I do not onely support but confirme the premises. And for proof of this I appeal unto experience, which will shew us, that a grave body, howbeit thirty or fourty times bigger then another; as for example, a ball of lead, and another of sugar, will not move much more than twice as fast. Now if the projection would not be made, albeit the velocity of the cadent body should diminish according to the proportion of the gravity, much lesse would it be made so

long as the velocity is but little diminished, by abating much from the gravity. But yet supposing that the velocity diminisheth with a proportion much greater than that wherewith the gravity decreaseth, nay though it were the self-same wherewith those parallels conteined between the tangent and circumference do decrease, yet cannot I see any necessity why I should grant the projection of matters of never so great levity; yea I farther averre, that there could no such projection follow, meaning alwayes of matters not properly and absolutely light, that is, void of all gravity, and that of their own natures move upwards, but that descend very slowly, and have very small gravity. And that which moveth me so to think is, that the diminution of gravity, made according to the proportion of the parallels between the tangent and the circumference, hath for its ultimate and highest term the nullity of weight, as those parallels have for their last term of their diminution the contact it self, which is an indivisible point: Now gravity never diminisheth so far as to its last term, for then the moveable would cease to be grave; but yet the space of the reversion of the project to the circumference is reduced to the ultimate minuity, which is when the moveable resteth upon the circumference in the very point of contact; so as that to return thither it hath no need of space: and therefore let the propension to the motion of descent be never so small, yet is it alwayes more than sufficient to reconduct the moveable to the circumference, from which it is distant but its least space, that is, nothing at all.

Sagr.Your discourse, I must confess, is very accurate; and yet no less concluding than it is ingenuous; and it must be granted that to go about to handle natural questions, without Geometry, is to attempt an impossibility.

Salv.But Simplicius will not say so; and yet I do not think that he is one of those Peripateticks that disswade their Disciples from studying the Mathematicks, as Sciences that vitiate the reason, and render it lesse apt for contemplation.

Simpl.I would not do so much wrong to Plato, but yet I may truly say with Aristotle,

that he too much lost himself in, and too much doted upon that his Geometry: for that in conclusion these Mathematical subtilties Salviatus are true in abstract, but applied to sensible and Physical matter, they hold not good. For the Mathematicians will very well demonstrate for example, that Sphæra tangit planum in puncto; a position like to that in dispute, but when one cometh to the matter, things succeed quite another way. And so I may say of these angles of contact, and these proportions; which all evaporate into Air, when they are applied to things material and sensible.

Salv.You do not think then, that the tangent toucheth the superficies of the terrestrial Globe in one point only?

Simpl.No, not in one sole point; but I believe that a right line goeth many tens and hundreds of yards touching the surface not onely of the Earth, but of the water, before it separate from the same.

Salv.But if I grant you this, do not you perceive that it maketh so much the more against your cause? For if it be supposed that the tangent was separated from the terrestrial superficies, yet it hath been however demonstrated that by reason of the great acuity of the angle of contingence (if happily it may be call'd an angle) the project would not separate from the same; how much lesse cause of separation would it have, if that angle should be wholly closed,The truth sometimes gaines strength by contradiction. and the superficies and the tangent become all one? Perceive you not that the Projection would do the same thing upon the surface of the Earth, which is asmuch as to say, it would do just nothing at all? You see then the power of truth, which while you strive to oppose it, your own assaults themselves uphold and defend it. But in regard that you have retracted this errour, I would be loth to leave you in that other which you hold, namely, that a material Sphere doth not touch a plain in one sole point: and I could wish some few hours conversation with some persons conversant in Geometry, might make you a little more intelligent

amongst those who know nothing thereof. Now to shew you how great their errour is who say, that a Sphere v. g. of brasse, doth not touch a plain v. g. of steel in one sole point, Tell me what conceipt you would entertain of one that should constantly aver, that the Sphere is not truly a Sphere.

Simpl.I would esteem him wholly devoid of reason.

The sphere although material, toucheth the material plane but in one point onely.Salv.He is in the same case who saith that the material Sphere doth not touch a plain, also material, in one onely point; for to say this is the same, as to affirm that the Sphere is not a Sphere. And that this is true, tell me in what it is that you constitute the Sphere to consist, that is, what it is that maketh the Sphere differ from all other solid bodies.

The definition of the sphere.Simpl.I believe that the essence of a Sphere consisteth in having all the right lines produced from its centre to the circumference, equal.

Salv.So that, if those lines should not be equal, that same solidity would be no longer a sphere?

Simpl.True.

Salv.Go to; tell me whether you believe that amongst the many lines that may be drawn between two points, there may be more than one right line onely.

Simpl.There can be but one.

Salv.But yet you understand that this onely right line shall again of necessity be the shortest of them all?

Simpl.I know it, and also have a demonstration thereof, produced by a great Peripatetick Philosopher, and as I take it, if my memory do not deceive me, he alledgeth it by way of reprehending Archimedes, that supposeth it as known, when it may be demonstrated.

Salv.This must needs be a great Mathematician, that knew how to demonstrate that

which Archimedes neither did, nor could demonstrate. And if you remember his demonstration, I would gladly hear it: for I remember very well, that Archimedes in his Books, de Sphæra & Cylindro, placeth this Proposition amongst the Postulata; and I verily believe that he thought it demonstrated.

Simpl.I think I shall remember it, for it is very easie and short.

Salv.The disgrace of Archimedes, and the honour of this Philosopher shall be so much the greater.

Simpl.I will describe the Figure of it. Between the points A and B,The demonstration of a Peripatetick, to prove the right line to be the shortest of all lines. [in Fig. 5.] draw the right line AB, and the curve line ACB, of which we will prove the right to be the shorter: and the proof is this; take a point in the curve-line, which let be C, and draw two other lines, AC and CB, which two lines together, are longer than the sole line AB, for so demonstrateth Euclid. But the curve-line ACB, is greater than the two right-lines AC, and CB; therefore, à fortiori, the curve-line ACB, is much greater than the right line AB, which was to be demonstrated.

The Paralogism of the same Peripatetick, which proveth ignotum pe ignotius.Salv.I do not think that if one should ransack all the Paralogisms of the world, there could be found one more commodious than this, to give an example of the most solemn fallacy of all fallacies, namely, than that which proveth ignotum per ignotius.

Simpl.How so?

Salv.Do you ask me how so? The unknown conclusion which you desire to prove, is it not, that the curved line ACB, is longer than the right line AB; the middle term which is taken for known, is that the curve-line ACB, is greater than the two lines AC and CB, the which are known to be greater than AB; And if it be unknown whether the curve-line be greater than the single right-line AB, shall it not be much more unknown whether it be greater than the two right lines AC & CB, which are known to be greater than the sole line AB, & yet you assume it as known?

Simpl.I do not yet very well perceive wherein lyeth the fallacy.

Salv.As the two right lines are greater than AB, (as may be known by Euclid) and in as much as the curve line is longer than the two right lines AC and BC, shall it not not be much greater than the sole right line AB?

Simpl.It shall so.

Salv.That the curve-line ACB, is greater than the right line AB, is the conclusion more known than the middle term, which is, that the same curve-line is greater than the two right-lines AC and CB. Now when the middle term is less known than the conclusion, it is called a proving ignotum per ignotius. But to return to our purpose, it is sufficient that you know the right line to be the shortest of all the lines that can be drawn between two points. And as to the principal conclusion, you say, that the material sphere doth not touch the sphere in one sole point. What then is its contact?

Simpl.It shall be a part of its superficies.

Salv.And the contact likewise of another sphere equal to the first, shall be also a like particle of its superficies?

Simpl.There is no reason why it should be otherwise.

Salv.Then the two spheres which touch each other, shall touch with the two same particles of a superficies, for each of them agreeing to one and the same plane, they must of necessity agree in like manner to each other.A demonstration that the sphere toucheth the plane but in one point. Imagine now that the two spheres [in Fig. 6.] whose centres are A and B, do touch one another: and let their centres be conjoyned by the right line AB, which passeth through the contact. It passeth thorow the point C, and another point in the contact being taken as D, conjoyn the two right lines AD and BD, so as that they make the triangle ADB; of which the two sides AD and DB shall be equal to the other one ACB, both those and this containing two semidiameters, which by the definition of the sphere are all equal: and thus the right line AB, drawn between the two centres A and B, shall not be the shortest of all, the

two lines AD and DB being equal to it: which by your own concession is absurd.

Simpl.This demonstration holdeth in the abstracted, but not in the material spheres.

Salv.Instance then wherein the fallacy of my argument consisteth, if as you say it is not concluding in the material spheres, but holdeth good in the immaterial and abstracted.

Simpl.The material spheres are subject to many accidents,Why the sphere in abstract, toucheth the plane onely in one point, and not the material in concrete. which the immaterial are free from. And because it cannot be, that a sphere of metal passing along a plane, its own weight should not so depress it, as that the plain should yield somewhat, or that the sphere it self should not in the contact admit of some impression. Moreover, it is very hard for that plane to be perfect, if for nothing else, yet at least for that its matter is porous: and perhaps it will be no less difficult to find a sphere so perfect, as that it hath all the lines from the centre to the superficies, exactly equal.

Salv.I very readily grant you all this that you have said; but it is very much beside our purpose: for whilst you go about to shew me that a material sphere toucheth not a material plane in one point alone, you make use of a sphere that is not a sphere, and of a plane that is not a plane; for that, according to what you say, either these things cannot be found in the world, or if they may be found, they are spoiled in applying them to work the effect. It had been therefore a less evil, for you to have granted the conclusion, but conditionally, to wit, that if there could be made of matter a sphere and a plane that were and could continue perfect, they would touch in one sole point, and then to have denied that any such could be made.

Simpl.I believe that the proposition of Philosophers is to be understood in this sense; for it is not to be doubted, but that the imperfection of the matter, maketh the matters taken in concrete, to disagree with those taken in abstract.

Salv.What, do they not agree? Why, that which you your self say at this instant,

proveth that they punctually agree.

Simpl.How can that be?

Salv.Do you not say, that through the imperfection of the matter, that body which ought to be perfectly spherical, and that plane which ought to be perfectly level, do not prove to be the same in concrete, as they are imagined to be in abstract?

Simpl.This I do affirm.

Salv.Then when ever in concrete you do apply a material Sphere to a material plane,Things are exactly the same in abstract as in concrete. you apply an imperfect Sphere to an imperfect plane, & these you say do not touch only in one point. But I must tell you, that even in abstract an immaterial Sphere, that is, not a perfect Sphere, may touch an immaterial plane, that is, not a perfect plane, not in one point, but with part of its superficies, so that hitherto that which falleth out in concrete, doth in like manner hold true in abstract. And it would be a new thing that the computations and rates made in abstract numbers, should not afterwards answer to the Coines of Gold and Silver, and to the merchandizes in concrete. But do you know Simplicius, how this commeth to passe? Like as to make that the computations agree with the Sugars, the Silks, the Wools, it is necessary that the accomptant reckon his tares of chests, bags, and such other things: So when the Geometricall Philosopher would observe in concrete the effects demonstrated in abstract, he must defalke the impediments of the matter, and if he know how to do that, I do assure you, the things shall jump no lesse exactly, than Arithmetical computations. The errours therefore lyeth neither in abstract, nor in concrete, nor in Geometry, nor in Physicks, but in the Calculator, that knoweth not how to adjust his accompts. Therefore if you had a perfect Sphere and plane, though they were material, you need not doubt but that they would touch onely in one point. And if such a Sphere was and is impossible to be procured, it was much besides the purpose to say, Quod Sphæra ænea non tangit in puncto. Furthermore, if I grant you Simplicius, that in

matter a figure cannot be procured that is perfectly spherical, or perfectly level: Do you think there may be had two materiall bodies, whose superficies in some part, and in some sort are incurvated as irregularly as can be desired?

Simpl.Of these I believe that there is no want.

Contact in a single point is not peculiar to the perfect Spheres onely, but belongeth to all curved figures.Salv.If such there be, then they also will touch in one sole point; for this contact in but one point alone is not the sole and peculiar priviledge of the perfect Sphere and perfect plane. Nay, he that should prosecute this point with more subtil contemplations would finde that it is much harder to procure two bodies that touch with part of their snperficies,It is more difficult to find Figures that touch with a part of their surface, than in one sole point. than with one point onely. For if two superficies be required to combine well together, it is necessary either, that they be both exactly plane, or that if one be convex, the other be concave; but in such a manner concave, that the concavity do exactly answer to the convexity of the other: the which conditions are much harder to be found, in regard of their too narrow determination, than those others, which in their casuall latitude are infinite.

Simpl.You believe then, that two stones, or two pieces of Iron taken at chance, and put together, do for the most part touch in one sole point?

Salv.In casual encounters, I do not think they do; as well because for the most part there will be some small yielding filth upon them, as because that no diligence is used in applying them without striking one another; and every small matter sufficeth to make the one superficies yield somewhat to the other; so that they interchangeably, at least in some small particle, receive figure from the impression of each other. But in case their superficies were very terse and polite, and that they were both laid upon a table, that so one might not presse upon the other, and gently put towards one another, I question not, but that they might be brought to the simple contact in one onely point.

Sagr.It is requisite, with your permission, that I propound a certain scruple of mine, which came into my minde, whil'st I heard proposed by Simplicius, the impossibility of finding a materiall and solid body, that is, perfectly of a Spherical figure, and whil'st I saw Salviatus in a certain manner, not gainsaying, to give his consent thereto; therefore I would know, whether there would be the same difficulty in forming a solid of some other figure, that is, to expresse my self better, whether there is more difficulty in reducing a piece of Marble into the figure of a perfect Sphere, than into a perfect Pyramid, or into a perfect Horse, or into a perfect Grasse-hopper?

Salv.To this I will make you the first answer: and in the first place, I will acquit my self of the assent which you think I gave to Simplicius, which was only for a time; for I had it also in my thoughts, before I intended to enter upon any other matter, to speak that, which, it may be, is the same, or very like to that which you are about to say;The Sphericall Figure is easier to be made than any other. And answering to your first question, I say, that if any figure can be given to a Solid, the Spherical is the easiest of all others, as it is likewise the most simple, and holdeth the same place amongst solid figures,The circular Figure only is placed amongst the postulata of Mathematicians. as the Circle holdeth amongst the superficial. The description of which Circle, as being more easie than all the rest, hath alone been judged by Mathematicians worthy to be put amongst the ** Demands or Petitions. postulata belonging to the description of all other figures. And the formation of the Sphere is so very easie, that if in a plain plate of hard metal you take an empty or hollow circle, within which any Solid goeth casually revolving that was before but grosly rounded, it shall, without any other artifice be reduced to a Spherical figure, as perfect as is possible for it to be; provided, that that same Solid be not lesse than the Sphere that would passe thorow that Circle. And that which is yet more worthy of our consideration is, that within the self-same incavity one may form Spheres of several magnitudes.Sphericall Figures of sundry magnitudes may be made with one

onely instrument. But what is required to the making of an Horse, or (as you say) of a Grass-hopper, I leave to you to judge, who know that there are but few statuaries in the world able to undertake such a piece of work. And I think that herein Simplicius will not dissent from me.

Simpl.I know not whether I do at all dissent from you; my opinion is this, that none of the afore-named figures can be perfectly obteined; but for the approaching as neer as is possible to the most perfect degree, I believe that it is incomparably more easie to reduce the Solid into a Spherical figure, than into the shape of an Horse, or Grasse-hopper?

Sagr.And this greater difficulty, wherein think you doth it depend?

Simpl.Like as the great facility in forming the Sphere ariseth from its absolute simplicity and uniformity so the great irregularity rendereth the construction of all other figures difficult.Irregular forms difficult to be introduced.

Sagr.Therefore the irregularity being the cause of the difficulty, than the figure of a stone broken with an hammer by chance, shall be one of the figures that are difficult to be introduced, it being perhaps more irregular than that of the horse?

Simpl.So it should be.

Sagr.But tell me; that figure what ever it is which the stone hath, hath it the same in perfection, or no?

Simpl.What it hath, it hath so perfectly, that nothing can be more exact.

Sagr.Then, if of figures that are irregular, and consequently hard to be procured, there are yet infinite which are most perfectly obteined, with what reason can it be said, that the most simple, and consequently the most easie of all, is impossible to be procured?

Salv.Gentlemen, with your favour, I may say that we have sallied out into a dispute not much more worth than the wool of a goat; and whereas our argumentations

should continually be conversant about serious and weighty points, we consume our time in frivolous and impertinent wranglings.The constitution of the Universe is one of the most noble Problems. Let us call to minde, I pray you, that the search of the worlds constitution, is one of the greatest and noblest Problems that are in nature; and so much the greater, inasmuch as it is directed to the resolving of that other; to wit, of the cause of the Seas ebbing and flowing, enquired into by all the famous men, that have hitherto been in the world, and possibly found out by none of them. Therefore if we have nothing more remaining for the full confutation of the argument taken from the Earths vertigo, which was the last, alledged to prove its immobility upon its own centre, let us passe to the examination of those things that are alledged for, and against the Annual Motion.

Sagr.I would not have you, Salviatus, measure our wits by the scale of yours: you, who use to be continually busied about the sublimest contemplations, esteem those notions frivolous and below you, which we think matters worthy of our profoundest thoughts: yet sometimes for our satisfaction do not disdain to stoop so low as to give way a little to our curiosity. As to the refutation of the last argument, taken from the extrusions of the diurnal vertigo, far less than what hath been said, would have given me satisfaction: and yet the things superfluously spoken, seemed to me so ingenious, that they have been so far from wearying my fancy, as that they have, by reason of their novelty, entertained me all along with so great delight, that I know not how to desire greater: Therefore, if you have any other speculation to add, produce it, for I, as to my own particular, shall gladly hearken to it.

Salv.I have always taken great delight in those things which I have had the fortune to discover, and next to that, which is my chief content, I find great pleasure in imparting them to some friends, that apprehendeth and seemeth to like them: Now, in regard you are one of these, slacking a little the reins of my ambition, which is much pleased when I shew my self more perspicacious, than some other that hath the reputation of a sharp sight, I will for a full and true measure of the past dispute,

produce another fallacy of the Sectators of Ptolomey and Aristotle, which I take from the argument alledged.

Sagr.See how greedily I wait to hear it.

Salv.We have hitherto over-passed, and granted to Ptolomey, as an effect indubitable, that the extrusion of the stone proceeding from the velocity of the wheel turn'd round upon its centre, the cause of the said extrusion encreaseth in proportion, as the velocity of the vertigo (or whirling) is augmented: from whence it was inferred, that the velocity of the Earth's vertigo being very much greater than that of any machin whatsoever, that we can make to turn round artificially; the extrusion of stones, of animals, &c. would consequently be far more violent. Now, I observe that there is a great fallacy in this discourse, in that we do compare these velocities indifferently and absolutely to one another. It's true, that if I compare the velocities of the same wheel, or of two wheels equal to each other, that which shall be more swiftly turn'd round, shall extrude the stone with greater violence; and the velocity encreasing, the cause of the projection shall likewise encrease: but when the velocity is augmented, not by encreasing the velocity in the same wheel, which would be by causing it to make a greater number of revolutions in equal times; but by encreasing the diameter, and making the wheel greater, so as that the conversion taking up the same time in the lesser wheel, as in the greater,The cause of the projection increaseth not according to the proportion of the velocity, increased by making the wheel bigger. the velocity is greater onely in the bigger wheel, for that its circumference is bigger; there is no man that thinketh that the cause of the extrusion in the great wheel will encrease according to the proportion of the velocity of its circumference, to the velocity of the circumference of the other lesser wheel; for that this is most false, as by a most expeditious experiment I shall thus grosly declare: We may sling a stone with a stick of a yard long, farther than we can do with a stick six yards long, though the motion of the end of the long stick, that is of the stone placed in the slit thereof, were more than double as swift as the motion of the end of

the other shorter stick, as it would be if the velocities were such that the lesser stick should turn thrice round in the time whilst the greater is making one onely conversion.

Sagr.This which you tell me, Salviatus, must, I see, needs succeed in this very manner; but I do not so readily apprehend the cause why equal velocities should not operate equally in extruding projects, but that of the lesser wheel much more than the other of the greater wheel; therefore I intreat you to tell me how this cometh to pass?

Simpl.Herein, Sagredus, you seem to differ much from your self, for that you were wont to penetrate all things in an instant, and now you have overlook'd a fallacy couched in the experiment of the stick, which I my self have been able to discover: and this is the different manner of operating, in making the projection one while with the short sling and another while with the long one, for if you will have the stone fly out of the slit, you need not continue its motion uniformly, but at such time as it is at the swiftest, you are to stay your arm, and stop the velocity of the stick; whereupon the stone which was in its swiftest motion, flyeth out, and moveth with impetuosity: but now that stop cannot be made in the great stick, which by reason of its length and flexibility, doth not entirely obey the check of the arm, but continueth to accompany the stone for some space, and holdeth it in with so much less force, and not as if you had with a stiff sling sent it going with a jerk: for if both the sticks or slings should be check'd by one and the same obstacle, I do believe they would fly aswell out of the one, as out of the other, howbeit their motions were equally swift.

Sagr.With the permission of Salviatus, I will answer something to Simplicius, in regard he hath addressed himself to me; and I say, that in his discourse there is somewhat good and somewhat bad: good, because it is almost all true; bad, because it doth not agree with our case: Truth is, that when that which carrieth the stones

with velocity, shall meet with a check that is immoveable, they shall fly out with great impetuosity: the same effect following in that case, which we see dayly to fall out in a boat that running a swift course, runs a-ground, or meets with some sudden stop, for all those in the boat, being surprized, Granting the diurnal vertigo of the Earth, & that by some sudden stop or obstacle it were arrested, houses, mountains themselves, and perhaps the whole Globe would be shaken in pieces. stumble forwards, and fall towards the part whither the boat steered. And in case the Earth should meet with such a check, as should be able to resist and arrest its vertigo, then indeed I do believe that not onely beasts, buildings and cities, but mountains, lakes and seas would overturn, and the globe it self would go near to shake in pieces; but nothing of all this concerns our present purpose, for we speak of what may follow to the motion of the Earth, it being turn'd round uniformly, and quietly about its own centre, howbeit with a great velocity. That likewise which you say of the slings, is true in part; but was not alledged by Salviatus, as a thing that punctually agreed with the matter whereof we treat, but onely, as an example, for so in gross it may prompt us in the more accurate consideration of that point, whether, the velocity increasing at any rate, the cause of the projection doth increase at the same rate: so that v. g. if a wheel of ten yards diameter, moving in such a manner that a point of its circumference will pass an hundred yards in a minute of an hour, and so hath an impetus able to extrude a stone, that same impetus shall be increased an hundred thousand times in a wheel of a million of yards diameter; the which Salviatus denieth, and I incline to his opinion; but not knowing the reason thereof, I have requested it of him, and stand impatiently expecting it.

Salv.I am ready to give you the best satisfaction, that my abilities will give leave: And though in my first discourse you thought that I had enquired into things estranged from our purpose, yet neverthelesse I believe that in the sequel of the dispute, you will find that they do not prove so. Therefore let Sagredus tell me wherein he hath observed that the resistance of any moveable to motion doth consist.

Sagr.I see not for the present that the moveable hath any internal resistance to motion, unlesse it be its natural inclination and propension to the contrary motion, as in grave bodies, that have a propension to the motion downwards, the resistance is to the motion upwards; and I said an internal resistance, because of this, I think, it is you intend to speak, and not of the external resistances, which are many and accidental.

Salv.It is that indeed I mean, and your nimblenesse of wit hath been too hard for my craftinesse, but if I have been too short in asking the question, I doubt whether Sagredus hath been full enough in his answer to satisfie the demand; and whether there be not in the moveable, besides the natural inclination to the contrary term, another intrinsick and natural quality,The inclination of grave bodies to the motion downwards, is equal to their resistance to the motion upwards. which maketh it averse to motion. Therefore tell me again; do you not think that the inclination v. g. of grave bodies to move downwards, is equal to the resistance of the same to the motion of projection upwards?

Sagr.I believe that it is exactly the same. And for this reason I see that two equal weights being put into a ballance, they do stand still in equilibrium, the gravity of the one resisting its being raised by the gravity wherewith the other pressing downwards would raise it.

Salv.Very well; so that if you would have one raise up the other, you must encrease the weight of that which depresseth, or lessen the weight of the other. But if the resistance to ascending motion cunsist onely in gravity, how cometh it to passe, that in ballances of unequal arms, to wit in the * A portable ballance wherewith market-people weigh their commodities, giving it gravity by removing the weight farther from the cock: call'd by the Latines, Campana trutina.* Stiliard, a weight sometimes of an hundred pounds, with its pression downwards, doth not suffice to raise up on of four pounds; that shall counterpoise with it, nay this of four,

descending shall raise up that of an hundred; for such is the effect of the pendant weight upon the weight which we would weigh? If the resistance to motion resideth onely in the gravity, how can the arm with its weight of four pounds onely, resist the weight of a sack of wool, or bale of silk, which shall be eight hundred, or a thousand weight; yea more, how can it overcome the sack with its moment, and raise it up? It must therefore be confest Sagredus, that here it maketh use of some other resistance, and other force, besides that of simple gravity.

Sagr.It must needs be so; therefore tell me what this second virtue should be.

Salv.It is that which was not in the ballance of equal arms; you see then what variety there is in the Stiliard; and upon this doubtlesse dependeth the cause of the new effect.

Sagr.I think that your putting me to it a second time, hath made me remember something that may be to the purpose. In both these beams the business is done by the weight, and by the motion; in the ballance, the motions are equal, and therefore the one weight must exceed it in gravity before it can move it; in the stiliard, the lesser weight will not move the greater, unless when this latter moveth little, as being hung at a lesser distance, and the other much, as hanging at a greater distance from the lacquet or cock. It is necessary therefore to conclude, that the lesser weight overcometh the resistance of the greater, by moving much, whilst the other is moved but little.

Salv.Which is as much as to say, that the velocity of the moveable less grave, compensateth the gravity of the moveable more grave and less swift.

Sagr.But do you think that the velocity doth fully make good the gravity?The greater velocity exactly compensates the greater gravity. that is, that the moment and force of a moveable of v. g. four pounds weight, is as great as that of one of an hundred weight, whensoever that the first hath an hundred degrees of velocity, and the later but four onely?

Salv.Yes doubtless, as I am able by many experiments to demonstrate: but for the present, let this onely of the stiliard suffice: in which you see that the light end of the beam is then able to sustain and equilibrate the great Wool-sack, when its distance from the centre, upon which the stiliard resteth and turneth, shall so much exceed the lesser distance, by how much the absolute gravity of the Wool-sack exceedeth that of the pendent weight. And we see nothing that can cause this insufficiencie in the great sack of Wool, to raise with its weight the pendent weight so much less grave, save the disparity of the motions which the one and the other should make, whilst that the Wool-sack by descending but one inch onely, will raise the pendent weight an hundred inches: (supposing that the sack did weigh an hundred times as much, and that the distance of the small weight from the centre of the beam were an hundred times greater, than the distance between the said centre and the point of the sacks suspension.) And again, the pendent weight its moving the space of an hundred inches, in the time that the sack moveth but one inch onely, is the same as to say, that the velocity of the motion of the little pendent weight, is an hundred times greater than the velocity of the motion of the sack. Now fix it in your belief, as a true and manifest axiom, that the resistance which proceedeth from the velocity of motion, compensateth that which dependeth on the gravity of another moveable: So that consequently, a moveable of one pound, that moveth with an hundred degrees of velocity, doth as much resist all obstruction, as another moveable of an hundred weight, whose velocity is but one degree onely. And two equal moveables will equally resist their being moved, if that they shall be moved with equal velocity: but if one be to be moved more swiftly than the other, it shall make greater resistance, according to the greater velocity that shall be conferred on it. These things being premised, let us proceed to the explanation of our Problem; and for the better understanding of things, let us make a short Scheme thereof. Let two unequal wheels be described about this centre A, [in Fig. 7.] and let the circumference of the lesser be BG, and of the greater CEH, and let the semidiameter ABC, be perpendicular to

the Horizon; and by the points B and C, let us draw the right lined Tangents BF and CD; and in the arches BG and CE, take two equal parts BG and CE: and let the two wheels be supposed to be turn'd round upon their centres with equal velocities, so as that two moveables, which suppose for example to be two stones placed in the points B and C, come to be carried along the circumferences BG and CE, with equal velocities; so that in the same time that the stone B shall have run the arch BG, the stone C will have past the arch CE. I say now, that the whirl or vertigo of the lesser wheel is much more potent to make the projection of the stone B, than the vertigo of the bigger wheel to make that of the stone C. Therefore the projection, as we have already declared, being to be made along the tangent, when the stones B and C are to separate from their wheel, and to begin the motion of projection from the points B and C, then shall they be extruded by the impetus conceived from the vertigo by (or along) the tangents BF and CD. The two stones therefore have equal impetuosities of running along the tangents BF and CD, and would run along the same, if they were not turn'd aside by some other force: is it not so Sagredus?

Sagr.In my opinion the businesse is as you say.

Salv.But what force, think you, should that be which averts the stones from moving by the tangents, along which they are certainly driven by the impetus of the vertigo.

Sagr.It is either their own gravity, or else some glutinous matter that holdeth them fast and close to the wheels.

Salv.But for the diverting of a moveable from the motion to which nature inciteth it, is there not required greater or lesser force, according as the deviation is intended to be greater or lesser? that is, according as the said moveable in its deviation hath a greater or lesser space to move in the same time?

Sagr.Yes certainly: for it was concluded even now, that to make a moveable to move; the movent vertue must be increased in proportion to the velocity wherewith it is to move.

Salv.Now consider, that for the deviating the stone upon the lesse wheel from the motion of projection, which it would make by the tangent BF, and for the holding of it fast to the wheel, it is required, that its own gravity draw it back the whole length of the secant FG, or of the perpendicular raised from the point G, to the line BF, whereas in the greater wheel the retraction needs to be no more than the secant DE, or the perpendicular let fall from the tangent DC to the point E, lesse by much than FG, and alwayes lesser and lesser according as the wheel is made bigger. And forasmuch as these retractions (as I may call them) are required to be made in equal times, that is, whil'st the wheels passe the two equal arches BG and CE, that of the stone B, that is, the retraction FG ought to be more swift than the other DE; and therefore much greater force will be required for holding fast the stone B to its little wheel, than for the holding the stone C to its great one, which is as much as to say, that such a small thing will impede the extrusion in the great wheel, as will not at all hinder it in the little one. It is manifest therefore that the more the wheel augmenteth, the more the cause of the projection diminisheth.

Sagr.From this which I now understand, by help of your minute dissertation, I am induced to think, that I am able to satisfie my judgment in a very few words. For equal impetus being impressed on both the stones that move along the tangents, by the equal velocity of the two wheels, we see the great circumference, by means of its small deviation from the tangent, to go seconding, as it were, and in a fair way refraining in the stone the appetite, if I may so say, of separating from the circumference; so that any small retention, either of its own inclination, or of some glutination sufficeth to hold it fast to the wheel. Which, again, is not able to work the like effect in the little wheel, which but little prosecuting the direction of the tangent, seeketh with too much eagernesse to hold fast the stone; and the restriction and glutination not being stronger than that which holdeth the other stone fast to the greater wheel, it ** Strappar la cavezza, is to break the bridle. breaks loose, and runneth along the tangent. Therefore I do not only finde that all those have erred,

who have believed the cause of the projection to increase according to the augmentation of the vertigo's velocity; but I am further thinking, that the projection diminishing in the inlarging of the wheel, so long as the same velocity is reteined in those wheels; it may possibly be true, that he that would make the great wheel extrude things like the little one, would be forced to increase them as much in velocity; as they increase in diameter, which he might do, by making them to finish their conversions in equal times; and thus we may conclude, that the Earths revolution or vertigo would be no more able to extrude stones, than any little wheel that goeth so slowly, as that it maketh but one turn in twenty four hours.

Salv.We will enquire no further into this point for the present: let it suffice that we have abundantly (if I deceive not my self) demonstrated the invalidity of the argument, which at first sight seemed very concluding, and was so held by very famous men: and I shall think my time and words well bestowed, if I have but gained some belief in the opinion of Simplicius, I will not say of the Earths mobility, but only that the opinion of those that believe it, is not so ridiculous and fond, as the rout of vulgar Philosophers esteem it.

Simpl.The answers hitherto produced against the arguments brought against this Diurnal Revolution of the Earth taken from grave bodies falling from the top of a Tower, and from projections made perpendicularly upwards, or according to any inclination sidewayes towards the East, West, North, South, &c. have somewhat abated in me the antiquated incredulity I had conceived against that opinion: but other greater doubts run in my mind at this very instant, which I know not in the least how to free my self of, and haply you your self will not be able to resolve them; nay, its possible you may not have heard them, for they are very modern. And these are the objections of two Authours, that ex professo write against Copernicus.Other objections of two modern Authors against Copernicus. Some of which are read in a little Tract of natural conclusions; The rest are by a great both Philosopher and Mathematician, inserted in a Treatise which he hath written in

favour of Aristotle, and his opinion touching the inalterability of the Heavens, where he proveth, that not onely the Comets, but also the new stars, namely, that anno 1572. in Cassiopeia, and that anno 1604. in Sagittarius were not above the Spheres of the Planets, but absolutely beneath the concave of the Moon in the Elementary Sphere, and this he demonstrateth against Tycho, Kepler, and many other Astronomical Observators, and beateth them at their own weapon; to wit, the Doctrine of Parallaxes. If you like thereof, I will give you the reasons of both these Authours, for I have read them more than once, with attention; and you may examine their strength, and give your opinion thereon.

Salv.In regard that our principal end is to bring upon the stage, and to consider what ever hath been said for, or against the two Systemes, Ptolomaick, and Copernican, it is not good to omit any thing that hath been written on this subject.

Simpl.I will begin therefore with the objections which I finde in the Treatise of Conclusions, and afterwards proceed to the rest.The first objection of the modern Author of the little tract of Conclusions. In the first place then, he bestoweth much paines in calculating exactly how many miles an hour a point of the terrestrial Globe situate under the Equinoctial, goeth, and how many miles are past by other points situate in other parallels: and not being content with finding out such motions in horary times, he findeth them also in a minute of an hour; and not contenting himself with a minute, he findes them also in a second minute; yea more, he goeth on to shew plainly, how many miles a Cannon bullet would go in the same time,A Cannon bullet would spend more than six days in falling from the Concave of the Moon to the centre of the Earth, according to the opinion of that modern Author of the Conclusions. being placed in the concave of the Lunar Orb, supposing it also as big as Copernicus himself representeth it, to take away all subterfuges from his adversary. And having made this most ingenious and exquisite supputation, he sheweth, that a grave body falling from thence above would consume more than six dayes in attaining to the centre of the Earth, to which all grave bodies naturally

move. Now if by the absolute Divine Power, or by some Angel, a very great Cannon bullet were carried up thither, and placed in our Zenith or vertical point, and from thence let go at liberty, it is in his, and also in my opinion, a most incredible thing that it, in descending downwards, should all the way maintain it self in our vertical line, continuing to turn round with the Earth, about its centre, for so many dayes, describing under the Equinoctial a Spiral line in the plain of the great circle it self; and under other Parallels, Spiral lines about Cones, and under the Poles falling by a simple right line. He, in the next place, stablisheth and confirmeth this great improbability by proving, in the way of interrogations, many difficulties impossible to be removed by the followers of Copernicus; and they are, if I do well remember———.

Salv.Take up a little, good Simplicius, and do not load me with so many novelties at once: I have but a bad memory, and therefore I must not go too fast. And in regard it cometh into my minde, that I once undertook to calculate how long time such a grave body falling from the concave of the Moon, would be in passing to the centre of the Earth, and that I think I remember that the time would not be so long; it would be fit that you shew us by what rule this Author made his calculation.

Simpl.He hath done it by proving his intent à fortiori, a sufficient advantage for his adversaries, supposing that the velocity of the body falling along the vertical line, towards the centre of the Earth, were equal to the velocity of its circular motion, which it made in the grand circle of the concave of the Lunar Orb. Which by equation would come to passe in an hour, twelve thousand six hundred German miles, a thing which indeed savours of impossibility: Yet neverthelesse, to shew his abundant caution, and to give all advantages to his adversaries, he supposeth it for true, and concludeth, that the time of the fall ought however to be more than six dayes.

Salv.And is this the sum of his method? And doth he by this demonstration prove

the time of the fall to be above six dayes?

Sagr.Me thinks that he hath behaved himself too modestly, for that having it in the power of his will to give what velocity he pleased to such a descending body, and might aswell have made it six moneths, nay, six years in falling to the Earth, he is content with six dayes. But, good Salviatus, sharpen my appetite a little, by telling me in what manner you made your computation, in regard you say, that you have heretofore cast it up: for I am confident that if the question had not required some ingenuity in working it, you would never have applied your minde unto it.

Salv.It is not enough, Sagredus, that the subjects be noble and great, but the businesse consists in handling it nobly. And who knoweth not, that in the dissection of the members of a beast, there may be discovered infinite wonders of provident and prudent Nature; and yet for one, that the Anatomist dissects, the butcher cuts up a thousand. Thus I, who am now seeking how to satisfie your demand, cannot tell with which of the two shapes I had best to appear on the Stage; but yet, taking heart from the example of Simplicius, his Authour, I will, without more delays, give you an account (if I have not forgot) how I proceeded. But before I go any further, I must not omit to tell you, that I much fear that Simplicius hath not faithfully related the manner how this his Authour found, that the Cannon bullet in coming from the concave of the Moon to the centre of the Earth, would spend more than six dayes: for if he had supposed that its velocity in descending was equal to that of the concave (as Simplicius saith he doth suppose) he would have shewn himself ignorant of the first, and more simple principles of Geometry; yea, I admire that Simplicius, in admitting the supposition which he speaketh of, doth not see the monstrous absurdity that is couched in it.

Simpl.Its possible that I may have erred in relating it; but that I see any fallacy in it, I am sure is not true.

Salv.Perhaps I did not rightly apprehend that which you said, Do you not say, that

this Authour maketh the velocity of the bullet in descending equall to that which it had in turning round, being in the concave of the Moon, and that comming down with the same velocity, it would reach to the centre in six dayes?

Simpl.So, as I think, he writeth.

Salv.And do not you perceive a shamefull errour therein? But questionlesse you dissemble it: For it cannot be, but that you should know that the semidiameter of the Circle is lesse than the sixth part of the circumference;A shamefull errour in the Argument taken from the bullets falling out of the Moons concave. and that consequently, the time in which the moveable shall passe the semidiameter, shall be lesse than the sixth part of the time; in which, being moved with the same velocity, it would passe the circumference; and that therefore the bullet descending with the velocity, wherewith it moved in the concave, will arrive in lesse than four hours at the centre, supposing that in the concave one revolution should be consummate in twenty four hours, as he must of necessity have supposed it, for to keep it all the way in the same vertical line.

Simpl.Now I thorowly perceive the mistake: but yet I would not lay it upon him undeservedly, for it's possible that I may have erred in rehearsing his Argument, and to avoid running into the same mistakes for the future, I could wish I had his Book; and if you had any body to send for it, I would take it for a great favour.

Sagr.You shall not want a Lacquey that will runne for it with all speed: and he shall do it presently, without losing any time; in the mean time Salviatus may please to oblige us with his computation.

Simpl.If he go, he shall finde it lie open upon my Desk, together with that of the other Author, who also argueth against Copernicus.

Sagr.We will make him bring that also for the more certainty: and in the interim Salviatus shall make his calculation: I have dispatch't away a messenger.

Salv.Above all things it must be considered, that the motion of descending grave

bodies is not uniform, but departing from rest they go continually accelerating:An exact compute of the time of the fall of the Canon bullet from the Moons concave to the Earths centre. An effect known and observed by all men, unlesse it be by the forementioned modern Authour, who not speaking of acceleration, maketh it even and uniforme. But this general notion is of no avail, if it be not known according to what proportion this increase of velocity is made; a conclusion that hath been until our times unknown to all Philosophers; and was first found out & demonstrated by the ** The Author. Academick, our common friend, who in some of his ** By these Writings, he every where meanes his Dialogues, De motu, which I promise to give you in my second Volume. writings not yet published, but in familiarity shewn to me, and some others of his acquaintance he proveth, how that the acceleration of the right motion of grave bodies, is made according to the numbers uneven beginning ab unitate, that is, any number of equal times being assigned, if in the first time the moveable departing from rest shall have passed such a certain space,Acceleration of the natural motion of grave bodies is made according to the odde numbers beginning at unity. as for example, an ell, in the second time it shall have passed three ells, in the third five, in the fourth seven, and so progressively, according to the following odd numbers; which in short is the same, as if I should say, that the spaces passed by the moveable departing from its rest,The spaces past by the falling grave body are as the squares of their times. are unto each other in proportion double to the proportion of the times, in which those spaces are measured; or we will say, that the spaces passed are to each other, as the squares of their times.

Sagr.This is truly admirable: and do you say that there is a Mathematical demonstration for it?

Salv.Yes, purely Mathematical; and not onely for this, but for many other very admirable passions, pertaining to natural motions, An intire and new Science of the Academick concerning local motion. and to projects also, all invented, and demonstrated by Our Friend, and I have seen and considered them all to my very

great content and admiration, seeing a new compleat Doctrine to spring up touching a subject, upon which have been written hundreds of Volumes; and yet not so much as one of the infinite admirable conclusions that those his writings contain, hath ever been observed, or understood by any one, before Our Friend made them out.

Sagr.You make me lose the desire I had to understand more in our disputes in hand, onely that I may hear some of those demonstrations which you speak of; therefore either give them me presently, or at least promise me upon your word, to appoint a particular conference concerning them, at which Simplicius also may be present, if he shall have a mind to hear the passions and accidents of the primary effect in Nature.

Simpl.I shall undoubtedly be much pleased therewith, though indeed, as to what concerneth Natural Philosophy, I do not think that it is necessary to descend unto minute particularities, a general knowledg of the definition of motion, and of the distinction of natural and violent, even and accelerate, and the like, sufficing: For if this were not sufficient, I do not think that Aristotle would have omitted to have taught us what ever more was necessary.

Salv.It may be so. But let us not lose more time about this, which I promise to spend half a day apart in, for your satisfaction; nay, now I remember, I did promise you once before to satisfie you herein. Returning therefore to our begun calculation of the time, wherein the grave cadent body would pass from the concave of the Moon to the centre of the earth, that we may not proceed arbitrarily and at randon, but with a Logical method, we will first attempt to ascertain our selves by experiments often repeated, in how long time a ball v. g. of Iron descendeth to the Earth from an altitude of an hundred yards.

Sagr.Let us therefore take a ball of such a determinate weight, and let it be the same wherewith we intend to make the computation of the time of descent from the Moon.

Salv.This is not material, for that a ball of one, of ten, of an hundred, of a thousand pounds, will all measure the same hundred yards in the same time.

Simpl.But this I cannot believe, nor much less doth Aristotle think so, who writeth, that the velocities of descending grave bodies, are in the same proportion to one another, as their gravities.

Salv.If you will admit this for true,The error of Aristotle in affirming, falling grave bodies to move according to the proportion of their gravities. you must believe also, that two balls of the same matter, being let fall in the same moment, one of an hundred pounds, and another of one, from an altitude of an hundred yards, the great one arriveth at the ground, before the other is descended but one yard onely: Now bring your fancy, if you can, to imagine, that you see the great ball got to the ground, when the little one is still within less than a yard of the top of the Tower.

Sagr.That this proposition is most false, I make no doubt in the world; but yet that yours is absolutely true, I cannot well assure my self: nevertheless, I believe it, seeing that you so resolutely affirm it; which I am sure you would not do, if you had not certain experience, or some clear demonstration thereof.

Salv.I have both: and when we shall handle the business of motions apart, I will communicate them: in the interim, that we may have no more occasions of interrupting our discourse, we will suppose, that we are to make our computation upon a ball of Iron of an hundred (a) pounds, the which by (a) (b) Note that these Calculations are made in Italian weights and measures. And 100 pounds Haverdupoise make 131 l. Florentine. And 100 English yards makes 1502/5 Braces Florent. so that the brace or yard of our Author is 3/4 of our yard.reiterated experiments descendeth from the altitude of an hundred (b) yards, in five second-minutes of an hour. And because, as we have said, the spaces that are measured by the cadent moveable, increase in double proportion; that is, according to the squares of the times, being that the time of one first-minute is duodecuple to

the time of five seconds, if we multiply the hundred yards by the square of 12, that is by 144, we shall have 14400, which shall be the number of yards that the same moveable shall pass in one first-minute of an hour: and following the same rule because one hour is 60 minutes, multiplying 14400, the number of yards past in one minute, by the square of 60, that is, by 3600, there shall come forth 51840000, the number of yards to be passed in an hour, which make 17280 miles. And desiring to know the space that the said ball would pass in 4 hours, let us multiply 17280 by 16, (which is the square of 4) and the product will be 276480 miles: which number is much greater than the distance from the Lunar concave to the centre of the Earth, which is but 196000 miles, making the distance of the concave 56 semidiameters of the Earth, as that modern Author doth; and the semidiameter of the Earth 3500 miles, of 3000 ** The Italian measure which I commonly translate yards. Braces to a †† The Italian mile is 1000/1056 of our mile. mile, which are our Italian miles.

Therefore, Simplicius, that space from the concave of the Moon to the centre of the Earth, which your Accomptant said could not be passed under more than six days, you see that (computing by experience, and not upon the fingers ends) that it shall be passed in much less than four hours; and making the computation exact, it shall be passed by the moveable in 3 hours, 22 min. prim. and 4 seconds.

Sagr.I beseech you, dear Sir, do not defraud me of this exact calculation, for it must needs be very excellent.

Salv.So indeed it is: therefore having (as I have said) by diligent tryal observed, that such a moveable passeth in its descent, the height of 100 yards in 5 seconds of an hour, we will say, if 100 yards are passed in 5 seconds; in how many seconds shall 588000000 yards (for so many are in 56 diameters of the Earth) be passed? The rule for this work is, that the third number must be multiplied by the square of the second, of which doth come 14700000000, which ought to be divided by the first, that is, by 100, and the root square of the quotient, that is, 12124 is the number

sought, namely 12124 min. secun. of an hour, which are 3 hours, 22 min. prim. and 4 seconds.

Sagr.I have seen the working, but I know nothing of the reason for so working, nor do I now think it a time to ask it.

Salv.Yet I will give it, though you do not ask it, because it is very easie. Let us mark these three numbers with the Letters A first, B second, C third. A and C are the numbers of the spaces, B is the number of the time; the fourth number is sought, of the time also. And because we know, that look what proportion the space A, hath to the spuace C, the same proportion shall the square of the time B have to the sqare of the time, which is sought.

Therefore by the Golden Rule, let the number C be multiplied by the square of the number B, and let the product be divided by the number A, and the quotient shall be the square of the number sought, and its square root shall be the number it self that is sought. Now you see how easie it is to be understood.

Sagr.So are all truths, when once they are found out, but the difficulty lyeth in finding them I very well apprehend it, and kindly thank you. And if there remain any other curiosity touching this point, I pray you let us hear it; for if I may speak my mind, I will with the favour of Simplicius, that from your discourses I alwayes learn some new motion, but from those of his Philosophers, I do not remember that I have learn't any thing of moment.

Salv.There might be much more said touching these local motions; but according to agreement, we will reserve it to a particular conference; and for the present I will speak something touching the Author named by Simplicius, who thinketh he hath given a great advantage to the adverse party in granting that, that Canon bullet in falling from the concave of the Moon may descend with a velocity equal to the velocity wherewith it would turn round, staying there above, and moving along with the diurnal conversion. Now I tell him, that that same ball falling from the concave

unto the centre, will acquire a degree of velocity much more than double the velocity of the diurnal motion of the Lunar concave;The falling moveable if it move with a degree of velocity acquired in a like time with an uniform motion, it shall paß a space double to that passed with the accelerated motion. and this I will make out by solid and not impertinent suppositions. You must know therefore that the grave body falling and acquiring all the way new velocity according to the proportion already mentioned, hath in any whatsoever place of the line of its motion such a degree of velocity, that if it should continue to move therewith, uniformly without farther encreasing it; in another time like to that of its descent, it would passe a space double to that passed in the line of the precedent motion of descent. And thus for example, if that ball in coming from the concave of the Moon to its centre hath spent three hours, 22 min. prim. and 4 seconds, I say, that being arrived at the centre, it shall find it self constituted in such a degree of velocity, that if with that, without farther encreasing it, it should continue to move uniformly, it would in other 3 hours, 22 min. prim. and 4 seconds, passe double that space, namely as much as the whole diameter of the Lunar Orb; and because from the Moons concave to the centre are 196000 miles, which the ball passeth in 3 hours 22 prim. min. and 4 seconds, therefore (according to what hath been said) the ball continuing to move with the velocity which it is found to have in its arrival at the centre, it would passe in other 3 hours 22 min. prim. and 4 seconds, a space double to that, namely 392000 miles; but the same continuing in the concave of the Moon, which is in circuit 1232000 miles, and moving therewith in a diurnal motion, it would make in the same time, that is in 3 hours 22 min. prim. and 4 seconds, 172880 miles, which are fewer by many than the half of the 392000 miles. You see then that the motion in the concave is not as the modern Author saith, that is, of a velocity impossible for the falling ball to partake of, &c.

Sagr.The discourse would pass for current, and would give me full satisfaction, if that particular was but salved, ofroof the moving of the moveable by a double space

to that passed in falling in another time equal to that of the descent, in case it doth continue to move uniformly with the greatest degree of velocity acquired in descending. A proposition which you also once before supposed as true, but never demonstrated.

Salv.This is one of the demonstrations of Our Friend, and you shall see it in due time; but for the present, I will with some conjectures (not teach you any thing that is new, but) remember you of a certain contrary opinion, and shew you, that it may haply so be. A bullet of lead hanging in a long and fine thread fastened to the roof, if we remove it far from perpendicularity, and then let it go, have you not observed that, it declining, will pass freely, and well near as far to the other side of the perpendicular?

Sagr.I have observed it very well, and find (especially if the plummet be of any considerable weight) that it riseth so little less than it descended, so that I have sometimes thought, that the ascending arch is equal to that descending, and thereupon made it a question whether the vibrations might not perpetuate themselves; and I believe that they might,The motion of grave penduli might be perpetuated, impediments being removed. if that it were possible to remove the impediment of the Air, which resisting penetration, doth some small matter retard and impede the motion of the pendulum, though indeed that impediment is but small: in favour of which opinion the great number of vibrations that are made before the moveable wholly ceaseth to move, seems to plead.

Salv.The motion would not be perpetual, Sagredus, although the impediment of the Air were totally removed, because there is another much more abstruse.

Sagr.And what is that? as for my part I can think of no other?

Salv.You will be pleased when you hear it, but I shall not tell it you till anon: in the mean time, let us proceed. I have proposed the observation of this Pendulum, to the intent, that you should understand, that the impetus acquired in the descending arch,

where the motion is natural, is of it self able to drive the said ball with a violent motion, as far on the other side in the like ascending arch; if so, I say, of it self, all external impediments being removed: I believe also that every one takes it for granted, that as in the descending arch the velocity all the way increaseth, till it come to the lowest point, or its perpendicularity; so from this point, by the other ascending arch, it all the way diminisheth, untill it come to its extreme and highest point: and diminishing with the same proportions, wherewith it did before increase, so that the dgrees of the velocities in the points equidistant from the point of perpendicularity, are equal to each other. Hence it seemeth to me (arguing with all due modesty) that I might easily be induced to believe,If the Terrestrial Globe were perforated, a grave body descending by that bore, would paß and ascend as far beyond the centre, as it did descend. that if the Terrestrial Globe were bored thorow the centre, a Canon bullet descending through that Well, would acquire by that time it came to the centre, such an impulse of velocity, that, it having passed beyond the centre, would spring it upwards the other way, as great a space, as that was wherewith it had descended, all the way beyond the centre diminishing the velocity with decreasements like to the increasements acquired in the descent: and the time spent in this second motion of ascent, I believe, would be equal to the time of descent. Now if the moveable by diminishing that its greatest degree of velocity which it 123456789101098765432 1had in the centre, successively until it come to total extinction, do carry the moveable in such a time such a certain space, as it had gone in such a like quantity of time, by the acquist of velocity from the total privation of it until it came to that its greatest degree; it seemeth very reasonable, that if it should move always with the said greatest degree of velocity it would pass, in such another quantity of time, both those spaces: For if we do but in our mind successively divide those velocities into rising and falling degrees, as v. g. these numbers in the margine; so that the first sort unto 10 be supposed the increasing velocities, and the others unto one 1, be the increasing; and let those of the time of

the descent, and the others of the time of the ascent being added all together, make as many, as if one of the two sums of them had been all of the greatest degrees, and therefore the whole space passed by all the degrees of the increasing velocities, and decreasing, (which put together is the whole diameter) ought to be equal to the space passed by the greatest velocities, that are in number half the aggregate of the increasing and decreasing velocities. I know that I have but obscurely expressed my self, and I wish I may be understood.

012345Sagr.I think I understand you very well; and also that I can in a few words shew, that I do understand you. You had a mind to say, that the motion begining from rest, and all the way increasing the velocity with equal augmentations, such as are those of continuate numbers beginning at 1, rather at 0, which representeth the state of rest, disposed as in the margine: and continued at pleasure, so as that the least degree may be 0, and the greatest v. g. 5, all these degrees of velocity wherewith the moveable is moved, make the sum of 15;but if the moveable should move with as many degrees in number as these are, and each of them equal to the biggest, which is 5, the aggregate of all these last velocities would be double to the others, namely 30. And therefore the moveable moving with a like time, but with uniform velocity, which is that of the highest degree 5, ought to pass a space double to that which it passeth in the accelerate time, which beginneth at the state of rest.

Salv.According to your quick and piercing way of apprehending things, you have explained the whole business with more plainness than I my self; and put me also in mind of adding something more: for in the accelerate motion, the augmentation being continual, you cannot divide the degrees of velocity, which continually increase, into any determinate number, because changing every moment, they are evermore infinite. Therefore we shall be the better able to exemplifie our intentions by describing a Triangle, which let be this ABC, [in Fig. 8.] taking in the side AC, as many equal parts as we please, AD, DE, EF, FG, and drawing by the points D, E, F, G, right lines parallel to the base BC. Now let us imagine the parts marked in the

line AC, to be equal times, and let the parallels drawn by the points D, E, F, G, represent unto us the degrees of velocity accelerated, and increasing equally in equal times; and let the Point A be the state of rest, from which the moveable departing, hath v. g. in the time AD, acquired the degree of velocity DH, in the second time we will suppose, that it hath increased the velocity from DH, as far as to EI, and so supposing it to have grown greater in the succeeding times,The acceleration of grave bodies naturally descendent, increaseth from moment to moment. according to the increase of the lines FK, GL, &c. but because the acceleration is made continually from moment to moment, and not disjunctly from one certain part of time to another; the point A being put for the lowest moment of velocity, that is, for the state of rest, and AD for the first instant of time following; it is manifest, that before the acquist of the degree of velocity DH, made in the time AD, the moveable must have past by infinite other lesser and lesser degrees gained in the infinite instants that are in the time DA, answering the infinite points that are in the line DA; therefore to represent unto us the infinite degrees of velocity that precede the degree DH, it is necessary to imagine infinite lines successively lesser and lesser, which are supposed to be drawn by the infinite points of the line DA, and parallels to DH, the which infinite lines represent unto us the superficies of the Triangle AHD, and thus we may imagine any space passed by the moveable, with a motion which begining at rest, goeth uniformly accelerating, to have spent and made use of infinite degrees of velocity, increasing according to the infinite lines that begining from the point A, are supposed to be drawn parallel to the line HD, and to the rest IE, KF, LG, the motion continuing as far as one will.

Now let us compleat the whole Parallelogram AMBC, and let us prolong as far as to the side thereof BM, not onely the Parallels marked in the Triangle, but those infinite others imagined to be drawn from all the points of the side AC; and like as BC, was the greatest of those infinite parallels of the Triangle, representing unto us the greatest degree of velocity acquired by the moveable in the accelerate motion,

and the whole superficies of the said Triangle, was the mass and sum of the whole velocity, wherewith in the time AC it passed such a certain space, so the parallelogram is now a mass and aggregate of a like number of degrees of velocity, but each equal to the greatest BC, the which mass of velocities will be double to the mass of the increasing velocities in the Triangle, like as the said Parallelogram is double to the Triangle: and therefore if the moveable, that falling did make use of the accelerated degrees of velocity, answering to the triangle ABC, hath passed in such a time such a space, it is very reasonable and probable, that making use of the uniform velocities answering to the parallelogram, it shall passe with an even motion in the same time a space double to that passed by the accelerate motion.

Sagr.I am entirely satisfied. And if you call this a probable Discourse, what shall the necessary demonstrations be? I wish that in the whole body of common Philosophy, I could find one that was but thus concludent.

In natural Sciences it is not necessary to seek Mathematicall evidence.Simpl.It is not necessary in natural Philosophy to seek exquisite Mathematical evidence.

Sagr.But this point of motion, is it not a natural question? and yet I cannot find that Aristotle hath demonstrated any the least accident of it. But let us no longer divert our intended Theme, nor do you fail, I pray you Salviatus, to tell me that which you hinted to me to be the cause of the Pendulum's quiescence, besides the resistance of the Medium ro penetration.

Salv.Tell me; of two penduli hanging at unequal distances, doth not that which is fastned to the longer threed make its vibrations more seldome?

The pendulum hanging at a longer threed, maketh its vibrations more seldome than the pendulum hanging at a shorter threed.Sagr.Yes, if they be moved to equall distances from their perpendicularity.

Salv.This greater or lesse elongation importeth nothing at all, for the same pendulum alwayes maketh its reciprocations in equall times, be they longer or shorter, that is,

though the pendulum be little or much removed from its perpendicularity,The vibrations of the same pendulum are made with the same frequency, whether they be small or great. and if they are not absolutely equal, they are insensibly different, as experience may shew you: and though they were very unequal, yet would they not discountenance, but favour our cause. Therefore let us draw the perpendicular AB [in Fig. 9.] and hang from the point A, upon the threed AC, a plummet C, and another upon the same threed also, which let be E, and the threed AC, being removed from its perpendicularity, and then letting go the plummets C and E, they shall move by the arches CBD, EGF, and the plummet E, as hanging at a lesser distance, and withall, as (by what you said) lesse removed, will return back again faster, and make its vibrations more frequent than the plummet C, and therefore shall hinder the said plummet C, from running so much farther towards the term D, as it would do, if it were free: and thus the plummet E bringing unto it in every vibration continuall impediment,The cause which impedeth the pendulum, and reduceth it to rest. it shall finally reduce it to quiescence. Now the same threed, (raking away the middle plummet) is a composition of many grave penduli, that is, each of its parts is such a pendulum fastned neerer and neerer to the point A, and therefore disposed to make it, vibrations successively more and more frequent; and consequently is able to bring a continual impediment to the plummet C; and for a proof that this is so, if we do but observe the thread AC, we shall see it distended not directly, but in an arch; and if instead of the thread we take a chain, we shall discern the effect more perfectly;The thread or chain to which a pendulum is fastned, maketh an arch, and doth not stretch it selfe streight out in its vibrations. and especially removing the gravity C, to a considerable distance from the perpendicular AB, for that the chain being composed of many loose particles, and each of them of some weight, the arches AEC, and AFD, will appear notably incurvated. By reason therefore, that the parts of the chain, according as they are neerer to the point A, desire to make their vibrations more frequent, they permit not the lower parts of the

said chain to swing so far as naturally they would: and by continual detracting from the vibrations of the plummet C, they finally make it cease to move, although the impediment of the air might be removed.

Sagr.The books are now come; here take them Simplicius, and find the place you are in doubt of.

Simpl.See, here it is where he beginneth to argue against the diurnal motion of the Earth, he having first confuted the annual. Motus terræ annuus asserere Copernicanos cogit conversionem ejusdem quotidianam; alias idem terræ Hemisphærium continenter ad Solem esset conversum obumbrato semper averso. [In English thus:] The annual motion of the Earth doth compell the Copernicans to assert the daily conversion thereof; otherwise the same Hemisphere of the Earth would be continually turned towards the Sun, the shady side being always averse. And so one half of the Earth would never come to see the Sun.

Salv.I find at the very first sight, that this man hath not rightly apprehended the Copernican Hypothesis, for if he had but taken notice how he alwayes makes the Axis of the terrestrial Globe perpetually parallel to it self, he would not have said, that one half of the Earth would never see the Sun, but that the year would be one entire natural day, that is, that thorow all parts of the Earth there would be six moneths day, and six moneths night, as it now befalleth to the inhabitants under the Pole, but let this mistake be forgiven him, and let us come to what remaineth.

Simpl.It followeth, Hanc autem gyrationem Terræ impossibilem esse sic demonstramus. Which speaks in English thus: That this gyration of the Earth is impossible we thus demonstrate. That which ensueth is the declaration of the following figure, wherein is delineated many descending grave bodies, and ascending light bodies, and birds that fly to and again in the air, &c.

Sagr.Let us see them, I pray you. Oh! what fine figures, what birds, what balls, and what other pretty things are here?

Simpl.These are balls which come from the concave of the Moon.

Sagr.and what is this?

Simpl.This is a kind of Shell-fish, which here at Venice they call buovoli; and this also came from the Moons concave.

Sagr.Indeed, it seems then, that the Moon hath a great power over these Oyster-fishes, which we call ** Pesci armai, or armati. armed sishes.

Simpl.And this is that calculation, which I mentioned▪ of this Journey in a natural day, in an hour, in a first minute, and in a second, which a point of the Earth would make placed under the Equinoctial, and also in the parallel of 48 gr. And then followeth this, which I doubted I had committed some mistake in reciting, therefore let us read it. His positis, necesse est, terra circulariter mota, omnia ex aëre eidem, &c. Quod si hasce pilas æquales ponemus pondere, magnitudine, gravitate, & in concavo Sphæræ Lunaris positas libero descensui permittamus, si motum deorsum æquemus celeritate motui circum, (quod tamen secus est, cum pila A, &c.) elabentur minimum (ut multum cedamus adversariis) dies sex: quo tempore sexies circa terram, &c. [In English thus.] These things being supposed, it is necessary, the Earth being circularly moved, that all things from the air to the same, &c. So that if we suppose these balls to be equal in magnitude and gravity, and being placed in the concave of the Lunar Sphere, we permit them a free descent, and if we make the motion downwards equal in velocity to the motion about, (which nevertheless is otherwise, if the ball A, &c.) they shall be falling at least (that we may grant much to our adversaries) six dayes; in which time they shall be turned six times about the Earth, &c.

Salv.You have but too faithfully cited the argument of this person. From hence you may collect Simplicius, with what caution they ought to proceed, who would give themselves up to believe others in those things, which perhaps they do not believe themselves. For me thinks it a thing impossible, but that this Author was advised,

that he did design to himself a circle, whose diameter (which amongst Mathematicians, is lesse than one third part of the circumference) is above 72 times bigger than it self: an errour that affirmeth that to be considerably more than 200 which is lesse than one.

Sagr.It may be, that these Mathematical proportions, which are true in abstract, being once applied in concrete to Physical and Elementary circles, do not so exactly agree: And yet, I think, that the Cooper, to find the semidiameter of the bottom, which he is to fit to the Cask, doth make use of the rule of Mathematicians in abstract, although such bottomes be things meerly material, and concrete: therefore let Simplicius plead in excuse of this Author; and whether he thinks that the Physicks can differ so very much from the Mathematicks.

Simpl.The substractions are in my opinion insufficient to salve this difference, which is so extreamly too great to be reconciled: and in this case I have no more to say but that, Quandoque bonus dormitet Homerus. But supposing the calculation of ** Not Sagredus, as the Latine ha h it.Salviatus to be more exact, and that the time of the descent of the ball were no more than three hours; yet me thinks, that coming from the concave of the Moon, which is so great a distance off, it would be an admirable thing, that it should have an instinct of maintaining it self all the way over the self-same point of the Earth, over which it did hang in its departure thence, and not rather be left a very great way behind.

Salv.The effect may be admirable, and not admirable, but natural and ordinary, according as the things precedent may fall out. For if the ball (according to the Authors suppositions) whilst it staid in the concave of the Moon, had the circular motion of twenty four hours together with the Earth, and with the rest of the things contained within the said Concave; that very vertue which made it turn round before its descent, will continue it in the same motion in its descending. And so far it is from not keeping pace with the motion of the Earth, and from staying behind, that it

is more likely to out-go it; being that in its approaches to the Earth, the motion of gyration is to be made with circles continually lesser and lesser; so that the ball retaining in it self that self-same velocity which it had in the concave, it ought to anticipate, as I have said, the vertigo or conversion of the Earth. But if the ball in the concave did want that circulation, it is not obliged in descending to maintain it self perpendicularly over that point of the Earth, which was just under it when the descent began. Nor will. Copernicus, or any of his followers affirm the same.

Simpl.But the Author maketh an objection, as you see, demanding on what principle this circular motion of grave and light bodies, doth depend: that is, whether upon an internal or an external principle.

Salv.Keeping to the Probleme of which we speak, I say, that that very principle which made the ball turn round, whil'st it was in the Lunar concave, is the same that maintaineth also the circulation in the descent: yet I leave the Author at liberty to make it internal or external at his pleasure.

Simpl.The Author proveth, that it can neither be inward nor outward.

Salv.And I will say then, that the ball in the concave did not move, and so he shall not be bound to shew how that in descending it continueth all the way vertically over one point, for that it will not do any such thing.

Simpl.Very well; But if grave bodies, and light can have no principle, either internal or external of moving circularly, than neither can the terrestrial Globe move with a circular motion: and thus you have the intent of the Author.

Salv.I did not say, that the Earth had no principle, either interne, or externe to the motion of gyration, but I say, that I do not know which of the two it hath; and yet my not knowing it hath not a power to deprive it of the same; but if this Author can tell by what principle other mundane bodies are moved round, of whose motion there is no doubt; I say, that that which maketh the Earth to move, is a vertue, like to that, by which Mars and Jupiter are moved, and wherewith he believes that the starry

Sphere it self also doth move; and if he will but assure me, who is the mover of one of these moveables, I will undertake to be able to tell him who maketh the Earth to move. Nay more; I will undertake to do the same, if he can but tell me, who moveth the parts of the Earth downwards.

Simpl.The cause of this is most manifest, and every one knows that it is gravity.

Salv.You are out, Simplicius, you should say, that every one knowes, that it is called Gravity: but I do not question you about the name, but the essence of the thing, of which essence you know not a tittle more than you know the essence of the mover of the stars in gyration; unlesse it be the name that hath been put to this, and made familiar, and domestical, by the many experiences which we see thereof every hour in the day,:We know no more who moveth grave bodies downwards; than who moveth the Stars round, nor know we any thing of these causes, more than the names imposed on them by us. but not as if we really understand any more, what principle or vertue that is which moveth a stone downwards, than we know who moveth it upwards, when it is separated from the projicient, or who moveth the Moon round, except (as I have said) onely the name, which more particularly and properly we have assigned to the motion of descent, namely, Gravity; whereas for the cause of circular motion, in more general termes, we assign the Vertue impressed, and call the same an Intelligence, either assisting, or informing; and to infinite other motions we ascribe Nature for their cause.

Simpl.It is my opinion, that this Author asketh far lesse than that, to which you deny to make answer; for he doth not ask what is nominally and particularly the principle that moveth grave and light bodies circularly, but whatsoever it be, he desireth to know, whether you think it intrinsecal, or extrinsecal: For howbeit, v.gr. I do not know, what kind of thing that gravity is, by which the Earth descendeth; yet I know that it is an intern principle, seeing that if it be not hindered, it moveth spontaneously: and on the contrary, I know that the principle which moveth it

upwards, is external; although that I do not know, what thing that vertue is, impressed on it by the projicient.

Salv.Into how many questions must we excurre, if we would decide all the difficulties, which successively have dependance one upon another! You call that an external (and you also call it a preternatural and violent) principle, which moveth the grave project upwards; but its possible that it may be no lesse interne and natural, than that which moveth it downwards; it may peradventure be called external and violent,The vertue which carrieth grave projects upwards, is no lesse natural to them, than the gravity which moveth them downwards. so long as the moveable is joyned to the projicient; but being separated, what external thing remaineth for a mover of the arrow, or ball? In summe, it must necessarliy be granted, that that vertue which carrieth such a moveable upwards, is no lesse interne, than that which moveth it downwards; and I think the motion of grave bodies ascending by the impetus conceived, to be altogether as natural, as the motion of descent depending on gravity.

Simpl.I will never grant this; for the motion of descent hath its principle internal, natural, and perpetual, and the motion of ascent hath its principle externe, violent, and finite.

Salv.If you refuse to grant me, that the principles of the motions of grave bodies downwards and upwards,Contrary principles cannot naturally reside in the same subject. are equally internal and natural; what would you do, if I should say, that they may also be the same in number?

Simpl.I leave it to you to judge.

Salv.But I desire you your self to be the Judge: Therefore tell me, Do you believe that in the same natural body, there may reside interne principles, that are contrary to one another?

Simpl.I do verily believe there cannot.

Salv.What do you think to be the natural inclination of Earth, of Lead, of Gold, and in sum, of the most ponderous matters; that is, to what motion do you believe that their interne principle draweth them?

Simpl.To that towards the centre of things grave, that is, to the centre of the Universe, and of the Earth, whither, if they be not hindered, it will carry them.

Salv.So that, if the Terrestrial Globe were bored thorow, and a Well made that should passe through the centre of it, a Cannon bullet being let fall into the same, as being moved by a natural and intrinsick principle, would passe to the centre; and it would make all this motion spontaneously, and by intrinsick principle, is it not so?

Simpl.So I verily believe.

Salv.But when it is arrived at the centre, do you think that it will passe any further, or else that there it would immediately stand still, and move no further?

Simpl.I believe that it would continue to move a great way further.

Salv.But this motion beyond the centre, would it not be upwards, and according to your assertion preternatural, and violent? And yet on what other principle do you make it to depend, but only upon the self same, which did carry the ball to the centre, and which you called intrinsecal, and natural? Finde, if you can, another external projicient, that overtaketh it again to drive it upwards. And this that hath been said of the motion thorow the centre,The natural motion changeth it selfe into that which is called preternatural and violent. is also seen by us here above; for the interne impetus of a grave body falling along a declining superficies, if the said superficies be reflected the other way, it shall carry it, without a jot interrupting the motion, also upwards. A ball of lead that hangeth by a thread, being removed from its perpendicularity, descendeth spontaneously, as being drawn by its internal inclination, and without any interposure of rest, passeth beyond the lowest point of perpendicularity: and without any additional mover, moveth upwards. I know that you will not deny, but that the principle of grave bodies that moveth them

downwards, is no less natural, and intrinsecal, than that principle of light bodies, which moveth them upwards: so that I propose to your consideration a ball of lead, which descending through the Air from a great altitude, and so moving by an intern principle, and comming to a depth of water, continueth its descent, and without any other externe mover, submergeth a great way; and yet the motion of descent in the water is preternatural unto it; but yet nevertheless dependeth on a principle that is internal, and not external to the ball. You see it demonstrated then, that a moveable may be moved by one and the same internal principle, with contrary motions.

Simpl.I believe there are solutions to all these objections, though for the present I do not remember them; but however it be, the Author continueth to demand, on what principle this circular motion of grave and light bodies dependeth; that is, whether on a principle internal, or external; and proceeding forwards, sheweth, that it can be neither on the one, nor on the other, saying; Si ab externo; Deusne illum excitat per continuum miraculum? an verò Angelus, an aër? Et hunc quidem multi assignant. Sed contra———[In English thus] If from an externe principle; Whether God doth not excite it by a continued Miracle? or an Angel, or the Air? And indeed many do assign this. But on the contrary———.

Salv.Trouble not your self to read his argument; for I am none of those who ascribe that principle to the ambient air. As to the Miracle, or an Angel, I should rather incline to this side; for that which taketh beginning from a Divine Miracle, or from an Angelical operation; as for instance, the transportation of a Cannon ball or bullet into the concave of the Moon, doth in all probability depend on the vertue of the same principle for performing the rest. But, as to the Air, it serveth my turn, that it doth not hinder the circular motion of the moveables, which we did suppose to move thorow it. And to prove that, it sufficeth (nor is more required) that it moveth with the same motion, and finisheth its circulations with the same velocity, that the Terrestrial Globe doth.

Simpl.And he likewise makes his opposition to this also; demanding who carrieth the air about, Nature, or Violence? And proveth, that it cannot be Nature, alledging that that is contrary to truth, experience, and to Copernicus himself.

Salv.It is not contrary to Copernicus in the least, who writeth no such thing; and this Author ascribes these things to him with two excessive courtesie. It's true, he saith, and for my part I think he saith well, that the part of the air neer to the Earth, being rather a terrestrial evaporation, may have the same nature, and naturally follow its motion; or, as being contiguous to it, may follow it in the same manner, as the Peripateticks say, that the superiour part of it, and the Element of fire, follow the motion of the Lunar Concave, so that it lyeth upon them to declare, whether that motion be natural, or violent.

Simpl.The Author will reply, that if Copernicus maketh only the inferiour part of the Air to move, and supposeth the upper part thereof to want the said motion, he cannot give a reason, how that quiet air can be able to carry those grave bodies along with it, and make them keep pace with the motion of the Earth.

Salv.Copernicus will say,The propension of elementary bodies to follow the Earth, hath a limited Sphere of activity. that this natural propension of the elementary bodies to follow the motion of the Earth, hath a limited Sphere, out of which such a natural inclination would cease; besides that, as I have said, the Air is not that which carrieth the moveables along with it; which being separated from the Earth, do follow its motion; so that all the objections come to nothing, which this Author produceth to prove, that the Air cannot cause such effects.

Simpl.To shew therefore, that that cannot be, it will be necessary to say, that such like effects depend on an interne principle, against which position, oboriuntur difficillimæ, immò inextricabiles quæstiones secundæ, of which sort are these that follow. Principium illud internum vel est accidens, vel substantia. Si primum; quale nam illud? nam qualitas locomotiva circum, hactenus nulla videtur agnita. (In

English thus:) Contrary to which position there do arise most difficult, yea inextricable second questions, such as these; That intern principle is either an accident, or a substance. If the first; what manner of accident is it? For a locomotive quality about the centre, seemeth to be hitherto acknowledged by none.

Salv.How, is there no such thing acknowledged? Is it not known to us, that all these elementary matters move round, together with the Earth? You see how this Author supposeth for true, that which is in question.

Simpl.He saith, that we do not see the same; and me thinks, he hath therein reason on his side.

Salv.We see it not, because we turn round together with them.

Simpl.Hear his other Argument. Quæ etiam si esset, quomodò tamen inveniretur in rebus tam contrariis? in igne, ut in aquâ; in aëre, ut in terra; in viventibus, ut in animà carentibus? [in English thus:] Which although it were, yet how could it be found in things so contrary? in the fire, as in the water? in the air, as in the earth? in living creatures, as in things wanting life?

Salv.Supposing for this time, that water and fire are contraries; as also the air and earth; (of which yet much may be said) the most that could follow from thence would be, that those motions cannot be common to them, that are contrary to one another: so that v. g. the motion upwards, which naturally agreeth to fire, cannot agree to water; but that, like as it is by nature contrary to fire: so to it that motion suiteth, which is contrary to the motion of fire, which shall be the motion deorsum; but the circular motion, which is not contrary either to the motion sursum, or to the motion deorsum, but may mix with both, as Aristotle himself affirmeth, why may it not equally suit with grave bodies and with light? The motions in the next place, which cannot be common to things alive, and dead, are those which depend on the soul: but those which belong to the body, in as much as it is elementary, and consequently participateth of the qualities of the elements, why may not they be

common as well to the dead corps, as to the living body? And therefore, if the circular motion be proper to the elements, it ought to be common to the mixt bodies also.

Sagr.It must needs be, that this Author holdeth, that a dead cat, falling from a window, it is not possible that a live cat also could fall; it not being a thing convenient, that a carcase should partake of the qualities which suit with things alive.

Salv.Therefore the discourse of this Author concludeth nothing against one that should affirm, that the principle of the circular motions of grave and light bodies is an intern accident: I know not how he may prove, that it cannot be a substance.

Simpl.He brings many Arguments against this. The first of which is in these words: Si secundum (nempè, si dicas tale principium esse substantiam) illud est aut materia, aut forma, aut compositum. Sed repugnant iterum tot diversæ rerum naturæ, quales sunt aves, limaces, saxa, sagittæ, nives, fumi, grandines, pisces, &c. quæ tamen omnia specie & genere differentia, moverentur à naturà suâ circulariter, ipsa naturis diversissima, &c. [In English thus] If the second, (that is, if you shall say that this principle is a substance) it is either matter, or form, or a compound of both. But such diverse natures of things are again repugnant, such as are birds, snails, stones, darts, snows, smoaks, hails, fishes, &c. all which notwithstanding their differences in species and kind, are moved of their own nature circularly, they being of their natures most different, &c.

Salv.If these things before named are of diverse natures, and things of diverse natures cannot have a motion in common, it must follow, if you would give satisfaction to all, that you are to think of, more than two motions onely of upwards and downwards: and if there must be one for the arrows, another for the snails, another for the stones, and another for fishes; then are you to bethink your self of worms, topazes and mushrums, which are not less different in nature from one

another, than snow and hail.

Simpl.It seems that you make a jest of these Arguments.

Salv.No indeed, Simplicius, but it hath been already answered above, to wit, that if one motion, whether downwards or upwards, can agree with all those things afore named, a circular motion may no less agree with them: and as you are a Peripatetick, do not you put a greater difference between an elementary comet and a celestial star, than between a fish and a bird? and yet both those move circularly. Now propose your second Argument.

Simpl.Si terra staret per voluntatem Dei, rotaréntne cætera, an non? si hoc, falsum est à naturâ gyrare; si illud, redeunt priores quæstiones. Et sanè mirum esset, quòd Gavia pisciculo, Alauda nidulo suo, & corvus limaci, petraque, etiam volans, imminere non posset. [Which I thus render:] If the Earth be supposed to stand still by the will of God, should the rest of bodies turn round or no? If not, then it's false that they are revolved by nature; if the other, the former questions will return upon us. And truly it would be strange that the Sea-pie should not be able to hover over the small fish, the Lark over her nest, and the Crow over the snail and rock, though flying.

Salv.I would answer for my self in general terms, that if it were appointed by the will of God, that the Earth should cease from its diurnal revolution, those birds would do what ever should please the same Divine will. But if this Author desire a more particular answer, I should tell him, that they would do quite contrary to what they do now, if whilst they, being separated from the Earth, do bear themselves up in the air, the Terrestrial Globe by the will of God, should all on a sudden be put upon a precipitate motion; it concerneth this Author now to ascertain us what would in this case succeed.

Sagr.I pray you, Salviatus, at my request to grant to this Author, that the Earth standing still by the will of God, the other things, separated from it, would continue

to turn round of their own natural motion, and let us hear what impossibilities or inconveniences would follow: for I, as to my own particular, do not see how there can be greater disorders, than these produced by the Author himself, that is, that Larks, though they should flie, could not be able to hover over their nests, nor Crows over snails, or rocks: from whence would follow, that Crows must suffer for want of snails, and young Larks must die of hunger, and cold, not being able to be fed or sheltered by the wings of the old ones. This is all the ruine that I can conceive would follow, supposing the Authors speech to be true. Do you see, Simplicius, if greater inconveniences would happen?

Simpl.I know not how to discover greater; but it is very credible, that the Author besides these, discovered other disorders in Nature, which perhaps in reverend respect of her, he was not willing to instance in. Therefore let us proceed to the third Objection. Insuper quî fit, ut istæ res tam variæ tantùm moveantur ab Occasu in Ortum, parallelæ ad Æquatorem? ut semper moveantur, nunquam quiescant? [which speaks to this sense:] Moreover, how comes it to pass that these things, so diverse, are onely moved from the West towards the East, parallel to the Æquinoctial? that they always move, and never rest?

Salv.They move from West to East parallel to the Aequinoctial without ceasing, in the same manner as you believe the fixed stars to move from East to West, parallel to the Æquinoctial, without ever resting.

Simpl.Quarè, quò sunt altiores, celeriùs; quò humiliores, tardiùs? (i. e.) Why are the higher the swifter, and the lower the slower?

Salv.Because that in a Sphere or circle, that turns about upon its own centre, the remoter parts describe greater circuits, and the parts nearer at hand describe lesser in the same time.

Simpl.Quare, quæ Æquinoctiali propriores, in majori; quæ remotiores, in minori circulo feruntur? [scilicet:] Why are those near the Æquinoctial carried about in a

greater circle, and those which are remote in a lesser?

Salv.To imitate the starry Sphere, in which those nearest to the Æquinoctial, move in greater circles, than the more remote.

Simpl.Quarè Pila eadem sub Æquinoctiali tota circa centrum terræ, ambitu maximo, celeritate incredibili; sub Polo verò circa centrum proprium, gyro nullo, tarditate supremà volveretur? [That is:] Why is the same ball under the Æquinoctial wholly turned round the centre of the Earth in the greatest circumference, with an incredible celerity; but under the Pole about its own centre, in no circuite, but with the ultimate degree of tardity?

Salv.To imitate the stars of the Firmament, that would do the like if they had the diurnal motion.

Simpl.Quare eadem res, pila v. g. plumbea, si semel terram circuivit, descripto circulo maximo, eandem ubique non circummigret secundùm circulum maximum, sed translata extra Æquinoctialem in circulis minoribus agetur? [Which speaketh thus:] Why doth not the same thing, as for example, a ball of lead turn round every where according to the same great circle, if once describing a great circle, it hath incompassed the Earth, but being removed from the Æquinoctial, doth move in lesser circles?

Salv.Because so would, nay, according to the doctrine of Ptolomey, so have some fixed stars done, which once were very near the Æquinoctial, and described very vast circles, and now that they are farther off, describe lesser.

Sagr.If I could now but keep in mind all these fine notions, I should think that I had made a great purchase; I must needs intreat you, Simplicius, to lend me this Book, for there cannot chuse but be a sea of rare and ingenious matters contained in it.

Simpl.I will present you with it.

Sagr.Not so, Sir; I would not deprive you of it: but are the Queries yet at an end?

Simpl.No Sir; hearken therefore. Si latio circularis gravibus & levibus est naturalis, qualis est ea quæ fit secundùm lineam rectam? Nam si naturalis, quomodo & is motus qui circum est, naturalis est, cùm specie differat à recto? Si violentus, quî fit, ut missile ignitum sursum evolans scintillosum caput sursùm à terrâ, non autem circum volvatur, &c. [Which take in our idiom:] If a circular lation is natural to heavy and light things, what is that which is made according to a right line? For if it be natural, how then is that motion which is about the centre natural, seeing it differs in species from a right motion? If it be violent, how is it that a fiery dart flying upwards, sparkling over our heads at a distance from the Earth, but not turning about, &c.

Salv.It hath been said already very often,Of the mixt motion we see not the part that is circular, because we partake thereof. that the circular motion is natural to the whole, and to its parts, whilst they are in perfect disposure, and the right is to reduce to order the parts disordered; though indeed it is better to say, that neither the parts ordered or disordered ever move with a right motion, but with one mixed, which might as well be averred meerly circular: but to us but one part onely of this motion is visible and observable, that is, the part of the right, the other part of the circular being imperceptible to us, because we partake thereof. And this answers to the rays which move upwards, and round about, but we cannot distinguish their circular motion, for that, with that we our selves move also. But I believe that this Author never thought of this mixture; for you may see that he resolutely saith, that the rays go directly upwards, and not at all in gyration.

Simpl.Quare centrum sphære delapsæ sub AEquatore spiram describit in ejus plano: sub aliis parallelis spiram describit in cono? sub Polo descendit in axe lineam gyralem, decurrens in superficie cylindricâ consignatam? (In English to this purpose:) Why doth the centre of a falling Globe under the Æquinoctial describe a spiral line in the plane of the Æquator; and in other parallels a spiral about a Cone; and under the Pole descend in the axis describing a gyral line, running in a

Cylindrical Superficie?

Salv.Because of the lines drawn from the Centre to the circumference of the sphere, which are those by which graves descend, that which terminates in the Æquinoctial designeth a circle, and those that terminate in other parallels describe conical superficies; now the axis describeth nothing at all, but continueth in its own being. And if I may give you my judgment freely, I will say, that I cannot draw from all these Queries, any sense that interfereth with the motion of the Earth; for if I demand of this Author, (granting him that the Earth doth not move) what would follow in all these particulars, supposing that it do move, as Copernicus will have it; I am very confident, that he would say that all these effects would happen, that he hath objected, as inconveniences to disprove its mobility: so that in this mans opinion necessary consequences are accounted absurdities: but I beseech you, if there be any more, dispatch them, and free us speedily from this wearisom task.

Simpl.In this which follows he opposes Copernicus & his Sectators, who affirm, that the motion of the parts separated from their whole, is onely to unite themselves to their whole; but that the moving circularly along with the vertigenous diurnal revolution is absolutely natural: against which he objecteth, saying, that according to these mens opinion; Si tota terra, unà cum aquà in nihilum redigeretur, nulla grando aut pluvia è nube decideret, sed naturalater tantùm circumferetur, neque ignis ullus, aut igneum ascenderet, cùm illorum non improbabili sententià ignis nullus sit suprà. [Which I translate to this sense:] If the whole Earth, together with the Water were reduced into nothing, no hail or rain would fall from the clouds, but would be onely naturally carried round; neither any fire or fiery thing would ascend, seeing to these that men it is no improbable opinion that there is no fire above.

Salv.The providence of this Philosopher is admirable, and worthy of great applause; for he is not content to provide for things that might happen, the course of Nature continuing, but will shew hic care in what may follow from those things that he very

well knows shall never come to pass. I will grant him therefore, (that I may get som pretty passages out of him) that if the Earth and Water should be reduced to nothing, there would be no more hails or rains, nor would igneal matters ascend any longer upwards, but would continually turn round: what will follow? what will the Philosopher say then?

Simpl.The objection is in the words which immediately follow; here they are: Quibus tamen experientia & ratio adversatur. Which nevertheless (saith he) is contrary to experience and reason.

Salv.Now I must yield, seeing he hath so great an advantage of me as experience, of which I am unprovided. For as yet I never had the fortune to see the Terrestrial Globe and the element of Water turn'd to nothing, so as to have been able to observe what the hail and water did in that little Chaos. But he perhaps tells us for our instruction what they did.

Simpl.No, he doth not.

Salv.I would give any thing to change a word or two with this person, to ask him, whether when this Globe vanished, it carried away with it the common centre of gravity, as I believe it did; in which case, I think that the hail and water would remain insensate and stupid amongst the clouds, without knowing what to do with themselves. It might be also, that attracted by that great void Vacuum, left by the Earths absenting, all the ambients would be rarified, and particularly, the air, which is extreme easily drawn, and would run thither with very great haste to fill it up. And perhaps the more solid and material bodies, as birds, (for there would in all probability be many of them scattered up and down in the air) would retire more towards the centre of the great vacant sphere; (for it seemeth very reasonable, that substances that under small bulk contain much matter, should have narrower places assigned them, leaving the more spacious to the more ra•ified) and there being dead of hunger, and resolved into Earth, would form a new little Globe, with that little

water, which at that time was among the clouds. It might be also, that those matters as not beholding the light, would not perceive the Earths departure, but like blind things, would descend according to their usual custom to the centre, whither they would now go, if that globe did not hinder them. And lastly, that I may give this Philosopher a less irresolute answer, I do tell him, that I know as much of what would follow upon the annihilation of the Terrestrial Globe, as he would have done that was to have followed in and about the same, before it was created. And because I am certain he will say, that he would never have been able to have known any of all those things which experience alone hath made him knowing in, he ought not to deny me pardon, and to excuse me if I know not that which he knows, touching what would ensue upon the annihilation of the said Globe: for that I want that experience which he hath. Let us hear if he have any thing else to say.

Simpl.There remains this figure, which represents the Terrestrial Globe with a great cavity about its centre, full of air; and to shew that Graves move not downwards to unite with the Terrestrial Globe, as Copernicus saith, he constituteth this stone in the centre; and demandeth, it being left at liberty, what it would do; and he placeth another in the space of this great vacuum, and asketh the same question. Saying, as to the first: Lapis in centro constitutus, aut ascendet ad terram in punctum aliquod, aut non. Si secundum; falsum est, partes ob solam sejunctionem à toto, ad illud moveri. Si primum; omnis ratio & experientia renititur, neque gravia in suæ gravitatis centro conquiescent. Item si suspensus lapis, liberatus decidat in centrum, separabit se à toto, contra Copernicum: si pendeat, refragatur omnis experientia, cùm videamus integros fornices corruere. (Wherein he saith:) The stone placed in the centre, either ascendeth to the Earth in some point, or no. If the second, it is false that the parts separated from the whole, move unto it. If the first; it contradicteth all reason and experience, nor doth the grave body rest in the centre of its gravity. And if the stone being suspended in the air, be let go, do descend to the centre, it will separate from its whole, contrary to Copernicus: if it do hang in the air, it

contradicteth all experience: since we see whole Vaults to fall down.

Salv.I will answer, though with great disadvantage to my self, seeing I have to do with one who hath seen by experience, what these stones do in this great Cave: a thing, which for my part I have not seen; and will say, that things grave have an existence before the common centre of gravity:Things grave are before the centre of gravity. so that it is not one centre alone, which is no other than indivisible point, and therefore of no efficacie, that can attract unto it grave matters; but that those matters conspiring naturally to unite, form to themselves a common centre, which is that about which parts of equal moment consist:The great maß of grave bodies being transferred out of their place, the separated parts would follow that maß. so that I hold, that if the great aggregate of grave bodies were gathered all into any one place, the small parts that were separated from their whole, would follow the same, and if they were not hindered, would penetrate wherever they should find parts less grave than themselves: but coming where they should meet with matters more grave, they would descend no farther. And therefore I hold, that in the Cave full of air, the whole Vault would press, and violently rest it self onely upon that air, in case its hardness could not be overcome and broken by its gravity; but loose stones, I believe, would descend to the centre, and not swim above in the air: nor may it be said, that they move not to their whole, though they move whither all the parts of the whole would transfer themselves, if all impediments were removed.

Simpl.That which remaineth, is a certain Errour which he observeth in a Disciple of Copernicus, who making the Earth to move with an annual motion, and a diurnal, in the same manner as the Cart-wheel moveth upon the circle of the Earth, and in it self, did constitute the Terrestrial Globe too great, or the great Orb too little; for that 365 revolutions of the Æquinoctial, are less by far than the circumference of the great Orb.

Salv.Take notice that you mistake, and tell us the direct contrary to what must needs

be written in that Book; for you should say, that that same Copernican Author did constitute the Terrestrial Globe too little, and the great Orb too big; and not the Terrestrial Globe too big, and the annual too little.

Simpl.The mistake is not mine; see here the words of the Book. Non videt, quòd vel circulum annuum æquo minorem, vel orbem terreum justo multò fabricet majorem. (In English thus:) He seeth not, that he either maketh the annual circle equal to the less, or the Terrestrial Orb much too big.

Salv.I cannot tell whether the first Author erred or no, since the Author of this Tractate doth not name him; but the error of this Book is certain and unpardonable, whether that follower of Copernicus erred or not erred; for that your Author passeth by so material an error, without either detecting or correcting it. But let him be forgiven this fault, as an error rather of inadvertencie, than of any thing else: Farthermore, were it not, that I am already wearied and tired with talking and spending so much time with very little profit, in these frivolous janglings and altercations, I could shew, that it is not impossible for a circle, though no bigger than a Cart-wheel,It is not impossible with the circumference of a small circle few times revolved to measure and describe a line bigger than any great circle whatsoever. with making not 365, but lesse than 20 revolutions, to describe and measure the circumference, not onely of the grand Orb, but of one a thousand times greater; and this I s y to shew, that there do not want far greater subtilties, than this wherewith your Author goeth about to detect the errour of Copernicus: but I pray you, let us breath a little, that so we may proceed to the other Philosopher, that opposeth of the same Copernicus.

Sagr.To confesse the truth, I stand as much in need of respite as either of you; though I have onely wearied my eares: and were it not that I hope to hear more ingenious things from this other Author, I question whether I should not go my ways, to take the air in my * Gondola.* Pleasure-boat.

Simpl.I believe that you will hear things of greater moment; for this is a most accomplished Philosopher, and a great Mathematician, and hath confuted Tycho in the businesse of the Comets, and new Stars.

* The name of the Author is Scipio Claramontius.Salv.Perhaps he is the same with the Author of the Book, called Anti-Tycho?

Simpl.He is the very same: but the confutation of the new Stars is not in his Anti-Tycho, onely so far as he proveth, that they were not prejudicial to the inalterability and ingenerability of the Heavens, as I told you before; but after he had published his Anti-Tycho, having found out, by help of the Parallaxes, a way to demonstrate, that they also are things elementary, and contained within the concave of the Moon, he hath writ this other Book, de tribus novis Stellis, &c. and therein also inserted the Arguments against Copernicus: I have already shewn you what he hath written touching these new Stars in his Anti-Tycho, where he denied not, but that they were in the Heavens; but he proved, that their production altered not the inalterability of the Heavens, and that he did, with a Discourse purely philosophical, in the same man¦ner as you have already heard. And I then forgot to tell you, how that he afterwards did finde out a way to remove them out of the Heavens; for he proceeding in this confutation, by way of computations and parallaxes, matters little or nothing at all understood by me, I did not mention them to you, but have bent all my studies upon these arguments against the motion of the Earth, which are purely natural.

Salv.I understand you very well: and it will be convenient after we have heard what he hath to say against Copernicus, that we hear, or see at least the manner wherewith he, by way of Parallaxes, proveth those new stars to be elementary, which so many famous Astronomers constitute to be all very high, and amongst the stars of the Firmament; and as this Author accomplisheth such an enterprize of pulling the new stars out of heaven, and placing them in the elementary Sphere, he shall be worthy

to be highly exalted, and transferred himself amongst the stars, or at least, that his name be by fame eternized amongst them. Yet before we enter upon this, let us hear what he alledgeth against the opinion of Copernicus, and do you begin to recite his Arguments.

Simpl.It will not be necessary that we read them ad verbum, because they are very prolix; but I, as you may see, in reading them several times attentively, have marked in the margine those words, wherein the strength of his arguments lie, and it will suffice to read them.The opinion of Copernicus overthrows the Criterium of Philosophy The first Argument beginneth here. Et primo, si opinio Copernici recipiatur, Criterium naturalis Philosophiae, ni prorsus tollatur, vehementer saltem labefactari videtur. [In our Idiom thus] And first, if Copernicus his opinion be imbraced, the Criterium of natural Philosophy will be, if not wholly subverted, yet at least extreamly shaken.

Which, according to the opinion of all the sects of Philosophers requireth, that Sense and Experience be our guides in philosophating: But in the Copernican position the Senses are greatly deluded, whil'st that they visibly discover neer at hand in a pure Medium, the gravest bodies to descend perpendicularly downwards, never deviating a single hairs breadth from rectitude; and yet according to the opinion of Copernicus, the sight in so manifest a thing is deceived, and that motion is not reall straight, but mixt of right and circular.

Salv.This is the first argument, that Aristotle, Ptolomy, and all their followers do produce; to which we have abundantly answered, and shewn the Paralogisme, and with sufficient plainnesse proved, that the motion in common to us and other moveables, is, as if there were no such thing; but because true conclusions meet with a thousand accidents,Common motion is, as if it never were. that confirme them, I will, with the favour of this Philosopher, adde something more; and you Simplicius personating him, answer me to what I shall ask you:The argument taken from things

falling perpendicularly, another way confuted. And first tell me, what effect hath that stone upon you, which falling from the top of the Tower, is the cause that you perceive that motion; for if its fall doth operate upon you neither more nor lesse, than its standing still on the Towers top, you doubtlesse could not discern its descent, or distinguish its moving from its lying still.

Simpl.I comprehend its moving, in relation to the Tower, for that I see it one while just against such a mark in the said Tower, and another while against another lower, and so successively, till that at last I perceive it arrived at the ground.

Salv.Then if that stone were let fall from the tallons of an Eagle flying, and should descend thorow the simple invisible Air, and you had no other object visible and stable, wherewith to make comparisons to that, you could not perceive its motion?

Simpl.No, nor the stone it self; for if I would see it, when it is at the highest,Whence the motion of a cadent body is collected. I must raise up my head, and as it descendeth, I must hold it lower and lower, and in a word, must continually move either that, or my eyes, following the motion of the said stone.

Salv.You have now rightly answered: you know then that the stone lyeth still,The motion of the eye argueth the motion of the object looked on. when without moving your eye, you alwayes see it before you; and you know that it moveth, when for the keeping it in sight, you must move the organ of sight, the eye. So then when ever without moving your eye, you continually behold an object in the self same aspect, you do always judge it immoveable.

Simpl.I think it must needs be so.

Salv.Now fancy your self to be in a ship, and to have fixed your eye on the point of the Sail-yard: Do you think, that because the ship moveth very fast, you must move your eye, to keep your sight alwayes upon the point of the Sail-yard, and to follow its motion?

Simpl.I am certain, that I should need to make no change at all; and that not only in

the sight; but if I had aimed a Musket at it, I should never have need, let the ship move how it will, to stir it an hairs breadth to keep it full upon the same.

Salv.And this happens because the motion, which the Ship conferreth on the Sail-yard, it conferreth also upon you, and upon your eye; so that you need not stir it a jot to behold the top of the Sail-yard: and consequently, it will seem to you immoveaable. Now this Discourse being applied to the revolution of the Earth, and to the stone placed in the top of the Tower, in which you cannot discern any motion, because that you have that motion which is necessary for the following of it, in common with it from the Earth; so that you need not move your eye. When again there is conferred upon it the motion of descent, which is its particular motion, and not yours, and that it is intermixed with the circular, that part of the circular which is common to the stone, and to the eye, continueth to be imperceptible, and the right onely is perceived, for that to the perception of it, you must follow it with your eye, looking lower and lower. I wish for the undeceiving of this Philosopher, that I could advise him, that some time or other going by water,An experiment that sheweth how the common motion is imperceptible. he would carry along with him a Vessel of reasonable depth full of water, and prepare a ball of wax, or other matter that would descend very slowly to the bottome, so that in a minute of an hour, it would scarce sink a yard; and that rowing the boat as fast as could be, so that in a minute of an hour it should run above an hundred yards, he would let the ball submerge into the water, & freely descend, & diligently observe its motion. If he would but do thus, he should see, first, that it would go in a direct line towards that point of the bottom of the vessel, whither it would tend, if the boat should stand still; & to his eye, and in relation to the vessel, that motion would appear most straight and perpendicular, and yet he could not say, but that it would be composed of the right motion downwards, and of the circular about the element of water. And if these things befall in matters not natural, and in things that we may experiment in their state of rest; & then again in the contrary state of motion, and yet as to appearance no diversity at all is

discovered, & that they seem to deceive our sense what can we distinguish touching the Earth, which hath been perpetually in the same constitution, as to motion and rest? And in what time can we experiment whether any difference is discernable amongst these accidents of local motion, in its diverse states of motion and rest, if it eternally indureth in but one onely of them?

Sagr.These Discourses have somewhat whetted my stomack, which those fishes, and snails had in part nauseated; and the former made me call to minde the correction of an errour, that hath so much appearance of truth, that I know not whether one of a thousand would refuse to admit it as unquestionable. And it was this, that sailing into Syria, and carrying with me a very good Telescope, that had been bestowed on me by our Common Friend, who not many dayes before had invented, I proposed to the Mariners, that it would be of great benefit in Navigation to make use of it upon the round top of a ship, to discover and kenne Vessels afar off. The benefit was approved, but there was objected the difficulty of using it,An ingenuous consideration about the possibility of using the Telescope with as much facility on the round top of the Mast of a ship, as on the Deck. by reason of the Ships continual fluctuation; and especially on the round top, where the agitation is so much greater, and that it would be better for any one that would make use thereof to stand at the Partners upon the upper Deck, where the tossing is lesse than in any other place of the Ship. I (for I will not conceal my errour) concurred in the same opinion, and for that time said no more: nor can I tell you by what hints I was moved to return to ruminate with my self upon this businesse, and in the end came to discover my simplicity (although excusable) in admitting that for true, which is most false; false I say, that the great agitation of the basket or round top, in comparison of the small one below, at the partners of the Mast, should render the use of the Telescope more difficult in finding out the object.

Salv.I should have accompanied the Mariners, and your self at the beginning.

Simpl.And so should I have done, and still do: nor can I believe, if I should think of it an hundred years, that I could understand it otherwise.

Sagr.I may then, it seems, for once prove a Master to you both. And because the proceeding by interrogatories doth in my opinion much dilucidate things, besides the pleasure which it affords of confounding our companion, forcing from him that which he thought he knew not, I will make use of that artifice. And first, I suppose that the Ship, Gally, or other Vessel, which we would discover, is a great way off, that is, four, six, ten, or twenty * I deviate here from the strict Sea Diallect, which denominates all distances by Leagues.* miles, for that to kenne those neer at hand there is no need of these Glasses: & consequently, the Telescope may at such a distance of four or six miles conveniently discover the whole Vessel, & a much greater bulk. Now I demand what for species, & how many for number are the motions that are made upon the round top, depending on the fluctuation of the Ship.

Salv.We will suppose that the Ship goeth towards the East. First,Different motions depending on the fluctuation of the Ship. in a calme Sea, it would have no other motion than this of progression, but adding the undulation of the Waves, there shall result thence one, which alternately hoysting and lowering the poop and prow, maketh the round top, to lean forwards and backwards; other waves driving the vessel sidewayes, bow the Mast to the Starboard and Larboard; others, may bring the ship somewhat abovt, and bear her away by the Misne from East, one while towards the * Greco, which the Latine Translator according to his usual carelessenesse (to call it no worse) translates Corum Ventum, the Northwest Wind, for Ventum Libanotum.* Northeast, another while toward the Southeast; others bearing her up by the Carine may make her onely to rise, and fall; and in sum, these motions are for species two, one that changeth the direction of the Telescope angularly, the other lineally, without changing angle, that is, alwayes keeping the tube of the Instrument parallel to its self.

Sagr.Tell me,Two mutations made in the Telescope, depending on the agitation of the Ship. in the next place, if we, having first directed the Telescope yonder away towards the Tower of ** This is a Castle six Italian miles from Venice Northwards. Burano, six miles from hence, do turn it angularly to the right hand, or to the left, or else upwards or downwards, but a †† Vn nero d' ugna, the black or paring of a nail. straws breadth, what effect shall it have upon us touching the finding out of the said tower?

Salv.It would make us immediately lose sight of it, for such a declination, though small here, may import there hundreds and thousands of yards.

Sagr.But if without changing the angle, keeping the tube alwayes parallel to it self, we should transfer it ten or twelve yards farther off to the right or left hand, upwards or downwards, what alteration would it make as to the Tower?

Salv.The change would be absolutely undiscernable; for that the spaces here and there being contained between parallel rayes, the mutations made here and there, ought to be equal, and because the space which the Instrument discovers yonder, is capable of many of those Towers; therefore we shall not lose sight of it.

Sagr.Returning now to the Ship, we may undoubtedly affirm, that the Telescope moving to the right or left, upwards, or downwards, and also forwards or backwards ten or fifteen fathom; keeping it all the while parallel to its self, the visive ray cannot stray from the point observed in the object, more than those fifteen fathom; and because in a distance of eight or ten miles, the Instrument takes in a much greater space than the Gally or other Vessel kenn'd; therefore that small mutation shall not make me lose sight of her. The impediment therefore, and the cause of losing the object cannot befall us, unlesse upon the mutation made angularly; since that Telescopes transportation higher or lower, to the right, or to the left, by the agitation of the ship, cannot import any great number of fathomes. Now suppose that you had two Telescopes fixed, one at the Partners close by the Deck, and the other at the

round top, nay at the main top, or main top-gallant top, where you hang forth the Pennon or streamer, and that they be both directed to the Vessel that is ten miles off, tell me, whether you believe that any agitation of the ship, & inclination of the Mast, can make greater changes, as to the angle, in the higher tube, than in the lower? One wave arising, the prow will make the main top give back fifteen or twenty fathom more than the foot of the Mast, and it shall carry the upper tube along with it so greata space, & the lower it may be not a palm; but the angle shall change in one Instrument aswell as in the other; and likewise a side-billow shall bear the higher tube an hundred times as far to the Larboard or Starboard, as it will the other below; but the angles change not at all, or else alter both alike. But the mutation to the right hand or left, forwards or backwards, upwards or downwards, bringeth no sensible impediment in the kenning of objects remote, though the alteration of the angle maketh great change therein; Therefore it must of necessity be confessed, that the use of the Telescope on the round top is no more difficult than upon the Deck at the Partners; seeing that the angular mutations are alike in both places.

Salv.How much circumspection is there to be used in affirming or denying a proposition? I say again, thar hearing it resolutely affirmed, that there is a greater motion made on the Masts top, than at its partners, every one will perswade himself, that the use of the Telescope is much more difficult above than below. And thus also I will excuse those Philosophers, who grow impatient and fly out into passion against such as will not grant them, that that Cannon bullet which they cleerly see to fall in a right line perpendicularly, doth absolutely move in that manner; but will have its motion to be by an arch, and also very much inclined and transversal: but let us leave them in these labyrinths, and let us hear the other objections, that our Author in hand brings against Copernicus.

Simpl.The Author goeth on to demonstrate that in the Doctrine of Copernicus, it is requisite to deny the Senses, and the greatest Sensations,The annual motion of the Earth must cause a perpetual and strong winde. as for instance it would be, if we that

feel the respirations of a gentle gale, should not feel the impulse of a perpetual winde that beateth upon us with a velocity that runs more than 2529 miles an hour, for so much is the space that the centre of the Earth in its annual motion passeth in an hour upon the circumference of the grand Orb, as he diligently calculates; and because, as he saith, by the judgment of Copernicus, Cum terra movetur circumpositus aër, motus tamen ejus, velocior licet ac rapidior celerrimo quocunque vento, à nobis non sentiretur, sed summa tum tranquilitas reputaretur, nisi alius motus accederet. Quid est verò decipi sensum, nisi hæc esset deceptio? [Which I make to speak to this sense.] The circumposed air is moved with the Earth, yet its motion, although more speedy and rapid than the swiftest wind whatsoever, would not be perceived by us, but then would be thought a great tranquillity, unlesse some other motion should happen; what then is the deception of the sense, if this be not?

Salv.It must needs be that this Philosopher thinketh, that that Earth which Copernicus maketh to turn round, together with the ambient air along the circumference of the great Orb, is not that whereon we inhabit, but some other separated from this; for that this of ours carrieth us also along with it with the same velocity,The air alwayes touching us with the same part of it cannot make us feel it. as also the circumjacent air: And what beating of the air can we feel, when we fly with equal speed from that which should accost us? This Gentleman forgot, that we no less than the Earth and air are carried about, and that consequently we are always touch'd by one and the same part of the air, which yet doth not make us feel it.

Simpl.But I rather think that he did not so think; hear the words which immediatey follow. Præterea nos quoque rotamur ex circumductione terræ &c.

Salv.Now I can no longer help nor excuse him; do you plead for him and bring him off, Simplicius.

Simpl.I cannot thus upon the sudden think of an excuse that pleaseth me.

Salv.Go to; take this whole night to think on it, and defend him to morrow; in the

mean time let us hear some other of his objections.

Simpl.He prosecuteth the same Objection, shewing, that in the way of Copernicus,He that will follow Copernicus, must deny his senses. a man must deny his own senses. For that this principle whereby we turn round with the Earth, either is intrinsick to us, or external; that is, a rapture of that Earth; and if it be this second, we not feeling any such rapture, it must be confessed that the sense of feeling, doth not feel its own object touching it, nor its impression on the sensible part: but if the principle be intrinsecal, we shall not perceive a local motion that is derived from our selves, and we shall never discover a propension perpetually annexed to our selves.

Salv.So that the instance of this Philosopher lays its stress upon this, that whether the principle by which we move round with the Earth be either extern, or intern, yet however we must perceive it, and not perceiving it, it is neither the one nor the other, and therefore we move not, nor consequently the Earth. Now I say,Our motion may be either interne or externe, and yet we never perceive or feel it. that it may be both ways, and yet we not perceive the same. And that it may be external, the experiment of the boat superabundantly satisfieth me; I say, superabundantly, because it being in our power at all times to make it move, and also to make it stand still, and with great exactness to make observation, whether by some diversity that may be comprehended by the sense of feeling, we can come to know whether it moveth or no, seeing that as yet no such science is obtained: Will it then be any matter of wonder, if the same accident is unknown to us on the Earth, the which may have carried us about perpetually, and we, without our being ever able to experiment its rest?The motion of a Boat insensible to those that are with in it, as to the sense of feeling. You, Simplicius, as I believe, have gone by boat many times to Padoua, and if you will confess the truth, you never felt in your self the participation of that motion, unless when the boat running a-ground, or encountring some obstacle, did stop, and that you with the other Passengers being taken on a sudden, were with danger over-set. It would be necessary that the Terrestrial Globe should meet with

some rub that might arrest it, for I assure you, that then you would discern the impulse residing in you, when it should toss you up towards the Stars. It's true, that by the other senses, but yet assisted by Reason,The boats motion is perceptible to the sight joyn'd with reason. you may perceive the motion of the boat, that is, with the sight, in that you see the trees and buildings placed on the shoar, which being separated from the boat, seem to move the contrary way.The terrestrial motion collected from the stars. But if you would by such an experiment receive intire satisfaction in this business of the Terrestrial motion, look on the stars, which upon this reason seem to move the contrary way. As to the wondering that we should not feel such a principle, supposing it to be internal, is a less reasonable conceit; for if we do not feel such a one, that cometh to us from without, and that frequently goeth away, with what reason can we expect to feel it, if it immutably and continually resides in us? Now let us see what you have farther to allege on this argument.

Simpl.Take this short exclamation. Ex hac itaque opinione necesse est diffidere nostris sensibus, ut penitùs fallacibus vel stupidis in sensilibus, etiam conjunctissimis, dijudicandis. Quam ergò veritatem sperare possumus à facultate adeò fallaci ortum trahentem? [Which I render thus:] From this opinion likewise, we must of necessity suspect our own senses, as wholly fallible, or stupid in judging of sensible things even very near at hand. What truth therefore can we hope for, to be derived from so deceiveable a faculty?

Salv.But I desire not to deduce precepts more profitable, or more certain, learning to be more circumspect and less confident about that which at first blush is represented to us by the senses, which may easily deceive us. And I would not have this Author trouble himself in attempting to make us comprehend by sense, that this motion of descending Graves is simply right, and of no other kind; nor let him exclaim that a thing so clear, manifest, and obvious should be brought in question; for in so doing, he maketh others believe, that he thinketh those that deny that motion to be absolutely streight, but rather circular, the stone did sensibly see it to move in an

arch, seeing that he inviteth their senses more than their Reason, to judg of that effect: which is not true, Simplicius, for like as I, that am indifferent in all these opinions, and onely in the manner of a Comedian, personate Copernicus in these our representations, have never seen, nor thought that I have seen that stone fall otherwise than perpendicularly, so I believe, that to the eyes of all others it seemed to do the same. Better it is therefore, that deposing that appearance in which all agree, we make use of our Reason, either to confirm the reality of that, or to discover its fallacy.

Sagr.If I could any time meet with this Philosopher, who yet me thinks is more sublime than the rest of the followers of the same doctrines, I would in token of my affection put him in mind of an accident which he hath doubtless very often beheld; from which, with great conformity to that which we now discourse of, it may be collected how easily one may be deceived by the bare appearance, or, if you will, representation of the sense. And the accident is, the Moons seeming to follow those that walk the streets in the night, with a pace equal to theirs, whilst they see it go gliding along the Roofs of houses, upon which it sheweth just like a cat, that really running along the ridges of houses, leaveth them behind. An appearance that, did not reason interpose, would but too manifestly delude the sight.

Simpl.Indeed there want not experiments that render us certain of the fallacy of the meer senses;Arguments against the Earths motion taken, ex rerum natura. therefore suspending such sensations for the present, let us hear the Arguments that follow which are taken, as he saith, ex rerum naturâ. The first of which is, that the Earth cannot of its own nature move with three motions very different; or otherwise we must deny many manifest Axioms.Three Axioms that are supposed manifest. The first whereof is, that Omnis effectus dependeat ab aliquâ causà; [i. e.] that every effect dependeth on some cause. The second, that Nulla res seipsam producat; [i. e.] that nothing produceth it self: from whence it follows, that it is not possible that the move and moved should be totally the same thing: And this is manifest, not onely in

things that are moved by an extrinsick mover; but it is gathered also from the principles propounded, that the same holdeth true in the natural motion dependent on an intrinsick principle; otherwise, being that the mover, as a mover, is the cause, and the thing moved, as moved, is the effect, the same thing would totally be both the cause and effect. Therefore a body doth not move its whole self, that is, so as that all moveth, and all is moved; but its necessary in the thing moved to distinguish in some manner the efficient principle of the motion, and that which with that motion is moved. The third Axiom is, that in rebus quæ sensui subjiciuntur, unum, quatenus unum, unam solam rem producat; i. e. That in things subject to the senses, one, as it is one, produceth but onely one thing: That is, the soul in animals produceth its true divers operations, as the sight, the hearing, the smell, generation, &c. but all these with several instruments. And in short, in things sensible, the diversity of operations, is observed to derive it self from the diversity that is in the cause.A simple body as the Earth, cannot move with three several motions. Now if we put all these Axioms together, it will be a thing very manifest, that one simple body, as is the Earth, cannot of its own nature move at the same time with three motions, very divers: For by the foregoing suppositions, all moveth not its self all; it is necessary therefore to distinguish in it three principles of its three motions; otherwise one and the same principle would produce many motions; but if it contein in it three principles of natural motions, besides the part moved, it shall not be a simple body, but compounded of three principle movers,The Earth cannot move with any of the motions assigned it by Copernicus. and of the part moved. If therefore the Earth be a simple body, it shall not move with three motions; nay more, it will not move with any of those which Copernicus ascribeth to it, it being to move but with one alone, for that it is manifest, by the reasons of Aristotle, that it moveth to its centre, as its parts do shew, which descend at right angles to the Earths Spherical Surface.

Salv.Many things might be said, and considered touching the connection of this

argument;Answers to the arguments contrary to the Earths motion, taken ex rerum natura. but in regard that we can resolve it in few words, I will not at this time without need inlarge upon it; and so much the rather, because the same Author hath furnished me with an answer, when he saith that from one sole prinple in animals, there are produced divers operations; so that for the present my answer shall be, that in the same manner the Earth from one onely principle deriveth several operations.

Simpl.But this answer will not at all satisfie the Author who makes the objection, yea, it is totally overthrown by that which immediately after he addeth for a greater confirmation of his argument, as you shall hear. He re-inforceth his argument, I say, with another Axiome,A fourth Axiome against the motion of the Earth which is this; That natura in rebus necessariis nec deficiat, nec abundat: i. e. That nature in things necessary is neither defective, nor superfluous.Flexures necessary in animals for the diversity of their motions. This is obvious to the observers of natural things, and chiefly of animals, in which, because they are to move with many motions, Nature hath made many flexures, and hath thereunto commodiously knitted the parts for motion, as to the knees, to the hips, for the inabling of living creatures to go, and run at their pleasure. Moreover in man he hath framed many flexions, and joynts, in the elbow, and hand, to enable them to perform many motions.Another argument against the three fold motion of the Earth. From these things the argument is taken against the threefold motion of the Earth. [Either the Body, that is one, and continuate, without any manner of knittings or flexions, can exercise divers motions, or cannot: If it can without them, then in vain hath nature framed the flexures in animals; which is contrary to the Axiome: but if it cannot without them, then the Earth, one body, and continuate, and deprived of flexures, and joynts, cannot of its own nature move with plurality of motions.] You see now how craftily he falls upon your answer, as if he had foreseen it.

Salv.Are you serious, or do you jest?

Simpl.I speak it with the best judgment I have.

Salv.You must therefore see that you have as fortunate an hand in defending the reply of this Philosopher, against some other rejoynders made to him; therefore answer for him, I pray you, seeing we cannot have him here. You first admit it for true, that Nature hath made the joynts, flexures, and knuckles of living creatures, to the intent that they might move with sundry and divers motions; and I deny this proposition; and say, that these flexions are made, that the animal may move one, or more of its parts,The Flexures in animals are not made for the diversity of motions. the rest remaining immoved: and I say, that as to the species and differences of motions those are of one kind alone, to wit, all circular, and for this cause you see all the ends of the moveable bones to be convex or concave,The motions of animals are of one sort. and of these some are spherical, as are those that are to move every way, as in the shoulder-joynt, The ends of the bones are all rotund. the arme of the Ensigne doth, in displaying the Colours, and that of the Falconer in bringing his Hawk to the lure; and such is the flexure of the elbow, upon which the hand turns round, in boring with an augure: others are circular onely one way, and as it were cylindrical, which serve for the members that bend onely in one fashion,It is demonstrated, that the ends of the bones are of necessity to be rotund. as the joynts of the fingers one above another, &c. But without more particular inductions, one only general discourse may make this truth understood; and this is, that of a solid body that moveth, one of its extreams standing still without chanching place,The motions of animals are all circular. the motion must needs be circular, and no other: and because in the living creatures moving, one of its members doth not separate from the other its conterminal, therefore that motion is of necessity circular.

Simpl.How can this be? For I see the animal move with an hundred motions that are not circular, and very different from one another, as to run, to skip, to climbe, to descend, to swim, and many others.

Salv.Tis well:Secondary motions of animals dependent on the first but these are secondary motions, depending on the preceding motions of the joynts and flexures. Upon the plying of the legs to the knees, and the thighs to the hips, which are circular motions of the parts, is produced, as consequents, the skip, or running, which are motions of the whole body, and these may possibly not be circular. Now because one part of the terrestrial Globe is not required to move upon another part immoveable, The Terrestriall Globe hath noe need of flexures. but that the motion is to be of the whole body, there is no need in it of flexures.

Simpl.This (will the aduersary rejoyn) might be, if the motion were but one alone, but they being three, and those very different from each other, it is not possible that they should concur in an ** Without joynts articulate body.

Salv.I verily believe that this would be the answer of the Philosopher. Against which I make opposition another way; and ask you, whether you think that by way of joynts and flexures one may adapt the terrestrial Globe to the participation of three different circular motions? Do you not answer me? Seeing you are speechlesse, I will undertake to answer for the Philosopher, who would absolutely reply that they might; for that otherwise it would have been superfluous, and besides the purpose to have proposed to consideration, that nature maketh the flexions, to the end, the moveable may move with different motions; and that therefore the terrestrial Globe having no flexures, it cannot have those three motions which are ascribed to it. For if he had thought, that neither by help of flexures, it could be rendered apt for such motions, he would have freely affirmed, that the Globe could not move with three motions. Now granting this, I intreat you,It is desired to know, by means of what flexures and joynts the Terrestrial Globe might move with three diverse motions. and by you, if it were possible, that Philosopher, Author of the Argument, to be so courteous as to teach me in what manner those flexures should be accommodated, so that those three motions might commodiously be excercised; and I grant you four or six moneths time to think of an answer. As to me, it seemeth that one principle onely

may cause a plurality of motions in the Terrestrial Globe,One only principle may cause a plurality of motions in the Earth. just in the same manner that, as I told you before, one onely principle with the help of various instruments produceth sundry and divers motions in living creatures. And as to the flexures there is no need of them, the motions being of the whole, and not of some particular parts; and because they are to be circular, the meer spherical figure is the most perfect articulation or flection that can be desired.

Simpl.The most that ought to be granted upon this, would be, that it may hold true in one single motion, but in three different motions, in my opinion, and that of the Author, it is impossible; as he going on, prosecuting the objection, writes in the following words. Let us suppose, with Copernicus, that the Earth moveth of its own faculty, and upon an intrinsick principle from West to East in the plane of the Ecliptick; and again, that it also by an intrinsick principle revolveth about its centre, from East to West; and for a third motion, that it of its own inclination deflecteth from North to South, and so back again. It being a continuate body, and not knit together with joints and flections, our fancy and our judgment will never be able to comprehend, that one and the same natural and indistinct principle, that is, that one and the same propension, should actuate it at the same instant with different, and as it were of contrary motions. I cannot believe that any one would say such a thing, unlesse he had undertook to maintain this position right or wrong.

Salv.Stay a little; and find me out this place in the Book. Fingamus modo cum Copernico, terram aliqua suâ vi, & ab indito principio impelli ab Occasu ad Ortum in Eclipticæ plano; tum rursus revolvi ab indito etiam principio, circa suimet centrum, ab Ortu in Occasum;tertio deflecti rursus suopte nutu à septentrione in Austrum, & vicissim. A grosse error of the opposer of Copernicus.I had thought, Simplicius, that you might have erred in reciting the words of the Author, but now I see that he, and that very grossely, deceiveth himself; and to my grief, I find that he hath set himself to oppose a position, which he hath not well understood; for these

are not the motions which Copernicus assignes to the Earth. Where doth he find that Copernicus maketh the annual motion by the Ecliptick contrary to the motion about its own centre? It must needs be that he never read his Book, which in an hundred places, and in the very first Chapters affirmeth those motions to be both towards the same parts, that is from West to East. But without others telling him, ought he not of himself to comprehend, that attributing to the Earth the motions that are taken, one of them from the Sun, and the other from the primum mobile, they must of necessity both move one and the same way.

Simpl.Take heed that you do not erre your self,A subtil and withal simple argument against Copernicus. and Copernicus also. The Diurnal motion of the primum mobile, is it not from East to West? And the annual motion of the Sun through the Ecliptick, is it not on the contrary from West to East? How then can you make these motions being conferred on the Earth, of contraries to become consistents?

Sagr.Certainly, Simplicius hath discovered to us the original cause of error of this Philosopher; and in all probability he would have said the very same.

Salv.Now if it be in our power, let us at least recover Simplicius from this errour, who seeing the Stars in their rising to appear above the Oriental Horizon, will make it no difficult thing to understand,The error of the Antagonist is manifest, by declaring that the annual and diurnal motions belonging to the Earth are both one way, and not contrary. that in case that motion should not belong to the Stars, it would be necessary to confesse, that the Horizon, with a contrary motion would go down; and that consequently the Earth would reoolve in it self a contrary way to that wherewith the Stars seem to move, that is from West to East, which is according to the order of the Signes of the Zodiack. As, in the next place, to the other motion, the Sun being fixed in the centre of the Zodiack, and the Earth moveable about its circumference, to make the Sun seem unto us to move about the said Zodiack, according to the order of the Signes, it is necessary, that the Earth move according to

the same order, to the end that the Sun may seem to us to possesse alwayes that degree in the Zodiack, that is opposite to the degree in which we find the Earth; and thus the Earth running, verbi gratia, through Aries, the Sun will appear to run thorow Libra; and the Earth passing thorow the signe Taurus, the Sun will passe thorow Scorpio, and so the Earth going thorow Gemini, the Sun seemeth to go thorow Sagittarius; but this is moving both the same way, that is according to the order of the signes; as also was the revolution of the Earth about its own centre.

Simpl.I understand you very well, and know not what to alledge in excuse of so grosse an error.

Salv.And yet, Simplicius, there is one yet worse then this; and it is, that he makes the Earth move by the diurnal motion about its own centre from East to West; and perceives not that if this were so, the motion of twenty four hours appropriated by him to the Universe, would, in our seeming, proceed from West to East; the quite contrary to that which we behold.

Simpl.Oh strange! Why I, that have scarce seen the first elements of the Sphere, would not, I am confident, have erred so horribly.

Salv.Judg now what pains this Antagonist may be thought to have taken in the Books of Copernicus,By another groß error it is seen that the Antagonist had but little studied Copernicus. if he absolutely invert the sense of this grand and principal Hypothesis, upon which is founded the whole summe of those things wherein Copernicus dissenteth from the doctrine of Aristotle and Ptolomy. As again, It is questioned, whether the opponent understood the third motion assigned to the Earth by Copernicus. to this third motion, which the Author assignes to the Terrestrial Globe, as the judgment of Copernicus, I know not which he would mean thereby: it is not that questionlesse, which Copernicus ascribes unto it conjunctly with the other two, annual and diurnal, which hath nothing to do with declining towards the South and North; but onely serveth to keep the axis of the diurnal revolution continually

parallel to it self; so that it must be confest, that either the Authour did not understand this, or that else he dissembled it. But although this great mistake sufficeth to free us from any obligation of a farther enquiry into his objections; yet neverthelesse I shall have them in esteem; as indeed they deserve to be valued much before the many others of impertinent Antagonists. Returning therefore to his objection, I say, that the two motions, annual and diurnal, are not in the least contrary, nay are towards the same way, and therefore may depend on one and the same principle. The third is of it self, and voluntarily so consequential to the annual, that we need not trouble our selves (as I shall shew in its place) to study for principles either internal or external, from which, as from its cause, to make it produced.

Sagr.I shall also, as being induced thereto by natural reason, say something to this Antagonist. He will condemn Copernicus,unlesse I be able to answer him to all objections, and to satisfie him in all questions he shall ask; as if my ignorance were a necessary argument of the falshood of his Doctrine. But if this way of condemning Writers be in his judgment legal, he ought not to think it unreasonable, if I should not approve of Aristotle and Ptolomy, when he cannot resolve, better than my self, those doubts which I propound to him, touching their Doctrine. He asketh me, what are the principles by which the Terrestrial Globe is moved The same argument answered by examples of the like motions in other cœlestial bodies.with the Annual motion through the Zodiack, and with the Diurnal through the Equinoctial about its own axis. I answer, that they are like to those by which Saturn is moved about the Zodiack in thirty years, and about its own centre in a much shorter time along the Equinoctial, as the collateral apparition and occultation of its Globes doth evince. They are principles like to those, whereby he scrupleth not to grant, that the Sun runneth thorow the Ecliptick in a year, and revolveth about its own centre parallel to the Equinoctial in lesse than a moneth, as its spots doth sensibly demonstrate. They are things like to those whereby the Medicean Stars run through the Zodiack in

twelve years, and all the while revolve in small circles, and short periods of time about Jupiter.

Simp.This Author will deny all these things, as delusions of the fight, caused by the crystals of the Telescope.

Sagr.But this would be to draw a further inconvenience upon himself, in that he holdeth, that the bare eye cannot be deceived in judging of the right motion of descending graves, and yet holds that it is deceived in beholding these other motions at such time as its visive vertue is perfected, and augmented to thirty times as much as it was before. We tell him therefore, that the Earth in like manner partaketh of the plurality of motions: and it is perhaps the same, whereby the Loadstone hath its motion downwards, as grave, and two circular motions, one Horizontal, and the other Vertical under the Meridian. But what more; tell me, Simplicius, between which do you think this Author would put a greater difference, 'twixt right and circular motion, or 'twixt motion and rest?

Motion and rest are more different than right motion and circular.Simp.'Twixt motion and rest, certainly. And this is manifest, for that circular motion is not contrary to the right, according to Aristotle; nay, he granteth that they may mix with each other; which it is impossible for motion and rest to do.

Sagr.Therefore its a proposition lesse improbable to place in one natural body two internal principles, one to right motion, and the other to circular, than two such interne principles one to motion, and the other to rest. Now both these positions agree to One may more rationally ascribe to the Earth two internal principles to the right, and circular motion, than two to motion and rest. the natural inclination that resideth in the parts of the Earth to return to their whole, when by violence they are divided from it; and they onely dissent in the operation of the whole: for the latter of them will have it by an interne principle to stand still, and the former ascribeth to it the circular motion. But by your concession, and the confession of this Philosopher,

two principles, one to motion, and the other to rest, are incompatible together, like as their effects are incompatible: but now this evenes not in the two motions, right, and circular, which have no repugnance to each other.

Salv.Adde this more, that in all probability it may be that The motion of the parts of the Earth returning to their whole may be circular.the motion, that the part of the Earth separated doth make whilst it returneth towards its whole, is also circular, as hath been already declared; so that in all respects, as far as concernes the present case, Mobility seemeth more likely than Rest. Now proceed, Simplicius, to what remains.

Simp.The Authour backs his Argument with producing another absurdity, that is, that the same motions agree to Natures extreamly different; but experience sheweth, that the operations The diversity of motions helpeth us in knowing the diversity of natures.and motions of different natures, are different; and Reason confirmeth the same: for otherwise we should have no way left to know and distinguish of natures, if they should not have their particular motions and operations, that might guide us to the knowledge of their substances.

Sagr.I have twice or thrice observed in the discourses of this Authour, that to prove that a thing is so, or so, he still alledgeth, that in that manner it is conformable with our understanding; or that otherwise we should never be able to conceive of it; or that the Criterium of Philosophy would be overthrown.Nature first made things as she pleased, and afterwards capacitated mens understandings for conceiving of them. As if that nature had first made mens brains, and then disposed all things in conformity to the capacity of their intellects. But I incline rather to think that Nature first made the things themselves, as she best liked, and afterwards framed the reason of men capable of conceiving (though not without great pains) some part of her secrets.

Salv.I am of the same opinion. But tell me, Simplicius, which are these different

natures, to which, contrary to experience and reason, Copernicus assignes the same motions and operations.

Simpl.They are these. The Water, the Air, (which doubtlesse are Natures different from the Earth) and all things that are in those elements comprised, shall each of them have those three motions, which Copernicus pretends to be in the Terrestriall Globe;Copernicus erroneously assigneth the same operations to different natures and my Authour proceedeth to demonstrate Geometrically, that, according to the Copernican Doctrine, a cloud that is suspended in the Air, and that hangeth a long time over our heads without changing place, must of necessity have all those three motions that belong to the Terrestrial Globe. The demonstration is this, which you may read your self, for I cannot repeat it without book.

Salv.I shall not stand reading of it, nay I think it an impertinency in him to have inserted it, for I am certain, that no Copernican will deny the same. Therefore admitting him what he would demonstrate, let us speak to the objection, which in my judgment hath no great strength to conclude any thing contrary to the Copernican Hypothesis, seeing that it derogates nothing from those motions, and those operations, whereby we come to the knowledge of the natures, &c. Answer me, I pray you, Simplicius: Those accidents wherein some things exactly concur, can they serve to inform us of the different natures of those things?

Simpl.No Sir:From commune accidents one cannot know different natures. nay rather the contrary, for from the idendity of operations and of accidents nothing can be inferred, but an idendity of natures.

Salv.So that the different natures of the Water, Earth, Air, and other things conteined in these Elements, is not by you argued from those operations, wherein all these Elements and their affixes agree, but from other operations; is it so?

Simpl.The very same.

Salv.So that he who should leave in the Elements all those motions, operations, and

other accidents, by which their natures are distinguished, would not deprive us of the power of coming to the knowledge of them; although he should remove those operations, in which they unitedly concur, and which for that reason are of no use for the distinguishing of those natures.

Simpl.I think your dissertation to be very good.

Salv.But that the Earth, Water, Air, are of a nature equally constituted immoveable about the centre, is it not the opinion of your self, Aristotle, Ptolomy, and all their sectators?

Simpl.Its on all hands granted as an undeniable truth.

Salv.Then from this common natural condition of quiescence about the centre, there is no argument drawn of the different natures of these Elements, and things elementary, but that knowledge must be collected from other qualities not common; and therefore whoso should deprive the Elements of this common rest only, and should leave unto them all their other operations, would not in the least block up the way that leadeth to the knowledge of their essences. But Copernicus depriveth them onely of this common rest, and changeth the same into a common motion, leaving them gravity, levity, the motions upwards, downwards, slower,The concurrence of the Elements in a common motion importeth no more or lesse, than their concurrence in a common rest. faster, rarity, density, the qualities of hot, cold, dry, moist, and in a word, all things besides. Therefore such an absurdity, as this Authour imagineth to himself, is no Copernican position; nor doth the concurrence in an identity of motion import any more or less, than the concurrence in an identity of rest about the diversifying, or not diversifying of natures. Now tell us, if there be any argument to the contrary.

Simpl.There followeth a fourth objection, taken from a natural observation, which is, A fourth argument against Copernicus. That bodies of the same kind, have motions that agree in kinde, or else they agree in rest. But by the Copernican

Hypothesis,Bodies of the same kinde have motions that agree in kinde. bodies that agree in kinde, and are most semblable to one another, would be very discrepant, yea diametrically repugnant as to motion; for that Stars so like to one another, would be neverthelesse so unlike in motion, as that six Planets would perpetually turn round; but the Sun and all the fixeed Stars would stand perpetually immoveable.

Salv.The forme of the argument appeareth good; but yet I believe that the application or matter is defective: and if the Authour will but persist in his assumption, the consequence shall make directly against him. The Argument runs thus; Amongst mundane bodies,From the Earths obscurity, and the splendour of the Sun, and fixed Stars, is argued, that it is moveable, and they immoveable. six there are that do perpetually move, and they are the six Planets; of the rest, that is, of the Earth, Sun, and fixed Stars, it is disputable which of them moveth, and which stands still, it being necessary, that if the Earth stand still, the Sun and fixed Stars do move; and it being also possible, that the Sun and fixed Stars may stand immoveable, in case the Earth should move: the matter of fact in dispute is, to which of them we may with most convenience ascribe motion, and to which rest. Natural reason dictates, that motion ought to be assigned to the bodies, which in kind and essence most agree with those bodies which do undoubtedly move, and rest to those which most dissent from them; and in regard that an eternal rest and perpetual motion are most different, it is manifest, that the nature of the body always moveable ought to be most different from the body alwayes stable. Therefore, in regard that we are dubious of motion and rest, let us enquire, whether by the help of some other eminent affection, we may discover, which most agreeth with the bodies certainly moveable, either the Earth, or the Sun and fixed Stars. But see how Nature, in favour of our necessity and desire, presents us with two eminent qualities, and no less different than motion and rest, and they are light and darkness, to wit, the being by nature most bright, and the being obscure, and wholly deprived of light: the bodies therefore adorned with an internal and eternal splendour, are most different in

essence from those deprived of light: The Earth is deprived of light, the Sun is most splendid in it self, and so are the fixed Stars. The six Planets do absolutely want light, as the Earth; therefore their essence agreeth with the Earth, and differeth from the Sun and fixed Stars. Therefore is the Earth moveable, immoveable the Sunne and Starry Sphere.

Simpl.But the Authour will not grant, that the six Planets are tenebrose, and by that negative will he abide. Or he will argue the great conformity of nature between the six Planets, and the Sun, and Fixed Stars; and the disparity between them and the Earth from other conditions than from tenebrosity and light; yea, now I remember in the fifth objection, which followeth, he layeth down the vast difference between the Earth and the Cœlestial Bodies,A fifth argument against Copernicus. in which he writeth, That the Copernican Hypothesis would make great confusion and perturbation in the Systeme of the Vniverse, and amongst its parts: As for instance, amongst Cœbodies that are immutable and incorruptible,Another difference between the Earth and the Cœlestial bodies, taken from purity & impurity. according to Aristotle, Tycho, and others; amongst bodies, I say, of such nobility, by the confession of every one, and Copernicus himself, who affirmeth them to be ordinate, and disposed in a perfect constitution, and removeth from them all inconstancy of vertue amongst, these bodies, I say once more, so pure, that is to say, amongst Venus, Mars, &c. to place the very sink of all corruptible matters, to wit, the Earth, Water, Air, and all mixt bodies.

But how much properer a distribution, and more with nature, yea with God himself, the Architect, is it, to sequester the pure from the impute, the mortal from the immortal, as other Schools teach; which tell us that these impure and frail matters are conteined within the angust concave of the Lunar Orb, above which with uninterrupted Series the things Celestial distend themselves.

Salv.It's true that the Copernican Systeme introduceth distraction in the universe of

Aristotle;Copernicus introduceth confusion in the Universe of Aristotle. but we speak of our own Universe, that is true and real. Again if this Author will infer the disparity of essence between the Earth and Celestial bodies from the incorruptibility of them, and the corruptibility of it in the method of Aristotle, from which disparity he concludeth motion to belong to the Sun and fixed Stars, and the immobility of the Earth,The Paralogisme of the Author of Anti-Tycho. he will flatter himself with a Paralogisme, supposing that which is in question; for Aristotle inferreth the incorruptibility of Celestial bodies from motion, which is in dispute, whether it belongeth to them or to the Earth. Of the vanity of these Rhetorical Illations enough hath been spoken.It seemeth a folly to affirm the Earth to be without the Heavens. And what can be more fond, than to say, that the Earth and Elements are banished and sequestred from the Celestial Spheres, and confined within the Lunar Orb? Is, not then the Moons Orb one of the Celestial Spheres, and according to consent comprised in the middle of all the rest? Its a new way to separate the pure from the impure, and the sick from the sound, to assigne the infected quarters in the heart of the City: I had thought that the ** Lazeretto Pest-house ought to have been removed as far off as was possible. Copernicus admireth the disposition of the parts of the Universe, for that God hath constituted the grand Lamp, which is to give light all over his Temple in the centre of it, and not on one side. And as to the Earths being betwixt Venus and Mars, we will but hint the same; and do you, in favour of this Author, trie to remove it thence. But let us not ** Intrecciare, to twine flowers in a garland. mix these Rhetorical Flowers with solid Demonstrations, rather let us leave them to the Orators, or if you will to the Poets, who know how in their drolling way to exalt by their prayses things most sordid, yea and sometimes most pernicious. And if any thing else remain, let us dispatch it, as we have done the rest.

Simpl.There is the sixth and last argument;A sixth argument against Copernicus, taken from animals, who have need of rest; though their motion be natural. wherein he maketh it a very improbale thing. [That a corruptible and dissipable body should

move with a perpetual and regular motion; and this be confirmeth with the example of living creatures, which moving with a motion natural to them, yet grow weary, and have need of repose to restore their strength.] But what hath this motion to do with that of the Earth, that in comparision to theirs is immense? Besides, to make it move with three motions that run and draw several wayes: Who would ever assert such Paradoxes, unlesse he had sworn to be their defender? Nor doth that avail in this case, which Copernicus alledgeth, that by reason this motion is natural to the Earth and not violent, it worketh contrary effects to violent motions; and that those things dissolve and cannot long subsist, to which impulse is conferred, but those so made by nature do continue in their perfect disposure; this answer sufficeth not, I say, for it is overthrown by that of ours. For the animal is a natural body, and not made by art, and its motion is natural, deriving it self from the soul, that is, from an intrinsick principle; and that motion is violent, whose beginning is without, and on which the thing moved conferreth nothing; however, if the animal continueth its motion any long time, it grows weary, and also dyeth, if it obstinately strive to persist therein. You see then that in nature we meet on all sides with notions contrary to the Copernican Hypothesis, and none in favour of it. And for that I have nothing more wherein to take the part of this Opponent, hear what he produceth against Keplerus (with whom he disputeth) upon that argument, which the said Kepler bringeth against those who think it an inconvenient, nay impossible thing, to augment the Starry Sphere immensely, as the Copernican Hypothesis requireth. Kepler An argument from Kepler in favour of Copernicus.therefore instanceth, saying: Difficilius est, accidens præter modulum subjecti intendere, quàm subjectum sine accidente augere. Copernicus ergo verisimilius facit, qui auget Orbem Stellarum fixarum absque motu, quam Ptolomæus, qui auget motum fixarum immensâ velocitate. [Which makes this English.] Its harder to stretch the accident beyond the model of the subject than to augment the subject without the accident. Copernicus hath more probability on his side, who encreaseth the Orb of the fixed Stars without

motion, than Ptolomy who augmenteth the motion of the fixed Stars to an immense degree of velocity. Which objection the Author answereth,The Author of the Anti-Tycho opposeth Kepler. wondering how much Kepler deceived himself, in saying, that in the Ptolomaick Hypothesis the motion encreaseth beyond the model of the subject, for in his judgment it doth not encrease, save onely in conformity to the model, and that according to its encreasement, the velocity of the motion is augmented.The velocity of the circular motion increaseth, according to the encrease of the diameter of the circle. Which he proveth by supposing a machine to be framed, that maketh one revolution in twenty four hours, which motion shall be called most slow; afterwards supposing its semidiameter to be prolonged, as far as to the distance of the Sun, its extreme will equal the velocity of the Sun; and it being continued out unto the Starry Sphere, it will equal the velocity of the fixed Stars, though in the circumference of the machine it be very slow. Now applying this consideration of the machine to the Starry Sphere, let us imagine any point in its semidiameter, as neer to the centre as is the semidiameter of the machine; the same motion that in the Starry Sphere is exceeding swift, shall in that point be exceeding slow; But the great magnitude of the body is that which maketh it of exceeding slow, to become exceeding swift, although it continueth still the same, and thus the velocity encreaseth, not beyond the model of the subject, but rather according to it, and to its magnitude; very differently from the imagination of Kepler.

Salv.I do not believe that this Author hath entertained so mean and poor a conceit of Kepler, as to perswade himself that he did not understand, that the highest term of a line drawn from the centre unto the Starry Sphere, moveth more swiftly than a point of the same line taken within a yard or two of the centre. And therefore of necessity he must have conceived and comprehended that the mind and intention of Kepler was to have said,An explanation of the true sense of Kepler and his defence. that it is lesse inconvenient to encrease an immoveable body to an extraordinary magnitude, than to ascribe an extraordinary velocity to a body, though very bigge, having regard

to the model, that is to the gauge, and to the example of other natural bodies; in which we see, that the distance from the centre encreasing, the velocity diminisheth; that is, that the periods of their circulations take up longer times.The greatnesse and smalnesse of the body make a difference in motion and not in rest. But in rest which is not capable of augmentation or diminution, the grandure or smalnesse of the body maketh no difference. So that if the answer of the Author would be directed against the argument of Kepler, it is necessary, that that Author doth hold, that to the movent principle its one and the same to move in the same time a body very small, or very immense, in regard that the augmentation of velocity inseparably attends the augmentation of the masse.The order of nature is to make the lesser Orbs to circulate in shorter times, and the bigger in longer times. But this again is contrary to the Architectonical rule of nature, which doth in the lesser Spheres, as we see in the Planets, and most sensibly in the Medicean Stars, observe to make the lesser Orbs to circulate in shorter times: Whence the time of Saturns revolution is longer than all the times of the other lesser Spheres, it being thirty years; now the passing from this to a Sphere very much bigger, and to make it move in 24. hours, may very well be said to exceed the rules of the model. So that if we would but attentively consider it, the Authors answer opposeth not the intent and sense of the argument, but the expressing and manner of delivering of it; where again the Author is injurious, and cannot deny but that he artificially dissembled his understanding of the words, that he might charge Kepler with grosse ignorance; but the imposture was so very dull and obvions, that he could not with all his craft alter the opinion which Kepler hath begot of his Doctrine in the minds of all the Learned. As in the next place, to the instance against the perpetual motion of the Earth, taken from the impossibility of its moving long without wearinesse, in regard that living creatures themselves, which yet move naturally, and from an intern principle, do grow weary, and have need of rest to relax and refresh their members ———

Sagr.Methinks I hear Kepler answer him to that, that there are some kinde of

animals which refresh themselves after wearinesse, by rowling on the Earth; and that therefore there is no need to fear that the Terrestrial Globe should tire,The feigned answer of Kepler covered with an artificial Irony. nay it may be reasonably affirmed, that it enjoyeth a perpetual & most tranquil repose, keeping it self in an eternal rowling.

Salv.You are too tart and Satyrical, Sagredus: but let us lay aside jests, whilst we are treating of serious things.

Sagr.Excuse me, Salviatus, this that I say is not so absolutely besides the business, as you perhaps make it; for a motion that serveth instead of rest, and removeth weariness from a body tired with travail, may much more easily serve to prevent the coming of that weariness,Animals would not grow weary of their motion, proceeding as that which is assigned to the terrestrial Globe. like as preventive remedies are more easie than curative. And I hold for certain, that if the motion of animals should proceed in the same manner as this that is ascribed to the Earth, they would never grow weary; Seeing that the weariness of the living creature, deriveth it self, in my opinion, from the imployment of but one part alone in the moving of its self,The cause of the wearinesse of animals. and all the rest of the body; as v. g. in walking, the thighs and the legs onely are imployed for carrying themselves and all the rest: on the contrary, you see the motion of the heart to be as it were indefatigable, because it moveth it self alone. Besides, I know not how true it may be,The motion of an animal is rather to be called violent than natural. that the motion of the animal is natural, and not rather violent: nay, I believe that one may truly say, that the soul naturally moveth the members of an animal with a motion preternatural, for if the motion upwards is preternatural to grave bodies, the lifting up of the legs, and the thighs, which are grave bodies, in walking, cannot be done without violence, and therefore not without labour to the mover. The climbing upwards by a ladder carrieth the grave body contrary to its natural inclination upwards, from whence followeth weariness, by reason of the bodies natural

aversness to that motion: but in moving a moveable with a motion, to which it hath no aversion, what lassitude,The strength diminisheth not, where it is not imployed. what diminution of vertue and strength need we fear in the mover? and how should the forces waste, where they are not at all imployed?

Simpl.They are the contrary motions wherewith the Earth is pretended to move, against which the Authour produceth his argument.

Sagr.It hath been said already, that they are no wise contraries, and that herein the Authour is extteamly deceived, so that the whole strength of the argument recoileth upon the Opponent himself,The argument of Claramontius, recoileth upon himself. whilst he will make the First Mover to hurry along with it all the inferiour Spheres, contrary to the motion which they themselves at the same time exercise. It belongs therefore to the Primum Mobile to grow weary, which besides the moving of its self is made to carry so many other Spheres, and which also strive against it with a contrary motion. So that the ultimate conclusion that the Authour inferred, saying, that discoursing of the effects of Nature, a man alwayes meets with things that favour the opinion of Aristotle and Ptolomy, and never any one that doth not interfer with Copernicus, stands in need of great consideration; and it is better to say, that one of these two Hypotheses being true, and the other necessarily false, it is impossible that a man should ever be able to finde any argument, experience, or right reason, in favour of that which is false,True Propositions meet with many conclusive arguments, so do not the false. like as to the truth none of these things can be repugnant. Vast difference, therefore, must needs be found between the reasons and arguments produced by the one and other party, for and against these two opinions, the force of which I leave you your self to judge of, Simplicius.

Salv.But you, Sagredus, being transported by the velocity of your wit, have taken my words out of my mouth, whilst I was about to say something, touching this last argument of the Author; and although you have more then sufficiently refuted him,

yet neverthelesse I will adde somewhat, which then ran in my minde. He proposeth it as a thing very unlikely, that a body dissipable and corruptible, as the Earth, should perpetually move with a regular motion, especially for that we see living creatures in the end to grow weary, and to stand in need of rest: and the improbability is increased, in that the said motion is required to be of velocity incomparable and immense, in respect to that of animals. Now, I cannot see why the velocity of the Earth should, at present, trouble it; so long as that of the starry Sphere so very much bigger doth not occasion in it any disturbance more considerable, than that which the velocity of a machine, that in 24 hours maketh but one sole revolution, produceth in the same. If the being of the velocity of the Earths conversion, according to the model of that machine, inferreth things of no greater moment than that, let the Author cease to fear the Earths growing weary; for that not one of the most feeble and slow-pac't animals, no not a Chamæleon would tire in moving no more than ** Cinque ò sei braccia Fiorentini. four or five yards in 24 hours; but if he please to consider the velocity to be no longer,Wearineß more to be feared in the starry Sphere than in the terrestriall Globe. in relation to the model of the machine, but absolutely, and inasmuch as the moveable in 24 hours is to pass a very great space, he ought to shew himself so much more reserved in granting it to the starry Sphere, which with a velocity incomparably greater than that of the Earth is to carry along with it a thousand bodies, each much bigger than the Terrestrial Globe.

Here it remains for us to see the proofs, whereby the Authour concludes the new stars Anno 1572. and Anno 1604. to be sublunary, and not cœlestial, as the Astronomers of those times were generally perswaded; an enterprize very great certainly; but I have considered, that it will be better, in regard the Book is new and long, by reason of its many calculations, that between this evening and to morrow morning I make them as plain as I can, and so meeting you again to morrow to continue our wonted conferences, give you a brief of what I shall observe therein;

and if we have time left, we will say something of the Annual motion ascribed to the Earth. In the mean time, if either of you, and Simplicius in particular, hath any thing to say more, touching what relates to the Diurnal motion, at large examined by me, we have a little time still left to treat thereof.

Simpl.I have no more to say, unlesse it be this, that the discourses that this day have falne under our debate, have appeared to me fraught with very acute and ingenious notions, alledged on Copernicus his side, in confirmation of the motion of the Earth, but yet I find not my self perswaded to believe it; for in short, the things that have been said conclude no more but this, that the reasons for the stability of the Earth are not necessary; but all the while no demonstration hath been produced on the other side, that doth necessarily convince and prove its mobility.

Salv.I never undertook, Simplicius, to remove you from that your opinion; much less dare I presume to determine definitively in this controversie: it onely was, and still shall be in the ensuing disputations my intent, to make it appear to you, that those who have thought that most swift motion of 24 hours doth belong to the Earth alone, and not to the Universe, the Earth onely excluded, were not induced to believe, that so it might and ought to do out of any blind perswasion; but that they did very well see, try, and examine the reasons on the contrary side, and also not slightly answer them. With the same intention, if it stand with your liking, and that of Sagredus, we may passe to the consideration of that other motion; first, by Aristarchus Samius, and afterwards by Nicholaus Copernicus ascribed to the said Terrestrial Globe, which is, as, I believe, you have heretofore heard, made under the Zodiack within the space of a year about the Sun, immoveably placed in the centre of the said Zodiack.

Simpl.The disquisition is so great, and so noble, that I shall gladly hearken to the discussion thereof, perswading my self that I shall hear what ever can be said of that matter. And I will afterwards by my self, according to my usual custome, make

more deliberate reflexions upon what hath been, and is to be spoken; and if I should gain no more but this, it will be no small benefit that I shall be able to discourse more Logically.

Sagr.Therefore, that we may no further weary Salviatus, we will put a period to the disputations of this day, and resume our conference to morrow in the usual manner, with hope to hear very pleasing novelties.

Simp. I will leave with you the Book De stellis novis, and carry back this of the Conclusions, to see what is written therein against the Annual motion, which are to be the arguments of our discourse to morrow.

The Third Dialogue

The Third Dialogue.

INTERLOCUTORS.

Salviatus, Sagredus, and Simplicius.

Sagr.

He great desire wherewith I have expected your coming, that I might hear the novel conceits touching the annual conversion of this our Globe, hath made me think the houres of the last night, and those of this morning very tedious, although I spent them not idly, but lying awake I imployed a good part thereof in ruminating upon our yesterdayes discourses, weighing the reasons alledged by both parties, in favour of the two contrary Hypotheses, that of Aristotle and Ptolomy, and this of Aristarchus, and Copernicus. And really methinks, that which ever of these parties have been deceived, they are worthy of excuse, so specious and valid in appearance are the reasons that may have perswaded them either way; though neverthelesse we do for the most part close with those produced by the grave Authours first above

mentioned. But albeit that the Peripatetick Hypothesis, by reason of its antiquity, hath had many followers and fautors, and the other very few; first, for its obscurity, and next, for its novelty, yet methinks I discover amongst those many, and particularly amongst the modernes some, who for the support of the opinion by them esteemed true, have introduced other reasons sufficiently childish, I could say ridiculous.

Salv.I have met with the like, and so much worse than yours,Some in arguing first fix in their minds the conclusion beleeved by them, and then adapt their reasons to that. that I blush to rehearse them, not so much to spare the fame of their Authours, the names of whom might be perpetually concealed, as because I am ashamed so much to stain the honour of mankinde. In observing of these men, I have found that some there are who preposterously reasoning, first stablish the conclusion in their fancy, and (either because it is their own, or else belongs to a person whom they much confide in) so firmly imprint it in their opinions, that it is altogether impossible ever wholly to efface it: and those reasons which they themselves stumble upon, or which they hear others to alledge in confirmation of the conceit entertained, though never so simple and insipid, instantly find credit and applause with them: but on the contrary, those which are brought against their opinion, though ingenuous and concluding, they receive not only with nauseating, but with disdain and bitter indignation, yea, you shall have one of these so inraged, as that he will not be backward to try all wayes to suppress and silence their adversaries: and of this I my self have had some experience.

Sagr.Indeed these men deduce not the conclusion from the premises, nor confirme them with reasons, but accomodate, or to say better, discommodate and distort the premises and arguments to make them speak in favour of their pre-assumed and pertinacious conclusions. It is not good therefore to contract familiarity with these men; and the rather, for that their conversation is not only unpleasant, but also dangerous. Yet let us continue our conference with Simplicius however, whom I

have known this long while for a man of great ingenuity; and altogether void of malice: besides he is well verst in the Peripatetick Doctrine; so that I may assure my self, that what shall not fall within the reach of his reason for the support of the Aristotelian Hypothesis, will not easily be found out by others. But see yonder he comes, quite out of winde, whose company we have so long desired: we were just now speaking against the small hast you made to come to us.

Simpl.You must not blame me, but Neptune, for this my long stay; which in the ebbe of this mornings tide hath in a manner drain'd away the waters, for the Gondola that brought me, being entered not far from hence into a certain Channel, wanting depth, where I was stranded, and forced to stay there more than a full hour, in expecting the return of the tide: and there waiting in this manner, without being able to get out of the boat, which on a sudden ran a ground,The motion of the water in ebbing and flowing not interrupted by rest. I observed a certain accident, which to me seemed very strange; and it was this, that in the waters ebbing I saw it retreat very fast by several small rivolets, the ouze being in many places discovered, and whilst I stood looking upon this effect, I saw this motion in an instant to cease, and without a minutes interval the same water to begin to return back again, and the tide from ebbing to become young flood, without standing still a moment: an effect that as long as I have dwelt in Venice, I never took notice of before.

Sagr.It is very much, that you should be left thus on ground, amongst small Channels; in which rivolets, as having very little declivity, the rising or falling of the main sea, the thickness onely of a paper is sufficient to make the water to ebbe and flow for good long spaces of time: like as in some creeks of the Sea, its flowing four or six * yards onely, maketh the water to overflow the adjacent Marshes for some hundreds and thousands of ** Pertiche venetiani. acres.

Simpl.This I know very well, but I should have thought, that between the ultimate terme of ebbing, and the first beginnng to flow, there should have interposed some

considerable interval of rest.

Sagr.This will appear unto you, if you cast your eye upon the bank or piles, where these mutations are made perpendicularly, but not that there is any real time of cessation.

Simpl.I did think, that because these two motions were contrary, there ought to be in the midst between them some kind of rest; conformable to the Doctrine of Aristotle, which demonstrates that in puncto regressus mediat quies.

Sagr.I very well remember this place: but I bear in minde also, that when I read Philosophy, I was not thorowly satisfied with Aristotles demonstration; but that I had many experiments on the contrary, which I could still rehearse unto you, but I am unwilling to sally out into any other digressions, we being met here to discourse of the proposed mattes, if it be possible, without these excursions wherewith we have interrupted our disputes in those dayes that are past.

Simpl.And yet we may with convenience, if not-interrupt them, at least prolong them very much, for returning yesterday home, I set my self to read the Tractate of Conclusions, where I find Demonstrations against this annual motion ascribed to the Earth, very solid; and because I would not trust my memory with the punctual relation of them, I have brought back the Book along with me.

Sagr.You have done very well; but if we would re-assume our Disputations according to yesterdayes appointment, it is requisite that we first hear what account Salviatus hath to give us of the Book, De stellis novis, and then without interruption we may proceed to the Annual motion. Now what say you, Salviatus touching those stars? Are they really pull'd down from Heaven to these lower regions, by vertue of that Authours calculations, whom Simplicius mentioneth?

Salv.I set my self last night to peruse his proceedings, and I have this morning had another view of him, to see whether that which he seemed over night to affirm, were really his sense, or my dreams and phantastical nocturnal imaginations; and in the

close found to my great grief that those things were really written and printed, which for the reputation-sake of this Philosopher I was unwilling to believe. It is in my judgment impossible, but that he should perceive the vanity of his undertaking, aswell because it is too apert, as because I remember, that I have heard him mentioned with applause by the Academick our Friend: it seemeth to me also to be a thing very unlikely, that in complacency to others, he should be induced to set so low a value upon his reputation, as to give consent to the publication of a work, for which he could expect no other than the censure of the Learned.

Sagr.Yea, but you know, that those will be much fewer than one for an hundred, compared to those that shall celebrate and extoll him above the greatest wits that are, or ever have been in the world: He is one that hath mentioned the Peripatetick inalterability of Heaven against a troop of Astronomers, and that to their greater disgrace hath foiled them at their own weapons: and what do you think four or five in a Countrey that discern his triflings, can do against the innumerable multitude, that, not being able to discover or comprehend them, suffer themselves to be taken with words, and so much more applaud him, by how much the lesse they understand him? You may adde also, that those few who understand, scorn to give an answer to papers so trivial and unconcludent; and that upon very good reasons, because to the intelligent there is no need thereof, and to those that do not understand, it is but labour lost.

Salv.The most deserved punishment of their demerits would certainly be silence, if there were not other reasons, for which it is haply no lesse than necessary to resent their timerity: one of which is, that we Italians thereby incur the censure of Illiterates, and attract the laughter of Forreigners; and especially to such who are separated from our Religion; and I could shew you many of those of no small eminency, who scoff at our Academick, and the many Mathematicians that are in Italic, for suffering the follies of such a ** Lorenzini. Fabler against Astronomers to come into the light, and to be openly maintained without contradiction; but this also

might be dispensed with, in respect of the other greater occasions of laughter, wherewith we may confront them depending on the dissimulation of the intelligent, touching the follies of these opponents of the Doctrines that they well enough understand.

Sagr.I desire not a greater proof of those mens petulancy, and the infelicity of a Copernican, subject to be opposed by such as understand not so much as the very first positions, upon which he undertakes the quarrel.

Salv.You will be no lesse astonished at their method in confuting the Astronomers, who affirm the new Stars to be superiour to the Orbs of the Planets; and peradventure in the †† He taketh the Firmament for the Starry Sphere, and as we vulgarly receive the word. Firmament it self.

Sagr.But how could you in so short a time examine all this Book, which is so great a Volume, and must needs contain very many demonstrations?

Salv.I have confined my self to these his first confutations, in which with twelve demonstrations founded upon the observations of twelve Astronomers, (who all held, that the Star, Anno 1572. which appeared in Cassiopeia, was in the Firmament) he proveth it on the contrary, to be beneath the Moon, conferring, two by two, the meridian altitudes, proceeding in the method that you shall understand by and by. And because, I think, that in the examination of this his first progression, I have discovered in this Authour a great unlikelihood of his ability to conclude any thing against the Astronomers, in favour of the Peripatetick Philosophers, and that their opinion is more and more concludently confirmed, I could not apply my self with the like patience in examining his other methods, but have given a very slight glance upon them, and am certain, that the defect that is in these first impugnations, is likewise in the rest. And as you shall see, by experience, very few words will suffice to confute this whole Book, though compiled with so great a number of laborious calculations,The method observed by Clar. in confuting the Astronomers, and by

Salviatus in confuting him. as here you see. Therefore observe my proceedings. This Authour undertaketh, as I say, to wound his adversaries with their own weapons, i.e. a great number of observations made by themselves, to wit, by twelve or thirteen Authours in number, and upon part of them he makes his supputations, and concludeth those stars to have been below the Moon. Now because the proceeding by interrogatories very much pleaseth me, in regard the Authour himself is not here, let Simplicius answer me to the questions that I shall ask him, as he thinks he himself would, if he were present. And presupposing that we speak of the foresaid Star, of Anno 1572. appearing in Cassiopeia, tell me, Simplicius, whether you believe that it might be in the same time placed in divers places, that is, amongst the Elements, aud also amongst the planetary Orbs, and also above these amongst the fixed Stars, and yet again infinitely more high.

Simpl.There is no doubt, but that it ought to be confessed that it is but in one only place, and at one sole and determinate distance from the Earth.

Salv.Therefore if the observations made by the Astronomers were exact, and the calculations made by this Author were not erroneous, it were easie from all those and all these to recollect the same distances alwayes to an hair, is not this true?

Simpl.My reason hitherto tells me that so it must needs be; nor do I believe that the Author would contradict it.

Salv.But when of many and many computations that have been made, there should not be so much as two onely that prove true, what would you think of them?

Simpl.I would think that they were all false, either through the fault of the computist, or through the defect of the observators, and at the most that could be said, I would say, that but onely one of them and no more was true; but as yet I know not which to choose.

Salv.Would you then from false fundamentals deduce and establish a doubtful conclusion for true? Certainly no. Now the calculations of this Author are such, that

no one of them agrees with another, you may see then what credit is to be given to them.

Simpl.Indeed, if it be so, this is a notable failing.

Sagr.But by the way I have a mind to help Simplicius, and the Author by telling Salviatus, that his arguments would hold good if the Author had undertook to go about to find out exactly the distance of the Star from the Earth, which I do not think to be his intention; but onely to demonstrate that from those observations he collected that the Star was sublunary. So that if from those observations, and from all the computations made thereon, the height of the Star be alwayes collected to be lesse than that of the Moon, it serves the Authors turn to convince all those Astronomers of most impardonable ignorance, that through the defect either of Geometry or Arithmetick, have not known how to draw true conclusions from their own observations themselves.

Salv.It will be convenient therefore that I turn my self to you, Sagredus, who so cunningly aphold the Doctrine of this Author. And to see whether I can make Simplicius, though not very expert in calculations, and demonstrations to apprehend the inconclusivenesse at least of the demonstrations of this Author, first proposed to consideration, and how both he, and all the Astronomers with whom he contendeth, do agree that the new Star had not any motion of its own, and onely went round with the diurnal motion of the primum mobile; but dissent about the placing of it, the one party putting it in the Celestial Region, that is above the Moon, and haply above the fixed Stars, and the other judging it to be neer to the Earth, that is, under the concave of the Lunar Orb. And because the situation of the new star, of which we speak, was towards the North, and at no very great distance from the Pole, so that to us Septentrionals, it did never set, it was an easie matter with Astronomical instruments to have taken its several meridian altitudes, as well its smallest under the Pole, as its greatest above the same; from the comparing of which altitudes, made in several

places of the Earth, situate at different distances from the North, that is, different from one another in relation to polar altitudes, the stars distance might be inferred:The greatest and least elevations of the new star differ not from each other more than the polar altitudes, the said star being in the Firmnment. For if it was in the Firmament amongst the other fixed stars, its meridian altitudes taken in divers elevations of the pole, ought necessarily to differ from each other with the same variations that are found amongst those elevations themselves; that is, for example, if the elevation of the star above the horizon was 30 degrees, taken in the place where the polar altitude was v. gr. 45 degrees, the elevation of the same star ought to have been encreased 4 or 5 degrees in those more Northernly places where the pole was higher by the said 4 or 5 degrees. But if the stars distance from the Earth was but very little, in comparison of that of the Firmament; its meridian altitudes ought approaching to the North to encrease considerably more than the polar altitudes; and by that greater encrease, that is, by the excesse of the encrease of the stars elevation, above the encrease of the polar elevation (which is called the difference of Parallaxes) is readily calculated with a cleer and sure method, the stars distance from the centre of the Earth. Now this Author taketh the observations made by thirteen Astronomers in sundry elevations of the pole, and conferring a part of them at his pleasure, he computeth by twelve collations the new stars height to have been alwayes beneath the Moon; but this he adventures to do in hopes to find so grosse ignorance in all those, into whose hands his book might come, that to speak the truth, it hath turn'd my stomack; and I wait to see how those other Astronomers, and particularly Kepler, against whom this Author principally inveigheth, can contein themselves in silence, for he doth not use to hold his tongue on such occasions; unlesse he did possibly think the enterprize too much below him. Now to give you to understand the same, I have upon this paper transcribed the conclusions that he inferreth from his twelve indagations; the first of which is upon the two observations:

These are twelve indagations made by the Author at his election, amongst many which, as he saith, might be made by combining the observations of these thirteen observators. The which twelve we may believe to be the most favourable to prove his intention.

Sagr.I would know whether amongst the so many other indagations pretermitted by the Author, there were not some that made against him, that is, from which calculating one might find the new star to have been above the Moon, as at the very first sight I think we may reasonably question; in regard I see these already produced to be so different from one another, that some of them give me the distance of the said star from the Earth, 4, 6, 10, 100, a thousand, and an hundred thousand times bigger one than another; so that I may well suspect that amongst those that he did not calculate, there was some one in fauour of the adverse party. And I guesse this to be the more probable, for that I cannot conceive that those Astronomers the observators could want the knowledg and practice of rhese computations, which I think do not depend upon the abstrucest things in the World. And indeed it will seem to me a thing more than miraculous, if whilst in these twelve investigations onely, there are some that make the star to be distant from the Earth but a few miles, and others that make it to be but a very fmall matter below the Moon, there are none to be found that in favour of the contrary part do make it so much as twenty yards above the Lunar Orb. And that which shall be yet again more extravagant, that all those Astronomers should have been so blind as not to have discovered that their so apparent mistake.

Salv.Begin now to prepare your ears to hear with infinite admiration to what excesses of confidence of ones own authority and others folly, the desire of contradicting and shewing ones self wiser than others, transports a man. Amongst the indagations omitted by the Author, there are such to be found as make the new star not onely above the Moon, but above the fixed stars also. And these are not a few, but the greater part, as you shall see in this other paper, where I have set them

down.

Sagr.But what saith the Author to these? It may be he did not think of them?

Salv.He hath thought of them but too much: but saith, that the observations upon which the calculations make the star to be infinitely remote, are erroneous, and that they cannot be combined to one another.

Simpl.But this seemeth to me a very lame evasion; for the adverse party may with as much reason reply, that those are erroneous wherewith he collecteth the star to have been in the Elementary Region.

Salv.Oh Simplicius, if I could but make you comprehend the craft, though no great craftinesse of this Author, I should make you to wonder, and also to be angry to see how that he palliating his sagacity with the vail of the simplicity of your self; and the rest of meer Philosophers, would insinuate himself into your good opinion, by tickling your ears, and swelling your ambition, pretending to have convinced and silenced these petty Astronomers, who went about to assault the impregnable inalterability of the Peripatetick Heaven, and which is more, to have foild and conquered them with their own arms. I will try with all my ability to do the same; and in the mean time let Sagredus take it in good part, if Simplicius and I try his patience, perhaps a little too much, whilst that with a superfluous circumlocution (superfluous I say to his most nimble apprehension) I go about to make out a thing, which it is not convenient should be hid and unknown unto him.

Sagr.I shall not onely without wearinesse, but also with much delight hearken to your discourses; and so ought all Peripatetick Philosophers, to the end they may know how much they are oblieged to this their Protector.

Salv.Tell me, Simplicius, whether you do well comprehend, how, the new star being placed in the meridian circle yonder towards the North, the same to one that from the South should go towards the North, would seem to rise higher and higher above the Horizon, as much as the Pole, although it should have been scituate amongst the

fixed stars; but, that in case it were considerably lower, that is nearer to the Earth, it would appear to ascend more than the said pole, and still more by how much its vicinity was greater?

Simpl.I think that I do very well conceive the same; in token whereof I will try if I can make a mathematical Scheme of it, and in this great circle [in Fig. 1. of this Dialogue.] I will marke the pole P; and in these two lower circles I will note two stars beheld from one place on the Earth, which let be A; and let the two stars be these B and C, beheld in the same line ABC, which line I prolong till it meet with a fixed star in D. And then walking along the Earth, till I come to the term E, the two stars will appear to me separated from the fixed star D, and advanced neerer to the pole P, and the lower star B more, which will appear to me in G, and the star C lesse, which will appear to me in F, but the fixed star D will have kept the same distance from the Pole.

Salv.I see that you understand the businesse very well. I believe that you do likewise comprehend, that, in regard the star B is lower than C, the angle which is made by the rayes of the sight, which departing from the two places A and E, meet in C, to wit, this angle ACE, is more narrow, or if we will say more acute than the angle constituted in B, by the rayes AB and EB.

Simpl.This I likewise understand very well.

Salv.And also, the Earth beine very little and almost insensible, in respect of the Firmament (or Starry Sphere;) and consequently the space AE, paced on the Earth, being very small in comparison of the immense length of the lines EG and EF, passing from the Earth unto the Firmament, you thereby collect that the star C might rise and ascend so much and so much above the Earth, that the angle therein made by the rayes which depart from the said stationary points A and E, might become most acute, and as it were absolutely null and insensible.

Simpl.And this also is most manifest to sense.

Salv.Now you know Simplicius that Astronomers and Mathematicians have found infallible rules by way of Geometry and Arithmetick, to be able by help of the quantity of these angles B and C, and of their differences, with the additional knowledg of the distance of the two places A and E, to find to a foot the remotenesse of sublime bodies; provided alwayes that the aforesaid distance, and angles be exactly taken.

Simpl.So that if the Rules dependent on Geometry and Astronomy be true, all the fallacies and errours that might be met with in attempting to investigate those altitudes of new Stars or Comets, or other things must of necessity depend on the distance AE, and on the angles B and C, not well measured. And thus all those differences which are found in these twelve workings depend, not on the defects of the rules of the Calculations, but on the errours committed in finding out those angles, and those distances, by means of the Instrumental Observations.

Salv.True; and of this there is no doubt to be made. Now it is necessary that you observe intensely, how in removing the Star from B to C, whereupon the angle alwayes grows more acute, the ray EBG goeth farther and farther off from the ray ABD in the part beneath the angle, as you may see in the line ECF, whose inferiour part EC is more remote from the part AC, than is the part EB, but it can never happen, that by any whatsoever immense recession, the lines AD and EF should totally sever from each other, they being finally to go and conjoyn in the Star: and onely this may be said, that they would separate, and reduce themselves to parallels, if so be the recession should be infinite, which case is not to be supposed. But because (observe well) the distance of the Firmament, in relation to the smallnesse of the Earth, as hath been said, is to be accounted, as if it were infinite; therefore the angle conteined betwixt the two rayes, that being drawn from the points A and E, go to determine in a fixed Star, is esteemed nothing, and those rayes held to be two parallel lines; and therefore it is concluded, that then only may the New Star be affirmed to have been in the Firmament, when from the collating of the

Observations made in divers places, the said angle is, by calculation, gathered to be insensible, and the lines, as it were, parallels. But if the angle be of a considerable quantity, the New Star must of necessity be lower than those fixed; and also than the Moon, in case the angle ABE should be greater than that which would be made in the Moons centre.

Simpl.Then the remotenesse of the Moon is not so great, that a like angle should be ** Imperceptible. insensible in her?

Salv.No Sir; nay it is sensible, not onely in the Moon, but in the Sun also.

Simpl.But if this be so, it's possible that the said angle may be observed in the New Star, without necessitating it to be inferiour to the Sun, aswell as to the Moon.

Salv.This may very well be, yea, and is in the present case, as you shall see in due place; that is, when I shall have made plain the way, in such manner that you also, though not very perfect in Astronomical calculations, may clearly see, and, as it were, with your hands feel how that this Author had it more in his eye to write in complacency of the Peripateticks, by palliating and dissembling sundry things, than to establish the truth, by producing them with naked sincerity: therefore let us proceed forwards. By the things hitherto spoken, I suppose that you comprehend very well how that the distance of the new Star can never be made so immense, that the angle so often named shall wholly disappear, and that the two rayes of the Observators at the places A and E, shall become altogether parallels: and you may consequently comprehend to the full, that if the calculations should collect from the observations, that that angle was totally null, or that the lines were truly parallels, we should be certain that the observations were at least in some small particular erroneous: But, if the calculations should give us the said lines to be separated not only to equidistance, that is, so as to be parallel, but to have past beyond that terme, and to be dilated more above than below, then must it be resolutely concluded, that the observations were made with lesse accuratenesse, and in a word, to be

erroneous; as leading us to a manifest impossibility. In the next place, you must believe me, and suppose it for true, that two right lines which depart from two points marked upon another right line, are then wider above than below, when the angles included between them upon that right line are greater than two right angles; and if these angles should be equal to two right angles, the lines would be parallels; but if they were less than two right angles, the lines would be concurrent, and being continued out would undoubtedly intersect the triangle.

Simpl.Without taking it upon trust from you, I know the same; and am not so very naked of Geometry, as not to know a Proposition, which I have had occasion of reading very often in Aristotle, that is, that the three angles of all triangles are equall to two right angles: so that if I take in my Figure the triangle ABE, it being supposed that the line EA is right; I very well conceive, that its three angles A, E, B, are equal to two right angles; and that consequently the two angles E and A are lesse than two right angles, so much as is the angle B. Whereupon widening the lines AB and EB (still keeping them from moving out of the points A and E) untill that the angle conteined by them towards the parts B, disappear, the two angles beneath shall be equal to two right angles, and those lines shall be reduced to parallels: and if one should proceed to enlarge them yet more, the angles at the points E and A would become greater than two right angles.

Salv.You are an Archimedes, and have freed me from the expence of more words in declaring to you, that whensoever the calculations make the two angles A and E to be greater than two right angles, the observations without more adoe will prove erroneous. This is that which I had a desire that you should perfectly understand, and which I doubted that I was not able so to make out, as that a meer Peripatetick Philosopher might attain to the certain knowledg thereof. Now let us go on to what remains. And re-assuming that which even now you granted me, namely, that the new star could not possibly be in many places, but in one alone, when ever the supputations made upon the observations of these Astronomers do not assign it the

same place, its necessary that it be an errour in the observations, that is, either in taking the altitudes of the pole, or in taking the elevations of the star, or in the one or other working. Now for that in the many workings made with the combinations two by two, there are very few of the observations that do agree to place the star in the same situation; therefore these few onely may happily be the non-erroneous, but the others are all absolutely false.

Sagr.It will be necessary then to give more credit to these few alone, than to all the rest together, and because you say, that these which accord are very few, and I amongst these 12, do find two that so accord, which both make the distance of the star from the centre of the Earth 4 semidiameters, which are these, the fifth and sixth, therefore it is more probable that the new star was elementary, than celestial.

Salv.You mistake the point; for if you note well it was not written, that the distance was exactly 4 semidiameters, but about 4 semidiameters; and yet you shall see that those two distances differed from each other many hundreds of miles. Here they are; you see that this fifth, which is 13389 Italian miles, exceeds the sixth, which is 13100 miles, by almost 300 miles.

Sagr.Which then are those few that agree in placing the star in the same situation?

Salv.They are, to the disgrace of this Author five workings, which all place it in the firmament, as you shall see in this note, where I have set down many other combinations. But I will grant the Author more than peradventure he would demand of me, which is in sum, that in each combination of the observations there is some error; which I believe to be absolutely necessary; for the observations being four in number that serve for one working, that is, two different altitudes of the Pole, and two different elevations of the star, made by different observers, in different places, Astronomical Instruments are very subject to errour. with different instruments, who ever hath any small knowledg of this art, will say, that amongst all the four, it is impossible but there will be some error; and especially since we see that in taking

but one onely altitude of the Pole, with the same instrument, in the same place, by the same observer, that hath repeated the observation a thousand times, there will still be a titubation of one, or sometimes of many minutes, as in this same book you may see in several places. These things presupposed, I ask you Simplicius whether you believe that this Authour held these thirteen observators for wise, understanding and expert men in using those instruments, or else for inexpert, and bunglers?

Simpl.It must needs be that he esteemed them very acute and intelligent; for if he had thought them unskilful in the businesse, he might have omitted his sixth book as inconclusive, as being founded upon suppositions very erroneous; and might take us for excessively simple, if he should think he could with their inexpertnesse perswade us to believe a false position of his for truth.

Salv.Therefore these observators being such, and that yet notwithstanding they did erre, and so consequently needed correction, that so one might from their observations infer the best hints that may be; it is convenient that we apply unto them the least and neerest emendations and corrections that may be; so that they do but suffice to reduce the observations from impossibility to possibility; so as v. gr. if one may but correct a manifest errour, and an apparent impossibility of one of their observations by the addition or substraction of two or three minutes, and with that amendment to reduce it to possibility, a man ought not to essay to adjust it by the addition or substraction of fifteen, twenty, or fifty.

Simpl.I think the Author would not deny this: for granting that they are expert and judicious men, it ought to be thought that they did rather erre little than much.

Salv.Observe again; The places where the new Star is placed, are some of them manifestly impossible, and others possible. Absolutely impossible it is, that it should be an infinite space superiour to the fixed Stars, for there is no such place in the world; and if there were, the Star there scituate would have been imperceptible to us: it is also impossible that it should go creeping along the superficies of the Earth; and

much lesse that it should be within the said Terrestrial Globe. Places possible are these that be in controversie, it not interferring with our understanding, that a visible object in the likenesse of a Star might be aswell above the Moon, as below it. Now whilst one goeth about to compute by the way of Observations and Calculations made with the utmost certainty that humane diligence can attain unto what its place was, it is found that the greatest part of those Calculations make it more than infinitely superiour to the Firmament, others make it very neer to the surface of the Earth, and some also under the same; and of the rest, which place it in situations not impossible, none of them agree with each other; insomuch that it must be confessed, hat all those observations are necessarily false; so that if we would nevertheless collect some fruit from so many laborious calculations, we must have recourse to the corrections, amending all the observations.

Simpl.But the Authour will say, that of the observations that assign to the Star impossible places, there ought no account to be made, as being extreamly erroneous and false; and those onely ought to be accepted, that constitute it in places not impossible: and amongst these a man ought to seek, by help of the most probable, and most numerous concurrences, not if the particular and exact situation, that is, its true distance from the centre of the Earth, at least, whether it was amongst the Elements, or else amongst the Cœlestial bodies.

Salv.The discourse which you now make, is the self same that the Author made, in favour of his cause, but with too unreasonable a disadvantage to his adversaries; and this is that principal point that hath made me excessively to wonder at the too great confidence that he expressed to have, no less of his own authority, than of the blindness and inadvertency of the Astronomers; in favour of whom I will speak, and you shall answer for the Author. And first, I ask you, whether the Astronomers, in observing with their Instruments, and seeking v. gr. how great the elevation of a Star is above the Horizon, may deviate from the truth, aswell in making it too great, as too little; that is, may erroneously compute, that it is sometime higher than the truth,

and sometimes lower; or else whether the errour must needs be alwayes of one kinde, to wit, that erring they alwayes make it too much, and never too little, or alwayes too little, and never too much?

Simpl.I doubt not, but that it is as easie to commit an errour the one way, as the other.

Salv.I believe the Author would answer the same. Now of these two kinds of errours, which are contraries, and into which the observators of the new star may equally have fallen, applied to calculations, one sort will make the star higher, and the other lower than really it is. And because we have already agreed, that all the observations are false; upon what ground would this Author have us to accept those for most congruous with the truth, that shew the star to have been near at hand, than the others that shew it excessively remote?

Simpl.By what I have, as yet, collected of the Authors mind, I see not that he doth refuse those observations, and indagations that might make the star more remote than the Moon, and also than the Sun, but only those that make it remote (as you your self have said) more than an infinite distance; the which distance, because you also do refuse it as impossible, he also passeth over, as being convicted of infinite falshood; as also those observations are of impossibility. Methinks, therefore, that if you would convince the Author, you ought to produce supputations, more exact, or more in number, or of more diligent observers, which constitute the star in such and such a distance above the Moon, or above the Sun, and to be brief, in a place possible for it to be in, like as he produceth these twelve, which all place the star beneath the Moon in places that have a being in the world, and where it is possible for it to be.

Salv.But Simplicius yours and the Authors Equivocation lyeth in this, yours in one respect, and the Authors in another; I discover by your speech that you have formed a conceit to your self, that the exorbitancies that are commited in the establishing the

distance of the Star do encrease successively, according to the proportion of the errors that are made by the Instrument, in taking the observations, and that by conversion, from the greatness of the exorbitancies, may be argued the greatnesse of the error; and that thereforefore hearing it to be infered from such an observation, that the distance of the star is infinite, it is necessary, that the errour in observing was infinite, and therefore not to be amended, and as such to be refused; but the businesse doth not succeed in that manner, my Simplicius, and I excuse you for not having comprehended the matter as it is, in regard of your small experience in such affairs; but yet cannot I under that cloak palliate the error of the Author, who dissembling the knowledge of this which he did perswade himself that we in good earnest did not understand, hath hoped to make use of our ignorance, to gain the better credit to his Doctrine, among the multitude of illiterate men. Therefore for an advertisement to those who are more credulous then intelligent, and to recover you from error, know that its possible (and that for the most part it will come to passe) that an observation, that giveth you the star v. gr. at the distance of Saturn, by the adition or substraction of but one sole minute from the elevation taken with the instrument, shall make it to become infinitely distant; and therefore of possible, impossible, and by conversion, those calculations which being grounded upon those observations, make the star infinitely remote, may possibly oftentimes with the addition or subduction of one sole minute, reduce it to a possible scituation: and this which I say of a minute, may also happen in the correction of half a minute, a sixth part, and less. Now fix it well in your mind, that in the highest distances, that is v. g. the height of Saturn, or that of the fixed Stars, very small errors made by the Observator, with the instrument, render the scituation determinate and possible, infinite & impossible. This doth not so evene in the sublunary distances, and near the earth, where it may happen that the observation by which the Star is collected to be remote v. g. 4. Semidiameters terrestrial, may encrease or diminish, not onely one minute but ten, and an hundred, and many more, without being rendred by the

calculation either infinitely remote, or so much as superior to the Moon. You may hence comprehend that the greatnesse of the error (to so speak) instrumental, are not to be valued by the event of the calculation, but by the quantity it self of degrees and minutes numbred upon the instrument, and these observations are to be called more just or less erroneous, which with the addition or substraction of fewer minutes, restore the star to a possible situation; and amongst the possible places, the true one may be believed to have been that, about which a greater number of distances concurre upon calculating the more exact observations.

Simpl.I do not very well apprehend this which you say: nor can I of my self conceive how it can be, that in greater distances, greater exorbitancies can arise from the errour of one minute only, than in the smaller from ten or an hundred; and therefore would gladly understand the same.

Salv.You shall see it, if not Theorically, yet at least Practically, by this short assumption, that I have made of all the combinations, and of part of the workings pretermitted by the Author, which I have calculated upon this same paper.

Sagr.You must then from yesterday, till now, which yet is not above eighteen hours, have done nothing but compute, without taking either food or sleep.

Salv.I have refreshed my self both those wayes; but truth is, make these supputations with great brevity; and, if I may speak the truth, I have much admired, that this Author goeth so farre about, and introduceth so many computations no wise necessary to the question in dispute. And for a full knowledge of this, and also to the end it may soon be seen, how that from the observations of the Astronomers, whereof this Author makes use, it is more probably gathered, that the new star might have been above the Moon, and also above all the Planets, yea amongst the fixed stars, and yet higher still than they, I have transcribed upon this paper all the observations set down by the said Authour, which were made by thirteen Astronomers, wherein are noted the Polar altitude, and the altitudes of the star in the

meridian, aswell the lesser under the Pole, as the greater and higher, and they are these.

Tycho. gr. m.

Altitude of the Pole 55 58

Altitude of the Star 84 00 the greatest.

27 57 the least.

And these are, according to the first paper: but according to the second, the greatest is— 27 45

Hainzelius.

gr. m. sec.

Altitude of the Pole 48 22

Altitude of the Star 76 34

76 33 45

76 35

20 09 40

20 09 30

20 09 20

Peucerus and Sculerus. Landgravius.

gr. m. gr. m.

Altitude of the pole 51 54 Altitude of the pole 51 18

Altitude of the Star 79 56 Altitude of the Star 79 30

23 33

Camerarius.

gr. m.

Altitude of the pole 52 24

Altitude of the Star 80 30

80 27

80 26

24 28

24 20

24 17

Hagecius Maurolycus.

gr. m. gr. m.

Altitude of the pole 48 22 Altitude of the pole 38 30

Altitude of the Star 20 15 Altitude of the Star 62 00

Munocius. Vrsinus.

gr. m. gr. m.

Altitude of the pole 39 30 Altitude of the pole 49 24

Altitude of the star 67 30 Altitude of the star 79 00

11 30 22 00

Reinholdus. Buchius.

gr. m. gr. m.

Altitude of the pole 51 18 Altitude of the pole 51 10

Altitude of the star 79 30 Altitude of the star 79 20

23 02 22 40

Gemma.

gr. m.

Altitude of the pole 50 50

Altitude of the star 79 45

Now to see my whole proceeding, we may begin from these calculations, which are four, omitted by the Author, perhaps because they make against him, in regard they place the star above the moon by many semidiameters of the Earth. The first of which is this, computed upon the observations of the Landgrave of Hassia, and Tycho; which are, even by the Authors concession, two of the most exact observers: and in this first, I will declare the order that I hold in the working; which shall serve for all the rest, in that they are all made by the same rule, not varying in any thing, save in the quantity of the given summes, that is, in the number of the degrees of the Poles altitude, and of the new Stars elevation above the Horizon, the distance of which from the centre of the Earth, in proportion to the semidiameter of the terrestrial Globe is sought, touching which it nothing imports in this case, to know how many miles that semidiameter conteineth; whereupon the resolving that, and the distance of places where the observations were made, as this Author doth, is but time and labour lost; nor do I know why he hath made the same, and especially why at the last he goeth about to reduce the miles found, into semidiameters of the Terrestrial Globe.

Simpl.Perhaps he doth this to finde with such small measures, and with their fractions the distance of the Star terminated to three or four inches; for we that do not understand your rules of Arithmetick, are stupified in hearing your conclusions; as for instance, whilst we read; Therefore the new Star or Comet was distant from the Earths centre three hundred seventy and three thousand eight hundred and seven miles; and moreover, two hundred and eleven, four thousand ninety sevenths 373807 211/4097, and upon these precise punctualities, wherein you take notice of such small matters, we do conceive it to be impossible, that you, who in our calculations keep an account of an inch, can at the close deceive us so much as an hundred miles.

Salv.This your reason and excuse would passe for currant, if in a distance of thousands of miles, a yard over or under were of any great moment, and if the suppositions that we take for true, were so certain, as that they could assure us of producing an indubitable truth in the conclusion; but here you see in the twelve workings of the Author, the distances of the Star, which from them one may conclude to have been different from each other, (and therefore wide of the truth) for many hundreds and thousands of miles: now whilst that I am more than certain, that that which I seek must needs differ from the truth by hundreds of miles, to what purppse is it to be so curious in our calculations, for fear of missing the quantity of an inch? But let us proceed, at last, to the working, which I resolve in this manner. Tycho, as may be seen in that same note observed the star in the polar altitude of 55 degrees and 58 mi. pri. And the polar altitude of the Landgrave was 51 degrees and 18 mi. pri. The altitude of the star in the Meridian taken by Tycho was 27 degrees 45 mi. pri. The Landgrave found its altitude 23 degrees 3 mi. pri. The which altitudes are these noted here, as you see.

gr. m. gr. m. Tycho. Pole 55 58 * 27 45 Landgr. Pole 51 18 * 23 3

This done, substract the lesse from the greater, and there remains these differences here underneath.

gr. m. 4 40 4 42 Parall. 2

Where the difference of the poles altitudes 4 gr. 4 mi. pr. is lesse than the difference of the altitudes of the Star 4 gr. 42 mi. pr. and therefore we have the difference of parallaxes, 0 gr. 2 mi. pri. These things being found, take the Authours own figure [Fig. 2.] in which the point B is the station of the Landgrave, D the station of Tycho, C the place of the star, A the centre of the Earth, ABE the vertical line of the Landgrave, ADF

of Tycho, and the angle BCD the difference of Parallaxes. And because the angle BAD, conteined between the vertical lines, is equal to the difference of the Polar

altitudes, it shall be 4gr. 40m. which I note here apart; and I finde the chord of it by the Table of Arches and Chords, and set it down neer unto it, which is 8142 parts, of which the semidiameter AB is 100000. Next, I finde the angle BDC with ease, for the half of the angle BAD, which is 2gr. 20 m. added to a right angle, giveth the angle BDF 92gr. 20 m. to which adding the angle CDF, which is the distance from the vertical point of the greatest altitude of the Star, which here is 62 gr. 15 m. it giveth us the quantity of the angle BDC, 154 grad. 45 min. the which I set down together with its Sine, taken out of the Table, which is 42657, and under this I note the angle of the Parallax BCD 0 gr. 2 m. with its Sine 58. And because in the Triangle BCD, the side DB is to the side BC; as the sine of the opposite angle BCD, to the sine of the opposite angle BDC: therefore, if the line BD were 58. BC would be 42657. And because the Chord DB is 8142. of those parts whereof the semidiameter BA is 100000. and we seek to know how many of those parts is BC; therefore we will say, by the Golden Rule, if when BD is 58. BG is 42657. in case the said DB were 8142. how much would BC be? I multiply the second term by the third, and the product is 347313294. which ought to be divided by the first, namely, by 58. and the quotient shall be the number of the parts of the line BC, whereof the semidiameter AB is 100000. And to know how many semidiameters BA, the said line BC doth contein, it will be necessary anew to divide the said quotient so found by 100000. and we shall have the number of semidiameters conteined in BC. Now the number 347313294. divided by 58. giveth 59881601/4. as here you may see.

59881601/458|3473132941/4571794101/45430001/4

And this divided by 100000. the product is 59 88160/100000

1|00000|59|88160.

But we may much abbreviate the operation, dividing the first quotient found, that is, 347313294. by the product of the multiplication of the two numbers 58. and 100000. that is, 58|00000|345958|00000|3473|1329458|00000|357158|00000|345

And this way also there will come forth 59 5113294/5800000

And so many semidiameters are contained in the line BC, to which one being added for the line AB, we shall have little lesse than 61. semidiameters for the two lines ABC; and therefore the right distance from the centre A, to the Star C, shall be more than 60. semidiameters, and therefore it is superiour to the Moon, according to Ptolomy, more than 27. semidiameters, and according to Copernicus, more than 8. supposing that the distance of the Moon from the centre of the Earth by Copernicus his account is what the Author maketh it, 52 semidiameters. With this same working, I find by the observations of Camerarius, and of Munosius, that the Star was situate in that same distance, to wit, somewhat more than 60. semidiameters. These are the observations, and these following next after them the calculations.

The next working is made upon two observations of Tycho, and of Munosius, from which the Star is calculated to be distant from the Centre of the Earth 478 Semidiameters and more.

The Golden Rule.

These workings following make the Star remote from the Centre, more than 358 Semidiameters.

The Golden Rule.

From this other working the star is found to be distant from the centre more than 716. semidiameters.

The Golden Rule.

These as you see are five workings which place the star very much above the Moon. And here I desire you to consider upon that particular, which even now I told you, namely, that in great distances, the mutations, or if you please corrections, of a very few minutes, removeth the star a very great way farther off. As for example, in the first of these workings, where the calculation made the star 60. semidiameters remote from the centre, with the Parallax of 2. minutes; he that would maintain that

it was in the Firmament, is to correct in the observations but onely two minutes, nay lesse, for then the Parallax ceaseth, or becommeth so small, that it removeth the star to an immense distance, which by all is received to be the Firmament. In the second indagation, or working, the correction of lesse than 4 m. prim. doth the same. In the third, and fourth, like as in the first, two minutes onely mount the star even above the Firmament. In the last preceding, a quarter of a minute, that is 15. seconds, gives us the same. But it doth not so occur in the sublunary altitudes; for if you fancy to your self what distance you most like, and go about to correct the workings made by the Authour, and adjust them so as that they all answer in the same determinate distance, you will find how much greater corrections they do require.

Sagr.It cannot but help us in our fuller understanding of things, to see some examples of this which you speak of.

Salv.Do you assign any whatsoever determinate sublunary distance at pleasure in which to constitute the star, for with small ado we may assertain our selves whether corrections like to these, which we see do suffice to reduce it amongst the fixed stars, will reduce it to the place by you assigned.

Sagr.To take a distance that may favour the Authour, we will suppose it to be that which is the greatest of all those found by him in his 12 workings; for whilst it is in controversie between him and Astronomers, and that they affirm the star to have been superiour to the Moon, and he that it was inferiour, very small space that he proveth it to have been lower, giveth him the victory.

Salv.Let us therefore take the seventh working wrought upon the observations of Tycho and Thaddæus Hagecius, by which the Authour found the star to have been distant from the centre 32. semidiameters, which situation is most favourable to his purpose; and to give him all advantages, let us moreover place it in the distance most disfavouring the Astronomers, which is to situate it above the Firmament. That therefore being supposed, let us seek in the next place what corrections it would be

necessary to apply to his other 11 workings. And let us begin at the first calculated upon the observations of Hainzelius and Mauroice; in which the Authour findeth the distance from the centre about 3. semidiameters with the Parallax of 4 gr. 42 m. 30. sec. Let us see whether by withdrawing it 20. minutes onely, it will rise to the height of 32. semidiameters: See the short and true operation. Multiply the sine of the angle BDC, by the sine of the

chord BD, and divide the product, the five last figures being cut off by the sine of the Parallax, and the quotient will be 28. semidiameters, and an half, so that though you make a correction of 4 gr. 22 min. 30 sec. taken from 4 gr. 42 min. 30 sec. it shall not elevate the star to the altitude of 32. semidiameters, which correction for Simplicius his understanding it, is of 262. minutes, and an half.

In the second operation made upon the observations of Hainzelius, and Sculerus, with the Parallax of 0 gr. 8 min. 30 sec. the star is found in the height of 25. semidiameters or thereabouts, as may be seen in the subsequent working.

And bringing back the Parallax 0 gr. 8 m. 30 sec. to 7 gr. 7 m. whose sine is 204, the star elevateth to 30 semidiameters or thereabouts; therefore the correction of 0 gr. 1 mi. 30 sec. doth not suffice.

Now let us see what correction is requisite for the third working made upon the observations of Hainzelius and Tycho, which rendereth the star about 19 semidiameters high, with the Parallax of 10 m. pri. The usual angles and their sines, and chord found by the Authour, are these next following; and they remove the star (as also in the Authours working) 19 semidiameters from the centre of the Earth. It is necessary therefore for the raising of it, to diminish the Parallax according to the Rule which he likewise observeth in the ninth working. Let us therefore suppose the Parallax to be 6 m. prim. whose sine is 175, and the division being made, there is found likewise lesse than 31 semidiameters for the stars distance. And therefore the correction of 4 min. prim. is too little to serve the Authours purpose.

Let us come to the fourth working, and the rest with the same rule, and with the chords and sines found out by the Authour himself; in this the Parallax is 14 m. prim. and the height found lesse than 10 semidiameters, and diminishing the Parallax from 14 min. to 4 min. yet neverthelesse you see that the star doth not elevate full 31 semidiameters. Therefore 10 min. in 14 min. doth not suffice.

In the fifth operation of the Authour we have the sines and the chord as you see, and the Parallax is 0 gr. 42 m. 30 sec. which rendereth the height of the star about 4 semidiameters, and correcting the Parallax, with reducing it from 0 gr. 42 m. 30 sec. to 0 gr. 5 m. onely, doth not suffice to raise it to so much as 28 semidiameters, the correction therefore of 0 gr. 37 m. 30 sec. is too little.

In the sixth operation the chord, the sines and Parallax are as followeth, and the star is found to be about 4. semidiameters; let us see whether it will be reduced, abating the Parallax from 8 m. to 1 m. onely; Here is the operation, and the star raised but to 27. semidiameters or thereabout; therefore the correction of 7 m. in 8 m. doth not suffice.

In the eighth operation the chord, the sines, and the Parallax, as you see, are these ensuing, and hence the Authour calculates the height of the star to be 1. semidiameter and an half, with the Parallax of 43. min. which reduced to 1 min. yet notwithstanding giveth the star lesse remote than 24. semidiameters, the correction therefore of 42. min. is not enough.

Let us now see the ninth. Here is the chord, the sines and the Parallax which is 15 m. From whence the Authour calculates the distance of the star from the superficies of the Earth to be lesse than a ** Here the Latine version is erroneous, making it a fortieth part of, &c. seven and fortieth part of a semidiameter, but this is an errour in the calculation, for it cometh forth truly, as we shall see here below, more than a fifth: See here the quotient is 20/436, which is more than one fifth.

That which the Authour presently after subjoyns in way of amending the

observations, that is, that it sufficeth not to reduce the difference of Parallax, neither to a minute, nor yet to the eighth part of a minute is true. But I say, that neither will the tenth part of a minute reduce the height of the star to 32. semidiameters; for the sine of the tenth part of a minute, that is of six seconds, is 3; by which if we according to our Rule should divide 90. or we may say, if we should divide 9058672. by 300000. the quotient will be 30 58672/100000, that is little more than 30. semidiameters and an half.

The tenth giveth the altitude of the star one fifth of a semidiameter, with these angles, sines, and Parallax, that is, 4 gr. 30 m. which I see that being reduced from 4 gr. 30 min. to 2 min. yet neverthelesse it elevates not the star to 29. semidiameters.

The eleventh rendereth the star to the Authour remote about 13. semidiameters, with the Parallax of 55. min. let us see, reducing it to 20 min. whether it will exalt the star: See here the calculation elevates it to little lesse than 33. semidiameters, the correction therefore is little lesse than 35. min. in 55. min.

The twelfth with the Parallax of 1. gr. 36. min. maketh the star lesse high than 6. semidiameters, reducing the Parallax to 20 min. it carrieth the star to lesse than 30. semidiameters distance, therefore the correction of 1 gr. 16. min. sufficeth not.

These are the Corrections of the Parallaxes of the ten workings of the Author, to reduce the Star to the altitude of 32 Semidiameters. gr. m. sec. gr. m. sec. 04 22 30 in 04 42 30 00 04 00 in 00 10 00 00 10 00 in 00 14 00 00 37 00 in 00 42 30 00 07 00 in 00 18 00 00 42 00 in 00 43 00 00 14 50 in 00 15 00 04 28 00 in 04 30 00 00 35 00 in 00 55 00 01 16 00 in 01 36 00

From hence we see, that to reduce the Star to 32. Semidiameters in altitude, it is requisite from the sum of the Parallaxes 836. to subtract 756. and to reduce them to 80. nor yet doth that correction suffice.

Here we see also, (as I have noted even now) that should the Authour consent to assign the distance of 32. Semidiameters for the true height of the Star, the

correction of those his 10. workings, (I say 10. because the second being very high, is reduced to the height of 32. Semidiameters, with 2. minutes correction) to make them all to restore the said Star to that distance, would require such a reduction of Parallaxes, that amongst the whole number of substractions they should make more than 756 m. pr. whereas in the 5. calculated by me, which do place the Star above the Moon, to correct them in such sort, as to constitute it in the Firmament, the correction onely of 10. minutes, and one fourth sufficeth.

Now adde to these, other 5. workings, that place the Star precisely in the Firmament, without need of any correction at all, and we shall have ten workings or indagations that agree to place it in the Firmament, with the correction onely of 5. of them (as hath been seen) but 10. m. and 15 sec. Whereas for the correction of those 10. of the Authour, to reduce them to the altitude of 32. semidiameters, there will need the emendations of 756 minutes in 836. that is, there must from the summe 836 be substracted 756. if you would have the Star elevated to the altitude of 32. semidiameters, and yet that correction doth not fully serve.

The workings that immediately without any correction free the Star from Parallaxes, and therefore place it in the Firmament, and that also in the remotest parts of it, and in a word, as high as the Pole it self, are these 5. noted here.

gr. m. gr. m. Camerar. Polar altit. 52 24 Altit. of the Star 80 26 Peucerus 51 54 79 56 0 30 0 30 gr. m. gr. m. Landgrav. Polar altit. 51 18 Altit. of the Star 79 30 Hainzel. 48 22 76 34 2 56 2 56 gr. m. gr. m. Tycho Polar altit. 55 58 Altit. of the Star 84 00 Peucerus 51 54 79 56 4 4 4 4 gr. m. gr. m. Reinhold. Polar altit. 51 18 Altit. of the Star 79 30 Hainzel. 48 22 36 34 2 56 2 56 gr. m. gr. m. Camerar. Polar altit. 52 24 Altit. of the Star 24 17 Hagecius 48 22 20 15 4 2 4 2

Of the remaining combinations that might be made of the Observations of all these Astronomers, those that make the Stars sublime to an infinite distance, are many in number, namely, about 30. more than those who give the Star, by calculation, to be

below the Moon; and because (as it was agreed upon between us) it is to be believed that the Observators have erred rather little than much, it is a manifest thing that the corrections to be applied to the Observaations, which make the star of an infinite altitude, to reduce it lower, do sooner, and with lesser amendment place it in the Firmament, than beneath the Moon; so that all these applaud the opinion of those who put it amongst the fixed Stars. You may adde, that the corrections required for those emendations, are much lesser than those, by which the Star from an unlikely proximity may be removed to the height more favourable for this Authour, as by the foregoing examples hath been seen; amongst which impossible proximities, there are three that seem to remove the Star from the Earths centre, a lesse distance than one Semidiameter, making it, as it were, to turn round under ground, and these are those combinations, wherein the Polar altitude of one of the Observators being greater than the Polar altitude of the other, the elevation of the Star taken by the first, is lesser than the elation of the Star taken by the latter.

The first of these is this of the Landgrave with Gemma, where the Polar altitude of the Landgrave 51 gr. 18 min. is greater than the Polar altitude of Gemma, which is 50 gr. 50 m. But the altitude of the Star of the Landgrave 79 gr. 30 min. is lesser than that of the Star, of Gemma 79 gr. 45 min.

gr. m. gr. m. Landgrave Polar altit. 51 18 Altit. of the Star 79 30 Gemma 50 50 79 45

The other two are these below. gr. m. gr. m. Buschius. Polar Altitude 51 10 Altit. of the Star 79 20 Gemma. 50 50 79 45 Reinholdus. Polar Altitude 51 18 Altit. of the Star 79 30 Gemma. 50 50 79 45

From what I have hitherto demonstrated, you may guesse how much this first way of finding out the distance of the Star, and proving it sublunary introduced by the Authour, maketh against himself, and how much more probably and clearly the distance thereof is collected to have been amongst the more remote fixed Stars.

Simpl.As to this particular, I think that the inefficacy of the Authors demonstrations is very plainly discovered; But I see that all this was comprised in but a few leaves of his Book, and it may be, that some other of his Arguments are more conclusive then these first.

Salv.Rather they must needs be lesse valid, if we will take those that lead the way for a proof of the rest: For (as it is clear) the uncertainty and inconclusivenesse of those, is manifestly observed to derive it self from the errours committed in the instrumental observations, upon which the Polar Altitude, and height of the Star was thought to have been justly taken, all in effect having easily erred; And yet to find the Altitude of the Pole, Astronomers have had Ages of time to apply themselves to it, at their leasure: and the Meridian Altitudes of the Star are easier to be observed, as being most terminate, and yielding the Observator some time to continue the same, in regard they change not sensibly, in a short time, as those do that are remote from the Meridian. And if this be so, as it is most certain, what credit shall we give to Calculations founded upon Observations more numerous, more difficult to be wrought, more momentary in variation, and we may add, with Instruments more incommodious and erroneous? Upon a slight perusal of the ensuing demonstrations, I see that the Computations are made upon Altitudes of the Star taken in different Vertical Circles, which are called by the Arabick name, Azimuths; in which observations moveable instruments are made use of, not only in the Vertical Circles, but in the Horizon also, at the same time; insomuch that it is requisite in the same moment that the altitude is taken, to have observed, in the Horizon, the distance of the Virtical point in which the Star is, from the Meridian; Moreover, after a considerable interval of time, the operation must be repeated, and exact account kept of the time that passed, trusting either to Dials, or to other observations of the Stars. Such an Olio of Observations doth he set before you, comparing them with such another made by another observer in another place with another different instrument, and at another time; and from this the Authour seeks to collect what would have

been, the Elevations of the Star, and Horizontal Latitudes happened in the time and hour of the other first observations, and upon such a coæquation he in the end grounds his account. Now I refer it to you, what credit is to be given to that which is deduced from such like workings. Moreover, I doubt not in the least, but that if any one would torture himself with such tedious computations, he would find, as in those aforegoing, that there were more that would favour the adverse party, than the Authour: But I think it not worth the while to take so much pains in a thing, which is not, amongst those primary ones, by us understood.

Sagr.I am of your Opinion in this particular: But this businesse being environed with so many intricacies, uncertainties, and errours, upon what confidence have so many Astronomers positively pronounced the new Star to have been so high?

Salv.Upon two sorts of observations most plain, most easie, and most certain; one only of which is more than sufficient to assure us, that it was scituate in the Firmament, or at least by a great distance superiour to the Moon. One of which is taken from the equality, or little differing inequality of its distances from the Pole, aswell whilst it was in the lowest part of the Meridian, as when it was in the uppermost: The other is its having perpetually kept the same distances from certain of the fixed Stars, adjacent to it, and particularly from the eleventh of Cassiopea, no more remote from it than one degree and an half; from which two particulars is undoubtedly inferred, either the absolute want of Parallax, or such a smalnesse thereof, that it doth assure us with very expeditious Calculations of its great distance from the Earth.

Sagr.But these things, were they not known to this Author? and if he saw them, what doth he say unto them?

Salv.We are wont to say, of one that having no reply that is able to cover his fault, produceth frivolous excuses, cerca di attaccarsi alle funi del cielo, [He strives to take hold of the Cords of Heaven;] but this Authour runs, not to the Cords, but to the

Spiders Web of Heaven; as you shall plainly see in our examination of these two particulars even now hinted. And first, that which sheweth us the Polar distances of the Observators one by one, I have noted down in these brief Calculations; For a full understanding of which, I ought first to advertise you, that when ever the new Star, or other Phænomenon is near to the earth, turning with a Diurnal motion about the Pole, it will seem to be farther off from the said Pole, whilst it is in the lower part of the Meridian, then whilst it is above, as in this Figure [being fig. third of this Dial.] may be seen. In which the point T. denotes the centre of the Earth; O. the place of the Observator; the Arch VPC the Firmament; P. the Pole. The Phænomenon, [or appearance] moving along the Circle FS. is seen one while under the Pole by the Ray OFC. and another while above, according to the Ray OSD. so that the places seen in the Firmament are D. and C. but the true places in respect of the Centre T, are B, and A, equidistant from the Pole. Where it is manifest that the apparent place of the Phænomenon S, that is the point D, is nearer to the Pole than the other apparent place C, seen along the Line or Ray OFC, which is the first thing to be noted. In the second place you must note that the exces of the apparent inferiour distance from the Pole, over and above the apparent superiour distance from the said Pole, is greater than the Inferiour Parallax of the Phænomenon, that is, I say, that the excesse of the Arch CP, (the apparent inferior distance) over and above the Arch PD, (the apparent superior distance) is greater then the Arch CA, (that is the inferiour Paralax.) Which is easily proved; for the Arch CP. more exceedeth PD, then PB; PB, being bigger than PD, but PB. is equal to PA, and the excesse of CP, above PA, is the arch, CA, therefore the excesse of the arch CP above the arch PD, is greater than the arch CA, which is the parallax of the Phænomenon placed in F, which was to be demonstrated. And to give all advantages to the Author, let us suppose that the parallax of the star in F, is the whole excesse of the arch CP (that is of the inferiour distance from the pole) above the arch PD (the inferiour distance.) I proceed in the next place to examine that which the observations of all Astronomers

cited by the Authour giveth us, amongst which, there is not one that maketh not against himself and his purpose. And let us begin with these of Buschius, who findeth the stars distance from the pole, when it was superiour, to be 28 gr. 10 m. and the inferiour to be 28 gr. 30 m. so that the excesse is 0 gr. 20 m. which let us take (in favour of the Author) as if it all were the parallax of the star in F, that is the angle TFO. Then the distance from the Vertex [or Zenith] that is the arch CV, is 67 gr. 20 m. These two things being found, prolong the line CO, and from it let fall the perpendicular TI, and let us consider the triangle TOI, of which the angle I is right angle, and the angle IOT known, as being vertical to the angle VOC, the distance of the star from the Vertex, Moreover in the triangle TIF, which is also rectangular, there is known the angle F, taken by the parallax. Then note in some place apart the two angles IOT and IFT, and of them take the sines, which are here set down to them, as you seen. And because in the triangle IOT, the sine TI is 92276. of those parts, whereof the whole sine TO is 100000; and moreover in the triangle IFT, the sine TI is 582. of those parts, whereof the whole sine TF is 100000, to find how many TF is of those parts, whereof TO is 100000; we will say by the Rule of three: If TI be 582. TF is an 100000. but if T I were 92276. how much would T F be. Let us multiply 92276. by 100000. and the product will be 9227600000. and this must be divided by 582. and the quotient will be 15854982. and so many shall there be in TF of those parts, of which there are in TO an 100000. So that if it were required to know how many lines TO, are in TF, we would divide 15854982 by 100000. and there will come forth 158. and very near an half; and so many diameters shall be the distance of the star F, from the centre T, and to abreviate the operation, we seeing, that the product of the multiplication of 92276. by 100000, ought to be divided first by 582, and then the quotient of that division by 100000. we may without multiplying 92276. by 100000. and with one onely division of the sine 92276. by the sine 582. soon obtain the same solution, as may be seen there below; where 92276. divided by 582. giveth us the said 158 1/2, or thereabouts. Let us bear in mind

therefore, that the onely division of the sine TI, as the sine of the angle TOI by the sine TI, as the sine of the angle IFT, giveth us the distance sought TF, in so many diameters TO.

See next that which the observations of Peucerus giveth us, in which the inferiour distance from the Pole is 28 gr. 21 m. and the superiour 28 gr. 2 m. the difference 0 gr. 19 m. and the distance from the vertical point 66 gr. 27 m. from which particulars is gathered the stars distance from the centre almost 166 semediameters.

Here take what Tycho his observation holdeth forth to us, interpreted with greatest favour to the adversary; to wit, the inferiour distance from the pole is 28 gr. 13 m. and the superiour 28 gr. 2 m. omitting the difference which is 0 gr. 11 m. as if all were one Parallax; the distance from the vertical point 62 gr. 15 m. Behold here below the operation, and the distance of the star from the centre found to be 976 9/16 semidiameters.

The observation of Reinholdus, which is the next ensuing, giveth us the distance of the Star from the Centre 793. Semidiameters.

From the following observation of the Landgrave, the distance of the Star from the Centre is made to be 1057, Semidiameters.

Two of the most favourable observations for the Authour being taken from Camerarius, the distance of the Star from the Centre is found to be 3143 Semidiameters.

The Observation of Munosius giveth no Parallax, and therefore rendreth the new Star amongst the highest of the fixed. That of Hainzelius makes it infinitely remote, but with the correction of an half min. prim. placeth it amongst the fixed Stars. And the same is collected from Vrsinus, with the correction of 12. min. prim. The other Astronomers have not give us the distance above and below the Pole, so that nothing can be concluded from them. By this time you see, that all the observations of all these men conspire against the Author, in placing the Star in the Heavenly and

highest Regions.

Sagr.But what defence hath he for himself against so manifest contradictions?

Salv.He betakes himself to one of those weak threads which I speak of; saying that the Parallaxes come to be lessened by means of the refractions, which opperating contrarily sublimate the Phænomenon, whereas the Parallaxes abase it. Now of what little stead this lamentable refuge is, judge by this, that in case that effect of the refractions were of such an efficacy, as that which not long time since some Astronomers have introduced, the most that they could work touching the elevating a Phæuomenon above the Horizon more than truth, when it is before hand 23. or 24. Degrees high, would be the lessening its Parallax about 3. minutes, the which abatement is too small to pull down the Star below the Moon, and in some cases is lesse than the advantage given him by us in admitting that the excesse of the inferiour distance from the Pole above the Superiour, is all Parallax, the which advantage is far more clear and palpable than the effect of Refracton, of the greatnesse of which I stand in doubt, and not without reason. But besides, I demand of the Author, whether he thinks that those Astronomers, of whose observations he maketh use, had knowledge of these effects of Refractions, and considered the same, or no; if they did know and consider them, it is reasonable to think that the, kept account of them in assigning the true Elevation of the Star, making in those degrees of Attitude discovered with the Instruments, such abatements as were convenient on the account of the alterations made by the Refractions; insomuch that the distances by them delivered, were in the end those corrected and exact, and not the apparent and false ones. But if he think that those Authors made no reflection upon the said Refractions, it must be confessed, that they had in like manner erred in determining all those things which cannot be perfectly adjusted without allowance for the Refractions; amongst which things one is the precise investigation of the Polar Altitudes, which are commonly taken from the two Meridian Altitudes of some of the fixed Stars that are constantly visible, which Altitudes will come to be altered by

Refraction in the same manner, just as those of the new Star; so that the Polar Altitude that is deduced from them, will prove to be defective, and to partake of the self same want which this Author assigns to the Altitudes ascribed to the new Star, to wit, both that and these will be with equal falshood placed higher than really they are. But any such errour, as far as concerns our present businesse, doth no prejudce at all: For we not needing to know any more, but onely the difference between the two distances of the new Star from the Pole at such time as it was inferiour and superiour, it is evident that such distances would be the same, taking the alteration of Refraction commonly for the Star and for the Pole, or for them when commonly amended. The Authors Argument would indeed have had some strength, though very small, if he had assured us that the Altitude of the Pole had been once precisely assigned, and corrected from the errour depending on refraction, from which again the Astronomers had not kept themselves in assigning the altitudes of the new Star; but he hath not ascertained us of that, nor perhaps could he have done, nor haply, (and this is more probable) was that caution wanting in the Observators.

Sagr.This argument is in my judgment sufficiently answered; therefore tell me how he dis-ingageth himself in the next place from that particular of the Stars having constantly kept the same distance from the fixed Stars circumjacent to it.

Salv.He betakes himself, in like manner, to two threads, yet more unable to uphold him than the former: one of which is likewise fastened to refraction, but so much less firmly, in that he saith, that refraction operating upon the new Star, and sublimating it higher than its true situation, maketh the seeming distances untain to be distinguished from the true, when compared to the circumposed fixed Stars that environ it. Nor can I sufficiently admire how he can dissemble his knowing how that the same refraction will work alike upon the new Star, as upon the antient one its neighbour, elevating both equally, so as that such a like accident altereth not the space betwixt them. His other subterfuge is yet more unhappy, and carryeth with it much of ridiculous, it being founded upon the errour that may arise in the

instrumental operation it self; whilst that the Observator not being able to constitute the centre of the eyes pupil in the centre of the Sextant (an Instrument imployed in observing the distance between two Stars) but holding it elevated above that centre, as much as the said pupil is distant from I know not what bone of the cheek, against which the end of the Instrument resteth, there is formed in the eye an angle more acute than that which is made by the sides of the Instrument; which angle of rayes differeth also from it self, at such time as a man looketh upon Stars, not much elevated above the Horizon, and the same being afterwards placed at a great height; that angle, saith he, is made different, while the Instrument goeth ascending, the head standing still: but if in mounting the Instrument, the neck should bend backwards, and the head go rising, together with the Instrument, the angle would then continue the same. So that the Authours answer supposeth that the Observators in using the Instrument have not raised the head, as they ought to have done; a thing which hath nothing of likelihood in it. But granting that so it had been, I leave you to judge what difference can be between two acute angles of two equicrural triangles, the sides of one of which triangles are each four [Italian] Braces [i.e. about three English yards] and those of the other, four braces within the quantity of the diameter of a Pea; for the differences cannot be absolutely greater between the length of the two visive rayes, whilst the line is drawn perpendicularly from the centre of the pupil, upon the plain of the Rule of the Sextant (which line is no bigger than the breath of the thumb) and the length of the same rayes, whilst elevating the Sextant, without raising the head together with it, that same line no longer falleth perpendicularly upon the said plane, but inclineth, making the angle towards the circumference something acute. But wholly to free this Authour from these unhappy lies, let him know, (in regard it appears that he is not very skilful in the use of Astronomicall Instruments) that in the sides of the Sextant or Quadrant there are placed two ** Traguardi. Sights, one in the centre, and the other at the other at the opposite end, which are raised an inch or more above the plane of the Rule; and

through the tops of those sights the ray of the eye is made to passe, which eye likewise is held an hands breadth or two, or it may be more, from the Instrument; so that neither the pupil, nor any bone of the cheek, nor of the whole body toucheth or stayeth it self upon the Instrument, nor much lesse is the Instrument upheld or mounted in the armes, especially if it be one of those great ones, as is usual, which weighing tens, hundreds, and also thousands of pounds, are placed upon very strong feet or frames: so that the whole objection vanisheth. These are the subterfuges of this Authour, which, though they were all of steel, would not secure him the hundredth part of a minute; and with these he conceits to make us believe, that he hath compensated that difference, which importeth more than an hundred minutes; I mean, that of the not observing a notable difference in the distances between one of the fixed stars, and the new star in in any of their circulations; which, had it been neer to the Moon, it ought to have been very conspicuous to the meer sight, without any Instrument, especially comparing it with the eleventh of Cassiopeia, its neighbour, within 1 gr. 30 m. which ought to have varied from it more than two diameters of the moon, as the more intelligent Astronomers of those times do well note.

Sagr.Methinks I see that unfortunate Husbandman, who after all his expected crops, have been beaten down and destroyed by a storm, goeth up and down with a languishing and down-cast look, gleaning up every small ear that would not suffice to keep a chicken alive one sole day.

Salv.Truly, this Authour came out too slenderly provided with armes against the assailants of the Heavens inalterability, and with too brittle a chain attempted to pull down the new star of Cassiopeia from the highest Regions, to these so low and elementary. And for that I think that we have sufficiently demonstrated the vast difference that is between the arguments of those Astronomers, and of this their Antagonist, it will be convenient that we leave this particular, and return to our principal matter; in which there presents it self to our consideration the annual

motion commonly ascribed to the Sun, but by Aristarchus Samius first of all, and after by Copernicus taken from the Sun, and transferred upon the Earth; against which Hypothesis, methinks I see Simplicius to come strongly provided, and particularly with the sword and buckler of the little Treatise of Conclusions, or Disquisitions Mathematical, the oppugnations of which it would be good to begin to produce.

Simpl.I will, if you so please, reserve them to the last, as those that are of latest invention.

Salv.It will therefore be necessary, that in conformity to the method hitherto observed, you do orderly, one by one, propound the arguments, on the contrary, aswell of Aristotle, as of the other ancients, which shall be my task also, that so nothing may escape our strict consideration and examination; and likewise Sagredus, with the vivacity of his wit, shall interpose his thoughts, as he shall finde himself inclined.

Sagr.I will do it with my wonted freedome; and your commands shall oblige you to excuse me in so doing.

Salv.The favour will challenge thanks, and not an excuse. But now let Simplicius begin to propose those doubts which disswade him from believing that the Earth, in like manner, as the other planets, may move round about a fixed centre.

Simpl.The first and greatest difficulty is the repugnance and incompatibility that is between being in the centre, and being far from it; for if the Terrestrial Globe were to move in a year by the circumference of a circle, that is, under the Zodiack, it is impossible that it should, at the same time, be in the centre of the Zodiack; but that the Earth is in the said centre Aristotle, Ptolomy, and others have many wayes proved.

Salv.You very well argue, and there is no question but that one that would make the Earth to move in the circumference of a circle, must first of necessity prove, that it is

not in the centre of that same circle; it now followeth, that we enquire, whether the Earth be, or be not in that centre, about which, I say, that it turneth, and you say that it is fixed; and before we speak of this, it is likewise necessary that we declare our selves, whether you and I have both the same conceit of this centre, or no. Therefore tell me, what and where is this your intended centre?

Simpl.When I speak of the centre, I mean that of the Universe, that of the World, that of the Starry Sphere.

Salv.Although I might very rationally put it in dispute, whether there be any such centre in nature,It hath not been hitherto proved by any, whether the World be finite or infinite. or no; being that neither you nor any one else hath ever proved, whether the World be finite and figurate, or else infinite and interminate; yet nevertheless granting you, for the present, that it is finite, and of a terminate Spherical Figure, and that thereupon it hath its centre; it will be requisite to see how credible it is that the Earth, and not rather some other body, doth possesse the said centre.

Simpl.That the world is finite, terminate, and spherical, Aristotle proveth with an hundred demonstrations.

Salv.All which in the end are reduced to one alone,The Demonstrations of Aristotle to prove that the Universe is finite, are all nullified by denying it to be moveable. and that one to none at all; for if I deny his assumption, to wit, that the Universe is moveable, all his demonstrations come to nothing, for he onely proveth the Universe to be finite and terminate, for that it is moveable. But that we may not multiply disputes, let it be granted for once, that the World is finite, spherical, and hath its centre. And seeing that that centre and figure is argued from its mobility, it will, without doubt, be very reasonable, if from the circular motions of mundane bodies we proceed to the particular investigation of that centres proper place:Aristotle makes that point to be the centre of the Universe about which all the Celestial Spheres do revolve. Nay Aristotle himself hath argued and determined in the same

manner, making that same to be the centre of the Universe about which all the Cœlelestial Spheres revolve, and in which he beleived the Terrestrial Globe to have been placed.A question is put, in case that if Aristotle were forced to receive one of two propositions that make against his doctrine, which he would admit. Now tell me Simplicius, if Aristotle should be constrained by evident experience to alter in part this his disposure and order of the Universe, and confesse himself to have been deceived in one of these two propositions, namely, either in placing the Earth in the centre, or in saying, that the Cœlestial Spheres do move about that centre, which of the two confessions think you would he choose?

Simpl.I believe, that if it should so fall out, the Peripateticks.

Salv.I do not ask the Peripateticks, I demand of Aristotle, for as to those, I know very well what they would reply; they, as observant and humble vassals of Aristotle, would deny all the experiments and all the observations in the World, nay, would also refuse to see them, that they might not be forced to acknowledg them, and would say that the World stands as Aristotle writeth, and not as nature will have it, for depriving them of the shield of his Authority, with what do you think they would appear in the field? Tell me therefore what you are perswaded Aristotle himself would do in the case.

Simpl.To tell you the truth, I know not how to resolve which of the two inconveniences is to be esteemed the lesser.

Salv.Apply not I pray you this term of inconvenience to a thing which possibly may of necessity be so. It was an inconvenience to place the Earth in the centre of the Cœlestial revolutions; but seeing you know not to which part he would incline, I esteeming him to be a man of great judgment, let us examine which of the two choices is the more rational, and that we will hold that Aristotle would have received. Reassuming therefore our discourse from the beginning, we suppose with the good liking of Aristotle, that the World (of the magnitude of which we have no

sensible notice beyond the fixed stars) as being of a spherical figure; and moveth circularly, hath necessarily, and in respect of its figure a centre; and we being moreover certain, that within the starry Sphere there are many Orbs, the one within another, with their stars, which likewise do move circulary, it is in dispute whether it is most reasonable to believe and to say that these conteined Orbs do move round the said centre of the World, or else about some other centre far remote from that? Tell me now Simplicius what you think concerning this particular.

Its more rational that the Orb conteining, and the parts conteined, do move all about one centre, than upon divers.Simpl.If we could stay upon this onely supposition, and that we were sure that we might encounter nothing else that might disturb us, I would say that it were much more reasonable to affirm that the Orb containing, and the parts contained, do all move about one common centre, than about divers.

If the centre of the World be the same with that about which the planets move, the Sun and not the Earth is placed in it.Salv.Now if it were true that the centre of the World is the same about which the Orbs of mundane bodies, that is to say, of the Planets, move, it is most certain that it is not the Earth, but the Sun rather that is fixed in the centre of the World. So that as to this first simple and general apprehension, the middle place belongeth to the Sun, and the Earth is as far remote from the centre, as it is from that same Sun.

Simpl.But from whence do you argue that not the Earth, but the Sun is in the centre of the Planetary revolutions?

Salv.I infer the same from most evident, and therefore necessarily concludent observations, of which the most palpable to exclude the Earth from the said centre,Observations from whence it is collected that the Sun and not the Earth is in the centre of the Celestial revolutions. and to place the Sun therein, are, the seeing all the Planets one while neerer and another while farther off from the Earth with so great differences, that for example, Venus when it is at the farthest, is six times more

remote from us, than when it is neerest, and Mars riseth almost eight times as high at one time as at another. See therefore whether Aristotle was not somewhat mistaken in thinking that it was at all times equidistant from us.

Simpl.What in the next place are the tokens that their motions are about the Sun?

Salv.It is argued in the three superiour planets Mars, Jupiter, and Saturn, in that we find them alwayes neerest to the Earth when they are in opposition to the Sun, and farthest off when they are towards the conjunction, and this approximatian and recession importeth thus much that Mars neer at hand, appeareth very neer 60 times greater than when it is remote.The mutation of figure in Venus argueth its motion to be about the Sun. As to Venus in the next place, and to Mercury, we are certain that they revolve about the Sun, in that they never move far from him, and in that we see them one while above and another while below it,The Moon cannot seperate from the Earth. as the mutations of figure in Venus necessarily argueth. Tonching the Moon it is certain, that she cannot in any way seperate from the Earth, for the reasons that shall be more distinctly alledged hereafter.

Sagr.I expect that I shall hear more admirable things that depend upon this annual motion of the Earth, than were those dependant upon the diurnal revolution.

Salv.You do not therein erre:The annual motion of the Earth mixing with the motions of the other Planets produce extravagant appearances. For as to the operation of the diurnal motion upon the Celestial bodies, it neither was, nor can be other, than to make the Universe seem to run precipitately the contrary way; but this annual motion intermixing with the particular motions of all the planets, produceth very many extravagancies, which have disarmed and non-plust all the greatest Scholars in the World. But returning to our first general apprehensions, I reply that the centre of the Celestial conversions of the five planets Saturn, Jupiter, Mars, Venus and Mercury, is the Sun; and shall be likewise the centre of the motion of the Earth, if we do but succeed in our attempt of placing it in Heaven. And as for the

Moon, this hath a circular motion about the Earth, from which (as I said before) it can by no means alienate it self, but yet doth it not cease to go about the Sun together with the Earth in an annual motion.

Simpl.I do not as yet very well apprehend this structure, but it may be, that with making a few draughts thereof, one may better and more easily discourse concerning the same.

Salv.Tis very true: yea for your greater satisfaction and admiration together, I desire you, that you would take the pains to draw the same; and to see that although you think you do not apprehend it, yet you very perfectly understand it; And onely by answering to my interrogations you shall designe it punctually. Take therefore a sheet of paper and Compasses;The Systeme of the Universe designed from the appearances. And let this white paper be the immense expansion of the Universe; in which you are to distribute and dispose its parts in order, according as reason shall direct you. And first, in regard that without my instruction you verily believe that the Earth is placed in this Universe, therefore note a point at pleasure, about which you intend it to to be placed, and mark it with some characters.

Simpl.Let this mark A be the place of the Terrestrial Globe.

Salv.Very well. I know secondly, that you understand perfectly that the said Earth is not within the body of the Sun, nor so much as contiguous to it, but distant for some space from the same, and therefore assign to the Sun what other place you best like, as remote from the Earth as you please, and mark this in like manner.

Simpl.Here it is done: Let the place of the Solar body be O.

Salv.These two being constituted, I desire that we may think of accomodating the body of Venus in such a manner that its state and motion may agree with what sensible experiments do shew us; and therefore recall to mind that which either by the past discourses, or your own observations you have learnt to befal that star, and afterwards assign unto it that state which you think agreeth with the same.

Simpl.Supposing those Phænomena expressed by you, and which I have likewise read in the little treatise of Conclusions, to [illustration] be true, namely, that that star never recedes from the Sun beyond such a determinate space of 40 degrees or thereabouts, so as that it never cometh either to apposition with the Sun, or so much as to quadrature, or yet to the sextile aspect; and more than that,Venus very great towards the respective conjunction and very small towards the matutine. supposing that it sheweth at one time almost 40 times greater than at another; namely, very great, when being retrograde, it goeth to the vespertine conjnnction of the Sun, and very small when with a motion straight forwards, it goeth to the matutine conjunction; and moreover it being true, that when it appeareth bigge it shews with a corniculate figure, and when it appeareth little, it seems perfectly round, these appearances, I say, being true, I do not see how one can choose but affirm the said star to revolve in a circle about the Sun,Venus necessarily proved to move about the Sun. for that the said circle cannot in any wise be said to encompasse or to contain the Earth within it, nor to be inferiour to the Sun, that is between it and the Earth, nor yet superiour to the Sun. That circle cannot incompasse the Earth, because Venus would then sometimes come to opposition with the Sun; it cannot be inferiour, for then Venus in both its conjunctions with the Sun would seem horned; nor can it be superiour, for then it would alwayes appear round, and never cornicular; and therefore for receit of it I will draw the circle CH, about the Sun, without encompassing the Earth.

Salv.Having placed Venus, it is requisite that you think of Mercury, which, as you know, alwayes keeping about the Sun, doth recede lesse distance from it than Venus; therefore consider with your self, what place is most convenient to assign it.

Simpl.It is not to be questioned,The revolution of Mercury concluded to be about the Sun, within the Orb of Venus. but that this Planet imitating Venus, the most commodious place for it will be, a lesser circle within this of Venus, in like manner about the Sun, being that of its greatest vicinity to the Sun, an argument, an evidence

sufficiently proving the vigour of its illumination, above that of Venus, and of the other Planets, we may therefore upon these considerations draw its Circle, marking it with the Characters BG.

Salv.But Mars,Mars necessarily includeth within its Orb the Earth, and also the Sun. Where shall we place it?

Simpl.Mars, Because it comes to an opposition with the Sun, its Circle must of necessity encompass the Earth; But I see that it must necessarily encompass the Sun also, for coming to conjunction with the Sun, if it did not move over it, but were below it, it would appear horned, as Venus and the Moon; but it shews alwayes round, and therefore it is necessary, that it no less includeth the Sun within its circle than the Earth.Mars at its opposition to the Sun shews to be sixty times bigger than towards the conjunction. And because I remember that you did say, that when it is in opposition with the Sun, it seems 60 times bigger than when it is in the conjunction, me thinks that a Circle about the Centre of the Sun, and that taketh in the earth, will very well agree with these Phænomena, which I do note and mark DI, where Mars in the point D, is near to the earth, and opposite to the Sun; but when it is in the point I, it is at Conjuction with the Sun, but very far from the Earth. And because the same appearances are observed in Jupiter and Saturn,Jupiter and Saturn do likewise encompasse the Earth, and the Sun. although with much lesser difference in Jupiter than in Mars, and with yet lesse in Saturn than in Jupiter; me thinks I understand that we should very commodiously salve all the Phænomena of these two Planets, with two Circles, in like manner, drawn about the Sun, and this first for Jupiter, marking it EL, and another above that for Saturn marked FM.

Salv.You have behaved your self bravely hitherto.The approximation and recession of the three superiour Planets, importeth double the Suns distance. And because (as you see) the approach and recession of the three Superiour Planets is measured with double the distance between the Earth and Sun, this maketh greater difference in

Mars than in Jupiter, the Circle DI,The difference of the apparent magnitude lesse in Saturn, than in Jupiter, an dn Jupiter than in Mars, and why. of Mars, being lesser than the Circle EL, of Jupiter, and likewise because this EL, is lesse than this Circle FM, of Saturn, the said difference is also yet lesser in Saturn than in Jupiter, and that punctually answereth the Phænomena. It remains now that you assign a place to the Moon.

Simpl.Following the same Method (which seems to me very conclusive) in regard we see that the Moon cometh to conjunction and opposition with the Sun,The Moons Orb invironeth the Earth, but not the Sun. it is necessary to say, that its circle encompasseth the Earth, but yet doth it not follow, that it must environ the Sun, for then at that time towards its conjunction, it would not seem horned, but alwayes round and full of Light. Moreover it could never make, as it often doth, the Eclipse of the Sun, by interposing betwixt it and us; It is necessary therefore to assign it a circle about the Earth, which should be this NP, so that being constituted in P, it will appear from the Earth A, to be in conjunction with the Sun, and placed in N, it appeareth opposite to the Sun, and in that position it may fall under the Earths shadow, and be obscured.

Salv.Now, Simplicius, what shall we do with the fixed stars? Shall we suppose them scattered through the immense abisses of the Universe, at different distances, from any one determinate point; or else placed in a superficies spherically distended about a centre of its own, so that each of them may be equidistant from the said centre?

Simpl.I would rather take a middle way;The probable situation of the fixed stars. and would assign them an Orb described about a determinate centre and comprized within two spherical superficies, to wit, one very high, and concave, and the other lower,Which ought to be accounted the sphere of the Universe. and convex, betwixt which I would constitute the innumerable multitude of stars, but yet at divers altitudes, and this might be called the Sphere of the Universe, conteining within it

the Orbs of the planets already by us described.

Salv.But now we have all this while, Simplicius, disposed the mundane bodies exactly, according to the order of Copernicus, and we have done it with your hand; and moreover to each of them you have assigned peculiar motions of their own, except to the Sun, the Earth, and starry Sphere; and to Mercury with Venus, you have ascribed the circular motion about the Sun, without encompassing the Earth; about the same Sun you make the three superiour Planets Mars, Jupiter, and Saturn, to move, comprehending the Earth within their circles. The Moon in the next place can move in no other manner than about the Earth, without taking in the Sun, and in all these motions you agree also with the same Copernicus. There remains now three things to be decided between the Sun, the Earth, and fixed stars, namely, Rest,Rest, the annual motion and the diurnal ought to be distributed betwixt the Sun, Earth, and Firmament. which seemeth to belong to the Earth; the annual motion under the Zodiack, which appeareth to pertain to the Sun; and the diurnal motion, which seems to belong to the Starry Sphere, and to be by that imparted to all the rest of the Universe, the Earth excepted, And it being true that all the Orbs of the Planets, I mean of Mercury,In a moveable sphere, it seemeth more reasonable that its centre be stable, than any other of its parts.Venus, Mars, Jupiter, and Saturn, do move about the Sun as their centre; rest seemeth with so much more reason to belong to the said Sun, than to the Earth, in as much as in a moveable Sphere, it is more reasonable that the centre stand still, than any other place remote from the said centre; to the Earth therefore, which is constituted in the midst of moveable parts of the Universe, I mean between Venus and Mars, one of which maketh its revolution in nine moneths, and the other in two years, may the motion of a year very commodiously be assigned, leaving rest to the Sun.Granting to the Earth the annual, it must of necessity also have the diurnal motion assigned to it. And if that be so, it followeth of necessary consequence, that likewise the diurnal motion belongeth to the Earth; for, if the Sun standing still, the Earth should not revolve about its self, but have

onely the annual motion about the Sun, our year would be no other than one day and one night, that is six moneths of day, and six moneths of night, as hath already been said. You may consider withal how commodiously the precipitate motion of 24 hours is taken away from the Universe, and the fixed stars that are so many Suns, are made in conformity to our Sun to enjoy a perpetual rest. You see moreover what facility one meets with in this rough draught to render the reason of so great appearances in the Celestial bodies.

Sagr.I very well perceive that facility, but as you from this simplicity collect great probabilities for the truth of that System, others haply could make thence contrary deductions; doubting, not without reason, why that same being the ancient Systeme of Pythagoreans, and so well accommodated to the Phænomena, hath in the succession of so many thousand years had so few followers, and hath been even by Aristotle himself refuted, and since that Copernicus himself hath had no better fortune.

Salv.If you had at any time been assaulted, as I have been, many and many a time, with the relation of such kind of frivolous reasons, as serve to make the vulgar contumacious, and difficult to be perswaded to hearken, (I will not say to consent) to this novelty, I believe that you wonder at the paucity of those who are followers of that opinion would be much diminished.Discourses more than childish, serve to keep fools in the opinion of the Earths stability. But small regard in my judgement, ought to be had of such thick sculs, as think it a most convincing proof to confirm, and steadfastly settle them in the belief of the earths immobility, to see that if this day they cannot Dine at Constantinople, nor Sup in Jappan, that then the Earth as being a most grave body cannot clamber above the Sun, and then slide headlong down again; Of such as these I say, whose number is infinite, we need not make any reckoning, nor need we to record their foolieries, or to strive to gain to our side as our partakers in subul and sublime opinions, men in whose definition the kind onely is concerned, and the difference is wanting. Moreover, what ground do you think

you could be able to gain, with all the demonstrations of the World upon brains so stupid, as are not able of themselves to know their down right follies? But my admiration, Sagredus, is very different from yours, you wonder that so few are followers of the Pythagorean Opinion; and I am amazed how there could be any yet left till now that do embrace and follow it:A declaration of the improbability of Copernicus his opinion. Nor can I sufficiently admire the eminencie of those mens wits that have received and held it to be true, and with the sprightlinesse of their judgements offered such violence to their own sences, as that they have been able to prefer that which their reason dictated to them, to that which sensible experiments represented most manifestly on the contrary. That the reasons against the Diurnal virtiginous revolution of the Earth by you already examined, do carry great probability with them, we have already seen; as also that the Ptolomaicks, and Aristotelicks, with all their Sectators did receive them for true, is indeed a very great argument of their efficacie; but those experiments which apertly contradict the annual motion,Reasons and discourse in Aristarcus and Copernicus prevailed over manifest sence. are of yet so much more manifestly repugnant, that (I say it again) I cannot find any bounds for my admiration, how that reason was able in Aristarchus and Copernicus, to commit such a rape upon their Sences, as in despight thereof, to make her self mistress of their credulity.

Sagr.Are we then to have still more of these strong oppositions against this annual motion?

Salv.We are, and they be so evident and sensible, that if a sence more sublime and excellent than those common and vulgar, did not take part with reason, I much fear, that I also should have been much more averse to the Copernican Systeem than I have been since the time that a clearer lamp than ordinary hath enlightned me.

Sagr.Now therefore Salviatus, let us come to joyn battail for every word that is spent on any thing else, I take to be cast away.

Salv.I am ready to serve you. You have already seen me draw the form of the Copernican Systeme;Mars makes an hot assault upon the Copernican Systeme. against the truth of which Mars himself, in the first place, makes an hot charge; who, in case it were true, that its distances from the earth should so much vary, as that from the least distance to the greatest, there were twice as much differences, as from the earth to the Sun; it would be necessary, that when it is nearest unto us, its discus would shew more than 60. times bigger than it seems, when it is farthest from us; nevertheless that diversity of apparent magnitude is not to be seen, nay in its opposition with the Sun, when its nearest to the Earth, it doth not shew so much as quadruple and quintuple in bigness, to what it is, when towards the conjunction it cometh to be occulted under the Suns rayes. Another and greater difficulty doth Venus exhibit; For if revolving about the Sun, as Copernicus affirmeth,The Phænomena of Venus appear contrary to the Systeme of Copernicus. it were one while above, & another while below the same, receding and approaching to us so much as the Diameter of the circle described would be, at such time as it should be below the Sun, and nearest to us, its discus would shew little less than 40 times bigger than when it is above the Sun, near to its other conjunction; yet neverthelesse,Another difficulty raised by Venus against Copernicus. the difference is almost imperceptible Let us add another difficulty, that in case the body of Venus be of it self dark, and onely shineth as the Moon, by the illumination of the Sun, which seemeth most reasonable; it would shew forked or horned at such time as it is under the Sun, as the Moon doth when she is in like manner near the Sun; an accident that is not to be discovered in her.Venus, according to Copernicus, either lucid in it self, or else of a transparent substance. Whereupon Copernicus affirmeth, that either she is light of her self, or else that her substance is of such a nature, that it can imbue the Solar light, and transmit the same through all its whole depth, so as to be able to appear to us alwayes shining; and in this manner Copernicus excuseth the not changing figure in Venus: but of her small variation of Magnitude,Copernicus

speaketh nothing of the small variation of bigness in Venus and in Mars. he maketh no mention at all; and much less of Mars than was needful; I believe as being unable so well as he desired to salve a Phænomenon so contrary to his Hypothesis, and yet being convinced by so many other occurrences and reasons he maintained, and held the same Hypothesis to be true. Besides these things, to make the Planets, together with the Earth, to move above the Sun as the Centre of their conversions, and the Moon onely to break that order,The moon much disturbeth the order of the other Planets. and to have a motion by it self about the earth; and to make both her, the Earth, and the whole Elementary Sphere, to move all together about the Sun in a year, this seemeth to pervert the order of this Systeme, which rendreth it unlikely and false. These are those difficulties that make me wonder how Aristarchus and Copernicus, who must needs have observed them, not having been able for all that to salve them, have yet notwithstanding by other admirable occurrences been induced to confide so much in that which reason dictated to them, as that they have confidently affirmed that the structure of the Universe could have no other figure than that which they designed to themselves. There are also several other very serious and curious doubts, not so easie to be resolved by the middle sort of wits, but yet penetrated and declared by Coperninus, which we shall defer till by and by, after we have answered to other objections that seem to make against this opinion. Now coming to the declarations and answers to those three before named grand Objections, I say, that the two first not onely contradict not the Copernican Systeme,Answers to the three first objections against the Copernican Systeme. but greatly and absolutely favour it; For both Mars and Venus seems unequal to themselves, according to the proportions assigned; and Venus under the Sun seemeth horned, and goeth changing figures in it self exactly like the Moon.

Sagr.But how came this to be concealed from Copernicus, and revealed to you?

Salv.These things cannot be comprehended, save onely by the sense of seeing, the which by nature was not granted to man so perfect, as that it was able to attain to the

discovery of such differences; nay even the very instrument of sight is an impediment to it self: But since that it hath pleased God in our age to vouchsafe to humane ingenuity, so admirable an invention of perfecting our sight, by multiplying it four, six, ten, twenty, thirty, and fourty times, infinite objects, that either by reason of their distance, or for their extream smallnesse were invisible unto us, have by help of the Telescope been rendered visible.

Sagr.But Venus and Mars are none of the objects invisible for their distance or smallnesse, yea, we do discern them with our bare natural sight; why then do we not distinguish the differences of their magnitudes and figures?

Salv.In this,The reason whence it happens that Venus and Mars do not appear to vary magnitude so much as is requisite. the impediment of our very eye it self hath a great share, as but even now I hinted, by which the resplendent and remote objects are not represented to us simple and pure; but gives them us fringed with strange and adventitious rayes, so long and dense, that their naked body sheweth to us agrandized, ten twenty, an hundred, yea a thousand times more than it would appear, if the capillitious rayes were taken away.

Sagr.Now I remember that I have read something on this subject, I know not whether in the Solar Letters, or in the Saggiatore of our common Friend, but it would be very good, aswell for recalling it into my memory, as for the information of Simplicius, who it may be never saw those writings, that you would declare unto us more distinctly how this businesse stands, the knowledge whereof I think to be very necessary for the assisting of us to understand that of which we now speak. Simpl.I must confesse that all that which Salviatus hath spoken is new unto me, for truth is, I never have had the curiosity to read those Books, nor have I hitherto given any great credit to the Telescope newly introduced;The operations of the Telescope accounted fallacies by the Peripateticks. rather treading in the steps of other Peripatetick Philosophers my companions, I have thought those things to be fallacies

and delusions of the Chrystals, which others have so much admired for stupendious operations: and therefore if I have hitherto been in an errour, I shall be glad to be freed from it, and allured by these novelties already heard from you, I shall the more attentively hearken to the rest.

Salv.The confidence that these men have in their own apprehensivenesse, is no less unreasonable than the small esteem they have of the judgment of others: yet its much that should esteem themselves able to judge better of such an instrument, without ever having made trial of it, than those who have made, and daily do make a thousand experiments of the same: But I pray you, let us leave this kind of pertinacious men, whom we cannot so much as tax without doing them too great honour. And returning to our purpose,Shining objects seem environed with adventitious rayes. I say, that resplendent objects, whether it is that their light doth refract on the humidity that is upon the pupils, or that it doth reflect on the edges of the eye-browes, diffusing its reflex rayes upon the said pupils, or whether it is for some other reason, they do appear to our eye, as if they were environ'd with new rayes, and therefore much bigger than their bodies would represent themselves to us, were they divested of those irradiations. The reason why luminous bodies appear enlarged much the more, by how much they are lesser. And this aggrandizement is made with a greater and greater proportion, by how much those lucid objects are lesser and lesser; in the same manner for all the world, as if we should suppose that the augmentation of shining locks were v. g. four inches, which addition being made about a circle that hath four inches diameter would increase its appearance to nine times its former bignesse: but———

Simpl.I believe you would have said three times; for adding four inches to this side, and four inches to that side of the diameter of a circle, which is likewise four inches, its quantity is thereby tripled, and not made nine times bigger.

Salv.A little more Geometry would do well,Superficial figures encreasing

proportion double to their lines.Simplicius. True it is, that the diameter is tripled, but the superficies, which is that of which we speak, increaseth nine times: for you must know, Simplicius, that the superficies of circles are to one another, as the squares of their diameters; and a circle that hath four inches diameter is to another that hath twelve, as the square of four to the square of twelve; that is, as 16. is to 144. and therefore it shall be increased nine times, and not three; this, by way of advertisement to Simplicius. And proceeding forwards, if we should add the said irradiation of four inches to a circle that hath but two inches of diameter onely, the diameter of the irradiation or Garland would be ten inches, and the superficial content of the circle would be the area of the naked body, as 100. to 4. for those are the squares of 10. and of 2. the agrandizement would therefore be 25. times so much; and lastly, the four inches of hair or fringe, added to a small circle of an inch in diameter, the same would be increased 81. times; and so continually the augmentations are made with a proportion greater and greater, according as the real objects that increase, are lesser and lesser.

Sagr.The doubt which puzzled Simplicius never troubled me, but certain other things indeed there are, of which I desire a more distinct understanding; and in particular, I would know upon what ground you affirm that the said agrandizement is alwayes equal in all visible objects.Objects the more vigorous they are in light, the more they do seem to increase.

Salv.I have already declared the same in part, when I said, that onely lucid objects so increased, and not the obscure; now I adde what remaines, that of the resplendent objects those that are of a more bright light, make the reflection greater and more resplendent upon our pupil; whereupon they seem to augment much more than the lesse lucid: and that I may no more inlarge my self upon this particular, come we to that which the true Mistris of Astronomy, Experience, teacheth us. Let us this evening, when the air is very obscure, observe the star of Jupiter; we shall see it very glittering,An easie experiment that sheweth the increase in the stars, by means of the

adventitious rays. and very great; let us afterwards look through a tube, or else through a small trunk, which clutching the hand close, and accosting it to the eye, we lean between the palm of the hands and the fingers, or else by an hole made with a small needle in a paper; and we shall see the said star divested of its beams, but so small, that we shall judge it lesse, even than a sixtieth part of its great glittering light seen with the eye at liberty: we may afterwards behold the Dog-stars beautiful and bigger than any of the other fixed stars,Jupiter augments lesse than the Dogstar. which seemeth to the bare eye no great matter lesse than Jupiter; but taking from it, as before, the irradiation, its Discus will shew so little, that it will not be thought the twentieth part of that of Jupiter, nay, he that hath not very good eyes, will very hardly discern it; from whence it may be rationally inferred, that the said star, as having a much more lively light than Jupiter, maketh its irradiation greater than Jupiter doth his. In the next place, as to the irradiation of the Sun and Moon,The Sun and Moon increase little. it is as nothing, by means of their magnitude, which possesseth of it self alone so great a space in our eye, that it leaveth no place for the adventitious rayes; so that their faces seem close clipt, and terminate. We may assure our selves of the same truth by another experiment which I have often made triall of; we may assure ourselves,It is seen by manifest experience, that the more splendid bodies do much more irradiate than the lesse lucid. I say, that bodies shining with most lively light do irradiate, or beam forth rayes more by far than those that are of a more languishing light. I have many times seen Jupiter and Venus together twenty or thirty degrees distant from the Sun, and the air being very dark, Venus appeared eight or ten times bigger than Jupiter, being both beheld by the eye at liberty; but being beheld afterwards with the Telescope, the Discus of Jupiter discovered it self to be four or more times greater than that of Venus, but the vivacity of the splendour of Venus was incomparably bigger than the languishing light of Jupiter; which was only because of Jupiters being far from the Sun, and from us; and Venus neer to us, and to the Sun. These things premised, it will not be

difficult to comprehend, how Mars, when it is in opposition to the Sun, and therefore neerer to the Earth by seven times, and more, than it is towards the conjunction, cometh to appear scarce four or five times bigger in that state than in this, when as it should appear more than fifty times so much; of which the only irradiation is the cause; for if we divest it of the adventitious rayes, we shall find it exactly augmented with the due proportion: but to take away the capillitious border,The Telescope is the best means to take away the irradiations of the Stars. the Telescope is the best and only means, which inlarging its Discus nine hundred or a thousand times, makes it to be seen naked and terminate, as that of the Moon,Another second reason of the small apparent increase of Venus. and different from it self in the two positions, according to its due proportions to an hair. Again, as to Venus, that in its vespertine conjunction, when it is below the Sun, ought to shew almost fourty times bigger than in the other matutine conjunction, and yet doth not appear so much as doubled; it happeneth, besides the effect of the irradiation, that it is horned; and its crescents, besides that they are sharp, they do receive the Suns light obliquely, and therefore emit but a faint splendour; so that as being little and weak, its irradiation becometh the lesse ample and vivacious, than when it appeareth to us with its Hemisphere all shining: but now the Telescope manifestly shews its hornes to have been as terminate and distinct as those of the Moon, and appear, as it were, with a great circle, and in a proportion those well neer fourty times greater than its same Discus, at such time as it is superiour to the Sun in its ultimate matutine apparition.

Sagr.Oh, Nicholas Copernicus, how great would have been thy joy to have seen this part of thy Systeme, confirmed with so manifest experiments!

Salv.Tis true.Copernicus perswaded by reasons contrary to sensible experiments. But how much lesse the fame of his sublime wit amongst the intelligent? when as it is seen, as I also said before, that he did constantly continue to affirm (being perswaded thereto by reason) that which sensible experiments seemed to contradict; for I cannot cease to wonder that he should constantly persist in saying, that Venus

revolveth about the Sun, and is more than six times farther from us at one time, than at another; and also seemeth to be alwayes of an equal bigness, although it ought to shew forty times bigger when nearest to us, than when farthest off.

Sagr.But in Jupiter, Saturn and Mercury, I believe that the differences of their apparent magnitudes, should seem punctually to answer to their different distances.

Salv.In the two Superiour ones, I have made precise observation yearly for this twenty two years last past:Mercury admitteth not of clear observations. In Mercury there can be no observation of moment made, by reason it suffers not it self to be seen, save onely in its greatest digrssieons from the Sun, in which its distances from the earth are insensibly unequal, and those differences consequently not to be observed; as also its mutations of figures which must absolutely happen in it, as in Venus. And if we do see it, it must of necessity appear in form of a Semicircle, as Venus likewise doth in her greatest digressions; but its discns is so very small, and its splendor so very great, by reason of its vicinity to the Sun, that the virtue of the Telescope doth not suffice to clip its tresses or adventitious rayes,The difficulties removed that arise from the Earths moving about the Sun, not solitarily, but in consort with the Moon. so as to make them appear shaved round about. It remains, that we remove that which seemed a great inconvenience in the motion of the Earth, namely that all the Planets moving about the Sun, it alone, not solitary as the rest, but in company with the Moon, and the whole Elementary Sphear, should move round about the Sun in a year; and that the said Moon withal should move every moneth about the earth. Here it is necessary once again to exclaim and extol the admirable perspicacity of Copernicus, and withal to condole his misfortune, in that he is not now alive in our dayes, when for removing of the seeming absurdity of the Earth and Moons motion in consort we see Jupiter, as if it were another Earth, not in consort with the Moon, but accompanied by four Moons to rovolve about the Sun in 12. years together, with what ever things the Orbs of the four Medicaean Stars can contain within them.

Salv.Why do you call the four jovial Planets, Moons?

Sagr.Such they would seem to be to one that standing in Jupiter should behold them;The Medicean Stars are as it were four Moons about Jupiter. for they are of themselves dark, and receive their light from the Sun, which is manifest from their being eclipsed, when they enter into the cone of Jupiters shadow: and because onely those their Hemispheres, that look towards the Sun are illuminated, to us that are without their Orbs, and nearer to the Sun, they seem alwayes lucid, but to one that should be in Jupiter, they would shew all illuminated, at such time as they were in the upper parts of their circles; but in the parts inferiour, that is between Jupiter and the Sun, they would from Jupiter be observed to be horned; and in a word they would, to the observators standing in Jupiter, make the self same changes of Figure, that to us upon the Earth, the Moon doth make. You see now how these three things, which at first seemed dissonant, do admirably accord with the Copernican Systeme. Here also by the way may Simplicius see, with what probability one may conclude, that the Sun and not the Earth, is in the Centre of the Planetary conversions. And since the Earth is now placed amongst mundane Bodies, that undoubtedly move about the Sun, to wit, above Mercury and Venus, and below Saturn, Jupiter, and Mars; shall it not be in like manner probable, and perhaps necessary to grant, that it also moveth round?

Simpl.These accidents are so notable and conspicuous, that it is not possible, but that Ptolomy and others his Sectators, should have had knowledge of them, and having so, it is likewise necessary, that they have found a way to render reasons of such, and so sensible appearances that were sufficient, and also congruous and probable, seeing that they have for so long a time been received by such numbers of learned men.

Salv.You argue very well;The Principal scope of Astronomers, is to give a reason of appearances. but you know that the principal scope of Astronomers, is to render only

reason for the appearances in the Cælestial Bodies, and to them, and to the motions of the Stars, to accomodate such structures and compositions of Circles, that the motions following those calculations, answer to the said appearances, little scrupling to admit of some exorbitances, that indeed upon other accounts they would much stick at. And Copernicus himself writes,Copernicus restored Astronomy upon the suppositions of Ptolomy: that he had in his first studies restored the Science of Astronomy upon the very suppositions of Ptolomy, and in such manner corrected the motions of the Planets, that the computations did very exactly agree with the Phænomena, and the Phænomena with the supputations, in case that he took the Planets severally one by one. But he addeth, that in going about to put together all the structures of the particular Fabricks, there resulted thence a Monster and Chimæra, composed of members most disproportionate to one another, and altogether incompatible; So that although it satisfied an Astronomer meerly Arithmetical, yet did it not afford satisfaction or content to the Astronomer Phylosophical.What moved Copernicus to establish his Systeme. And because he very well understood, that if one might salve the Cælestial appearances with false assumptions in nature, it might with much more ease be done by true suppositions, he set himself diligently to search whether any amongst the antient men of fame, had ascribed to the World any other structure, than that commonly received by Ptolomy; and finding that some Pythagoreans had in particular assigned the Diurnal conversion to the Earth, and others the annual motion also, he began to compare the appearances, and particularities of the Planets motions, with these two new suppositions, all which things jumpt exactly with his purpose; and seeing the whole correspond, with admirable facility to its parts, he imbraced this new Systeme, and it took up his rest.

Simpl.But what great exorbitancies are there in the Ptolomaick Systeme, for which there are not greater to be found in this of Copernicus?

Salv.In the Ptolomaick Hypothesis there are diseases,Inconveniencies that are in the

Systeme of Ptolomy. and in the Copernican their cures. And first will not all the Sects of Phylosophers, account it a great inconvenience, that a body naturally moveable in circumgyration, should move irregularly upon its own Centre, and regularly upon another point? And yet there are such deformed motions as these in the Ptolomæan Hypothesis, but in the Copernican all move evenly about their own Centres. In the Ptolomaick, it is necessary to assign to the Cælestial bodies, contrary motions, and to make them all to move, from East to West, and at the same time, from West to East; But in the Copernican, all the Cælestial revolutions are towards one onely way, from West to East. But what shall we say of the apparent motion of the Planets, so irregular, that they not only go one while swift, and another while slow, but sometimes wholly seace to move; and then after a long time return back again? To salve which appearances Ptolomie introduceth very great Epicicles, accommodating them one by one to each Planet, with some rules of incongruous motions, which are all with one single motion of the Earth taken away. And would not you, Simplicius, call it a great absurditie, if in the Ptolomaick Hypothesis, in which the particular Planets, have their peculiar Orbs assigned them one above another, one must be frequently forced to say, that Mars, constituted above the Sphære of the Sun, doth so descend, that breaking the Solar Orb, it goeth under it, and approacheth nearer to the Earth, than to the Body of the Sun, and by and by immeasurably ascendeth above the same? And yet this, and other exorbitancies are remedied by the sole and single annual motion of the Earth.

Sagr.I would gladly be bettter informed how these stations, and retrograde and direct motions, which did ever seem to me great improbalities, do accord in this Copernican Systeme.

Salv.You shall see them so to accord,Its a great Argument in favour of Copernicus, that he obviates the stations & retrogradations of the motions of the Planets. Sagredus, that this onely conjecture ought to be sufficient to make one that is not more than pertinacious or stupid, yield, assent to all the rest of this Doctrine. I tell

you therefore, that nothing being altered in the motion of Saturn, which is 30 years, in that of Jupiter, which is 12, in that of Mars, which is 2, in that of Venus, which is 9. moneths, in that of Mercury, which is 80. dayes, or thereabouts, the sole annual motion of the Earth between Mars and Venus,The sole annual motion of the Earth causeth great inequality of motions in the five Planets. causeth the apparent inequalities in all the five stars before named. And for a facile and full understanding of the whole, I will describe this figure of it. Therefore suppose the Sun to be placed in the centre O, about which we will draw the Orb described by the Earth, with the annual motion BGM, and let the circle described, v. gr. by Jupiter about the Sun in 12. years, be this BGM, and in the starry sphere let us imagine the Zodiack YVS.

A demonstration of the inequalities of the three superiour Planets dependent on the annual motion of the Earth. Again, in the annual Orb of the Earth let us take certain equal arches, BC, CD, EF, FG, GH, HI, IK, KL, LM}}, and in the Sphere of Jupiter let us make certain other arches, passed in the same times in which the Earth passeth hers, which let be BC, CD, DE, EF, FG, GH, HI, IK, KL, LM, which shall each be proportionally lesse than these marked in the Earths Orb, like as the motion of Jupiter under the Zodiack is slower than the annual. Supposing now, that when the Earth is in B, Jupiter is in B, it shall appear to us in the Zodiack to be in P, describing the right line BbP. Next suppose the Earth to be moved from B to C, and Jupiter from B to C, in the same time; Iupiter shall appear to have passed in the Zodiack to Q, and to have moved straight forwards, according to the order of the signes PQ. In the next place, the Earth passing to D, and Iupiter to D, it shall be seen in the Zodiack in R, and from E, Iupiter being come to E; will appear in the Zodiack in S, having all this while moved right forwards. But the Earth afterwards beginning to interpose more directly between Iupiter and the Sun, she being come to F, and Iupiter to F, he will appear in T, to have already begun to return apparently back again under the Zodiack, and in that time that the Earth shall have pased the arch EF,

Iupiter shall have entertained himself between the points ST, and shall have appeared to us almost motionlesse and stationary. The Earth being afterwards come to G, and Iupiter to G, in opposition to the Sun, it shall be visible in the Zodiack at V, and much returned backwards by all the arch of the Zodiack TV; howbeit that all the way pursuing its even course it hath really gone forwards not onely in its own circle, but in the Zodiack also in respect to the centre of the said Zodiack, and to the Sun placed in the same. The Earth and Iupiter again continuing their motions, when the Earth is come to H, and Iupiter to H, it shall seem very much gone backward in the Zodiack by all the arch VX. The Earth being come to I, and Iupiter to I, it shall be apparently moved in the Zodiack by the little space XY, and there it will seem stationary. When afterwards the Earth shall be come to K, and Iupiter to K; in the Zodiack he shall have passed the arch YN in a direct motion; and the Earth pursuing its course to L, shall see Iupiter in L, in the point Z. And lastly Iupiter in M shall be seen from the Earth M, to have passed to A, with a motion still right forwards; and its whole apparent retrogadation in the Zodiack shall answer to the arch SY, made by Iupiter, whilst that he in his own circle passeth the arch EI, and the Earth in hers the arch EI. And this which hath been said,Retrogradations more frequent in Saturn, lesse in Jupiter, and yet lesse in Mars, and why. is intended of Saturn and of Mars also; and in Saturn those retrogradations are somewhat more frequent than in Jupiter, by reason that its motion is a little slower than that of Jupiter, so that the Earth overtaketh it it in a shorter space of time; in Mars again they are more rare, for that its motion is more swift than that of Jupiter. Whereupon the Earth consumeth more time in recovering it. Next as to Venus and Mercury,The Retrogradation of Venus and Mercury demonstrated by Apollonius and Copernicus. whose Circles are comprehended by that of the Earth, their stations and regressions appear to be occasioned, not by their motions that really are such, but by the anual motion of the said Earth, as Copernicus exellently demonstrateth, together with Appollonius Pergæus in lib. 5. of his Revolutions, Chap. 35.

You see, Gentlemen, with what facility and simplicity the annual motion,The annual motion of the Earth most apt to render a reason of the exorbitances of the five Planets. were it appertaining to the Earth, is accommodated to render a reason of the apparent exorbitances, that are observed in the motions of the five Planets, Saturn, Jupiter, Mars, Venus and Mercury, taking them all away, and reducing them to equal and regular motions.The Sun it self testifieth the annual motion to belong to the Earth. And of this admirable effect, Nicholas Copernicus, hath been the first that hath made the reason plain unto us. But of another effect, no lesse admirable than this, and that with a knot, perhaps more difficult to unknit, bindeth the wit of man, to admit this annual conversion, and to leave it to our Terrestrial Globe; a new and unthought of conjecture ariseth from the Sun it self, which sheweth that it is unwilling to be singular in shifting, of this attestation of so eminent a conclusion, rather as a testimony beyond all exception, it hath desired to be heard apart. Hearken then to this great and new wonder.

The first discoverer and observer of the Solar spots,The Lyncæan Academick the first discoverer of the Solar spots, and all the other celestial novelties. as also of all the other Cœlestial novelties, was our Academick Lincæus; and he discovered them anno 1610. being at that time Reader of the Mathematicks, in the Colledge of Padua, and there, and in Venice,The history of the proceedings of the Academian for a long time about the observation of the Solar spots. he discoursed thereof with several persons, of which some are yet living: And the year following, he shewed them in Rome to many great personages, as he relates in the first of his Letters to Marcus Velserus, ** Duumviro Sheriffe of Augusta. He was the first that against the opinions of the too timorous and too jealous assertors of the Heavens inalterability, affirmed those spots to be matters, that in short times were produced and dissolved: for as to place, they were contiguous to the body of the Sun, and revolved about the same; or else being carried about by the said Solar body, which revolveth in it selfe about its own Centre, in the space almost of a moneth, do finish their course in that

time; which motion he judged at first to have been made by the Sun about an Axis erected upon the plane of the Ecliptick; in regard that the arches described by the said spots upon the Discus of the Sun appear unto our eye right lines, and parallels to the plane of the Ecliptick: which therefore come to be altered, in part, with some accidental, wandring, and irregular motions, to which they are subject, and whereby tumultuarily, and without any order they successively change situations amongst themselves, one while crouding close together, another while dissevering, and some dividing themselves into many and very much changing figures, which, for the most part, are very unusual. And albeit those so inconstant mutations did somewhat alter the primary periodick course of the said spots, yet did they not alter the opinion of our friend, so as to make him believe, that they were any essential and fixed cause of those deviations, but he continued to hold, that all the apparent alterations derived themselves from those accidental mutations: in like manner, just as it would happen to one that should from far distant Regions observe the motion of our Clouds; which would be discovered to move with a most swift, great, and constant motion, carried round by the diurnal Vertigo of the Earth (if haply that motion belong to the same) in twenty four hours, by circles parallel to the Equinoctial, but yet altered, in part, by the accidental motions caused by the winds, which drive them, at all adventures, towards different quarters of the World. While this was in agitation, it came to pass that Velserus sent him two Letters, written by a certain person, under the feigned name of ** This Authors true name is Christopher Scheinerus a Jesuit, and his Book here meant is intituled, Apelles post tabulam. Apelles, upon the subject of these Spots, requesting him, with importunity, to declare his thoughts freely upon those Letters, and withall to let him know what his opinion was touching the essence of those spots; which his request he satisfied in 3 Letters, shewing first of all how vain the conjectures of Apelles were; & discovering, secondly, his own opinions; withal foretelling to him, that Apelles would undoubtedly be better advised in time, and turn to his opinion, as it afterwards came to pass. And because that our Academian

(as it was also the judgment of many others that were intelligent in Natures secrets) thought he had in those three Letters investigated and demonstrated, if not all that could be desired, or required by humane curiosity, at least all that could be attained by humane reason in such a matter, he, for some time (being busied in other studies) intermitted his continual observations, and onely in complacency to some friend, joyned with him, in making now and then an abrupt observation: till that he, and after some years, we, being then at my ** La mia villa delle Selue. Country-seat, met with one of the solitary Solar spots very big, and thick, invited withal by a clear and constant serenity of the Heavens, he, at my request, made observations of the whole progresse of the said spot, carefully marking upon a sheet of paper the places that it was in every day at the time of the Suns coming into the Meridian; and we having found that its course was not in a right line, but somewhat incurvated, we came to resolve, at last, to make other observations from time to time; to which undertaking we were strongly induced by a conceit, that accidentally came into the minde of my Guest, which he imparted to me in these or the like words.

In my opinion, Philip, there is a way opened to a business of very great consequence. For if the Axis about which the Sun turneth be not erect perpendicularly to the plane of the Ecliptick, A concipt that came suddenly into the minde of the Academian Lyncæus concerning the great consequence that followed upon the motion of the Solar spots. but is inclined upon the same, as its crooked course, but even now observed, makes me believe, we shall be able to make such conjectures of the states of the Sun and Earth, as neither so solid or so rational have been hitherto deduced from any other accident whatsoever. I being awakened at so great a promise, importun'd him to make a free discovery of his conceit unto me. And he continued his discourse to this purpose.Extravagant mutations to be observed in the motions of the spots, foreseen by the Academick, in case the Earth had the annual motion. If the Earths motion were along the Ecliptique about the Sun; and the Sun were constituted in the centre of the said Ecliptick, and therein revolved

in its self, not about the Axis of the said Ecliptique (which would be the Axis of the Earths annual motion) but upon one inclined, it must needs follow, that strange changes will represent themselves to us in the apparent motions of the Solar spots, although the said Axis of the Sun should be supposed to persist perpetually and immutably in the same inclination, and in one and the same direction towards the self-same point of the Universe. Therefore the Terrestrial Globe in the annual motion moving round it, it will first follow, that to us, carried about by the same, the courses of the spots shall sometimes seem to be made in right lines, but this only twice a year, and at all other times shall appear to be made by arches insensibly incurvated. Secondly, the curvity of those arches for one half of the year, will shew inclined the contrary way to what they will appear in the other half; that is, for six moneths the convexity of the arches shall be towards the upper part of the Solar Discus, and for the other six moneths towards the inferiour. Thirdly, the spots beginning to appear, and (if I may so speak) to rise to our eye from the left side of the Solar Discus, and going to hide themselves and to set in the right side, the Oriental termes, that is, of their first appearings for six moneths, shall be lower than the opposite termes of their occultations; and for other six moneths it shall happen contrarily, to wit, that the said spots rising from more elevated points, and from them descending, they shall, in their courses, go and hide themselves in lower points; and onely for two dayes in all the year shall those termes of risings and settings be equilibrated: after which freely beginning by small degrees the inclination of the courses of the spots, and day by day growing bigger, in three moneths, it shall arrive at its greatest obliquity, and from thence beginning to diminish, in such another time it shall reduce it self to the other Æquilibrium. It shall happen, for a fourth wonder, that the course of the greatest obliquity shall be the same with the course made by the right line, and in the day of the Libration the arch of the course shall seem more than ever incurvated. Again, in the other times, according as the pendency shall successively diminish, and make it approach

towards the Æquilibrium, the incurvation of the arches of the courses on the contrary shall, by degrees, increase.

Sagr.I confesse, Salviatus, that to interrupt you in your Discourse is ill manners, but I esteem it no lesse rudeness to permit you to run on any farther in words, whilst they are, as the saying is, cast into the air: for, to speak freely, I know not how to form any distinct conceit of so much as one of these conclusions, that you have pronounced; but because, as I thus generally and confusedly apprehend them, they hold forth things of admirable consequence, I would gladly, some way or other, be made to understand the same.

Salv.The same that befalls you, befell me also, whilst my Guest transported me with bare words; who afterwards assisted my capacity,The first Accident to be observed in the motion of the Solar spots; and consequently all the rest explained. by describing the businesse upon a material Instrument, which was no other than a simple Sphere, making use of some of its circles, but to a different purpose from that, to which they are commonly applied. Now I will supply the defect of the Sphere, by drawing the same upon a piece of paper, as need shall require. And to represent the first accident by me propounded, which was, that the courses or journeys of the spots, twice a year, and no more, might be seen to be made in right lines, let us suppose this point O [in Fig. 4.] to be the centre of the grand Orb, or, if you will, of the Ecliptick, and likewise also of the Globe of the Sun it self; of which, by reason of the great distance that is between it and the Earth, we that live upon the Earth, may suppose that we see the one half: we will therefore describe this circle ABCD about the said centre O, which representeth unto us the extream term that divideth and separates the Hemisphere of the Sun that is apparent to us, from the other that is occult. And because that our eye, no lesse than the centre of the Earth, is understood to be in the plane of the Ecliptick, in which is likewise the centre of the Sun, therefore, if we should fancy to our selves the body of the Sun to be cut thorow by the said plane, the section will appear to our eye a right line, which let be BOD,

and upon that a perpendicular being let fall AOC, it shall be the Axis of the said Ecliptick, and of the annual motion of the Terrestrial Globe. Let us next suppose the Solar body (without changing centre) to revolve in it self, not about the Axis AOC (which is the erect Axis upon the plane of the Ecliptick) but about one somewhat inclined, which let be this EOI, the which fixed and unchangeable Axis maintaineth it self perpetually in the same inclination and direction towards the same points of the Firmament, and of the Universe. And because, in the revolutions of the Solar Globe, each point of its superficies (the Poles excepted) describeth the circumference of a circle, either bigger or lesser, according as it is more or lesse remote from the said Poles, let us take the point F, equally distant from them, and draw the diameter FOG, which shall be perpendicular to the Axis EI, and shall be the diameter of the grand circle described about the Poles EI. Supposing not that the Earth, and we with her be in such a place of the Ecliptick, that the Hemisphere of the Sun to us apparent is determin'd or bounded by the circle ABCD, which passing (as it alwayes doth) by the Poles AC, passeth also by EI. It is manifest, that the grand circle, whose diameter is FG, shall be erect to the circle ABCD, to which the ray that from our eye falleth upon the centre O, is perpendicular; so that the said ray falleth upon the plane of the circle, whose diameter is FG, and therefore its circumference will appear to us a right line, and the self same with FG, whereupon if there should be in the point F, a spot, it comming afterwards to be carried about by the Solar conversion, would, upon the surface of the Sun, trace out the circumference of that circle, which seems to us a right line. Its course or passage will therefore seem straight. And straight also will the motion of the other spots appear, which in the said revolution shall describe lesser circles, as being all parallel to the greater, and to our eye placed at an immense distance from them. Now, if you do but consider, how that after the Earth shall in six moneths have run thorow half the grand Orb, and shall be situate opposite to that Hemisphere of the Sun, which is now occult unto us, so as that the boundary of the part that then shall be seen, may be the self same

ABCD, which also shall passe by the Poles EI; you shall understand that the same will evene in the courses of the spots, as before, to wit, that all will appear to be made by right lines. But because that that accident takes not place, save onely when the teminator or boundary passeth by the Poles EI, and the said terminator from moment to moment, by meanes of the Earths annual motion, continually altereth, therefore its passage by the fixed Poles EI, shall be momentary, and consequently momentary shall be the time, in which the motions of those spots shall appear straight. From what hath been hitherto spoken one may comprehend also how that the apparition and beginning of the motion of the spots from the part F, proceeding towards G, their passages or courses are from the left hand, ascending towards the right; but the Earth being placed in the part diametrically opposite the appearance of the spots about G, shall still be to the left hand of the beholder, but the passage shall be descending towards the right hand F. Let us now describe the Earth to be situate one fourth part farther distant from its present state, and let us draw, as in the other figure, the terminator ABCD, [as in Fig. 5.] and the Axis, as before AC, by which the plane of our Meridian would passe, in which plane should also be the Axis of the Suns revolution, with its Poles, one towards us, that is, in the apparent Hemisphere, which Pole we will represent by the point E, and the other shall fall in the occult Hemisphere, and I mark it I. Inclining therefore the Axis EI, with the superiour part E, towards us, the great circle described by the Suns conversion, shall be this BFDG, whose half by us seen, namely BFD, shall no longer seem unto us a right line, by reason the Poles EI are not in the circumference ABCD, but shall appear incurvated, and with its convexity towards the inferiour part C. And it is manifest, that the same will appear in all the lesser circles parallel to the same BFD. It is to be understood also, that when the Earth shall be diametrically opposite to this state, so that it seeth the other Hemisphere of the Sun, which now is hid, it shall of the said great circle behold the part DGB incurved, with its convexity towards the superiour part A; and the courses of the spots in these constitutions shall be first, by the arch BFD, and

afterwards by the other DGB, and the first apparitions and ultimate occultations made about the points B and D, shall be equilibrated, and not those that are more or lesse elevated than these. But if we constitute the Earth in such a place of the Ecliptick, that neither the boundary ABCD, nor the Meridian AC, passeth by the Poles of the Axis EI, as I will shew you anon, drawing this other Figure [viz. Fig. 6.] wherein the apparent or visible Pole E falleth between the arch of the terminator AB, and the section of the Meridian AC; the diameter of the great circle shall be FOG, and the apparent semicircle FNG, and the occult semicircle GSF, the one incurvated with its convexity N towards the inferiour part, and the other also bending with its convexity S towards the upper part of the Sun. The ingressions and exitions of the spots, that is, the termes F and G shall not be librated, as the two others B and D; but F shall be lower, and G higher: but yet with lesser difference than in the first Figure. The arch also FNG shall be incurvated, but not so much as the precedent BFD; so that in this position the passages or motions of the spots shall be ascendent from the left side F, towards the right G, and shall be made by curved lines. And imagining the Earth to be constituted in the position diametrically opposite; so that the Hemisphere of the Sun, which was before the occult, may be the apparent, and terminated by the same boundary ABCD, it will be manifestly discerned, that the course of the spots shall be by the arch GSF, beginning from the upper point G, which shall then be likewise from the left hand of the beholder, and going to determine, descending towards the right, in the point F. What I have hitherto said, being understood, I believe that there remains no difficulty in conceiving how from the passing of the terminator of the Solar Hemispheres by the Poles of the Suns conversion, or neer or far from the same, do arise all the differences in the apparent courses of the spots; so that by how much the more those Poles shall be remote from the said terminator, by so much the more shall those courses be incurvated, and lesse oblique; whereupon at the same distance, that is, when those Poles are in the section of the Meridian, the incurvation is reduced to the greatest, but the obliquity to the

least, that is to Æquilibrium, as the second of these three last figures [viz. Fig. 5.] demonstrateth. On the contrary, when the Poles are in the terminator, as the first of these three figures [viz. Fig. 4.] sheweth the inclination is at the greatest, but the incurvation at the least, and reduced to rectitude. The terminator departing from the Poles, the curvity begins to grow sensible, the obliquity all the way encreasing, and the inclination growing lesser.

These are those admirable and extravagant mutations, that my Guest told me would from time to time appear in the progresses of the Solar spots, if so be it should be true that the annual motion belonged to the Earth, and that the Sun being constituted in the centre of the Ecliptick, were revolved in it self upon an Axis, not erect, but inclined to the Plane of the said Ecliptick.

Sagr.I do now very well apprehend these consequences, and believe that they will be better imprinted in my fancy, when I shall come to reflect upon them, accommodating a Globe to those inclinations, and then beholding them from several places. It now remains that you tell us what followed afterwards touching the event of these imaginary consequences.

The events being observed, were answerable to the predictions.Salv.It came to passe thereupon, that continuing many several moneths to make most accurate observations, noting down with great exactnesse the courses or transitions of sundry spots at divers times of the year, we found the events punctually to correspond to the predictions.

Sagr.Simplicius, if this which Salviatus saith be true; (nor can we distrust him upon his word) the Ptolomeans and Aristoteleans had need of solid arguments, strong conjectures, and well grounded experiments to counterpoise an objection of so much weight, and to support their opinion from its final overthrow.

Simpl.Fair and softly good Sir, for haply you may not yet be got so far as you perswade your self you are gone. And though I am not an absolute master of the

subject of that narration given us by Salviatus;Though the annual motion assigned to the Earth answerth to the Phænomena of the solar spots, yet doth it not follow by conversion that from the Phænomena of the spots one may infor the annual motion to belong to the Earth. yet do I not find that my Logick, whilst I have a regard to form, teacheth me, that that kind of argumentation affords me any necessary reason to conclude in favour of the Copernican Hypothesis, that is, of the stability of the Sun in the centre of the Zodiack, and of the mobility of the Earth under its circumference. For although it be true, that the said conversion of the Sun, and cirnition of the Earth being granted, there be a necessity of discerning such and such strange extravagancies as these in the spots of the Sun, yet doth it not follow that arguing per conversum, from finding such like unusual accidents in the Sun, one must of necssity conclude the Earth to move by the circumference, and the Sun to be placed in the centre of the Zodiack. For who shall assertain me that the like irregularities may not as well be visible in the Sun, it being moveable by the Ecliptick, to the inhabitants of the Earth, it being also immoveable in the centre of the same? Unlesse you demonstrate to me, that there can be no reason given for that appearance, when the Sun is made moveable, and the Earth stable, I will not alter my opinion and belief that the Sun moveth, and the Earth standeth still.

Sagr.Simplicius behaveth himself very bravely, and argueth very subtilly in defence of the cause of Aristotle and Ptolomy; and if I may speak the truth, mythinks that the conversation of Salviatus, though it have been but of small continuance, hath much farthered him in discoursing silogistically. An effect which I know to be wrought in others as well as him. But as to finding and judging whether competent reason may be rendered of the apparent exorbitancies and irregularities in the motions of the spots, supposing the Earth to be immoveable, and the Sun moveable, I shall expect that Salviatus manifest his opinion to us, for it is very probable that he he hath considered of the same, and collected together whatever may be said upon the point.

Salv.I have often thought thereon, and also discoursed thereof with my Friend and

Guest afore-named; and touching what is to be produced by Philosophers and Astronomers, in defence of the ancient Systeme, we are on one hand certain, certain I say,The Pure Peripatetick Philosophers will laugh at the spots and their Phænomena, as illusions of the Chrystals in the Telescope. that the true and pure Peripateticks laughing at such as employ themselves in such, to their thinking, insipid fooleries, will censure all these Phænomena to be vain illusions of the Christals; and in this manner will with little trouble free themselves from the obligation of studying any more upon the same. Again, as to the Astronomical Philosophers, after we have with some diligence weighed that which may be alledged as a mean between those two others, we have not been able to find out an answer that sufficeth to satisfie at once the course of the spots, and the discourse of the Mind. I will explain unto you so much as I remember thereof, that so you may judge thereon as seems best unto you.

Supposing that the apparent motions of the Solar spots are the same with those that have been above declared, and supposing the Earth to be immoveable in the centre of the Ecliptick, in whose circumference let the center of the Sun be placed; it is necessary that of all the differences that are seen in those motions, the causes do reside in the motions that are in the body of the Sun: Which in the first place must necessarily revolve in it self (i. e. about its own axis) carrying the spots along therewith;If the Earth be immoveable in the centre of the Zodiack, there must be ascribed to the Sun four several motions, as is declared at length. which spots have been supposed, yea and proved to adhere to the Solar superficies. It must secondly be confest, that the Axis of the Solar conversion is not parallel to the Axis of the Ecliptick, that is as much as to say, that it is not perpendicularly erected upon the Plane of the Ecliptick, because if it were so, the courses and exitions of those spots would seem to be made by right lines parallel to the Ecliptick. The said Axis therefore is inclining, in regard the said courses are for the most part made by curve lines. It will be necessary in the third place to grant that the inclination of this Axis

is not fixed, and continually extended towards one and the same point of the Universe, but rather that it doth alwayes from moment to moment go changing its direction; for if the pendency should always look towards the self same point, the courses of the spots would never change appearance; but appearing at one time either right or curved, bending upwards or downwards, ascending or descending, they would appear the same at all times. It is therefore necessary to say, that the said Axis is convertible; and is sometimes found to be in the Plane of the circle that is extreme, terminate, or of the visible Hemisphere, I mean at such time as the courses of the spots seem to be made in right lines, and more than ever pendent, which happeneth twice a year; and at other times found to be in the Plane of the Meridian of the Observator, in such sort that one of its Poles falleth in the visible Hemisphere of the Sun, and the other in the occult; and both of them remote from the extreme points, or we may say, from the poles of another Axis of the Sun, which is parallel to the Axis of the Ecliptick; (which second Axis must necessarily be assigned to the Solar Globe) remote, I say, as far as the inclination of the Axis of the revolution of the spots doth import; and moreover that the Pole falling in the apparent Hemisphere, is one while in the superiour, another while in the inferiour part thereof; for that it must be so, the courses themselves do manifestly evince at such time as they are equilibrated, and in their greatest curvity, one while with their convexity towards the upper part, and another while towards the lower part of the Solar Discus. And because those positions are in continuall alteration, making the inclinations and incurvations now greater, now lesser, and sometimes reduce themselves, the first sort to perfect libration, and the second to perfect perpendicularity, it is necessary to assert that the self same Axis of the monethly revolution of the spots hath a particular revolution of its own, whereby its Poles describe two circles about the Poles of another Axis, which for that reason ought (as I have said) to be assigned to the Sun, the semidiameter of which circles answereth to the quantity of the inclination of the said Axis. And it is necessary, that the time

of its Period be a year; for that such is the time in which all the appearances and differences in the courses of the spots do return. And that the revolution of this Axis, is made about the Poles of the other Axis parallel to that of the Ecliptick, & not about other points, the greatest inclinations and greatest incurvations, which are always of the same bigness, do clearly prove. So that finally, to maintain the Earth fixed in the centre, it will be necessary to assign to the Sun, two motions about its own centre, upon two several Axes, one of which finisheth its conversion in a year, and the other in lesse than a moneth; which assumption seemeth, to my understanding, very hard, and almost impossible; and this dependeth on the necessity of ascribing to the said Solar body two other motions about the Earth upon different Axes, describing with one the Ecliptick in a year, and with the other forming spirals, or circles parallel to the Equinoctial one every day: whereupon that third motion which ought to be assigned to the Solar Clobe about its own centre (I mean not that almost monethly, which carrieth the spots about, but I speak of that other which ought to passe thorow the Axis and Poles of this monethly one) ought not, for any reason that I see, to finish its Period rather in a year, as depending on the annual motion by the Ecliptick, than in twenty four hours, as depending on the diurnal motion upon the Poles of the Equinoctial. I know, that what I now speak is very obscure, but I shall make it plain unto you, when we come to speak of the third motion annual, assigned by Copernicus, to the Earth. Now if these four motions, so incongruous with each other, (all which it would be necessary to assign to the self same body of the Sun) may be reduced to one sole and simple motion, assigned the Sun upon an Axis that never changeth position, and that without innovating any thing in the motions for so many other causes assigned to the Terrestrial Globe, may so easily salve so many extravagant appearances in the motions of the Solar spots, it seemeth really that such an Hypothesis ought not to be rejected.

This, Simplicius, is all that came into the minds of our friend, and my self, that could be alledged in explanation of this Phænomenon by the Copernicans, and by the

Ptolomæans, in defence of their opinions. Do you inferre from thence what your judgment perswades you.

Simpl.I acknowledge my self unable to interpose in so important a decision: And, as to my particular thoughts, I will stand neutral; and yet neverthelesse I hope that a time will come, when our minds being illumin'd by more lofty contemplations than these our humane reasonings, we shall be awakened and freed from that mist which now is so great an hinderance to our sight.

Sagr.Excellent and pious is the counsel taken by Simplicius, and worthy to be entertained and followed by all, as that which being derived from the highest wisdome and supreamest authority, may onely, with security be received. But yet so far as humane reason is permitted to penetrate, confining my self within the bounds of conjectures, and probable reasons, I will say a little more resolutely than Simplicius doth, that amongst all the ingenuous subtilties I ever heard, I have never met with any thing of greater admiration to my intellect, nor that hath more absolutely captivated my judgment, (alwayes excepting pure Geometrical and Arithmetical Demonstrations) than these two conjectures taken, the one from the stations and retrogradations of the five Planets, and the other from these irregularities of the motions of the Solar spots: and because they seem to me so easily and clearly to assign the true reason of so extravagant appearances, shewing as if they were but one sole simple motion, mixed with so many others, simple likewise, but different from each other, without introducing any difficulty, rather with obviating those that accompany the other Hypothesis; I am thinking that I may rationally conclude, that those who contumaciously withstand this Doctrine, either never heard, or never understood, these so convincing arguments.

Salv.I will not ascribe unto them the title either of convincing, or non-convincing; in regard my intention is not, as I have several times told you, to resolve any thing upon so high a question, but onely to propose those natural and Astronomicall

reasons, which, for the one and other Systeme, may be produced by me, leaving the determination to others; which determination cannot at last, but be very manifest: for one of the two positions being of necessity to be true, and the other of necessity to be false, it is a thing impossible that (alwayes confining our selves within the limits of humane doctrine) the reasons alledged for the true Hypothesis should not manifest themselves as concludent as those for the contrary vain and ineffectual.

Sagr.It will be time therefore, that we hear the objections of the little Book of ** I should have told you, that the true name of this concealed Authour is Christopher Scheinerus, and its title Disquisitiones Mathematicæ. Conclusions, or Disquisitions which Simplicius did bring with him.

Simpl.Here is the Book, and this is the place where the Author first briefly describeth the Systeme of the world, according to the Hypothesis of Copernicus, saying, Terram igitur unà cum Luna, totoque hoc elementari mundo Copernicus, &c.

Salv.Forbear a little, Simplicius, for methinks that this Authour, in this first entrance, shews himself to be but very ill verst in the Hypothesis which he goeth about to confute, in regard, he saith that Copernicus maketh the Earth, together with the Moon, to describe the ** i.e. the Ecliptick grand Orb in a year moving from East to West; a thing that as it is false and impossible, so was it never affirmed by Copernicus, who rather maketh it to move the contrary way, I mean from West to East, that is, according to the order of the Signes; whereupon we come to think the same to be the annual motion of the Sun, constituted immoveable in the centre of the Zodiack. See the too adventurous confidence of this man; to undertake the confutation of anothers Doctrine, and yet to be ignorant of the primary fundamentals; upon which his adversary layeth the greatest and most important part of all the Fabrick. This is a bad beginning to gain himself credit with his Reader; but let us go on.

Simpl.Having explained the Universal Systeme, he beginneth to propound his

objections against this annual motion: and the first are these, which he citeth Ironically, and in derision of Copernicus,Instances of a certain Book Ironically propounded against Copernicus. and of his followers, writing that in this phantastical Hypothesis of the World one must necessarily maintain very grosse absurdities; namely, that the Sun, Venus, and Mercury are below the Earth; and that grave matters go naturally upwards, and the light downwards; and that Christ, our Lord and Redeemer, ascended into Hell, and descended into Heaven, when he approached towards the Sun, and that when Joshuah commanded the Sun to stand still, the Earth stood still, or the Sun moved a contrary way to that of the Earth; and that when the Sun is in Cancer, the Earth runneth through Capricorn; and that the Hyemal (or Winter) Signes make the Summer, and the Æstival Winter; and that the Stars do not rise and set to the Earth, but the Earth to the Stars; and that the East beginneth in the West, and the West in the East; and, in a word, that almost the whole course of the World is inverted.

Salv.Every thing pleaseth me, except it be his having intermixed places out of the sacred Scriptures (alwayes venerable, and to be rever'd) amongst these, but two scurrilous fooleries, and attempting to wound with holy Weapons, those who Philosophating in jest, and for divertisement, neither affirm nor deny, but, some presupposals and positions being assumed, do familiarly argue.

Simpl.Truth is, he hath displeased me also, and that not a little; and especially, by adding presently after that, howbeit, the Copernichists answer, though but very impertinently to these and such like other reasons, yet can they not reconcile nor answer those things that follow.

Salv.This is worse than all the rest; for he pretendeth to have things more efficacious and concludent than the Authorities of the sacred Leaves; But I pray you, let us reverence them, and passe on to natural and humane reasons: and yet if he give us amongst his natural arguments, things of no more solidity, than those hitherto

alleadged, we may wholly decline this undertaking, for I as to my own parricular, do not think it fit to spend words in answering such trifling impertinencies. And as to what he saith, that the Copernicans answer to these objections, it is most false, nor may it be thought, that any man should set him self to wast his time so unprofitably.

Simpl.I concur with you in the same judgement;Supposing the annual motion to belong to the Earth, it followeth, that one fixed Star, is bigger than the whole grand Orb. therefore let us hear the other instances that he brings, as much stronger. And observe here, how he with very exact computations concludeth, that if the grand Orb of the Earth, or the ecliptick, in which Copernicus maketh it to run in a year round the Sun, should be as it were, insensible, in respect of the immensitie of the Starry Sphære, according as the said Copernicus, saith it is to be supposed, it would be necessary to grant and confirm, that the fixed Stars were remote from us, an unconceivable distance, and that the lesser of them, were bigger than the whole grand Orb aforesaid, and some other much bigger than the whole Sphære of Saturn; Masses certainly too excessively vast, unimaginable, and incredible.

Salv.I have heretofore seen such another objection brought by Tycho against Copernicus,Tycho his Argument grounded upon a false Hypothesis. and this is not the first time that I have discovered the fallacy, or, to say better, the fallacies of this Argumemtation, founded upon a most false Hypothesis, and upon a Proposition of the said Copernicus,Litigious Lawyers that are entertained in an ill cause, keep close to some expression fallen from the adverse party at unawares. understood by his adversaries, with too punctual a nicity, according to the practise of those pleaders, who finding the flaw to be in the very merit of their cause, keep to some one word, fallen unawares from the contrary partie, and fly out into loud and tedious descants upon that. But for your better information; Copernicus having declared those admirable consequences which are derived from the Earths annual motion, to the other Planets, that is to say, of the ** Or progressions. directions and retrogradations of the three uppermost in particular;The apparent diversity of motion in the Planets,

is insensible in the fixed Start. he subjoyneth, that this apparent mutation (which is discerned more in Mars than in Jupiter, by reason Jupiter is more remote, and yet lesse in Saturn, by reason it is more remote than Jupiter) in the fixed Stars, did remain imperceptible, by reason of their immense remotenesse from us, in comparison of the distances of Jupiter or Saturn. Here the Adversaries of this opinion rise up, and supposing that fore-named imperceptibility of Copernicus, as if it had been taken by him, for a real and absolute thing of nothing, and adding, that a fixed Star of one of the lesser magnitudes, is notwithstanding perceptible, seeing that it cometh under the sence of seeing, they go on to calculate with the intervention of other false assumptions, and concluding that it is necessary by the Copernican Doctrine, to admit, that a fixed Star is much bigger than the whole grand Orb.Supposing that a fixed Star of the sixth magnitude is no bigger than the Sun, the diversitie which is so great in the Planets, in the fixed Stars is almost insensible. Now to discover the vanity of this their whole proceeding, I shall shew that a fixed Star of the sixth magnitude, being supposed to be no bigger than the Sun, one may thence conclude with true demonstrations, that the distance of the said fixed Stars from us, cometh to be so great, that the annual motion of the Earth, which causeth so great and notable variations in the Planets, appears scarce observable in them; and at the same time, I will distinctly shew the gross fallacies, in the assumptions of Copernicus his Adversaries.

And first of all,The distance of the Sun, containeth 1208 Semid. of the Earth. I suppose with the said Copernicus, and also with his opposers, that the Semidiameter of the grand Orb, which is the distance of the Earth from the Sun, containeth 1208 Semidiameters of the said Earth. Secondly, I premise with the allowance aforesaid, and of truth, that the ** The Diameter of the Sun, half a degree. apparent diameter of the Sun in its mean distance, to be about half a degree, that is, 30. min. prim. which are 1800. seconds, that is, 108000. thirds. And because the The Diameter of a fixed Star, of the first magnitude, and of one of the sixth. apparent Diameter of a fixed

Star of the first magnitude, is no more than 5. seconds, that is, 300. thirds, and the Diameter of a fixed Star of the sixth magnitude, 50. thirds, (and herein is the greatest errour of the Anti-Copernicans) Therefore the Diameter of the Sun,The apparent Diameter of the Sun, how much it is bigger than that of a fixed star. containeth the Diameter of a fixed Star of the sixth magnitude 2160. times. And therefore if a fixed Star of the sixth magnitude, were supposed to be really equal to the Sun, and not bigger, which is the same as to say, if the Sun were so far removed, that its Diameter should seem to be one of the 2160. parts of what it now appeareth, its distance ought of necessity to be 2160. times greater than now in effect it is, which is as much as to say, that the distance of the fixed Stars of the sixth magnitude, is 2160. Semidiameters of the grand Orb.The distance of a fixed star of the sixth magnitude, how much it is, the star being supposed to be equal to the Sun. And because the distance of the Sun from the Earth, contains by common consent 1208. Semidiameters of the said Earth, and the distance of the fixed Stars (as hath been said) 2160. Semediameters of the grand Orb, therefore the Semidiameter of the Earth is much greater (that is almost double) in comparison of the grand Orb, than the Semidiameter of the grand Orb, in relation to the distance of the Starry Sphære;In the fixed stars the diversitie of aspect, caused by the grand Orb, is little more then that caused by the Earth in the Snn. and therefore the variation of aspect in the fixed Stars, caused by the Diameter of the grand Orb, can be but little more observable, than that which is observed in the Sun, occasioned by the Semidiameter of the Earth.

Sagr.This is a great fall for the first step.

Salv.It is doubtlesse an errour; for a fixed Star of the sixth magnitude,A star of the sixth magnitude, supposed by Tycho and the Authour of the Book of Conclusions, an hundred and six millions of times bigger than needs. which by the computation of this Authour, ought, for the upholding the proposition of Copernicus, to be as big as the whole grand Orb, onely by supposing it equal to the Sun, which Sun is lesse by

far, than the hundred and six millionth part of the said grand Orb, maketh the starry Sphære so great and high as sufficeth to overthrow the instance brought against the said Copernicus.

Sagr.Favour me with this computation.

Salv.The supputation is easie and short. The Diameter of the Sun,The computation of the magnitude of the fixed Stars, in respect to the grand Orb. is eleven semidiameters of the Earth, and the Diameter of the grand Orb, contains 2416. of those same semidiameters, by the ascent of both parties; so that the Diameter of the said Orb, contains the Suns Diameter 220. times very near. And because the Spheres are to one another, as the Cubes of their Diameters, let us make the Cube of 220. which is 106480000. and we shall have the grand Orb, an hundred and six millions, four hundred and eighty thousand times bigger than the Sun, to which grand Orb, a star of the sixth magnitude, ought to be equal, according to the assertion of this Authour.

Sagr.The errour then of these men, consisteth in being extreamly mistaken, in taking the apparent Diameter of the fixed Stars.

Salv.This is one, but not the onely errour of them; and indeed,A common errour of all the Astronomers, touching the magnitude of the stars. I do very much admire how so many Astronomers, and those very famous, as are Alfagranus, Albategnus, Tebizius, and much more modernly the Tycho's and Clavins's, and in sum, all the predecessors of our Academian, should have been so grosly mistaken, in determining the magnitudes of all the Stars, as well fixed as moveable, the two Luminaries excepted out of that number; and that they have not taken any heed to the adventitious irradiations that deceitfully represent them an hundred and more times bigger, than when they are beheld, without those capillious rayes, nor can this their inadvertency be excused, in regard that it was in their power to have beheld them at their pleasure without those tresses, which is done, by looking upon them at

their first appearance in the evening,Venus renders the errour of Astronomers in determining the magnitudes of stars inexcusable. or their last occultation in the comming on of day; and if none of the rest, yet Venus, which oft times is seen at noon day, so small, that one must sharpen the sight in discerning it; and again, in the following night, seemeth a great flake of light, might advertise them of their fallacy; for I will not believe that they thought the true Discus to be that which is seen in the obscurest darknesses, and not that which is discerned in the luminous Medium: for our lights, which seen by night afar off appear great, and neer at hand shew their true lustre to be terminate and small, might have easily have made them cautious; nay, if I may freely speak my thoughts, I absolutely believe that none of them, no not Tycho himself, so accurate in handling Astronomical Instruments, and that so great and accurate, without sparing very great cost in their construction, did ever go about to take and measure the apparent diameter of any Star, the Sun and Moon excepted; but I think, that arbitrarily, and as we say, with the eye, some one of the more antient of them pronounced the thing to be so and so, and that all that followed him afterwards, without more ado, kept close to what the first had said; for if any one of them had applied himself to have made some new proof of the same, he would doubtlesse have discovered the fraud.

Sagr.But if they wanted the Telescope, and you have already said, that our Friend with that same Instrument came to the knowledge of the truth, they ought to be excused, and not accused of ignorance.

Salv.This would hold good, if without the Telescope the businesse could not be effected. Its true, that this Instrument by shewing the Discus of the Star naked, and magnified an hundred or a thousand times, rendereth the operation much more easie, but the same thing may be done, although not altogether so exactly, without the Instrument, and I have many times done the same, and my method therein was this. I have caused a rope to be hanged towards some Star,A way to measure the apparent diameter of a star. and I have made use of the Constellation, called the Harp, which

riseth between the North and ** Rendred in Latine Corum, that is to say, Northwest. North-east, and then by going towards, and from the said rope, interposed between me and the Star, I have found the place from whence the thicknesse of the rope hath just hid the Star from me: this done, I have taken the distance from the eye to the rope, which was one of the sides including the angle that was composed in the eye, and ** i.e. Is subtended by. which insisteth upon the thicknesse of the rope, and which is like, yea the same with the angle in the Starry Sphere, that insisteth upon the diameter of the Star, and by the proportion of the ropes thicknesse to the distance from the eye to the rope, by the table of Arches and Chords, I have immediately found the quantity of the angle; using all the while the wonted caution that is observed in taking angles so acute, not to forme the concourse of the visive rayes in the centre of the eye, where they are onely refracted, but beyond the eye, where really the pupils greatnesse maketh them to concur.

Sagr.I apprehend this your cautelous procedure, albeit I have a kind of hæsitancy touching the same, but that which most puzzleth me is, that in this operation, if it be made in the dark of night, methinks that you measure the diameter of the irradiated Discus, and not the true and naked face of the Star.

Salv.Not so, Sir, for the rope in covering the naked body of the Star, taketh away the rayes, which belong not to it, but to our eye, of which it is deprived so soon as the true Discus thereof is hid; and in making the observation, you shall see, how unexpectedly a little cord will cover that reasonable big body of light, which seemed impossible to be hid, unlesse it were with a much broader Screene: to measure, in the next place, and exactly to find out, how many of those thicknesses of the rope interpose in the distance between the said rope and the eye, I take not onely one diameter of the rope, but laying many pieces of the same together upon a Table, so that they touch, I take with a pair of Compasses the whole space occupied by fifteen, or twenty of them, and with that measure I commensurate the distance before with another smaller cord taken from the rope to the concourse of the visive rayes. And

with this sufficiently-exact operation I finde the apparent diameter of a fixed Star of the first magnitude, commonly esteemed to be 2 min. pri. and also 3 min. prim. by Tycho in his Astronomical Letters,The diameter of a fixed star of the first magnitude not more than five sec. min. cap. 167. to be no more than 5 seconds, which is one of the 24. or 36. parts of what they have held it: see now upon what grosse errours their Doctrines are founded.

Sagr.I see and comprehend this very well, but before we passe any further, I would propound the doubt that ariseth in me in the finding the concourse [or intersection] of the visual rayes beyond the eye, when observation is made of objects comprehended between very acute angles; and my scruple proceeds from thinking, that the said concourse may be sometimes more remote, and sometimes lesse; and this not so much, by meanes of the greater or lesser magnitude of the object that is beheld, as because that in observing objects of the same bignesse, it seems to me that the concourse of the rayes, for certain other respects ought to be made more and lesse remote from the eye.

Salv.I see already, whither the apprehension of Sagredus, a most diligent observer of Natures secrets, tendeth; and I would lay any wager,The circle of the pupil of the eye enlargeth and contracteth. that amongst the thousands that have observed Cats to contract and inlarge the pupils of their eyes very much, there are not two, nor haply one that hath observed the like effect to be wrought by the pupils of men in seeing, whilst the medium is much or little illumin'd, and that in the open light the circlet of the pupil diminisheth considerably: so that in looking upon the face or Discus of the Sun, it is reduced to a smallnesse lesser than a grain of * * Panicum, a small grain like to Mill, I take it to be the same with that called Bird Seed.Panick, and in beholding objects that do not shine, and are in a lesse luminous medium, it is inlarged to the bignesse of a Lintel or more; and in summe this expansion and contraction differeth in more than decuple proportion: From whence it is manifest, that when the pupil is much dilated, it is necessary that the angle of the rayes

concourse be more remote from the eye; which happeneth in beholding objects little luminated. This is a Doctrine which Sagredus hath, just now, given me the hint of, whereby, if we were to make a very exact observation, and of great consequence, we are advertized to make the observation of that concourse in the act of the same, or just such another operation; but in this our case, wherein we are to shew the errour of Astronomers, this accuratenesse is not necessary: for though we should, in favour of the contrary party, suppose the said concourse to be made upon the pupil it self, it would import little, their mistake being so great. I am not certain, Sagredus, that this would have been your objection.

Sagr.It is the very same, and I am glad that it was not altogether without reason, as your concurrence in the same assureth me; but yet upon this occasion I would willingly hear what way may be taken to finde out the distance of the concourse of the visual rayes.

Salv.The method is very easie, and this it is, I take two long ** Strisce. How to find the distance of the rays concourse from the pupil. labels of paper, one black, and the other white, and make the black half as broad as the white; then I stick up the white against a wall, and far from that I place the other upon a stick, or other support, at a distance of fifteen or twenty yards, and receding from this, second another such a space in the same right line, it is very manifest, that at the said distance the right lines will concur, that departing from the termes of the breadth of the white piece, shall passe close by the edges of the other label placed in the mid-way; whence it followeth, that in case the eye were placed in the point of the said concourse or intersection, the black slip of paper in the midst would precisely hide the opposite blank, if the sight were made in one onely point; but if we should find, that the edges of the white cartel appear discovered, it shall be a necessary argument that the visual rayes do not issue from one sole point. And to make the white label to be hid by the black, it will be requisite to draw neerer with the eye: Therefore, having approached so neer, that the intermediate label covereth the other, and noted how much the

required approximation was, the quantity of that approach shall be the certain measure, how much the true concourse of the visive rayes, is remote from the eye in the said operation, and we shall moreover have the diameter of the pupil, or of that circlet from whence the visive rayes proceed: for it shall be to the breadth of the black paper, as is the distance from the concourse of the lines, that are produced by the edges of the papers to the place where the eye standeth, when it first seeth the remote paper to be hid by the intermediate one, as that distance is, I say, to the distance that is between those two papers. And therefore when we would, with exactnesse, measure the apparent diameter of a Star, having made the observation in manner, as aforesaid, it would be necessary to compare the diameter of the rope to the diameter of the pupil; and having found v. g. the diameter of the rope to be quadruple to that of the pupil, and the distance of the eye from the rope to be, for example, thirty yards, we would say, that the true concourse of the lines produced from the ends or extremities of the diameter of the star, by the extremities of the diameter of the rope, doth fall out to be fourty yards remote from the said rope, for so we shall have observed, as we ought, the proportion between the distance of the rope from the concourse of the said lines, and the distance from the said concourse to the place of the eye, which ought to be the same that is between the diameter of the rope, and diameter of the pupil.

Sagr.I have perfectly understood the whole businesse, and therefore let us hear what Simplicius hath to alledge in defence of the Anti-Copernicans.

Simpl.Albeit that grand and altogether incredible inconvenience insisted upon by these adversaries of Copernicus be much moderated and abated by the discourse of Salviatus, yet do I not think it weakened so, as that it hath not strength enough left to foil this same opinion. For, if I have rightly apprehended the chief and ultimate conclusion, in case, the stars of the sixth magnitude were supposed to be as big as the Sun, (which yet I can hardly think) yet it would still be true, that the grand Orb [or Ecliptick] would occasion a mutation and variation in the starry Sphere, like to

that which the semidiameter of the Earth produceth in the Sun, which yet is observable; so that neither that, no nor a lesse mutation being discerned in the fixed Stars, methinks that by this means the annual motion of the Earth is destroyed and overthrown.

Salv.You might very well so conclude, Simplicius, if we had nothing else to say in behalf of Copernicus: but we have many things to alledge that yet have not been mentioned; and as to that your reply, nothing hindereth, but that we may suppose the distance of the fixed Stars to be yet much greater than that which hath been allowed them, and you your self, and whoever else will not derogate from the propositions admitted by Piolomy's sectators, must needs grant it as a thing most requisite to suppose the Starry Sphere to be very much bigger yet than that which even now we said that it ought to be esteemed.All Astronomers agree that the greater magnitudes of the Orbes is the cause of the tardity of the conversions. For all Astronomers agreeing in this, that the cause of the greater tardity of the Revolutions of the Planets is, the majority of their Spheres, and that therefore Saturn is more slow than Jupiter, and Jupiter than the Sun, for that the first is to describe a greater circle than the second, and that than this later, &c. considering that Saturn v. g. the altitude of whose Orb is nine times higher than that of the Sun, and that for that cause the time of one Revolution of Saturn, is thirty times longer than that of a conversion of the Sun, in regard that according to the Doctrine of Ptolomy, one conversion of the starry Sphere is finished in 36000. years, whereas that of Saturn is consummate in thirty, and that of the Sun in one,By another supposition taken from Astronomers, the distance of the fixed Stars is calculated to be 10800 semidiameters of the grand Orb. arguing with a like proportion, and saying, if the Orb of Saturn, by reason it is nine times bigger than that of the Sun, revolves in a time thirty times longer, by conversion, how great ought that Orb to be, which revolves 36000. times more slowly? it shall be found that the distance of the starry Sphere ought to be 10800 semidiameters of the grand Orb, which should be full five times bigger than that,

which even now we computed it to be, in case that a fixed Star of the sixth magnitude were equal to the Sun. Now see how much lesser yet; upon this account, the variation occasioned in the said Stars, by the annual motion of the Earth, ought to appear. And if at the same rate we would argue the distance of the starry Sphere from Jupiter,By the proportion of Jupiter and of Mars, the starry Sphere is found to be yet more remote. and from Mars, that would give it us to be 15000. and this 27000 semidiameters of the grand Orb, to wit, the first seven, and the second twelve times bigger than what the magnitude of the fixed Star, supposed equal to the Sun, did make it.

Simpl.Methinks that to this might be answered, that the motion of the starry Sphere hath, since Ptolomy, been observed not to be so slow as he accounted it; yea, if I mistake not, I have heard that Copernicus himself made the Observation. Salv.You say very well; but you alledge nothing in that which may favour the cause of the Ptolomæans in the least, who did never yet reject the motion of 36000. years in the starry Sphere, for that the said tardity would make it too vast and immense. For if that the said immensity was not to be supposed in Nature, they ought before now to to have denied a conversion so slow as that it could not with good proportion adapt it self, save onely to a Sphere of monstrous magnitude.

Sagr.Pray you, Salviatus, let us lose no more time in proceeding, by the way of these proportions with people that are apt to admit things most dis-proportionate; so that its impossible to win any thing upon them this way: and what more disproportionate proportion can be imagined than that which these men swallow down, and admit, in that writing, that there cannot be a more convenient way to dispose the Cœlestial Spheres, in order, than to regulate them by the differences of the times of their periods, placing from one degree to another the more slow above the more swift, when they have constituted the Starry Sphere higher than the rest, as being the slowest, they frame another higher still than that, and consequently greater, and make it revolve in twenty four hours, whilst the next below, it moves not round

under 36000. years?

Salv.I could wish, Simplicius, that suspending for a time the affection rhat you bear to the followers of your opinion, you would sincerely tell me, whether you think that they do in their minds comprehend that magnitude, which they reject afterwards as uncapable for its immensity to be ascribed to the Universe. For I,Immense magnitudes and numbers are incomprehensible by our understanding. as to my own part, think that they do not; But believe, that like as in the apprehension of numbers, when once a man begins to passe those millions of millions, the imagination is confounded, and can no longer form a conceipt of the same, so it happens also in comprehending immense magnitudes and distances; so that there intervenes to the comprehension an effect like to that which befalleth the sense; For whilest that in a serene night I look towards the Stars, I judge, according to sense, that their distance is but a few miles, and that the fixed Stars are not a jot more remote than Jupiter or Saturn, nay than the Moon. But without more ado, consider the controversies that have past between the Astronomers and Peripatetick Philosophers, upon occasion of the new Stars of Cassiopeia and of Sagittary, the Astronomers placing them amongst the fixed Stars, and the Philosophers believing them to be below the Moon. So unable is our sense to distinguish great distances from the greatest, though these be in reality many thousand times greater than those. In a word, I ask of thee, O foolish man! Doth thy imagination comprehend that vast magnitude of the Universe, which thou afterwards judgest to be too immense? If thou comprehendest it; wilt thou hold that thy apprehension extendeth it self farther than the Divine Power? wilt thou say, that thou canst imagine greater things than those which God can bring to passe? But if thou apprehendest it not, why wilt thou passe thy verdict upon things beyond thy comprehension?

Simpl.All this is very well, nor can it be denied, but that Heaven may in greatnesse surpasse our imagination, as also that God might have created it thousands of times vaster than now it is; but we ought not to grant any thing to have been made in vain,

and to be idle in the Universe. Now, in that we see this admirable order of the Planets, disposed about the Earth in distances proportionate for producing their effects for our advantage, to what purpose is it to interpose afterwards between the sublime Orb of Saturn and the starry Sphere, a vast vacancy, without any star that is superfluous, and to no purpose? To what end? For whose profit and advantage?

Salv.Methinks we arrogate too much to our selves, Simplicius, whilst we will have it, that the onely care of us, is the adaequate work, and bound, beyond which the Divine Wisdome and Power doth, or disposeth of nothing. But I will not consent, that we should so much shorten its hand, but desire that we may content our selves with an assurance that God and Nature are so imployed in the governing of humane affairs,God & Nature do imploy themselves in caring for men, as if they minded nothing else. that they could not more apply themselves thereto, although they had no other care than onely that of mankind; and this, I think, I am able to make out by a most pertinent and most noble example, taken from the operation of the Suns light, which whilest it attracteth these vapours,An example of Gods care of mankind taken from the Sun. or scorcheth that plant, it attracteth, it scorcheth them, as if it had no more to do; yea, in ripening that bunch of grapes, nay that one single grape, it doth apply it self so, that it could not be more intense, if the sum of all its business had been the only maturation of that grape. Now if this grape receiveth all that it is possible for it to receive from the Sun, not suffering the least injury by the Suns production of a thousand other effects at the same time; it would be either envy or folly to blame that grape, if it should think or wish that the Sun would onely appropriate its rayes to its advantage. I am confident that nothing is omitted by the Divine Providence, of what concernes the government of humane affairs; but that there may not be other things in the Universe, that depend upon the same infinite Wisdome, I cannot, of my self, by what my reason holds forth to me, bring my self to believe. However, if it were not so, yet should I not forbear to believe the reasons laid before me by some more sublime intelligence. In the mean time, if one should

tell me, that an immense space interposed between the Orbs of the Planets and the Starry Sphere, deprived of stars and idle, would be vain and uselesse, as likewise that so great an immensity for receipt of the fixed stars, as exceeds our utmost comprehension would be superfluous, I would reply, that it is rashnesse to go about to make our shallow reason judg of the Works of God, and to call vain and superfluous, whatsoever thing in the Universe is not subservient to us.

It is great rashnesse to censure that to be superfluous in the Universe, which we do not perceive to be made for us.Sagr.Say rather, and I believe you would say better, that we know not what is subservient to us; and I hold it one of the greatest vanities, yea follies, that can be in the World, to say, because I know not of what use Jupiter or Saturn are to me, that therefore these Planets are superfluous, yea more, that there are no such things in rerum natura; when as, oh foolish man! I know not so much as to what purpose the arteries, the gristles, the spleen, the gall do serve; nay I should not know that I have a gall, spleen, or kidneys, if in many desected Corps, they were not shewn unto me; and then onely shall I be able to know what the spleen worketh in me, when it comes to be taken from me. To be able to know what this or that Cœlestial body worketh in me (seeing you will have it that all their influences direct themselves to us) it would be requisite to remove that body for some time;By depriving Heaven of some star, one might come to know what influence it hath upon us. and then whatsoever effect I should find wanting in me, I would say that it depended on that star. Moreover, who will presume to say that the space which they call too vast and uselesse between Saturn and the fixed stars, is void of other mundane bodies? Must it be so,Many things may be in Heauen, that are invisible to us because we do not see them? Then the four Medicean Planets, and the companions of Saturn came first into Heaven, when we began to see them, and not before? And by this rule the innumerable other fixed stars had no existence before that men did look on them? and the cloudy constellations called Nebulosæ were at first only white flakes, but afterwards with the Telescope we made them to become

constellations of many lucid and bright stars. Oh presumptious, rather oh rash ignorance of man!

Salv.It's to no purpose Sagredus, to sally out any more into these unprofitable exaggerations: Let us pursue our intended designe of examining the validity of the reasons alledged on either side, without determining any thing, remitting the judgment thereof when we have done, to such as are more knowing. Returning therefore to our natural and humane disquisitions, I say,Great, small, immense, &c. are relative terms. that great, little, immense, small, &c. are not absolute, but relative terms, so that the self same thing compared with divers others, may one while be called immense, and another while imperceptible, not to say small. This being so, I demand in relation to what the Starry Sphere of Copernicus may be called over vast. In my judgment it cannot be compared, or said to be such, unlesse it be in relation to some other thing of the same kind;Vanity of those mens discourse who judg the starry sphere too vast in the Copernican Hypothesis. now let us take the very least of the same kind, which shall be the Lunar Orb; and if the Starry Orb may be so censured to be too big in respect to that of the Moon, every other magnitude that with like or greater proportion exceedeth another of the same kind, ought to be adjudged too vast, and for the same reason to be denied that they are to be found in the World; and thus an Elephant, and a Whale, shall without more ado be condemned for Chymæra's, and Poetical fictions, because that the one as being too vast in relation to an Ant, which is a Terrestrial animal, and the other in respect to the ** Spilloncola, which is here put for the least of Fishes. Gudgeon, which is a Fish, and are certainly seen to be in rerum natura, would be too immeasurable; for without all dispute, the Elephant and Whale exceed the Ant and Gudgeon in a much greater proportion than the Starry Sphere doth that of the Moon, although we should fancy the said Sphere to be as big as the Copernican Systeme maketh it.The space assigned to a fixed star, is much lesse than that of a Planet. Moreover, how hugely big is the Sphere of Jupiter, or that of Saturn, designed for a receptacle but for one

single star; and that very small in comparison of one of the fixed? Certainly if we should assign to every one of the fixed stars for its receptacle so great a part of the Worlds space, it would be necessary to make the Orb wherein such innumerable multitudes of them reside, very many thousands of times bigger than that which serveth the purpose of Copernicus.A star is called in respect of the space that environs it. Besides, do not you call a fixed star very small, I mean even one of the most apparent, and not one of those which shun our sight; and do we not call them so in respect of the vast space circumfused? Now if the whole Starry Sphere were one entire lucid body;The whole starry sphere beheld from a great distance might appear as small as one single star. who is there, that doth not know that in an infinite space there might be assigned a distance so great, as that the said lucid Sphere might from thence shew as little, yea lesse than a fixed star, now appeareth beheld from the Earth? From thence therefore we should then judg that self same thing to be little, which now from hence we esteem to be immeasurably great.

Sagr.Great in my judgment, is the folly of those who would have had God to have made the World more proportinal to the narrow capacities of their reason, than to his immense, rather infinite power.

Simpl.All this that you say is very true; but that upon which the adversary makes a scruple, is, to grant that a fixed star should be not onely equal to, but so much bigger than the Sun; when as they both are particular bodies situate within the Starry Orb: "And indeed in my opinion this Authour very pertinently questioneth and asketh: To what end, and for whose sake are such huge machines made?Instances of the Authour of the Conclusions by way of interrogation. Were they produced for the Earth, for an inconsiderable point? And why so remote? To the end they might seem so very small, and might have no influence at all upon the Earth? To what purpose is such a needlesse monstrous ** Or Gulph. immensity between them and Saturn? All those assertions fall to the ground that are not upheld by probable reasons."

Salv.I conceive by the questions which this person asketh, that one may collect,Answers to the interrogatories of the said Authour. that in case the Heavens, the Stars, and the quantity of their distances and magnitudes which he hath hitherto held, be let alone, (although he never certainly fancied to himself any conceivable magnitude thereof) he perfectly discerns and comprehends the benefits that flow from thence to the Earth, which is no longer an inconsiderable thing; nor are they any longer so remote as to appeare so very small, but big enough to be able to operate on the Earth; and that the distance between them and Saturn is very well proportioned, and that he, for all these things, hath very probable reasons; of which I would gladly have heard some one:The Authour of the Conclusions confound and contradicts himself in his interrogations. but being that in these few words he confounds and contradicts himself, it maketh me think that he is very poor and ill furnished with those probable reasons, and that those which he calls reasons, are rather fallacies, or dreams of an over-weening fancy. For I ask of him, whether these Celestial bodies truly operate on the Earth,Interrogatories put to the Authour of the Conclusions, by which the weaknesse of his is made appear. and whether for the working of those effects they were produced of such and such magnitudes, and disposed at such and such distances, or else whether they have nothing at all to do with Terrene mattets. If they have nothing to do with the Earth; it is a great folly for us that are Earth-born, to offer to make our selves arbitrators of their magnitudes, and regulators of their local dispositions, seeing that we are altogether ignorant of their whole businesse and concerns; but if he shall say that they do operate, and that they are directed to this end, he doth affirm the same thing which a little before he denied, and praiseth that which even now he condemned, in that he said, that the Celestial bodies situate so far remote as that they appear very small, cannot have any influence at all upon the Earth. But, good Sir, in the Starry Sphere pre-established at its present distance, and which you did acknowledg to be in your judgment, well proportioned to have an influence upon these Terrene bodies, many stars appear

very small, and an hundred times as many more are wholly invisible unto us (which is an appearing yet lesse than very small) therefore it is necessary that (contradicting your self) you do now deny their operation upon the Earth; or else that (still contradicting your self) you grant that their appearing very small doth not in the least lessen their influence; or else that (and this shall be a more sincere and modest concession) you acknowledg and freely confesse, that our passing judgment upon their magnitudes and distances is a vanity, not to say presumption or rashnesse.

Simpl.Truth is, I my self did also, in reading this passage perceive the manifest contradiction, in saying, that the Stars (if one may so speak) of Copernicus appearing so very small, could not operate on the Earth, and not perceiving that he had granted an influence upon the Earth to those of Ptolomy, and his sectators, which appear not only very small, but are, for the most part, very invisible.

Salv.But I proceed to another consideration: What is the reason, doth he say, why the stars appear so little? Is it haply, because they seem so to us?That remote objects appeare so small, is the defect of the eye, as is demonstrated. Doth not he know, that this commeth from the Instrument that we imploy in beholding them, to wit, from our eye? And that this is true, by changing Instrument, we shall see them bigger and bigger, as much as we will. And who knows but that to the Earth, which beholdeth them without eyes, they may not shew very great, and such as in reality they are? But it's time that, omitting these trifles, we come to things of more moment; and therefore I having already demonstrated these two things: First, how far off the Firmament ought to be placed to make, that the grand Orb causeth no greater difference than that which the Terrestrial Orb occasioneth in the remotenesse of the Sun; And next, how likewise to make that a star of the Firmament appear to us of the same bignesse, as now we see it, it is not necessary to suppose it bigger than the Sun; I would know whether Tycho, or any of his adherents hath ever attempted to find out, by any means, whether any appearance be to be discovered in the starry Sphere, upon which one may the more resolutely deny or admit the annual motion of

the Earth.

Sagr.I would answer for them, that there is not, no nor is there any need there should;Tycho nor his followers ever attempted to see whether there are any appearances in the Firmament for or against the annual motion. seeing that it is Copernicus himself that saith, that no such diversity is there: and they, arguing ad hominem, admit him the same; and upon this assumption they demonstrate the improbability that followeth thereupon, namely, that it would be necessary to make the Sphere so immense, that a fixed star, to appear unto us as great as it now seems, ought of necessity to be of so immense a magnitude, as that it would exceed the bignesse of the whole grand Orb, a thing, which notwithstanding, as they say, is altogether incredible.

Salv.I am of the same judgment, and verily believe that they argue contra hominem, studying more to defend another man, than desiring to come to the knowledge of the truth. And I do not only believe,Astronomers, perhaps, have not known what appearances ought to follow upon the annual motion of the Earth. that none of them ever applied themselves to make any such observation, but I am also uncertain, whether any of them do know what alteration the Earths annual motion ought to produce in the fixed stars, in case the starry Sphere were not so far distant, as that in them the said diversity, by reason of its minuity dis-appeareth; for their surceasing that inquisition, and referring themselves to the meer assertion of Copernicus, may very well serve to convict a man, but not to acquit him of the fact:Copernicus understood not some things for want of Instruments. For its possible that such a diversity may be, and yet not have been sought for; or that either by reason of its minuity, or for want of exact Instruments it was not discovered by Copernicus; for though it were so, this would not be the first thing, that he either for want of Instruments, or for some other defect hath not known; and yet he proceeding upon other solid and rational conjectures, affirmeth that, which the things by him not discovered do seem to contradict: for, as hath been said already, without the

Telescope, neither could Mars be discerned to increase 60. times; nor Venus 40. more in that than in this position; yea, their differences appear much lesse than really they are and yet neverthelesse it is certainly discovered at length, that those mutations are the same, to an hair that the Copernican Systeme required.Tycho and others argue against the annual motion, from the invariable elevation of the Pole. Now it would be very well, if with the greatest accuratenesse possible one should enquire whether such a mutation as ought to be discoverable in the fixed stars, supposing the annual motion of the Earth, would be observed really and in effect, a thing which I verily believe hath never as yet been done by any; done, said I? no, nor haply (as I said before) by many well understood how it ought to be done. Nor speak I this at randome, for I have heretofore seen a certain Manuscript of one of these Anti-Copernicans, which said, that there would necessarily follow, in case that opinion were true, a continual rising and falling of the Pole from six moneths to six moneths, according as the Earth in such a time, by such a space as is the diameter of the grand Orb, retireth one while towards the North, and another while towards the South; and yet it seemed to him reasonable, yea necessary, that we, following the Earth, when we were towards the North should have the Pole more elevated than when we are towards the South. In this very error did one fall that was otherwise a very skilful Mathematician, & a follower of Copernic. as Tycho relateth in his * * Christophorus Rothmannus.Progymnasma. pag. 684. which said, that he had observed the Polar altitude to vary, and to differ in Summer from what it is in Winter: and because Tycho denieth the merit of the cause, but findeth no fault with the method of it; that is, denieth that there is any mutation to be seen in the altitude of the Pole, but doth not blame the inquisition, for not being adapted to the finding of what is sought, he thereby sheweth, that he also esteeemed the Polar altitude varied, or not varied every six moneths, to be a good testimony to disprove or inferre the annual motion of the Earth.

Simpl.In truth, Salviatus, my opinion also tells me, that the same must necessarily

ensue: for I do not think that you will deny me, but that if we walk only 60. miles towards the North, the Pole will rise unto us a degree higher, and that if we move 60. miles farther Northwards, the Pole will be elevated to us a degree more, &c. Now if the approaching or receding 60. miles onely, make so notable a change in the Polar altitudes, what alteration would follow, if the Earth and we with it, should be transported, I will not say 60. miles, but 60. thousand miles that way.

Salv.It would follow (if it should proceed in the same proportion) that the Pole shall be elevated a thousand degrees. See, Simplicius, what a long rooted opinion can do. Yea, by reason you have fixed it in your mind for so many years, that it is Heaven, that revolveth in twenty four hours, and not the Earth, and that consequently the Poles of that Revolution are in Heaven, and not in the Terrestrial Globe, cannot now, in an hours time shake off this habituated conceipt, and take up the contrary, fancying to your self, that the Earth is that which moveth, only for so long time as may suffice to conceive of what would follow, thereupon should that lye be a truth. If the Earth Simplicius, be that which moveth in its self in twenty four hours, in it are the Poles, in it is the Axis, in it is the Equinoctial, that is, the grand Circle, described by the point, equidistant from the Poles, in it are the infinite Parallels bigger and lesser described by the points of the superficies more and lesse distant from the Poles, in it are all these things, and not in the starry Sphere, which, as being immoveable, wants them all, and can only by the imagination be conceived to be therein, prolonging the Axis of the Earth so far, till that determining, it shall mark out two points placed right over our Poles, and the plane of the Equinoctial being extended, it shall describe in Heaven a circle like it self. Now if the true Axis, the true Poles, the true Equinoctial, do not change in the Earth so long as you continue in the same place of the Earth, and though the Earth be transported, as you do please, yet you shall not change your habitude either to the Poles, or to the circles, or to any other Earthly thing; and this because, that that transposition being common to you and to all Terrestrial things;Motion where it is common, is as if it never were.

and that motion where it is common, is as if it never were; and as you change not habitude to the Terrestrial Poles (habitude I say, whether that they rise, or descend) so neither shall you change position to the Poles imagined in Heaven; alwayes provided that by Celestial Poles we understand (as hath been already defined) those two points that come to be marked out by the prolongation of the Terrestrial Axis unto that length. Tis true those points in Heaven do change, when the Earths transportment is made after such a manner, that its Axis cometh to passe by other and other points of the immoveable Celestial Sphere, but our habitude thereunto changeth not, so as that the second should be more elevated to us than the first. If any one will have one of the points of the Firmament, which do answer to the Poles of the Earth to ascend, and the other to descend, he must walk along the Earth towards the one, receding from the other, for the transportment of the Earth, and with it us our selves, (as I told you before) operates nothing at all.

Sagr.Permit me, I beseech you Salviatus, to make this a little more clear by an example, which although grosse, is acommodated to this purpose.An example fitted to prove that the altitude of the Pole ought not to vary by means of the Earths annual motion. Suppose your self, Simplicius, to be aboard a Ship, and that standing in the Poope, or Hin-deck; you have directed a Quadrant, or some other Astronomical Instrument, towards the top of the Top-gallant-Mast, as if you would take its height, which suppose it were v. gr. 40. degrees, there is no doubt, but that if you walk along the ** Corsia, the bank or bench on which slaves sit in a Gally. Hatches towards the Mast 25. or 30. paces; and then again direct the said Instrument to the same Top-Gallant-Top. You shall find its elevation to be greater, and to be encreased v. gr. 10. degrees; but if instead of walking those 25. or 30. paces towards the Mast, you stand still at the Sterne, and make the whole Ship to move thitherwards, do you believe that by reason of the 25. or 30. paces that it had past, the elevation of the Top-Gallant-Top would shew 10. degrees encreased?

Simpl.I believe and know that it would not gain an hairs breadth in the passing of

30. paces, nor of a thousand, no nor of an hundred thousand miles; but yet I believe withal that looking through the sights at the Top and Top-Gallant, if I should find a fixed Star that was in the same elevation, I believe I say, that, holding still the Quadrant, after I had sailed towards the star 60. miles, the eye would meet with the top of the said Mast, as before, but not with the star, which would be elevated to me one degree.

Sagr.Then you do not think that the sight would fall upon that point of the Starry Sphere, that answereth to the direction of the Top-Gallant Top?

Simpl.No: For the point would be changed, and would be beneath the star first observed.

Sagr.You are in the right. Now like as that which in this example answereth to the elevation of the Top-Gallant-Top, is not the star, but the point of the Firmament that lyeth in a right line with the eye, and the said top of the Mast, so in the case exemplified, that which in the Firmament answers to the Pole of the Earth, is not a star, or other fixed thing in the Firmament; but is that point in which the Axis of the Earth continued streight out, till it cometh thither doth determine, which point is not fixed, but obeyeth the mutations that the Pole of the Earth doth make.Upon the annual motion of the Earth, alteration may ensue in some fixed star, not in the Pole. And therefore Tycho, or who ever else that did alledg this objection, ought to have said that upon that same motion of the Earth, were it true, one might observe some difference in the elevation and depression (not of the Pole, but) of some fixed star toward that part which answereth to our Pole.

Simpl.I already very well understand the mistake by them committed; but yet therefore (which to me seems very great) of the argument brought on the contrary is not lessened, supposing relation to be had to the variation of the stars, and not of the Pole; for if the moving of the Ship but 60. miles, make a fixed star rise to me one degree, shall I not find alike, yea and very much greater mutation, if the Ship should

sail towards the said star for so much space as is the Diameter of the Grand Orb, which you affirm to be double the distance that is between the Earth and Sun?

Sagr.Herein Simplicius, there is another fallacy, which, truth is,The equivoke of those who believe that in the annual motion great mutations are to be made about the elevation of a fixed star, is confuted. you understand, but do not upon the sudden think of the same, but I will try to bring it to your remembrance: Tell me therefore; if when after you have directed the Quadrant to a fixed star, and found v. g. its elevation to be 40. degrees, you should without stirring from the place, incline the side of the Quadrant, so as that the star might remain elevated above that direction, would you thereupon say that the star had acquired greater elevation?

Simpl.Certainly no: For the mutation was made in the Instrument and not in the Observer, that did change place, moving towards the same.

Sagr.But if you sail or walk along the surface of the Terrestrial Globe, will you say that there is no alteration made in the said Quadrant, but that the same elevation is still retained in respect of the Heavens, so long as you your self do not incline it, but let it stand at its first constitution? Simpl.

Give me leave to think of it. I would say without more ado, that it would not retain the same, in regard the progresse I make is not in plano, but about the circumference of the Terrestrial Globe, which at every step changeth inclination in respect to Heaven, and consequently maketh the same change in the Instrument which is erected upon the same.

Sagr.You say very well: And you know withal, that by how much the bigger that circle shall be upon which you move, so many more miles you are to walk, to make the said star to rise that same degree higher; and that finally if the motion towards the star should be in a right line, you ought to move yet farther, than if it were about the circumference of never so great a circle?

Salv.True:The right line, and circumference of an infinite circle, are the same thing.

For in short the circumference of an infinite circle, and a right line are the same thing.

Sagr.But this I do not understand, nor as I believe, doth Simplicius apprehend the same; and it must needs be concealed from us under some mistery, for we know that Salviatus never speaks at random, nor proposeth any Paradox, which doth not break forth into some conceit, not trivial in the least. Therefore in due time and place I will put you in mind to demonstrate this, that the right line is the same with the circumference of an infinite circle, but at present I am unwilling that we should interrupt the discourse in hand. Returning then to the case, I propose to the consideration of Simplicius, how the accession and recession that the Earth makes from the said fixed star which is neer the Pole can be made as it were by a right line, for such is the Diameter of the Grand Orb, so that the attempting to regulate the elevation and depression of the Polar star by the motion along the said Diameter, as if it were by the motion about the little circle of the Earth, is a great argument of but little judgment.

Simpl.But we continue still unsatisfied, in regard that the said small mutation that should be therein, would not be discerned; and if this be null, then must the annual motion about the Grand Orb ascribed to the Earth, be null also.

Sagr.Here now I give Salviatus leave to go on, who as I believe will not overpasse the elevation and depression of the Polar star or any other of those that are fixed as null, although not discovered by any one, and affirmed by Copernicus himself to be, I will not say null, but unobservable by reason of its minuity.

Salv.I have already said above, that I do not think that any one did ever set himself to observe,Enquiry is made what mutations, & in what stars, are to be discovered, by means of the annual motion of the Earth. whether in different times of the year there is any mutation to be seen in the fixed stars, that may have a dependance on the annual motion of the Earth, and added withal, that I doubted least haply some might

never have understood what those mutations are, and amongst what stars they should be discerned; therefore it would be necessary that we in the next place narrowly examine this particular.Astronomers having omitted to instance what alterations those are that may be derived from the annual motion of the Earth, do thereby testifie that they never rightly understood the same. My having onely found written in general terms that the annual motion of the Earth about the Grand Orb, ought not to be admitted, because it is not probable but that by means of the same there would be discoverd some apparent mutation in the fixed stars, and not hearing say what those apparent mutations ought to be in particular, and in what stars, maketh me very reasonably to infer that they who rely upon that general position, have not understood, no nor possibly endeavoured to understand, how the businesse of these mutations goeth, nor what things those are which they say ought to be seen.The mutations of the fixed stars ought to be in some greater, in others lesser, and in others nothing at all. And to this judgment I am the rather induced; knowing that the annual motion ascribed by Copernicus to the Earth, if it should appear sensible in the Starry Sphere, is not to make apparent mutations equal in respect to all the stars, but those appearances ought to be made in some greater, in others lesser, and in others yet lesser; and lastly, in others absolutely nothing at all, by reason of the vast magnitude that the circle of this annual motion is supposed to be of. As for the mutations that should b• seen, they are of two kinds, one is the said stars changing apparent magnitude, and the other their variation of altitudes in the Meridian. Upon which necessarily followeth the mutation of risings and settings, and of their distances from the Zenith, &c.

Sagr.Methinks I see preparing for me such a skean of these revolutions, that I wish it may never be my task to dis-intangle them, for to confesse my infirmity to Salviatus, I have sometimes thought thereon, but could never find the ** Bandola that end of a skeen where with housewives fasten their hankes of yarn, thread or silk. Lay-band of it, and I speak not so much of this which pertains to the fixed stars, as of another

more terrible labour which you bring to my remembrance by maintaining these Meridian Altitudes, Ortive Latitudes and distances from the Vertex, &c.The grand difficulty in Copernicus his Doctrine, is that which concerns the Phænomena of the Sun and fixed stars. And that which puzzleth my brains, ariseth from what I am now about to tell you. Copernicus supposeth the Starry Sphere immoveable, and the Sun in the centre thereof immoveable also. Therefore every mutation which seemeth unto us to be made in the Sun or in the fixed stars, must of necessity befall the Earth and be ous. But the Sun riseth and declineth in our Meridian by a very great arch of almost 47. degrees, and by arches yet greater and greatet, varieth its Ortive and Occidual Latitudes in the oblique Horizons. Now how can the Earth ever incline and elevate so notably to the Sun, and nothing at all to the fixed stars, or so little, that it is not to be perceived? This is that knot which could never get thorow my ** Pettine, it is the stay in a Weavets Loom, that permitteth no knot or snarle to passe it, called by them the Combe of the Loom. Loom-Combe; and if you shall untie it, I shall hold you for more than an Alexander.

Salv.These are scruples worthy of the ingenuity of Sagredus, and this doubt is so intricate, that even Copernicus himself almost despaired of being able to explain the same, so as to render it intelligible, which we see as well by his own confession of its obscurity, as also by his, at two several times, taking two different wayes to make it out. And, I ingenuously confesse that I understood not his explanation, till such time as another method more plain and manifest, had rendred it intelligible; and yet neither was that done without a long and laborious application of my thoughts to the same.

Simpl.Aristotle saw the same scruple,Aristotles argument against the Ancients, who held that the Earth was a Planet. and makes use thereof to oppose certain of the Ancients, who held that the Earth was a Planet; against whom he argueth, that if it were so, it would follow that it also, as the rest of the Planets, should have a plurality of motions, from whence would follow these variations in the risings and settings of

the fixed stars, and likewise in the Meridian Altitudes. And in regard that he propoundeth the difficulty, and doth not answer it, it must needs be, if not impossible, at least very difficult to be resolved.

Salv.The stresse and strength of the knot rendereth the solution thereof more commendable and admirable; but I do not promise you the same at this time, and pray you to dispense with me therein till too morrow, and for the present we will go considering and explaining those mutations and differences that by means of the annual motion ought to be discerned in the fixed stars, like as even now we said, for the explication whereof certain preparatory points offer themselves, which may facilitate the answer to the grand objection. Now reassuming the two motions ascribed to the Earth (two I say, for the third is no motion, as in its place I will declare) that is the annual and diurnal,The annual motion made by the centre of the Earth under the Ecliptick and the diurnal motion made by the Earth about its own centre. the first is to be understood to be made by the centre of the Earth in or about the circumference of the grand Orb, that is of a very great circle described in the plain of the fixed and immutable Ecliptick; the other, namely the diurnal, is made by the Globe of the Earth in it self about its own centre, and own Axis, not erect, but inclined to the Plane of the Ecliptick, with the inclination of 23. degrees and an half, or thereabouts, the which inclination is maintained all the year about, and that which ought especially to be observed, is alwayes situate towards the same point of Heaven:The axis of the Earth continueth alwayes parallel to it self, and describeth a Cylindraical superficies, inclining to the grand Orb. in so much that the Axis of the diurnal motion doth alwayes remain parallel to it self; so that if we imagine that same Axis to be continued out until it reach the fixed stars, whilst the centre of the Earth is encircling the whole Ecliptick in a year, the said Axis describeth the superficies of an oblique Cylinder, which hath for one of its bases the said annual circle, and for the other a like circle imaginarily described by its extremity, or, (if you will) Pole, amongst the fixed stars. And this same cylinder is oblique to the

Plane of the Ecliptick, according to the inclination of the Axis that describeth it, which we have said to be 23 degrees and an half, the which continuing perpetually the same (save onely, that in many thousands of years it maketh some very small mutation, which nothing importeth in our present businesse) causeth that the Terrestrial Globe doth never more incline or elevate,The Orb of the Earth never inclineth, but is immutably the same. but still conserveth the same state without mutation. From whence ensueth, that as to what pertaineth to the mutations to be observed in the fixed stars dependant on the sole annual motion, the same shall happen to any point whatsoever of the Earths surface, as befalleth unto the centre of the Earth it self; and therefore in the present explanations we will make use of the centre, as if it were any whatsoever point of the superficies. And for a more facile understanding of the whole,The fixed stars placed in the Ecliptick never elevate nor descend, on account of the annual motion, but yet approach and recede. let us design the same in lineal figures: And first of all let us describe in the Plane of the Ecliptick the circle ANBO [in Fig. 7.] and let us understand the points A and B, to be the extreams towards the North and South; that is, the beginning of [or entrance into] Cancer or Capricorn, and let us prolong the Diameter AB, indeterminately by D and C towards the Starry Sphere. I say now in the first place, that none of the fixed stars placed in the Ecliptick, shall ever vary elevation, by reason of any whatsoever mutation made by the Earth along the said Plane of the Ecliptick, but shall alwayes appear in the same superficies, although the Earth shall approach and recede as great a space as is that of the diameter of the Grand Orb, as may plainly be seen in the said figure. For whether the Earth be in the point A or in B, the star C alwayes appeareth in the same line ABC; although the distance BC, be lesse than AC, by the whole diameter AB. The most therefore that can be discovered in the star C, and in any other placed in the Ecliptick, is the augmented or diminished apparent magnitude, by reason of the approximation or recession of the Earth.

Sagr.Stay a while I pray you, for I meet with a certain scruple, which much troubleth

me, and it is this: That the star C may be seen by the same line ABC, as wel when the Earth is in A, as when it is in B, I understand very well, as also furthermore I apprehend that the same would happen in all the points of the line AB,Objections against the Earths annual motion taken from the fixed stars placed in the Ecliptick. so long as the Earth should passe from A to B by the said line; but it passing thither, as is to be supposed, by the arch ANB, it is manifest that when it shall be in the point N, and in any other except those two A and B, the said star shall no longer be observed in the line AB; but in others. So that, if the appearing under several lines ought to cause apparent mutations, some difference must needs appear in this case. Nay more, I will speak it with that Philosophical freedom, which ought to be allowed amongst Philosophick friends, methinks that you, contradicting your self, deny that now, which but even now to our admiration, you proved to be really true, and considerable; I mean that which happeneth in the Planets, and particularly in the three superiour ones, that being constantly in the Ecliptick, or very near unto it, do not onely shew themselves one while near unto us, and another while remote, but so deformed in their regular motions, that they seem sometimes immoveable, and sometimes many degrees retrograde; and all upon no other occasion than the annual motion of the Earth.

Salv.Though by a thousand accidents I have been heretofore assured of the wittinesse of Sagredus, yet I had a desire by this one experiment more to ascertain me of what I may expect from his ingenuity, and all this for my own interest, for in case my Propositions stand but proof against the hammer and furnace of his judgment, I shall be confident that they will abide the ** Or will prove of good alloy. test of all Touch-stones. I say therefore that I had purposely dissembled this objection, but yet not with any intent to deceive you, and to put any falshood upon you, as it might have happened if the objection by me disguised, and by you over-lookt, had been the same in effect as it seemed to be in appearance, that is, really valid and conclusive; but it is not so; nay I rather suspect that to try me, you

make as if you did not see its nullity. But I will herein be too hard for you, and force from your tongue, that which you would so artificially conceal; and therefore tell me, what that thing should be, whereby you come to know the station and retrogradation of the Planets, which is derived from the annual motion, aud which is so great, that at least some foot-steps of such an effect ought to appear in the stars of the Ecliptick?

Sagr.This demand of yours containeth two questions, to which it is necessary that I make reply; the first relates to the imputation which you lay upon me of a Dissembler; the other concerneth that which may appear in the stars, &c. As to the first, I will say with your permission, that it is not true, that I have dissembled my knowing the nullity of that objection; and to assure you of the same, I now tell you that I very well understand the nullity thereof.

Salv.But yet I do not understand how it can be, that you spake not friendly, when you said you did not know that same fallacy which you now confesse that you know very well.

Sagr.The very confession of knowing it may assure you that I did not dissemble, when I said that I did not understand it; for if I had had a mind, and would dissemble, who could hinder me from continuing in the same simulation, and denying still that I understand the fallacy? I say therefore that I understood not the same, at that time, but that I do now at this present apprehend it, for that you have prompted my intellect, first by telling me resolutely that it is null, and then by beginning to question me so at large what thing that might be, whereby I might come to know the station and retrogradation of the Planets;The station, direction and retrogradation of the Planets is known, in relation to the fixed stars. and because this is known by comparing them with the fixed stars, in relation to which, they are seen to vary their motions, one while towards the West, and another towards the East, and sometimes to abide immoveable; and because there is not any thing above the Starry

Sphere, immensely more remote from us, and visible unto us, wherewith we may compare our fixed stars, therefore we cannot discover in the fixed stars any foot-steps of what appeareth to us in the Planets. This I believe is the substance of that which you would force from me.

An Indice in the fixed stars like to that which is seen in the Planets, is an argument of the Earths annual motion.Salv.It is so, with the addition moreover of your admirable ingenuity; and if with half a word I did open your eyes, you by the like have remembred me that it is not altogether impossible, but that sometime or other something observable may be found amongst the fixed stars, by which it may be gathered wherein the annual conversion resides, so as that they also no lesse than the Planets and Sun it self, may appear in judgment to bear witnesse of that motion, in favour of the Earth; for I do not think that the stas are spread in a spherical superficies equally remote from a common centre, but hold, that their distances from us are so various, that some of them may be twice and thrice as remote as others; so that if with the Telescope one should observe a very small star neer to one of the bigger, and which therefore was very exceeding high, it might happen, that some sensible mutation might fall out between them, correspondent to that of the superiour Planets. And so much shall serve to have spoken at this time touching the stars placed in the Ecliptick.The fixed stars without the Ecliptick elevate and descend more or lesse, according to their distance from the said Ecliptick. Let us now come to the fixed stars, placed out of the Ecliptick, and let us suppose a great circle erect upon [i. e. at right angles to] the Plane of the ** i. e. of the Ecliptick. same; and let it, for example, be a circle that in the Starry Sphere answers to the Solstitial Colure, and let us mark it CEH [in Fig. 8.] which shall happen to be withal a Meridian, and in it we will take a star without the Ecliptick, which let be E. Now this star will indeed vary its elevation upon the Earths motion; for from the Earth in A it shall be seen according to the ray AE, with the elevation of the angle EAC; but from the Earth placed in B, it shall be seen according to the ray BE, with the

elevation of the angle EBC, bigger than the other EAC, that being extern, and this intern and opposite in the triangle EAB, the distance therefore of the star E from the Ecliptick, shall appear changed; and likewise its altitude in the Meridian shall become greater in the position B, than in the place A, according as the angle EBC exceeds the angle EAC, which excesse is the quantity of the angle AEB: For in the triangle EAB, the side AB being continued to C, the exteriour angle EBC (as being equal to the two interiour and opposite E and A) exceedeth the said angle A, by the quantity of the angle E. And if we should take another star in the same Meridian, more remote from the Ecliptick, as for instance the star H, the diversity in it shall be greater by being observed from the two stations A and B, according as the angle AHB is greater than the other E; which angle shall encrease continually according as the observed star shall be farther and farther from the Ecliptick, till that at last the greatest mutation will appear in that star that should be placed in the very Pole of the Ecliptick. As for a full understanding thereof we thus demonstrate. Suppose the diameter of the Grand Orb to be AB, whose centre [in the same Figure] is G, and let it be supposed to be continued out as far as the Starry Sphere in the points D and C, and from the centre G let there be erected the Axis of the Ecliptick GF, prolonged till it arrive at the said Sphere, in which a Meridian DFC is supposed to be described, that shall be perpendicular to the Plane of the Ecliptick; and in the arch FC any points H and E, are imagined to be taken, as places of fixed stars: Let the lines FA, FB, AH, HG, HB, AE, GE, BE, be conjoyned. And let the angle of difference, or, if you will, the Parallax of the star placed in the Pole F, be AFB, and let that of the star placed in H, be the angle AHB, and let that of the star in E, be the angle AEB. I say, that the angle of difference of the Polar star F, is the greatest, and that of the rest, those that are nearer to the greatest are bigger than the more remote; that is to say, that the angle F is bigger than the angle H, and this bigger than the angle E. Now about the triangle FAB, let us suppose a circle to be described. And because the angle F is acute, (by reason that its base AB is lesse than the diameter

DC, of the semicircle DFC) it shall be placed in the greater portion of the circumscribed circle cut by the base AB. And because the said AB is divided in the midst, and at right angles by FG, the centre of the circumscribed circle shall be in the line FG, which let be the point I; and because that of such lines as are drawn from the point G, which is not the centre, unto the circumference of the circumscribed circle, the biggest is that which passeth by the centre, GF shall be bigger than any other that is drawn from the point G, to the circumference of the said circle; and therefore that circumference will cut the line GH (which is equal to the line GF) and cutting GH, it will also cut AH. Let it cut it in L, and conjoyn the line LB. These two angles, therefore, AFB and ALB shall be equal, as being in the same portion of the circle circumscribed. But ALB external, is bigger than the internal H; therefore the angle F is bigger than the angle H. And by the same method we might demonstrate the angle H to be bigger than the angle E, because that of the circle described about the triangle AHB, the centre is in the perpendicular GF, to which the line GH is nearer than the line GE, and therefore the circumference of it cutteth GE, and also AE, whereupon the proposition is manifest. We will conclude from hence, that the difference of appearance, (which with the proper term of art, we might call the Parallax of the fixed stars) is greater, or lesse, according as the Stars observed are more or lesse adjacent to the Pole of the Ecliptick, so that, in conclusion of those Stars that are in the Ecliptick it self, the said diversity is reduced to nothing. In the next place,The Earth approacheth or recedeth from the fixed stars of the Ecliptick, the quantity of the Diameter of the Grand Orb. as to the Earths accession by that motion to, or recession from the Stars, it appeareth to, and recedeth from those that are in the Ecliptick, the quantity of the whole diameter of the grand Orb, as we did see even now, but that accession or recession to, or from the stars about the Pole of the Ecliptick, is almost nothing; and in going to and from others, this difference groweth greater, according as they are neerer to the Ecliptick. We may,The stars nearer to us make greater differences than the more remote. in the

third place, know, that the said difference of Aspect groweth greater or lesser, according as the Star observed shall be neerer to us, or farther from us. For if we draw another Meridian, lesse distant from the Earth; as for example, this DFI [in Fig. 7.] a Star placed in F, and seen by the same ray AFE, the Earth being in A, would, in case it should be observed from the Earth in B, appear according to the ray BF, and would make the angle of difference, namely, BFA, bigger than the former AEB, being the exteriour angle of the triangle BFE.

Sagr.With great delight, and also benefit have I heard your discourse;The Epilogue of the Phænomena of the fixed stars caused by the annual motion of the Earth. and that I may be certain, whether I have rightly understood the same, I shall give you the summe of the Conclusions in a few words. As I take it, you have explained to us the different appearances, that by means of the Earths annual motion, may be by us observed in the fixed stars to be of two kinds: The one is, that of their apparent magnitudes varied, according as we, transported by the Earth, approach or recede from the same: The other (which likewise dependeth on the same accession and recession) their appearing unto us in the same Meridian, one while more elevated, and another while lesse. Moreover, you tell us (and I understand it very well) that the one and other of these mutations are not made alike in all the stars, but in some greater, and in others lesser, and in others not at all. The accession and recession whereby the same star ought to appear, one while bigger, and another while lesser, is insensible, and almost nothing in the stars neer unto the pole of the Ecliptick, but is greatest in the stars placed in the Ecliptick it self, and indifferent in the intermediate: the contrary happens in the other difference, that is, the elevation or depression of the stars placed in the Ecliptick is nothing at all, greatest in those neerest to the Pole of the said Ecliptick, and indifferent in the intermediate. Besides, both these differences are more sensible in the Stars neerest to us, in the more remote lesse sensible, and in those that are very far distant wholly disappear. This is, as to what concerns my self; it remaineth now, as I conceive, that something be said for the

satisfaction of Simplicius, who, as I believe, will not easily be made to over-passe those differences, as insensible that are derived from a motion of the Earth so vast, and from a mutation that transports the Earth into places twice as far distant from us as the Sun.

Simpl.Truth is, to speak freely, I am very loth to confesse, that the distance of the fixed Stars ought to be such, that in them the fore-mentioned differences should be wholly imperceptible.

Salv.Do not throw your self into absolute despair, Simplicius, for there may perhaps yet some qualification be found for your difficulties. And first, that the apparent magnitude of the stars is not seen to make any sensible alteration, ought not to be judged by you a thing improbable, in regard you see the guesses of men in this particular to be so grossely erroneous, especially in looking upon splendid objects; and you your self beholding v. g. a lighted Torch at the distance of 200 paces,In objects far remote, and luminous, a small approach or recession is imperceptible. if it approach nearer to you 3. or 4. yards, do you think that it will shew any whit encreased in magnitude? I for my part should not perceive it certainly, although it should approach 20. or 30. yards nearer; nay it hath sometimes happened that in seeing such a light at that distance I know not how to resolve whether it came towards me, or retreated from me, when as it did in reality approach nearer to me. But what need I speak of this? If the self same accession and recession (I speak of a distance twice as great as that from the Sun to us) in the star of Saturn is almost totally imperceptible, and in Jupiter not very observable, what shall we think of the fixed stars, which I believe you will not scruple to place twice as far off as Saturn? In Mars, which for that it is nearer to us———

Simpl.Pray Sir, put your self to no farther trouble in this particular, for I already conceive that what hath been spoken touching the unaltered apparent magnitude of the fixed stars may very well come to passe, but what shall we say of the other

difficulty that proceeds from not perceiving any variation in the mutation of aspect?

Salv.We will say that which peradventure may satisfie you also in this particular. And to make short, would you not be satisfied if there should be discovered in the stars face mutations that you think ought to be discovered, in case the annual motion belonged to the Earth?

Simpl.I should so doubtlesse, as to what concerns this particular.

Salv.I could wish you would say that in case such a difference were discovered,If in the fixed stars one should discover any annual mutation, the motion of the Earth would be undeniable. nothing more would remain behind, that might render the mobility of the Earth questionable. But although yet that should not sensibly appear▪ yet is not its mobility removed, nor its immobility necessarily proved, it being possible, (as Copernicus affirmeth) that the immense distance of the Starry Sphere rendereth such very small Phænomena unobservable; the which as already hath been said, may possibly not have been hitherto so much as sought for, or if sought for, yet not sought for in such a way as they ought,It is proved what small credit is to be given to Astronomical Instruments in minute observations. to wit, with that exactnesse which to so minute a punctuality would be necessary; which exactnesse is very difficult to obtain, as well by reason of the deficiency of Astronomical Instruments, subject to many alterations, as also through the fault of those that manage them with less diligence then is requisite. A necessary argument how little credit is to be given to those observations may be deduced from the differences which we find amongst Astronomers in assigning the places, I will not say, of the new Stars or Comets, but of the fixed stars themselves, even to the altitudes of the very Poles, in which, most an end, they are found to differ from one another many minutes. And to speak the truth, who can in a Quadrant, or Sextant, that at most shall have its side ** Braccia Italian. 3. or 4. yards long, ascertain himself in the incidence of the perpendicular, or in the direction of the sights, not to erre two or three

minutes, which in its circumference shall not amount to the breadth of a grain of ** Or Mill. Mylet? Besides that, it is almost impossible, that the Instrument should be made, and kept with absolute exactnesse. Ptolomey sheweth his distrust of a Spherical Instrument composed by Archimedes hismelf to take the Suns ingression into the Æquinoctial.Ptolomy did not trust to an Instrument made by Archimedes.

Simpl.But if the Instruments be so suspitious,Instruments of Tycho made with great expence. and the observations so dubious, how can we ever come to any certainty of things, or free our selves from mistakes? I have heard strange things of the Instruments of Tycho made with extraordinary cost, and of his singular diligence in observations.

Salv.All this I grant you; but neither one nor other of these is sufficient to ascertain us in a businesse of this importance. I desire that we may make use of Instruments greater by far,What Instruments are apt for most exact observation. and by far certainer than those of Tycho, made with a very small charge; the sides of which are of 4. 6. 20. 30. and 50. miles, so as that a degree is a mile broad, a minute prim. 50 ** Italian braces. yards, a second but little lesse than a yard, and in short we may without a farthing expence procure them of what bignesse we please. I being in a Countrey Seat of mine near to Florence,An exquisite observation of the approach and departure of the Sun from the Summer Solstice. did plainly observe the Suns arrival at, and departure from the Summer Solstice, whilst one Evening at the time of its going down it appeared upon the top of a Rock on the Mountains of Pietrapana, about 60. miles from thence, leaving discovered of it a small streak or filament towards the North, whose breadth was not the hundredth part of its Diameter; and the following Evening at the like setting, it shew'd such another part of it, but notably more small, a necessary argument, that it had begun to recede from the Tropick; and the regression of the Sun from the first to the second observation, doth not import doubtlesse a second minute in the East.A place accommodated for the observation of the fixed stars, as to what concers the annual motion of the Earth.

The observation made afterwards with an exquisite Telescope, and that multiplyeth the Discus of the Sun more than a thousand times, would prove easie, and with all delightful. Now with such an Instrument as this, I would have observations to be made in the fixed stars, making use of some of those wherein the mutation ought to appear more conspicuous, such as are (as hath already been declared) the more remote from the Ecliptick, amongst which the Harp a very great star, and near to the Pole of the Ecliptick, would be very proper in Countries far North, proceeding according to the manner that I shall shew by and by, but in the use of another star; and I have already fancied to my self a place very well adapted for such an observation. The place is an open Plane, upon which towards the North there riseth a very eminent Mountain, in the apex or top whereof is built a little Chappel, situate East and West, so as that the ridg of its Roof may intersect at right angles, the meridian of some building standing in the Plane. I will place a beam parallel to the said ridg, or top of the Roof, and distant from it a yard or thereabouts. This being placed, I will seek in the Plain the place from whence one of the stars of Charls's Waine, in passing by the Meridian, cometh to hide it self behind the beam so placed, or in case the beam should not be so big as to hide the star, I will finde a station where one may see the said beam to cut the said star into two equal parts; an effect that with an * exquisite Telescope may be perfectly discerned. And if in the place where the said accident is discovered, there were some building, it will be the more commodious; but if not, I will cause a Pole to be stuck very fast in the ground, with some standing mark to direct where to place the eye anew, when ever I have a mind to repeat the observation. The first of which observations I will make about the Summer Solstice, to continue afterwards from Moneth to Moneth, or when I shall so please, to the other Solstice; with which observation one may discover the elevation and depression of the star, though it be very small. And if in that operation it shall happen, that any mutation shall discover it self, what and how great benefit will it bring to Astronomy? Seeing that thereby, besides our being assured of the annual

motion, we may come to know the grandure and distance of the same star.

Sagr.I very well comprehend your whole proceedings; and the operation seems to me so easie, and so commodious for the purpose, that it may very rationally be thought, that either Copernicus himself, or some other Astronomer had made trial of it.

Salv.But I judg the quite contrary, for it is not probable, that if any one had experimented it, he would not have mentioned the event, whether it fell out in favour of this, or that opinion; besides that, no man that I can find, either for this, or any other end, did ever go about to make such an Observation; which also without an exact Telescope could but badly be effected.

Simpl.I am fully satisfied with what you say. But seeing that it is a great while to night, if you desire that I shall passe the same quietly, let it not be a trouble to you to explain unto us those Problems, the declaration whereof you did even now request might be deferred until too morrow. Be pleased to grant us your promised indulgence, and, laying aside all other discourses, proceed to shew us, that the motions which Copernicus assigns to the Earth being taken for granted, and supposing the Sun and fixed stars immoveable, there may follow the same accidents touching the elevations and depressions of the Sun, touching the mutations of the Seasons, and the inequality of dayes and nights, &c. in the self same manner, just as they are with facility apprehended in the Ptolomaick Systeme.

Salv.I neither ought, nor can deny any thing that Sagredus shall request: And the delay by me desired was to no other end, save only that I might have time once again to methodize those prefatory points, in my fancy, that serve for a large and plain declaration of the manner how the forenamed accidents follow, as well in the Copernican position, as in the Ptolomaick: nay, with much greater facility and simplicity in that than in this.The Copernican Systeme difficult to be understood, but easie to be effected. Whence one may manifestly conceive that Hypothesis to be as

easie to be effected by nature, as difficult to be apprehended by the understanding: yet neverthelesse, I hope by making use of another kind of explanation,Necessary prepositions for the better conceiving of the consequences of the Earths motion. than that used by Copernicus, to render likewise the apprehending of it somewhat lesse obscure. Which that I may do, I will propose certain suppositions of themselves known and manifest, and they shall be these that follow.

First, I suppose that the Earth is a spherical body, turning round upon its own Axis and Poles, and that each point assigned in its superficies, describeth the circumference of a circle, greater or lesser, according as the point assigned shall be neerer or farther from the Poles: And that of these circles the greatest is that which is described by a point equidistant from the said Poles; and all these circles are parallel to each other; and Parallels we will call them.

Secondly, The Earth being of a Spherical Figure, and of an opacous substance, it is continually illuminated by the Sun, according to the half of its surface, the other half remaining obscure, and the boundary that distinguisheth the illuminated part from the dark being a grand circle, we will call that circle the terminator of the light.

Thirdly, If the Circle that is terminator of the light should passe by the Poles of the Earth, it would cut (being a grand and principal circle) all the parallels into equal parts; but not passing by the Poles, it would cut them all in parts unequal, except only the circle in the middle, which, as being a grand circle will be cut into equal parts.

Fourthly, The Earth turning round upon its own Poles, the quantities of dayes and nights are termined by the arches of the Parallels, intersected by the circle, that is, the terminator of the light, and the arch that is scituate in the illuminated Hemisphere prescribeth the length of the day, and the remainer is the quantity of the night.

These things being presupposed,A plain Scheme representing the Copernican

Hypothesis, and its consequences. for the more clear understanding of that which remaines to be said, we will lay it down in a Figure. And first, we will draw the circumference of a circle, that shall represent unto us that of the grand Orb described in the plain of the Ecliptick, and this we will divide into four equal parts with the two diameters Capricorn Cancer, and Libra Aries, which, at the same time, shall represent unto us the four Cardinal points, that is, the two Solstices, and the two Equinoctials; and in the centre of that circle we will place the Sun O, fixed and immoveable.

Let us next draw about the four points, Capricorn, Cancer, Libra and Aries, as centres, four equal circles, which represent unto us the Earth placed in them at four several times of the year. The which, with its centre, in the space of a year, passeth through the whole circumference, Capricorn, Aries, Cancer, Libra, moving from East to West, that is, according to the order of the Signes. It is already manifest, that whilst the Earth is in Capricorn,The Suns annual motion, how it comes to passe, according to Copernicus. the Sun will appear in Cancer, and the Earth moving along the arch Capricorn Aries, the Sun will seem to move along the arch Cancer Libra, and in short, will run thorow the Zodiack according to the order of the Signes, in the space of a year; and by this first assumption, without all question, full satisfaction is given for the Suns apparent annual motion under the Ecliptick. Now, coming to the other, that is, the diurnal motion of the Earth in it self, it is necessary to establish its Poles and its Axis, the which must be understood not to be erect perpendicularly upon the plain of the Ecliptick, that is, not to be parallel to the Axis of the grand Orb, but declining from a right angle 23 degrees and an half, or thereabouts, with its North Pole towards the Axis of the grand Orb, the Earths centre being in the Solstitial point of Capricorn. Supposing therefore the Terrestrial Globe to have its centre in the point Capricorn, we will describe its Poles and Axis AB, inclined upon the diameter Capricorn Cancer 23 degrees and an half; so that the angle A Capricorn Cancer cometh to be the complement of a Quadrant or Radius, that is, 66 degrees

and an half; and this inclination must be understood to be immutable, and we will suppose the superiour Pole A to be Boreal, or North, and the other Austral, or South. Now imagining the Earth to revolve in it self about the Axis AB in twenty four hours, from West to East, there shall by all the points assigned in its superficies, be circles described parallel to each other. We will draw, in this first position of the Earth, the greatest CD, and those two distant from it gr. 23. and an half, EF above, and GM beneath, and the other two extream ones IK and LM remote, by those intervals from the Poles A and B; and as we have marked these five, so we may imagine innumerable others, parallel to these, described by the innumerable points of the Terrestrial surface. Next let us suppose the Earth, with the annual motion of its centre, to transferre it self into the other places already marked; but to passe thither in such a manner, that its own Axis AB shall not only not change inclination upon the plain of the Ecliptick, but shall also never vary direction; so that alwayes keeping parallel to it self, it may continually tend towards the same part of the Universe, or, if you will, of the Firmament, whereas, if we do but suppose it prolonged, it will, with its extream termes, designe a Circle parallel and equal to the grand Orb, Libra Capricorn Aries Cancer, as the superiour base of a Cylinder described by it self in the annual motion above the inferiour base, Libra Capricorn Aries Cancer. And therefore this immutability of inclination continuing, we will design these other three figures about the centres Aries, Cancer, and Libra, alike in every thing to that first described about the centre Capricorn. Now we will consider the first figure of the Earth, in which, in regard the Axis AB is declined from perpendicularity upon the diameter Capricorn Cancer 23 degrees and an half towards the Sun O, and the arch AI being also 23 degrees and an half, the illumination of the Sun will illustrate the Hemisphere of the Terrestrial Globe exposed towards the Sun (of which, in this place, half is to be seen) divided from the obscure part by the Terminator of the light IM, by which the parallel CD, as being a grand circle, shall come to be divided into equal parts, but all the rest into parts

unequal; being that the terminator of the light IM passeth not by their Poles AB, and the parallel IK, together with all the rest described within the same, and neerer to the pole A, shall wholly be included in the illuminated part; as on the contrary, the opposite ones towards the Pole B, contained within the parallel LM, shall remain in the dark. Moreover, the arch AI being equal to the arch FD, and the arch AF, common to them both, the two arches IKF and AFD shall be equal, and each a quadrant or 90 degrees. And because the whole arch IFM is a semicircle, the arch FM shall be a quadrant, and equal to the other FKI; and therefore the Sun O shall be in this state of the Earth vertical to one that stands in the point F. But by the revolution diurnal about the standing Axis AB, all the points of the parallel EF passe by the same point F: and therefore in that same day the Sun, at noon, shall be vertical to all the inhabitants of the Parallel EF, and will seem to them to describe in its apparent motion the circle which we call the Tropick of Cancer. But to the inhabitants of all the Parallels that are above the parallel EF, towards the North pole A, the Sun declineth from their Vertex or Zenith towards the South; and on the contrary, to all the inhabitants of the Parallels that are beneath EF, towards the Equinoctial CD, and the South Pole B, the Meridian Sun is elevated beyond their Vertex towards the North Pole A. Next, it is visible that of all the Parallels, only the greatest CD is cut in equal parts by the Terminator of the light IM. But the rest, that are beneath and above the said grand circle, are all intersected in parts unequal: and of the superiour ones, the semidiurnal arches, namely those of the part of the Terrestrial surface, illustrated by the Sun, are bigger than the seminocturnal ones that remain in the dark: and the contrary befalls in the remainder, that are under the great one CD, towards the pole B, of which the semidiurnal arches are lesser than the seminocturnal, It is likewise apparently manifest, that the differences of the said arches go augmenting, according as the Parallels are neerer to the Poles, till such time as the parallel IK comes to be wholly in the part illuminated, and the inhabitants thereof have a day of twenty four hours long, without any night; and on

the contrary, the Parallel LM, remaining all in obscurity, hath a night of twenty four hours, without any day. Come we next to the third Figure of the Earth, placed with its centre in the point Cancer, where the Sun seemeth to be in the first point of Capricorn. We have already seen very manifestly, that by reason the Axis AB doth not change inclination, but continueth parallel to it self, the aspect and situation of the Earth is the same to an hair with that in the first Figure; save onely that that Hemisphere which in the first was illuminated by the Sun, in this remaineth obtenebrated, and that cometh to be luminous, which in the first was tenebrous: whereupon that which happened before concerning the differences of dayes and nights, touching the dayes being greater or lesser than the nights, now falls out quite contrary. And first, we see, that whereas in the first Figure the circle IK was wholly in the light, it is now wholly in the dark; and the opposite arch LM is now wholly in the light, which was before wholly in the dark. Of the parallels between the grand circle CD, and the Pole A, the semidiurnal arches are now lesser than the seminocturnal, which before were the contrary. Of the others likewise towards the Pole B, the semidiurnal arches are now bigger than the seminocturnal, the contrary to what happened in the other position of the Earth. We now see the Sun made vertical to the inhabitants of the Tropick GN, and to be depressed towards the South, with those of the Parallel EF, by all the arch ECG, that is, 47 degrees; and in summe, to have passed from one to the other Tropick, traversing the Equinoctial, elevating and declining in the Meridians the said space of 47 degrees. And all this mutation is derived not from the inclination or elevation of the Earth, but on the contrary, from its not inclining or elevating at all; and in a word, by continuing always in the same position, in respect of the Universe, onely with turning about the Sun situate iu the midst of the said plane, in which it moveth it self about circularly with its annual motion. And here is to be noted an admirable accident,An admirable accident depending on the not inclining of the Earths axis which is, that like as the Axis of the Earth conserving the same direction towards the Universe, or we may say,

towards the highest Sphere of the fixed stars, causeth the Sun to appear to elevate and incline so great a space, namely, for 47 degrees, and the fixed Stars to incline or elevate nothing at all; so, on the contrary, if the same Axis of the Earth should maintain it self continually in the same inclination towards the Sun, or, if you will, towards the Axis of the Zodiack, no mutation would appear to be made in the Sun about its elevating or declining, whereupon the inhabitants of one and the same place would alwayes have one and the same difference of dayes and nights, and one and the same constitution of Seasons, that is, some alwayes Winter, others alwayes Summer, others Spring, &c. but, on the contrary, the alterations in the fixed Stars would appear very great, as touching their elevation, and inclination to us, which would amount to the same 47 degrees. For the understanding of which let us return to consider the position of the Earth, in its first Figure, where we see the Axis AB, with the superiour Pole A, to incline towards the Sun; but in its third Figure, the same Axis having kept the same direction towards the highest Sphere, by keeping parallel to it self, inclines no longer towards the Sun with its superiour Pole A, but on the contrary reclines from its former position gr. 47. and inclineth towards the opposite part, so that to restore the same inclination of the said Pole A towards the Sun, it would be requisite by turning round the Terrestrial Globe, according to the circumference ACBD, to transport it towards E those same gr. 47. and for so many degrees, any whatsoever fixed star observed in the Meridian, would appear to be elevated, or inclined. Let us come now to the explanation of that which remains, and let us consider the Earth placed in the fourth Figure, that is, with its centre in the first point of Libra; upon which the Sun will appear in the beginning of Aries. And because the Axis of the Earth, which in the first Figure is supposed to be inclined upon the diameter Capricorn Cancer, and therefore to be in that same plane, which cutting the plane of the grand Orb, according to the line Capricorn Cancer, was erected perpendicularly upon the same, transposed into the fourth Figure, and maintained, as hath alwayes been said, parallel to it self, it shall come to be in a

plane in like manner erected to the superficies of the Grand Orbe, and parallel to the plane, which at right angles cuts the same superficies, according to the diameter Capricorn Cancer. And therefore the line which goeth from the centre of the Sunne to the centre of the Earth, that is, O Libra, shall be perpendicular to the Axis BA: but the same line which goeth from the centre of the Sunne to the centre of the Earth, is also alwayes perpendicular to the circle that is the Terminator of the light; therefore this same circle shall passe by the Poles AB in the fourth figure, and in its plain the Axis AB shall fall, but the greatest circle passing by the Poles of the Parallels, divideth them all in equal parts; therefore the arches IK, EF, CD, GN, LM, shall be all semicircles, and the illumin'd Hemisphere shall be this which looketh towards us, and the Sun, and the Terminator of the light shall be one and the same circle ACBD, and the Earth being in this place shall make it Equinoctial to all its Inhabitants. And the same happeneth in the second figure, where the Earth having its illuminated Hemisphere towards the Sun, sheweth us the other that is obscure, with its nocturnal arches, which in like manner are all semicircles, and consequently, here also it maketh the Equinoctial. And lastly in regard that the line produced from the centre of the Sun to the centre of the Earth, is perpendicular to the Axis AB, to which the greatest circle of the parallels CD, is likewise erect, the said line O Libra shall passe of necessity by the same Plain of the parallel CD, cutting its circumference in the midst of the diurnal arch CD; and therefore the Sun shall be vertical to any one that shall stand where that intersection is made; but all the Inhabitants of that Parallel shall passe the same, as being carried about by the Earths diurnal conversion; therefore all thes upon that day shall have the Meridian Sun in their vertex. And the Sun at the same time to all the Inhabitants of the Earth shall seem to describe the Grand Parallel called the Equinoctial. Furthermore, forasmuch as the Earth being in both the Solstitial points of the Polar circles IK and LM, the one is wholly in the light, and the other wholly in the dark; but when the Earth is in the Equinoctial points, the halves of those same polar circles are in the light, the remainder of them

being in the dark; it should not be hard to understand, how that the Earth v. gr. from Cancer (where the parallel IK is wholly in the dark) to Leo, one part of the parallel towards the point I, beginneth to enter into the light, and that the Terminator of the light IM beginneth to retreat towards the Pole AB, intersecting the circle ACBD no longer in IM, but in two other points falling between the terms IA and MB, of the arches IA and MB; whereupon the Inhabitants of the circle begin to enjoy the light, and the other Inhabitants of the circle LM to partake of night. And thus you see that by two simple motions made in times proportionate to their bignesses, and not contrary to one another, but performed, as all others that belong to moveable mundane bodies, from West to East assigned to the Terrestrial Globe, adequate reasons are rendred of all those Phænomena or appearances, for the accommodating of which to the stability of the Earth it is necessary (forsaking that Symetry which is observed to be between the velocities and magnitudes of moveables) to ascribe to a Sphere, vast above all others, an unconceiveable celerity, whilst the other lesser Spheres move extream slowly; and which is more, to make that motion contrary to all their motions; and, yet again to adde to the improbability, to make that superiour Sphere forcibly to transport all the inferiour ones along with it contrary to their proper inclination. And here I refer it to your judgment to determine which of the two is the most probable.

Sagr.To me, as far as concerneth sense, there appeareth no small difference betwixt the simplicity and facility of operating effects by the means assigned in this new constitution, and the multiplicity, confusion, and difficulty, that is found in the ancient and commonly received Hypothesis. For if the Universe were disposed according to this multiplicity, it would be necessary to renounce many Maximes in Philosophy commonly received by Philosophers,Axiomes commonly admitted by all Philosophers. as for instance, That Nature doth not multiply things without necessity; and, That She makes use of the most facile and simple means in producing her effects; and, That She doth nothing in vain, and the like. I do confesse

that I never heard any thing more admirable than this, nor can I believe that Humane Understanding ever penetrated a more sublime speculation. I know not what Simplicius may think of it.

Simpl.These (if I may speak my judgment freely) do seem to me some of those Geometrical subtilties which Aristotle finds fault with in Plato,Aristotle taxeth Plato for being too studious of Geometry. when he accuseth him that by his too much studying of Geometry he forsook solid Philosophy; and I have known and heard very great Peripatetick Philosophers to disswade their Scholars from the Study of the Mathematicks, as those that render the wit cavilous, and unable to philosophate well; an Institute diametrically contrary to that of Plato, who admitted one to Philosophy, unlesse he was first well entered in Geometry.

Salv.I commend the policy of these your Peripateticks,Peripatetick Philosophers condemn the Study of Geometry, and why. in dehorting their Disciples from the Study of Geometry, for that there is not art more commodious for detecting their fallacies; but see how they differ from the Mathematical Philosophers, who much more willingly converse with those that are well verst in the commune Peripatetick Philosophy, than with those that are destitute of that knowledg, who for want thereof cannot distinguish between doctrine and doctrine. But passing by this, tell me I beseech you, what are those extravagancies and those too affected subtilties that make you think this Copernican Systeme the lesse plausible?

Simpl.To tell you true, I do not very well know; perhaps, because I have not so much as learnt the reasons that are by Ptolomy produced, of those effects, I mean of those stations, retrogradations, accessions, recessions of the Planets; lengthenings and shortnings of dayes, changes of seasons, &c. But omitting the consequences that depend on the first suppositions, I find in the suppositions themselves no small difficulties; which suppositions, if once they be overthrown, they draw along with them the ruine of the whole fabrick. Now forasmuch as because the whole module

of Copernicus seemeth in my opinion to be built upon infirm foundations, in that it relyeth upon the mobility of the earth, if this should happen to be disproved, there would be no need of farther dispute. And to disprove this, the Axiom of Aristotle is in my judgement most sufficient, That of one simple body, one sole simple motion can be natural: but here in this case, to the Earth,Four several motions assigned to the Earth. a simple body, there are assigned 3. if not 4. motions, and all very different from each other. For besides the right motion, as a grave body towards its centre, which cannot be denied it, there is assigned to it a circular motion in a great circle about the Sun in a year, and a vertiginous conversion about its own centre in twenty four hours. And that in the next place which is more exorbitant, & which happly for that reason you pass over in silence, there is ascribed to it another revolution about its own centre, contrary to the former of twenty four hours, and which finisheth its period in a year. In this my understanding apprehendeth a very great contradiction.

The motion of descent belongs not to the terrestrial Globe, but to its parts.Salv.As to the motion of descent, it hath already been concluded not to belong to the Terrestrial Globe which did never move with any such motion, nor never shall do; but is (if there be such a thing) that propension of its parts to reunite themselves to their whole. As, in the next place, to the Annual motion, and the Diurnal,The annual and diurnal motion are compatible in the Earth. these being both made towards one way, are very compatible, in the same manner just as if we should let a Ball trundle downwards upon a declining superficies, it would in its descent along the same spontaneously revolve in it self. As to the third motion assigned it by Copernicus, namely about it self in a year, onely to keep its Axis inclined and directed towards the same part of the Firmament, I will tell you a thing worthy of great consideration: namely ut tantum abest (although it be made contrary to the other annual) it is so far from having any repugnance or difficulty in it,Every pensil and librated, body carryed round in the circumference of a circle, acquireth of it self a motion in it self

contrary to that. that naturally and without any moving cause, it agreeth to any whatsoever suspended and librated body, which if it shall be carried round in the circumference of a circle, immediate of it self, it acquireth a conversion about its own centre, contrary to that which carrieth it about, and of such velocity, that they both finish one revolution in the same time precisely. You may see this admirable, and to our purpose accommodate experience,An Experiment which sensibly shews that two contrary motions may naturally agree in the same moveable. if putting in a Bason of water a Ball that will swim; and holding the Bason in your hand, you turn round upon your toe, for you shall immediatly see the Ball begin to revolve in it self with a motion, contrary to that of the Bason, and it shall finish its revolution, when that of the Bason it shall finish. Now what other is the Earth than a pensil Globe librated in tenuous and yielding aire, which being carried about in a year along the circumference of a great circle,The third motion ascribed to the Earth is rather a resting immoveable. must needs acquire, without any other mover, a revolution about its own centre, annual, and yet contrary to the other motion in like manner annual? You shall see this effect I say, but if afterwards you more narrowly consider it, you shall find this to be no real thing, but a meer appearance; and that which you think to be a revolution in it self, you will find to be a not moving at all, but a continuing altogether immoveable in respect of all that which without you, and without the vessel is immoveable: for if in that Ball you shall make some mark, and consider to what part of the Room where you are, or of the Field, or of Heaven it is situate, you shall see that mark in yours, and the vessels revolution to look alwayes towards that same part; but comparing it to the vessel and to your self that are moveable, it will appear to go altering its direction, and with a motion contrary to yours, and that of the vessel, to go seeking all the points of its circumgyration; so that with more reason you and the bason may be said to turn round the immoveable Ball, than that it moveth round in the bason. In the same manner the Earth suspended and librated in the circumference of the Grand Orbe, and scituate in such

sort that one of its notes, as for example, its North Pole, looketh towards such a Star or other part of the Firmament, it always keepeth directed towards the same, although carried round by the annual motion about the circumference of the said Grand Orbe. This alone is sufficient to make the Wonder cease, and to remove all difficulties. But what will Simplicius say, if to this non-indigence of the co-operating cause we should adde an admirable intrinsick vertue of the Terrestrial Globe,An admirable intern vertue of the terrestrial Globe of alwayes beholding the same part of Heaven. of looking with its determinate parts towards determinate parts of the Firmament, I speak of the Magnetick vertue constantly participated by any whatsoever piece of Loade-stone. And if every minute particle of that S•one have in it such a vertue,The terrestriæl Globe made of Loade-stone. who will question but that the same more powerfully resides in this whole Terrestrial Globe, abounding in that Magnetick matter, and which happily it self, as to its internal and primary substance, is nothing else but a huge masse of Loade-stone.

Simpl.Then you are one of those it seems that hold the Magnetick Phylosophy * An eminent Doctor of Physick, our Countreyman, born at Colchester, and famous for this his learned Treatise, published about 60 years since at London, The Magnetick Philosophy of William Gilbert. * William Gilbert.

Salv.I am for certain, and think that all those that have seriously read his Book, and tried his experiments, will bear me company therein; nor should I despair, that what hath befallen me in this case, might possibly happen to you also, if so be a curiosity, like to mine, and a notice that infinite things in Nature are still conceal'd from the wits of mankind, by delivering you from being captivated by this or that particular writer in natural things, should but slacken the reines of your Reason, and mollifie the contumacy and tenaceousnesse of your sense; so as that they would not refuse to hearken sometimes to novelties never before spoken of.The Pusillanimity of Popular Wits. But (permit me to use this phrase) the pusillanimity of vulgar Wits is come to that passe, that not only like blind men, they make a gift, nay tribute of their own

assent to whatsoever they find written by those Authours, which in the infancy of their Studies were laid before them, as authentick by their Tutors, but refuse to hear (not to say examine) any new Proposition or Probleme, although it not only never hath been confuted, but not so much as examined or considered by their Authours. Amongst which, one is this, of investigating what is the true, proper, primary, interne, and general matter and substance of this our Terrestrial Globe; For although it never came into the mind either of Aristotle, or of any one else, before William Gilbert to think that it might be a Magnet, so far are Aristotle and the rest from confuting this opinion, yet neverthelesse I have met with many, that at the very first mention of it, as a Horse at his own shadow, have start back, and refused to discourse thereof, and censured the conceipt for a vain Chymæra, yea, for a solemn madnesse: and its possible the Book of Gilbert had never come to my hands, if a Peripatetick Philosopher, of great fame, as I believe, to free his Library from its contagion, had not given it me.

Simpl.I, who ingenuously confesse my self to be one of those vulgar Wits, and never till within these few dayes that I have been admitted to a share in your conferences, could I pretend to have in the least withdrawn from those trite and popular paths, yet, for all that, I think I have advantaged my self so much, as that I could without much trouble or difficulty, master the roughnesses of these novel and fantastical opinions.

Salv.If that which Gilbert writeth be true, then is it no opinion, but the subject of Science; nor is it new, but as antient as the Earth it self; nor can it (being true) be rugged or difficult, but plain and easie; and when you please I shall make you feel the same in your hand, for that you of your self fancy it to be a Ghost, and stand in fear of that which hath nothing in it of dreadfull, like as a little child doth fear the Hobgoblin, without knowing any more of it, save the name; as that which besides the name is nothing.

Simpl.I should be glad to be informed, and reclaimed from an errour.

Salv.Answer me then to the questions that I shall ask you. And first of all, Tell me whether you believe, that this our Globe, which we inhabit and call Earth, consisteth of one sole and simple matter, or else that it is an aggregate of matters different from each other.

Simpl.I see it to be composed of substances and bodies very different;The Terrestrial Globe composed of sundry matters. and first, for the greatest parts of the composition, I see the Water and the Earth, which extreamly differ from one another.

Salv.Let us, for this once, lay aside the Seas and other Waters, and let us consider the solid parts, and tell me, if you think them one and the same thing, or else different.

Simpl.As to appearance, I see that they are different things, there being very great heaps of unfruitful sands, and others of fruitful soiles; There are infinite sharp and steril mountains, full of hard stones and quarries of several kinds, as Porphyre, Alablaster, Jasper, and a thousand other kinds of Marbles: There are vast Minerals of so many kinds of metals; and in a word, such varieties of matters, that a whole day would not suffice only to enumerate them.

Salv.Now of all these different matters, do you think, that in the composition of this grand masse, there do concur portions, or else that amongst them all there is one part that far exceeds the rest, and is as it were the matter and substance of the immense lump?

Simpl.I believe that the Stones, Marbles, Metals, Gems, and the so many other several matters are as it were Jewels, and exteriour and superficial Ornaments of the primary Globe, which in grosse, as I believe, doth without compare exceed all these things put together.

Salv.And this principal and vast masse, of which those things above named are as it

were excressences and ornaments, of what matter do you think that it is composed?

Simpl.I think that it is the simple, or lesse impure element of Earth.

Salv.But what do you understand by Earth? Is it haply that which is dispersed all over the fields, which is broke up with Mattocks and Ploughs, wherein we sowe corne, and plant fruits, and in which great boscages grow up, without the help of culture, and which is, in a word, the habitation of all animals, and the womb of all vegetables?

Simpl.Tis this that I would affirm to be the substance of this our Globe.

Salv.But in this you do, in my judgment, affirm that which is not right: for this Earth which is broke up, is sowed, and is fertile, is but one part, and that very small of the surface of the Globe, which doth not go very deep, yea, its depth is very small, in comparison of the distance to the centre: and experience sheweth us, that one shall not dig very low, but one shall finde matters very different from this exteriour scurf, more solid, and not good for the production of vegetables. Besides the interne parts, as being compressed by very huge weights that lie upon them, are, in all probability, slived, and made as hard as any hard rock. One may adde to this, that fecundity would be in vain conferred upon those matters which never were designed to bear fruit, but to rest eternally buried in the profound and dark abysses of the Earth.

Simpl.But who shall assure us, that the parts more inward and near to the centre are unfruitful? They also may, perhaps, have their productions of things unknown to us?

Salv.You may aswell be assured thereof, as any man else, as being very capable to comprehend, that if the integral bodies of the Universe be produced onely for the benefit of Mankind, this above all the rest ought to be destin'd to the sole conveniences of us its inhabitants. But what benefit can we draw from matters so hid and remote from us, as that we shall never be able to make use of them?The interne parts of the terrestrial Globe must of necessity be solid. Therefore the interne substance of this our Globe cannot be a matter frangible, dissipable, and

non-coherent, like this superficial part which we call ** Or MOULD. Earth: but it must, of necessity, be a most dense and solid body, and in a word, a most hard stone. And, if it ought to be so, what reason is there that should make you more scrupulous to believe that it is a Loadstone than a Porphiry, a Jasper, or other hard Marble? Happily if Gilbert had written, that this Globe is all compounded within of ** Of which with the Latin translatour, I must once more professe my self ignorant.Pietra Serena, or of Chalcedon, the paradox would have seemed to you lesse exorbitant?

Simpl.That the parts of this Globe more intern are more compressed, and so more slived together and solid, and more and more so, according as they lie lower, I do grant, and so likewise doth Aristotle, but that they degenerate and become other than Earth, of the same sort with this of the superficial parts, I see nothing that obliegeth me to believe.

Salv.I undertook not this discourse with an intent to prove demonstratively that the primary and real substance of this our Globe is Load-stone; but onely to shew that no reason could be given why one should be more unwilling to grant that it is of Load-stone,Our Globe would have been called stone, in stead of Earth, if that name had been giuen it in the beginning. than of some other matter. And if you will but seriously consider, you shall find that it is not improbable, that one sole, pure, and arbitrary name, hath moved men to think that it consists of Earth; and that is their having made use commonly from the beginning of this word Earth, as well to signifie that matter which is plowed and sowed, as to name this our Globe. The denomination of which if it had been taken from stone, as that it might as well have been taken from that as from the Earth; the saying that its primary substance was stone, would doubtlesse have found no scruple or opposition in any man. And is so much the more probable, in that I verily believe, that if one could but pare off the scurf of this great Globe, taking away but one full thousand or two thousand yards; and afterwards seperate the Stones from the Earth, the accumulation of the stones would be very much biger than that of the fertile Mould. But as for the reasons

which concludently prove de facto, that is our Globe is a Magnet, I have mentioned none of them, nor is this a time to alledg them, and the rather, for that to your benefit you may read them in Gilbert; onely to encourage you to the perusal of them, I will set before you, in a similitude of my own,The method of Gilbert in his Philosophy. the method that he observed in his Philosophy. I know you understand very well how much the knowledg of the accidents is subservient to the investigation of the substance and essence of things; therefore I desire that you would take pains to informe your self well of many accidents and properties that are found in the Magnet,Many properties in the Magnet. and in no other stone, or body; as for instance of attracting Iron, of conferring upon it by its sole presence the same virtue, of communicating likewise to it the property of looking towards the Poles, as it also doth it self; and moreover endeavour to know by trial, that it containeth in it a virtue of conferring upon the magnetick needle not onely the direction under a Meridian towards the Poles, with an Horizontal motion, (a property a long time ago known) but a new found accident, of declining (being ballanced under the Meridian before marked upon a little spherical Magnet) of declining I say to determinate marks more or lesse, according as that needle is held nearer or farther from the Pole, till that upon the Pole it self it erecteth perpendicularly, whereas in the middle parts it is parallel to the Axis. Furthermore procure a proof to be made, whether the virtue of attracting Iron, residing much more vigorously about the Poles, than about the middle parts, this force be not notably more vigorous in one Pole than in the other, and that in all pieces of Magnet; the stronger of which Poles is that which looketh towards the South. Observe, in the next place, that in a little Magnet this South and more vigorous Pole, becometh weaker, when ever it is to take up an iron in presence of the North Pole of another much bigger Magnet: and not to make any tedious discourse of it, assertain your self, by experience, of these and many other properties described by Gilbert, which are all so peculiar to the Magnet, as that none of them agree with any other matter.An Argument proving the terrestrial Globe to be a

Magnet. Tell me now, Simplicius, if there were laid before you a thousand pieces of several matters, but all covered and concealed in a cloth, under which it is hid, and you were required, without uncovering them, to make a guesse, by external signes, at the matter of each of them, and that in making trial, you should hit upon one that should openly shew it self to have all the properties by you already acknowledged to reside onely in the Magnet, and in no other matter, what judgment would you make of the essence of such a body? Would you say, that it might be a piece of Ebony, or Alablaster, ot Tin.

Simpl.I would say, without the least hæsitation, that it was a piece of Load-stone.

Salv.If it be so, say resolutely, that under this cover and scurf of Earth, stones, metals, water, &c. there is hid a great Magnet, forasmuch as about the same there may be seen by any one that will heedfully observe the same, all those very accidents that agree with a true and visible Globe of Magnet; but if no more were to be seen than that of the Declinatory Needle, which being carried about the Earth, more and more inclineth, as it approacheth to the North Pole, and declineth lesse towards the Equinoctial, under which it finally is brought to an Æquilibrium, it might serve to perswade even the most scrupulous judgment. I forbear to mention that other admirable effect, which is sensibly observed in every piece of Magnet, of which, to us inhabitants of the Northern Hemisphere, the Meridional Pole of the said Magnet is more vigorous than the other; and the difference is found greater, by how much one recedeth from the Equinoctial; and under the Equinoctial both the parts are of equal strength, but notably weaker. But, in the Meridional Regions, far distant from the Equinoctial, it changeth nature, and that part which to us was more weak, acquireth more strength than the other: and all this I confer with that which we see to be done by a small piece of Magnet, in the presence of a great one, the vertue of which superating the lesser, maketh it to become obedient to it, and according as it is held, either on this or on that side the Equinoctial of the great one, maketh the self same mutations, which I have said are made by every Magnet, carried on this side,

or that side of the Equinoctiall of the Earth.

Sagr.I was perswaded, at the very first reading of the Book of Gilbertus; and having met with a most excellent piece of Magnet,The Magnet armed takes up much more Iron, than when unarmed. I, for a long time, made many Observations, and all worthy of extream wonder; but above all, that seemeth to me very stupendious of increasing the faculty of taking up Iron so much by arming it, like as the said Authour teacheth; and with arming that piece of mine, I multiplied its force in octuple proportion; and whereas unarmed it scarce took up nine ounces of Iron, it being armed did take up above six pounds: And, it may be, you have seen this Loadstone in the †† Or Closet of rarities. Gallery of your Most Serene Grand Duke (to whom I presented it) upholding two little Anchors of Iron.

Salv.I saw it many times, and with great admiration, till that a little piece of the like stone gave me greater cause of wonder, that is in the keeping of our Academick, which being no more than of six ounces weight, and sustaining, when unarmed, hardly two ounces, doth, when armed, take up 160. ounces, so as that it is of 80. times more force armed than unarmed, and takes up a weight 26. times greater than its own; a much greater wonder than Gilbert could ever meet with, who writeth, that he could never get any Loadstone that could reach to take up four times its own weight.

Sagr.In my opinion, this Stone offers to the wit of man a large Field to Phylosophate in; and I have many times thought with my self, how it can be that it conferreth on that Iron, which armeth it, a strength so superiour to its own; and finally, I finde nothing that giveth me satisfaction herein; nor do I find any thing extraordinary in that which Gilbert writes about this particular; I know not whether the same may have befallen you.

Salv.I extreamly praise, admire, and envy this Authour, for that a conceit so stupendious should come into his minde, touching a thing handled by infinite

sublime wits, and hit upon by none of them: I think him moreover worthy of extraordinary applause for the many new and true Observations that he made, to the disgrace of so many fabulous Authours, that write not only what they do not know, but what ever they hear spoken by the foolish vulgar, never seeking to assure themselves of the same by experience, perhaps, because they are unwilling to diminish the bulk of their Books. That which I could have desired in Gilbert, is, that he had been a little greater Mathematician, and particularly well grounded in Geometry, the practice whereof would have rendered him less resolute in accepting those reasons for true Demonstrations, which he produceth for true causes of the true conclusions observed by himself. Which reasons (freely speaking) do not knit and bind so fast, as those undoubtedly ought to do, in that of natural, necessary, and lasting conclusions may be alledged. And I doubt not, but that in processe of time this new Science will be perfected with new observations, and, which is more, with true and necessary Demonstrations. The first observers and inventers of things ought to be admired.Nor ought the glory of the first Inventor to be thereby diminished; nor do I lesse esteem, but rather more admire, the Inventor of the Harp (although it may be supposed that the Instrument at first was but rudely framed, and more rudely fingered) than an hundred other Artists, that in the insuing Ages reduced that profession to great perfection. And methinks, that Antiquity had very good reason to enumerate the first Inventors of the Noble Arts amongst the Gods; seeing that the common wits have so little curiosity, and are so little regardful of rare and elegant things, that though they see and hear them exercitated by the exquisite professors of them, yet are they not thereby perswaded to a desire of learning them. Now judge, whether Capacities of this kind would ever have attempted to have found out the making of the Harp, or the invention of Musick, upon the hint of the whistling noise of the dry sinews of a Tortois, or from the striking of four Hammers. The application to great inventions moved by small hints, and the thinking that under a primary and childish appearance admirable Arts may lie hid, is not the part of a trivial, but of a

super-humane spirit. Now answering to your demands, I say, that I also have long thought upon what might possibly be the cause of this so tenacious and potent union, that we see to be made between the one Iron that armeth the Magnet, and the other that conjoyns it self unto it. And first,The true cause of the multiplication of vertue in the Magnet, by means of the arming. we are certain, that the vertue and strength of the stone doth not augment by being armed, for it neither attracts at greater distance, nor doth it hold an Iron the faster, if between it, and the arming or cap, a very fine paper, or a leaf of beaten gold, be interposed; nay, with that interposition, the naked stone takes up more Iron than the armed. There is therefore no alteration in the vertue, and yet there is an innovation in the effect. And because its necessary,Of a new effect its necessary that the cause be likewise new. that a new effect have a new cause, if it be inquired what novelty is introduced in the act of taking up with the cap or arming, there is no mutation to be discovered, but in the different contact; for whereas before Iron toucht Loadstone, now Iron toucheth Iron. Therefore it is necessary to conclude, It is proved, that Iron consists of parts more subtil, pure, and compact than the magnet.that the diversity of contacts is the cause of the diversity of effects. And for the difference of contacts it cannot, as I see, be derived from any thing else, save from that the substance of the Iron is of parts more subtil, more pure, and more compacted than those of the Magnet, which are more grosse, impure, and rare. From whence it followeth, that the superficies of two Irons that are to touch, by being exquisitely plained, filed, and burnished, do so exactly conjoyn, that all the infinite points of the one meet with the infinite points of the other; so that the filaments, if I may so say, that collegate the two Irons, are many more than those that collegate the Magnet to the Iron, by reason that the substance of the Magnet is more porous, and lesse compact, which maketh that all the points and filaments of the Loadstone do not close with that which it unites unto. In the next place, that the substance of Iron (especially the well refined, as namely, the purest steel) is of parts much more dense, subtil, and pure than the matter of the Loadstone,

is seen, in that one may bring its edge to an extraordinary sharpnesse, such as is that of the Rasor, which can never be in any great measure effected in a piece of Magnet.A sensible proof of the impurity of the Magnet. Then, as for the impurity of the Magnet, and its being mixed with other qualities of stone, it is first sensibly discovered by the colour of some little spots, for the most part white; and next by presenting a needle to it, hanging in a thread, which upon those stonynesses cannot find repose, but being attracted by the parts circumfused, seemeth to fly from ** The Author hereby meaneth that the stone doth not all consist of magnetick matter, but that the whiter specks being weak, those other parts of the Loadstone of a more dark & constant colour, contain all that vertue wherewith bodies are attracted. those, and to leap upon the Magnet contiguous to them: and as some of those Heterogeneal parts are for their magnitude very visible, so we may believe, that there are others, in great abundance, which, for their smallnesse, are imperceptible, that are disseminated throughout the whole masse. That which I say, (namely, that the multitude of contacts that are made between Iron and Iron, is the cause of the so solid conjunction) is confirmed by an experiment, which is this, that if we present the sharpned point of a needle to the cap of a Magnet, it will stick no faster to it, than to the same stone unarmed: which can proceed from no other cause, than from the equality of the contacts that are both of one sole point. But what then? Let a ** A common sewing needle. Needle be taken and placed upon a Magnet, so that one of its extremities hang somewhat over, and to that present a Nail; to which the Needle will instantly cleave, insomuch that withdrawing the Nail, the Needle will stand in suspense, and with its two ends touching the Magnet and the Iron; and withdrawing the Nail yet a little further, the Needle will forsake the Magnet; provided that the eye of the Needle be towards the Nail, and the point towards the Magnet; but if the eye be towards the Loadstone, in withdrawing the Nail the Needle will cleave to the Magnet; and this, in my judgment, for no other reason, save onely that the Needle, by reason it is bigger towards the eye, toucheth in much more points

than its sharp point doth.

Sagr.Your whole discourse hath been in my judgment very concluding, and this experiment of the Needle hath made me think it little inferiour to a Mathematical Demonstration; and I ingenuously confesse, that in all the Magnetick Philosophy, I never heard or read any thing, that with such strong reasons gave account of its so many admirable accidents, of which, if the causes were with the same perspicuity laid open, I know not what sweeter food our Intellects could desire.

Salv.In seeking the reasons of conclusions unknown unto us, it is requisite to have the good fortune to direct the discourse from the very beginning towards the way of truth; in which if any one walk, it will easily happen, that one shall meet with several other Propositions known to be true, either by disputes or experiments, from the certainty of which the truth of ours acquireth strength and evidence; as it did in every respect happen to me in the present Probleme, for being desirous to assure my self, by some other accident, whether the reason of the Proposition, by me found, were true; namely, whether the substance of the Magnet were really much lesse continuate than that of Iron or of Steel, I made the Artists that work in the Gallery of my Lord the Grand Duke, to smooth one side of that piece of Magnet, which formerly was yours, and then to polish and burnish it; upon which to my satisfaction I found what I desired. For I discovered many specks of colour different from the rest, but as splendid and bright, as any of the harder sort of stones; the rest of the Magnet was polite, but to the tact onely, not being in the least splendid; but rather as if it were smeered over with foot; and this was the substance of the Load-stone, and the shining part was the fragments of other stones intermixt therewith, as was sensibly made known by presenting the face thereof to filings of Iron, the which in great number leapt to the Load-stone, but not so much as one grain did stick to the said spots, which were many, some as big as the fourth part of the nail of a mans finger, others somewhat lesser, the least of all very many, and those that were scarce visible almost innumerable. So that I did assure my self, that my conjecture was

true, when I first thought that the substance of the Magnet was not close and compact, but porous, or to say better, spongy; but with this difference, that whereas the sponge in its cavities and little cels conteineth Air or Water, the Magnet hath its pores full of hard and heavy stone, as appears by the exquisite lustre which those specks receive. Whereupon, as I have said from the beginning, applying the surface of the Iron to the superficies of the Magnet the minute particles of the Iron, though perhaps more continuate than these of any other body (as its shining more than any other matter doth shew) do not all, nay but very few of them incounter pure Magnet; and the contacts being few, the union is but weak. But because the cap of the Load-stone, besides the contact of a great part of its superficies, invests its self also with the virtue of the parts adjoyning, although they touch not; that side of it being exactly smoothed to which the other face, in like manner well polisht of the Iron to be attracted, is applyed, the contract is made by innumerable minute particles, if not haply by the infinite points of both the superficies, whereupon the union becometh very strong. This observation of smoothing the surfaces of the Irons that are to touch, came not into the thoughts of Gilbert, for he makes the Irons convex, so that their contact is very small; and thereupon it cometh to passe that the tenacity, wherewith those Irons conjoyn, is much lesser.

Sagr.I am, as I told you before, little lesse satisfied with this reason, that if it were a pure Geometrical Demonstration; and because we speak of a Physical Problem, I believe that also Simplicius will find himself satisfied as far as natural science admits, in which he knows that Geometrical evidence is not to be required.

Simpl.I think indeed,Sympathy and Antipathy, terms used by Philosophers to give a reason easily of many natural effests. that Salviatus with a fine circumlocution hath so manifestly displayed the cause of this effect, that any indifferent wit, though not verst in the Sciences, may apprehend the same; but we, confining our selves to the terms of Art, reduce the cause of these and other the like natural effects to Sympathy, which is a certain agreemet and mutual appetite which ariseth between

things that are semblable to one another in qualities; as likewise on the contrary that hatred & enmity for which other things shun & abhor one another we call Antipathy.

Sagr.And thus with these two words men come to render reasons of a great number of accidents and effects which we see not without admiration to be produced in nature. But this kind of philosophating seems to me to have great sympathy with a certain way of Painting that a Friend of mine used,A pleasant example declaring the invalidity of some Phylosophical argumentations. who writ upon the Tele or Canvasse in chalk, here I will have the Fountain with Diana and her Nimphs, there certain Hariers, in this corner I will have a Hunts-man with the Head of a Stag, the rest shall be Lanes, Woods, and Hills; and left the remainder for the Painter to set forth with Colours; and thus he perswaded himself that he had painted the Story of Acteon, when as he had contributed thereto nothing of his own more than the names. But whether are we wandred with so long a digression, contrary to our former resolutions? I have almost forgot what the point was that we were upon when we fell into this magnetick discourse: and yet I had something in my mind that I intended to have spoken upon that subject.

Salv.We were about to demonstrate that third motion ascribed by Copernicus to the Earth to be no motion but a quiescence and maintaining of it self immutably directed with its determinate parts towards the same & determinate parts of the Universe, that is a perpetual conservation of the Axis of its diurnal revolution parallel to it self, and looking towards such and such fixed stars; which most constant position we said did naturally agree with every librated body suspended in a fluid and yielding medium, which although carried about, yet did it not change direction in respect of things external, but onely seemed to revolve in its self, in respect of that which carryed it round, and to the vessel in which it was transported. And then we added to this simple and natural accident the magnetick virtue, whereby the self Terrestrial Globe might so much the more constantly keep it immutable,———

Sagr.Now I remember the whole businesse; and that which then came into my minde, & which I would have intimated, was a certain consideration touching the scruple and objection of Simplicius, which he propounded against the mobility of the Earth, taken from the multiplicity of motions,The several natural motions of the Magnet. impossible to be assigned to a simple body, of which but one sole and simple motion, according to the doctrine of Aristotle, can be natural; and that which I would have proposed to consideration, was the Magnet, to which we manifestly see three motions naturally to agree: one towards the centre of the Earth, as a Grave; the second is the circular Horizontal Motion, whereby it restores and conserves its Axis towards determinate parts of the Universe; and the third is this, newly discovered by Gilbert, of inclining its Axis, being in the plane of a Meridian towards the surface of the Earth, and this more and lesse, according as it shall be distant from the Equinoctial, under which it is parallel to the Axis of the Earth. Besides these three, it is not perhaps improbable, but that it may have a fourth, of revolving upon its own Axis, in case it were librated and suspended in the air or other fluid and yielding Medium, so that all external and accidental impediments were removed, and this opinion Gilbert himself seemeth also to applaud. So that, Simplicius, you see how tottering the Axiome of Aristotle is.

Simpl.This doth uot only not make against the Maxime, but not so much as look towards it: for that he speaketh of a simple body, and of that which may naturally consist therewith; but you propose that which befalleth a mixt body; nor do you tell us of any thing that is new to the doctrine of Aristotle, for that he likewise granteth to mixt bodies compound motions by———

Sagr.Stay a little, Simplicius, & answer me to the questions I shall ask you.Aristole grants a compound motion to mixt bodies. You say that the Load-stone is no simple body, now I desire you to tell me what those simple bodies are, that mingle in composing the Load-stone.

Simpl.I know not how to tell you th'ingredients nor simples precisely, but it sufficeth that they are things elementary.

Salv.So much sufficeth me also. And of these simple elementary bodies, what are the natural motions?

Simpl.They are the two right and simple motions, sursum and deorsum.

Sagr.Tell me in the next place? Do you believe that the motion, that shall remain natural to that same mixed body, should be one that may result from the composition of the two simple natural motions of the simple bodies compounding, or that it may be a motion impossible to be composed of them.The motion of mixt bodies ought to be such as may result from the composition of the motions of the simple bodies compounding.

Simpl.I believe that it shall move with the motion resulting from the composition of the motions of the simple bodies compounding, and that with a motion impossible to be composed of these, it is impossible that it should move.

Sagr.But, Simplicius, with two right and simple motions, you shall never be able to compose a circular motion, such as are the two, or three circular motions that the magnet hath: you see then into what absurdities evil grounded Principles, or, to say better,With two right motions one cannot compose circular motions. the ill-inferred consequences of good Principles carry a man; for you are now forced to say, that the Magnet is a mixture compounded of substances elementary and cœlestial, if you will maintain that the straight motion is a peculiar to the Elements, and the circular to the cœlestial bodies. Therefore if you will more safely argue, you must say, that of the integral bodies of the Universe, those that are by nature moveable, do all move circularly, and that therefore the Magnet, as a part of the true primary,Philosophers are forced to confesse that the Magnet is compounded of cœlestial substances, and of elementary. and integral substance of our Globe, pertaketh of the same qualities with it. The errour of those who call the Magnet a mixt body, and the terrestrial

Globe a simble body.And take notice of this your fallacy, in calling the Magnet a mixt body, and the Terrestrial Globe a simple body, which is sensibly perceived to be a thousand times more compound: for, besides that it containeth an hundred an hundred matters, exceeding different from one another, it containeth great abundance of this which you call mixt, I mean of the Load-stone. This seems to me just as if one should call bread a mixt body, and * Ogliopotrida a Spanish dish of many ingredients boild together. Pannada a simple body, in which there is put no small quantity of bread, besides many other things edible. This seemeth to me a very admirable thing, amongst others of the Peripateticks,The Discourses of Peripateticks, full of errours and contradictions. who grant (nor can it be denied) that our Terrestrial Globe is, de facto, a compound of infinite different matters; and grant farther that of compound bodies the motion ought to be compound: now the motions that admit of composition are the right and circular: For the two right motions, as being contrary, are incompatible together, they affirm, that the pure Element of Earth is no where to be found; they confesse, that it never hath been moved with a local motion; and yet they will introduce in Nature that body which is not to be found, and make it move with that motion which it never exercised, nor never shall do, and to that body which hath, and ever had a being, they deny that motion, which before they granted, ought naturally to agree therewith.

Salv.I beseech you, Sagredus, let us not weary our selves any more about these particulars, and the rather, because you know that our purpose was not to determine resolutely, or to accept for true, this or that opinion, but only to propose for our divertisement such reasons, and answers as may be alledged on the one side, or on the other; and Simplicius maketh this answer, in defence of his Peripateticks, therefore let us leave the judgment in suspense, and remit the determination into the hands of such as are more known than we. And because I think that we have, with sufficient prolixity, in these three dayes, discoursed upon the Systeme of the Universe, it will now be seasonable, that we proceed to the grand accident, from

whence our Disputations took beginning, I mean, of the ebbing and flowing of the Sea, the cause whereof may, in all probability, be referred to the motion of the Earth. But that, if you so please, we will reserve till to morrow. In the mean time, that I may not forget it, I will speak to one particular, to which I could have wished, that Gilbert had not lent an ear;An improbable effect admired by Gilbertus in the Loadstone. I mean that of admitting, that in case a little Sphere of Loadstone might be exactly librated, it would revolve in it self; because there is no reason why it should do so; For if the whole Terrestrial Globe hath a natural faculty of revolving about its own centre in twenty four hours, and that all its parts ought to have the same, I mean, that faculty of turning round together with their whole, about its centre in twenty four hours; they already have the same in effect, whilst that, being upon the Earth, they turn round along with it: And the assigning them a revolution about their particular centres, would be to ascribe unto them a second motion much different from the first: for so they would have two, namely, the revolving in twenty four hours about the centre of their whole; and the turning about their own: now this second is arbitrary, nor is there any reason for the introducing of it: If by plucking away a piece of Loadstone from the whole natural masse, it were deprived of the faculty of following it, as it did, whilst it was united thereto, so that it is thereby deprived of the revolution about the universal centre of the Terrestrial Globe, it might haply, with somewhat greater probability be thought by some, that the said Magnet was to appropriate to it self a new conversion about its particular centre; but if it do no lesse, when separated, than when conjoyned, continue always to pursue its first, eternal, and natural course, to what purpose should we go about to obtrude upon it another new one?

Sagr.I understand you very well, and this puts me in mind of a Discourse very like to this for the vanity of it,The vain argumentation of some to prove the Element of Water to be of a Spherical superficies. falling from certain Writers upon the Sphere, and I think, if I well remember, amongst others from Sacrobosco, who, to shew how

the Element of Water, doth, together with the Earth, make a compleat Spherical Figure, and so between them both compose this our Globe, writeth, that the seeing the small * particles of water shape themselves into rotundity, as in the drops, and in the dew daily apparent upon the leaves of several herbs, is a strong argument; and because, according to the trite Axiome, there is the same reason for the whole, as for the parts, the parts affecting that same figure, it is necessary that the same is proper to the whole Element: and truth is, methinks it is a great oversight that these men should not perceive so apparent a vanity, and consider that if their argument had run right, it would have followed, that not only the small drops, but that any whatsoever greater quantity of water separated from the whole Element, should be reduced into a Globe: Which is not seen to happen; though indeed the Senses may see, and the Understanding perceive that the Element of Water loving to form it self into a Spherical Figure about the common centre of gravity, to which all grave bodies tend (that is, the centre of the Terrestrial Globe) it therein is followed by all its parts, according to the Axiome; so that all the surfaces of Seas, Lakes, Pools, and in a word, of all the parts of Waters conteined in vessels, distend themselves into a Spherical Figure, but that Figure is an arch of that Sphere that hath for its centre the centre of the Terrestrial Globe, and do not make particular Spheres of themselves.

Salv.The errour indeed is childish; and if it had been onely the single mistake of Sacrobosco, I would easily have allowed him in it; but to pardon it also to his Commentators, and to other famous men, and even to Ptolomy himselfe; this I cannot do, without blushing for their reputation. But it is high time to take leave, it now being very late, and we being to meet again to morrow, at the usual hour, to bring all the foregoing Discourses to a final conclusion.

The Fourth Dialogue

The Fourth Dialogue.

INTERLOCUTORS.

Salviatus, Sagredus, and Simplicius.

Sagr.

know not whether your return to our accustomed conferences hath really been later than usual, or whether the desire of hearing the thoughts of Salviatus, touching a matter so curious, hath made me think it so: But I have tarried a long hour at this window, expecting every moment when the Gondola would appear that I sent to fetch you.

Salv.I verily believe that your imagination more than our tarriance hath prolonged the time:Nature in sport maketh the ebbing and flowing of the Sea, to approve the Earths mobility. and to make no longer demurre, it would be well, if without interposing more words, we came to the matter it self; and did shew, that nature hath permitted (whether the business in rei veritate be so, or else to play and sport with our Fancies) hath,The tide, and mobility of the Earth mutually confirm each other I say, hath permitted that the motions for every other respect, except to resolve the ebbing and flowing of the Sea, assigned long since to the earth, should be found now at last to answer exactly to the cause thereof; and, as it were,All terrene effects, indifferently confirm the motion or rest of the Earth, except the ebbing and flowing of the Sea. with mutual a emulation, the said ebbing and flowing to appear in confirmation of the Terrestrial motion: the judices whereof have hitherto been taken from the cœlestial Phænomena, in regard that of those things that happen on Earth, not any one was of force to prove one opinion more than another, as we already have at large proved, by shewing that all the terrene occurrences upon which the stability of the Earth and mobility of the Sun and Firmament is commonly inferred, are to seem to us performed in the same manner, though we supposed the mobility of the Earth, and the immobility of them. The Element of Water onely, as being

most vast, and which is not annexed and concatenated to the Terrestrial Globe as all its other solid parts are; yea, rather which by reason of its fluidity remaineth apart sui juris, and free, is to be ranked amongst those sublunary things, from which we may collect some hinte and intimation of what the Earth doth in relation to motion and rest. After I had many and many a time examined with my self the effects and accidents, partly seen and partly understood from others, that are to be observed in the motions of waters: and moreover read and heard the great vanities produced by many, as the causes of those accidents, The first general conclusion of the impossibility of the ebbing and flowing the immobility of the terrestrial Globe being granted. I have been induced upon no slight reasons to omit these two conclusions (having made withal the necessary presupposals) that in case the terrestrial Globe be immoveable, the flux and reflux of the Sea cannot be natural; and that, in case those motions be conferred upon the said Globe, which have been long since assigned to it, it is necessary that the Sea be subject to ebbing and flowing, according to all that which we observe to happen in the same.

Sagr.The Proposition is very considerable, as well for it self as for what followeth upon the same by way of consequence, so that I shall the more intensly hearken to the explanation and confirmation of it.

Salv.Because in natural questions,The knowledge of the effests contributes to the investigation of the causes. of which number this which we have in hand is one, the knowledge of the effects is a means to guide us to the investigation and discovery of the causes, and without which we should walk in the dark, nay with more uncertainty, for that we know not whither we would go, whereas the blind, at least, know where they desire to arrive; therefore first of all it is necessary to know the effects whereof we enquire the causes: of which effects you, Sagredus, ought more abundantly and more certainly to be informed than I am, as one, that besides your being born, and having, for a long time, dwelt in Venice, where the Tides are very notable for their greatnesse, have also sailed into Syria, and, as an ingenuous and

apprehensive wit, must needs have made many Observations upon this subject: whereas I, that could onely for a time, and that very short, observe what happened in these extream parts of the Adriatick Gulph, and in our Seas below about the Tyrrhene shores, must needs take many things upon the relation of others, who, for the most part, not very well agreeing, and consequently being very uncertain, contribute more of confusion than confirmation to our speculations. Neverthelesse, from those that we are sure of, and which are the principal, I think I am able to attain to the true and primary causes; not that I pretend to be able to produce all the proper and adequate reasons of those effects that are new unto me, and which consequently I could never have thought upon. And that which I have to say, I propose only, as a key that openeth the door to a path never yet trodden by any, in certain hope, that some wits more speculative than mine, will make a further progresse herin, and penetrate much farther than I shall have done in this my first Discovery: And although that in other Seas, remote from us, there may happen several accidents, which do not happen in our Mediterranean Sea, yet doth not this invalidate the reason and cause that I shall produce, if so be that it verifie and fully resolve the accidents which evene in our Sea: for that in conclusion there can be but one true and primary cause of the effects that are of the same kind. I will relate unto you, therefore, the effects that I know to be true, and assigne the causes thereof that I think to be true, and you also, Gentlemen, shall produce such others as are known to you, besides mine, and then we will try whether the cause, by me alledged, may satisfie them also.

Three Periods of ebbings and flowings, diurnal, monethly, and annual.I therefore affirm the periods that are observed in the fluxes and refluxes of the Sea-waters to be three: the first and principal is this great and most obvious one; namely, the diurnal, according to which the intervals of some hours with the waters flow and ebbe; and these intervals are, for the most part, in the Mediterrane from six hours to six hours, or thereabouts, that is, they for six hours flow, and for six hours ebbe. The

second period is monethly, and it seemes to take its origen from the motion of the Moon, not that it introduceth other motions, but only altereth the greatnesse of those before mentioned, with a notable difference, according as it shall wax or wane, or come to the Quadrature with the Sun. The third Period is annual, and is seen to depend on the Sunne, and onely altereth the diurnal motions, by making them different in the times of the Solstices, as to greatnesse, from what they are in the Equinoxes.

We will speak (in the first place, of the diurnal motion, as being the principal, and upon which the Moon and Sun seem to exercise their power secondarily,Varieties that happen in the diurnal period. in their monethly and annual alterations. Three differences are observable in these horary mutations; for in some places the waters rise and fall, without making any progressive motion; in others, without rising or falling they run one while towards the East, and recur another while towards the West; and in others they vary the heights and course also, as happeneth here in Venice, where the Tides in coming in rise, and in going out fall; and this they do in the extermities of the lengths of Gulphs that distend from West to East, and terminate in open shores, up along which shores the Tide at time of flood hath room to extend it self: but if the course of the Tide were intercepted by Cliffes and Banks of great height and steepnesse, there it will flow and ebbe without any progressive motion. Again, it runs to and again, without changing height in the middle parts of the Mediterrane, as notably happeneth in the ** A Strait, so called.Faro de Messina, between Scylla and Carybdis, where the Currents, by reason of the narrownesse of the Channel, are very swift; but in the more open Seas, and about the Isles that stand farther into the Mediterranean Sea, as the Baleares, Corsica, Sardignia, ** Or Ilva.Elba, Sicily towards the Affrican Coasts, Malta, ** Or Creta.Candia, &c. the changes of watermark are very small; but the currents indeed are very notable, and especially when the Sea is pent between Islands, or between them and the Continent.

Now these onely true and certain effects, were there no more to be observed, do, in

my judgment, very probably perswade any man, that will contain himself within the bounds of natural causes, to grant the mobility of the Earth: for to make the vessel (as it may be called) of the Mediterrane stand still, and to make the water contained therein to do, as it doth, exceeds my imagination, and perhaps every mans else, who will but pierce beyond the rinde in these kind of inquiries.

Simpl.These accidents, Salviatus, begin not now, they are most ancient, and have been observed by very many, and several have attempted to assigne, some one, some another cause for the same: and there dwelleth not many miles from hence a famous Peripatetick,The cause of the ebbing and flowing alledged by a certain modern Philosopher. that alledgeth a cause for the same newly fished out of a certain Text of Aristotle, not well understood by his Expositors, from which Text he collecteth, that the true cause of these motions doth only proceed from the different profundities of Seas: for that the waters of greatest depth being greater in abundance, and therefore more grave, drive back the Waters of lesse depth, which being afterwards raised, desire to descend, and from this continual colluctation or contest proceeds the ebbing and flowing.The cause of the ebbing and flowing ascribed to the Moon by a certain Prelate. Again those that referre the same to the Moon are many, saying that she hath particular Domination over the Water; and at last a certain Prelate hath published a little Treatise, wherein he saith that the Moon wandering too and fro in the Heavens attracteth and draweth towards it a Masse of Water, which goeth continually following it, so that it is full Sea alwayes in that part which lyeth under the Moon; and because, that though she be under the Horizon, yet neverthelesse the Tide returneth, he saith that no more can be said for the salving of that particular, save onely, that the Moon doth not onely naturally retain this faculty in her self; but in this case hath power to confer it upon that degree of the Zodiack that is opposite unto it. Others,Hieronymus Borrius and other Peripateticks refer it to the temperate heat of the Moon. as I believe you know, do say that the Moon is able with her temperate heat to rarefie the Water, which being rarefied, doth thereupon flow. Nor

hath there been wanting some that—

Sagr.I pray you Simplicius let us hear no more of them, for I do not think it is worth the while to wast time in relating them, or to spend our breath in confuting them; and for your part, if you gave your assent to any of these or the like fooleries, you did a great injury to your judgment, which neverthelesse I acknowledg to be very piercing.

Salv.But I that am a little more flegmatick than you,Answers to the vanities alledged as causes of the ebbing and flowing.Sagredus, will spend a few words in favour of Simplicius, if haply he thinks that any probability is to be found in those things that he hath related. I say therefore: The Waters, Simplicius, that have their exteriour superficies higher, repel those that are inferiour to them, and lower; but so do not those Waters that are of greatest profundity; and the higher having once driven back the lower, they in a short time grow quiet and ** Or rather smooth. level. This your Peripatetick must needs be of an opinion, that all the Lakes in the World that are in a calme, and that all the Seas where the ebbing and flowing is insensible, are level in their bottoms; but I was so simple, that I perswaded my self that had we no other plummet to sound with,The Isles are tokens of the unevennesse of the bottomes of Seas. the Isles that advance so high above Water, had been a sufficient evidence of the unevennesse of their bottomes. To that Prelate I could say that the Moon runneth every day along the whole Mediterrane, and yet its Waters do not rise thereupon, save onely in the very extream bounds of it Eastward, and here to us at Venice. And for those that make the Moons temperate heat able to make the Water swell, bid them put fire under a Kettle full of Water, and hold their right hand therein till that the Water by reason of the heat do rise but one sole inch, and then let them take it out, and write off the tumefaction of the Sea. Or at least desire them to shew you how the Moon doth to rarefie a certain part of the Waters, and not the remainder; as for instance, these here of Venice, and not those of Ancona, Naples, Genova: the truth is Poetick Wits are of two kinds,Poetick wits of two kinds. some are ready and

apt to invent Fables, and others disposed and inclined to believe them.

Simpl.I believe that no man believeth Fables, so long as he knows them to be so; and of the opinions concerning the causes of ebbing and flowing, which are many, because I know that of one single effect there is but one single cause that is true and primary, I understand very well, and am certain that but one alone at the most can be true, and for all the rest I am sure that they are fabulous, and false; and its possible that the true one may not be among those that have been hitherto produced; nay I verily believe that it is not, for it would be very strange that the truth should have so little light,Truth hath not so little light as not to be discovered amidst the umbrages of falshoods. as that it should not be visible amongst the umbrages of so many falshoods. But this I shall say with the liberty that is permitted amongst us, that the introduction of the Earths motion, and the making it the cause of the ebbing and flowing of Tides, seemeth to me as yet a conjecture no lesse fabulous than the rest of those that I have heard; and if there should not be proposed to me reasons more conformable to natural matters, I would without any more ado proceed to believe this to be a supernatural effect, and therefore miraculous, and unsearchable to the understandings of men, as infinite others there are, that immediately depend on the Omnipotent hand of God.

Sagr.You argue very prudently,Aristotle holdeth those effects to be miraculous, of which the causes are unknown. and according to the Doctrine of Aristotle, who you know in the beginning of his mechanical questions referreth those things to a Miracle, the causes whereof are occult. But that the cause of the ebbing and flowing is one of those that are not to be found out, I believe you have no greater proof than onely that you see, that amongst all those that have hitherto been produced for true causes thereof, there is not one wherewith, working by what artifice you will, we are able to represent such an effect; in regard that neither with the light of the Moon nor of the Sun, nor with temperate heats, nor with different profundities, shall one ever artificially make the Water conteined in an immoveable Vessel to run one way or

another, and to ebbe and flow in one place, and not in another. But if without any other artifice, but with the onely moving of the Vessel, I am able punctually to represent all those mutations that are observed in the Sea Water, why will you refuse this reason and run to a Miracle?

Simpl.I will run to a Miracle still, if you do not with some other natural causes, besides that of the motion of the Vessels of the Sea-water disswade me from it; for I know that those Vessels move not, in regard that all the entire Terrestrial Globe is naturally immoveable.

Salv.But do not you think, that the Terrestrial Globe might supernaturally, that is, by the absolute power of God, be made moveable?

Simpl.Who doubts it?

Salv.Then Simplicius, seeing that to make the flux and reflux of the Sea, it is necessary to introduce a Miracle, let us suppose the Earth to move miraculously, upon the motion of which the Sea moveth naturally: and this effect shall be also the more simple, and I may say natural, amongst the miraculous operations, in that the making a Globe to move round, of which kind we see many others to move, is lesse difficult than to make an immense masse of water go forwards and backwards, in one place more swiftly, and in another lesse, and to rise and fall in some places more; in some lesse, and in some not at all: and to work all these different effects in one and the same Vessel that containeth it: besides, that these are several Miracles, and that is but one onely. And here it may be added, that the Miracle of making the water to move is accompanied with another, namely, the holding of the Earth stedfast against impetuosities of the water, able to make it swage sometimes one way, and sometimes another, if it were not miraculously kept to rights.

Sagr.God Simplicius, let us for the present suspend our judgement about sentencing the new opinion to be vain that Salviatus is about to explicate unto us, nor let us so hastily flye out into passion like the scolding overgrown Haggs: and as for the

Miracle, we may as well recurre to it when we have done hearing the Discourses contained within the bounds of natural causes: though to speak freely, all the Works of nature, or rather of God, are in my judgement miraculous.

Salv.And I am of the same opinion; nor doth my saying, that the motion of the Earth is the Natural cause of the ebbing and flowing, hinder, but that the said motion of the Earth may be miraculous. Now reassuming our Argument, I apply, and once again affirm, that it hath been hitherto unknown how it might be that the Waters contained in our Mediterranean Straights should make those motions, as we see it doth, if so be the said Straight, or containing Vessel were immoveable. And that which makes the difficulty, and rendreth this matter inextricable, are the things which I am about to speak of, and which are daily observed. Therefore lend me your attention.

We are here in Venice, where at this time the Waters are low, the Sea calm,It is proved impossible that there should naturally be any ebbing and flowing, the Earth being immoveable. the Air tranquil; suppose it to be young flood, and that in the term of five or six hours the water do rise ten * hand breadths and more; that rise is not made by the first water, which was said to be rarefied, but it is done by the accession of new Water: Water of the same sort with the former, of the same brackishness, of the same density, of the same weight: Ships, Simplicius, float therein as in the former, without drawing an hairs * Palms.breadth more water; a Barrel of this second doth not weigh one single grain more or less than such another quantity of the other, and retaineth the same coldness without the least alteration: And it is, in a word, Water newly and visibly entred by the Channels and Mouth of the † † Lio is a fair Port in the Venetian Gulph, lying N. E. from the City.Lio. Consider now, how and from whence it came thither. Are there happly hereabouts any Gulphs or Whirle-pools in the bottom of the Sea, by which the Earth drinketh in and spueth out the Water, breathing as it were a great and monstruous Whale? But if this be so, how comes it that the Water doth not flow in the space of six hours in Ancona, in * Ragusa, in Corfu, where the Tide is very small, and happly

unobservable? Who will invent a way to pour new Water into an immoveable Vessel, and to make that it rise onely in one determinate part of it, and in other places not? Will you say, that this new Water is borrowed from the Ocean, being brought in by the Straight of Gibraltar? This will not remove the doubt aforesaid, but will beget a greater. And first tell me what ought to be the current of that Water, that entering at the Straights mouth, is carried in six hours to the remotest Creeks of the Mediterrane, at a distance of two or three thousand Miles, and that returneth the same space again in a like time at its going back? What would Ships do that lye out at Sea? What would become of those that should be in the Straights-mouth in a continual precipice of a vast accumulation of Waters, that entering in at a Channel but eight Miles broad, is to give admittance to so much Water as in six hours over-floweth a tract of many hundred Miles broad, & thousands in length? What Tygre, what Falcon runneth or flyeth with so much swiftness? With the swiftness, I say, of above 400 Miles an hour. The currents run (nor can it be denied) the long-wayes of the Gulph, but so slowly, as that a Boat with Oars will out-go them, though indeed not without defalking for their wanderings. Moreover, if this Water come in at the Straight, the other doubt yet remaineth, namely, how it cometh to flow here so high in a place so remote, without first rising a like or greater height in the parts more adjacent? In a word, I cannot think that either obstinacy, or sharpness of wit can ever find an answer to these Objections, nor consequently to maintain the stability of the Earth against them, keeping within the bounds of Nature.

Sagr.I have all the while perfectly apprehended you in this; and I stand greedily attending to hear in what manner these wonders may occur without obstruction from the motion already assigned to the Earth.

Salv.These effects being to ensue in consequence of the motions that naturally agree with the Earth, it is necessary that they not onely meet with no impediment or obstacle, but that they do follow easily, & not onely that they follow with facility, but with necessity, so as that it is impossible that it should succeed otherwise, for

such is the property & condition of things natural & true. Having therefore shewen the impossibility of rendring a reason of the motions discerned in the Waters,True and natural effects follow without difficulty. & at the same time to maintain the immobility of the vessel that containeth them we may proceed to enquire, whether the mobility of the Container may produce the required effect, in the manner that it is observed to evene.

Two kinds of motions may be conferred upon a Vessel, whereby the Water therein contained,Two sorts of motions of the containing Vessel, may make the contained water to rise and fall. may acquire a faculty of fluctuating in it, one while towards one side, and another while towards another; and there one while to ebbe, and another while to flow. The first is, when first one, and then another of those sides is declined, for then the Water running towards the inclining side, will alternately be higher and lower, sometimes on one side, and sometimes on another. But because that this rising and abating is no other than a recession and accession to the centre of the Earth, such a motion cannot be ascribed to the Cavities of the said Earth, that are the Vessels which contain the Waters; the parts of which Vessel cannot by any whatsoever motion assigned to the Earth,The Cavities of the Earth cannot approach or go farther from the centre of the same. be made to approach or recede from the centre of the same: The other sort of motion is, when the Vessel moveth (without inclining in the least) with a progressive motion, not uniform, but that changeth velocity, by sometimes accellerating, and other times retarding: from which disparity it would follow,The progressive and uneven motion may make the water contained in a Vessel to run to and fro. that the Water contained in the Vessel its true, but not fixed fast to it, as its other solid parts, but by reason of its fluidity, as if it were separated and at liberty, and not obliged to follow all the mutations of its Container, in the retardation of the Vessel, it keeping part of the impetus before conceived, would run towards the the preceding part, whereupon it would of necessity come to rise; and on the contrary, if new velocity should be added to the

Vessel, with retaining parts of its tardity, staying somewhat behind, before it could habituate it self to the new impetus, it would hang back towards the following part, where it would come to rise something. The which effects we may plainly declare and make out to the Sense by the example of one of those same Barks yonder, which continually come from † A Town lying S. E. of Venice* Lizza-Fusina, laden with fresh water, for the service of the City. Let us therefore fancy one of those Barks, to come from thence with moderate velocity along the Lake, carrying the water gently, of which it is full: and then either by running a ground, or by some other impediment that it shall meet with, let it be notably retarded. The water therein contained shall not, by that means, lose, as the Bark doth, its pre-conceived impetus, but retaining the same, shall run forwards towards the prow, where it shall rise notably, falling as much a stern. But if, on the contrary, the said Bark, in the midst of its smooth course, shall have a new velocity, with notable augmentation added to it, the water contained before it can habituate it self thereto, continuing in its tardity, shall stay behinde, namely a stern, where of consequence it shall mount, and abate for the same at the prow. This effect is undoubted and manifest, and may hourly be experimented; in which I desire that for the present three particulars may be noted. The first is, that to make the water to rise on one side of the vessel, there is no need of new water, nor that it run thither, forsaking the other side. The second is, that the water in the middle doth not rise or fall notably, unlesse the course of the Bark were not before that very swift, and the shock or other arrest that held it exceeding strong and sudden, in which case its possible, that not only all the water might run forwards, but that the greater part thereof might issue forth of the Bark: and the same also would ensue, whilst that being under sail in a smooth course, a most violent impetus should, upon an instant, overtake it: But when to its calme motion there is added a moderate retardation or incitation, the middle parts (as I said) unobservedly rise and fall: and the other parts, according as they are neerer to the middle, rise the lesse; and the more remote, more. The third is, that whereas the parts about the midst

do make little alteration in rising and falling, in respect of the waters of the sides; on the contrary, they run forwards and backwards very much, in comparison of the extreams. Now, my Masters, that which the Bark doth, in respect of the water by it contained, and that which the water contained doth, in respect of the Bark its container, is the self-same, to an hair, with that which the Mediterranean Vessel doth, in respect of the waters in it contained, and that which the waters contained do, in respect of the Mediterranean Vessel their container.The parts of the terrestrial Globe accelerate and retard in their motion. It followeth now that we demonstrate how, and in what manner it is true, that the Mediterrane, and all the other Straits; and in a word, all the parts of the Earth do all move, with a motion notably uneven, though no motion that is not regular and uniforme, is thereby assigned to all the said Globe taken collectively.

Simpl.This Proposition, at first sight to me, that am neither Geometrician nor Astronomer, hath the appearance of a very great Paradox; and if it should be true, that the motion of the whole, being regular, that of the parts, which are all united to their whole, may be irregular, the Paradox will overthrow the Axiome that affirmeth, Eandem esse rationem totius & partium.

Salv.I will demonstrate my Paradox, and leave it to your care, Simplicius, to defend the Axiome from it, or else to reconcile them; and my demonstration shall be short and familiar, depending on the things largely handled in our precedent conferences, without introducing the least syllable, in favour of the flux and reflux.

We have said,Demonstrations how the parts of the terrestriall Globe accelerate and retard. that the motions assigned to the Terrestrial Globe are two, the first Annual, made by its centre about the circumference of the Grand Orb, under the Ecliptick, according to the order of the Signes, that is, from West to East; the other made by the said Globe revolving about its own centre in twenty four hours; and this likewise from West to East: though about an Axis somewhat inclined, and not equidistant

from that of the Annual conversion. From the mixture of these two motions, each of it self uniform, I say, that there doth result an uneven and deformed motion in the parts of the Earth. Which, that it may the more easily be understood, I will explain, by drawing a Scheme thereof. And first, about the centre A [in Fig. 1. of this Dialogue] I will describe the circumference of the Grand Orb B C,The parts of a Circle regularly moved about its own centre move in divers times with contrary motions. in which any point being taken, as B, about it as a centre we will describe this lesser circle D E F G, representing the Terrestrial Globe; the which we will suppose to run thorow the whole circumference of the Grand Orb, with its centre B, from the West towards the East, that is, from the part B towards C; and moreover we will suppose the Terrestrial Globe to turn about its own centre B likewise from West to East, that is, according to the succession of the points D E F G, in the space of twenty four hours. But here we ought carefully to note, that a circle turning round upon its own centre, each part of it must, at different times, move with contrary motions: the which is manifest, considering that whilst the parts of the circumference, about the point D move to the left hand, that is, towards E, the opposite parts that are about F, approach to the right hand, that is, towards G; so that when the parts D shall be in F, their motion shall be contrary to what it was before. when it was in D. Furthermore, the same time that the parts E descend, if I may so speak, towards F, those in G ascend towards D. It being therefore presupposed, that there are such contrarieties of motions in the parts of the Terrestrial Surface,The mixture of the two motions annnal and diurnal, causeth the inequality in the motion of the parts of the terrestrial Globe. whilst it turneth round upon its own centre, it is necessary, that in conjoyning this Diurnal Motion, with the other Annual, there do result an absolute motion for the parts of the said Terrestrial Superficies, one while very accelerate, and another while as slow again. The which is manifest, considering first the parts about D, the absolute motion of which shall be extream swift, as that which proceedeth from two motions made both one way, namely, towards the left

hand; the first of which is part of the Annual Motion, common to all the parts of the Globe, the other is that of the said point D., carried likewise to the left, by the Diurnal Revolution; so that, in this case, the Diurnal motion increaseth and accelerateth the Annual. The contrary to which happeneth in the opposite part F, which, whilst it is by the common annual motion carried, together with the whole Globe, towards the left, it happeneth to be carried by the Diurnal conversion also towards the right: so that the Diurnal motion by that means detracteth from the Annual, whereupon the absolute motion, resulting from the composition of both the other, is much retarded. Again, about the points E and G, the absolute motion becometh in a manner equal to the simple Annual one, in regard that little or nothing increaseth or diminisheth it, as not tending either to the left hand, or to the right, but downwards and upwards. We will conclude therefore, that like as it is true, that the motion of the whole Globe, and of each of its parts, would be equal and uniforme, in case they did move with one single motion, whether it were the meer Annual, or the single Diurnal Revolution, so it is requisite, that mixing those two motions together, there do result thence for the parts of the said Globe irregular motions, one while accelerated, and another while retarded, by means of the additions or substractions of the Diurnal conversion from the annual circulation. So that, if it be true (and most true it is, as experience proves) that the acceleration and retardation of the motion of the Vessel, makes water contained therein to run to and again the long wayes of it, and to rise and fall in its extreames, who will make scruple of granting, that the said effect may, nay ought to succeed in the Sea-waters, contained within their Vessels, subject to such like alterations, and especially in those that distend themselves long-wayes from West to East, which is the course that the motion of those same Vessels steereth?The most potent and primary cause of the ebbing and flowing. Now this is the most potent and primary cause of the ebbing and flowing, without the which no such effect would ensue. But because the particular accidents are many and various, that in several places and times are observed, which must of necessity

have dependance on other different concomitant causes, although they ought all to have connexion with the primary; therefore it is convenient that we propound and examine the several accidents that may be the causes of such different effects.

Sundry accidents that happen in the ebbings & flowingsThe first of which is, that when ever the water, by means of a notable retardation or acceleration of the motion of the Vessel, its container, shall have acquired a cause of running towards this or that extream,The first accident. and shall be raised in the one, and abated in the other, it shall not neverthelesse continue, for any time in that state, when once the primary cause is ceased: but by vertue of its own gravity and natural inclination to level and grow, even it shall speedily return backwards of its own accord, The Water raised in one end of the Vessel returneth of its self to Æquilibrium.and, as being grave and fluid, shall not only move towards Æquilibrium; but being impelled by its own impetus, shall go beyond it, rising in the part, where before it was lowest; nor shall it stay here, but returning backwards anew, with more reiterated reciprocations of its undulations, it shall give us to know, that it will not from a velocity of motion, once conceived, reduce it self, in an instant, to the privation thereof, and to the state of rest, but will successively, by decreasing a little and a little, reduce it self unto the same, just in the same manner as we see a weight hanging at a cord, after it hath been once removed from its state of rest, that is, from its perpendicularity, of its own accord, to return thither and settle it self, but not till such time as it shall have often past to one side, and to the other, with its reciprocall vibrations.

In the shorter Vessels the undulations of waters are more frequent.The second accident to be observed is, that the before-declared reciprocations of motion come to be made and repeated with greater or lesser frequency, that is, under shorter or longer times, according to the different lengths of the Vessels containing the waters; so that in the shorter spaces the reciprocations are more frequent, and in the longer more rare: just as in the former example of pendent bodies, the vibrations of those that are hanged to longer cords are seen to be lesse frequent, than those of them that

hang at shorter strings.

The greater profundity maketh the undulations of waters more frequent.And here, for a third observation, it is to be noted, that not onely the greater or lesser length of the Vessel is a cause that the water maketh its reciprocations under different times; but the greater or lesser profundity worketh the same effect. And it happeneth, that of waters contained in receptacles of equall length, but of unequal depth, that which shall be the deepest, maketh its undulations under shorter times, and the reciprocations of the shallower waters are lesse frequent.

Fourthly, there are two effects worthy to be noted, and diligently observed, which the water worketh in those its vibrations; the one is its rising and falling alternately towards the one and other extremity;Water riseth & falleth in the extream parts of the Vessel, and runneth to and fro in the midst. the other is its moving and running, to so speak, Horizontally forwards and backwards. Which two different motions differently reside in divers parts of the Water: for its extream parts are those which most eminently rise and fall; those in the middle never absolutely moving upwards, and downwards; of the rest successively those that are neerest to the extreams rise and fall proportionally more than the remote: but on the contrary, touching the other progressive motion forwards and backwards, the middle parts move notably, going and returning, and the waters that are in the extream parts gain no ground at all; save onely in case that in their rising they overflow their banks, and break forth of their first channel and receptacle; but where there is the obstacle of banks to keep them in, they onely rise and fall; which yet hindereth not the waters in the middle from fluctuating to and again; which likewise the other parts do in proportion, undulating more or lesse, according as they are neerer or more remote from the middle.

The fifth particular accident ought the more attentively to be considered,An accident of the Earths motions impossible to be reduced to practice by art. in that it is impossible to represent the effect thereof by an experiment or example; and the

accident is this. In the vessels by us framed with art, and moved, as the abovenamed Bark, one while more, and another while lesse swiftly, the acceleration and retardation is imparted in the same manner to all the vessel, and to every part of it; so that whilst v. g. the Bark forbeareth to move, the parts precedent retard no more than the subsequent, but all equally partake of the same retardment; and the self-same holds true of the acceleration, namely, that conferring on the Bark a new cause of greater velocity, the Prow and Poop both accelerate in one and the same manner. But in huge great vessels, such as are the very long bottomes of Seas, albeit they also are no other than certain cavities made in the solidity of the Terrestrial Globe, it alwayes admirably happeneth, that their extreams do not unitedly equall, and at the same moments of time increase and diminish their motion, but it happeneth that when one of its extreames hath, by vertue of the commixtion of the two Motions, Diurnal, and Annual, greatly retarded its velocity, the other extream is animated with an extream swift motion. Which for the better understanding of it we will explain, reassuming a Scheme like to the former; in which if we do but suppose a tract of Sea to be long, v. g. a fourth part, as is the arch B C [in Fig. 2.] because the parts B are, as hath been already declared, very swift in motion, by reason of the union of the two motions diurnal and annual, towards one and the same way, but the part C at the same time is retarded in its motion, as being deprived of the progression dependant on the diurnal motion: If we suppose, I say, a tract of Sea as long as the arch B C, we have already seen, that its extreams shall move in the same time with great inequality. And extreamly different would the velocities of a tract of Sea be that is in length a semicircle, and placed in the position B C D, in regard that the extream B would be in a most accelerate motion, and the other D, in a most slow one; and the intermediate parts towards C, would be in a moderate motion. And according as the said tracts of Sea shall be shorter, they shall lesse participate of this extravagant accident, of being in some hours of the day with their parts diversly affected by velocity and tardity of motion. So that, if, as in the first case, we see by

experience that the acceleration and retardation, though equally imparted to all the parts of the conteining Vessel, is the cause that the water contained fluctuates too and again, what may we think would happen in a Vessel so admirably disposed, that retardation and acceleration of motion is very unequally contributed to its parts? Certainly we must needs grant that greater and more wonderful causes of the commotions in the Water ought to be looked for. And though it may seem impossible to some, that in artificial Machines and Vessels we should be able to experiment the effects of such an accident; yet neverthelesse it is not absolutely impossible to be done; and I have by me the model of an Engine, in which the effect of these admirable commixtions of motions may be particularly observed. But as to what concerns our present purpose, that which you may have hitherto comprehended with your imagination may suffice.

Sagr.I for my own particular very well conceive that this admirable accident ought necessarily to evene in the Straights of Seas, and especially in those that distend themselves for a great length from West to East; namely according to the course of the motions of the Terrestrial Globe; and as it is in a certain manner unthought of, and without a president among the motions possible to be made by us, so it is not hard for me to believe, that effects may be derived from the same, which are not to be imitated by our artificial experiments.

Salv.These things being declared, it is time that we proceed to examine the particular accidents, which, together with their diversities, are observed by experience in the ebbing and flowing of the waters.Reasons renewed of the particular accidents observed in the ebbings and flowings. And first we need not think it hard to guesse whence it happeneth, that in Lakes, Pooles, and also in the lesser Seas there is no notable flux and reflux; the which hath two very solid reasons. The one is, that by reason of the shortnesse of the Vessel,Second causes why in small Seas and in Lakes there are no ebbings and flowings. in its acquiring in several hours of the day several degrees of velocity, they are with very little

difference acquired by all its parts; for as well the precedent as the subsequent, that is to say, both the Eastern and Western parts, do accelerate and retard almost in the same manner; and withal making that alteration by little and little, and not by giving the motion of the conteining Vessel a sudden check, and retardment, or a sudden and great impulse or acceleration; both it and all its parts, come to be gently and equally impressed with the same degrees of velocity; from which uniformity it followeth, that also the conteined water with but small resistance and opposition, receiveth the same impressions, and by consequence doth give but very obscure signes of its rising or falling, or of its running towards one part or another. The which effect is likewise manifestly to be seen in the little artificial Vessels, wherein the contained water doth receive the self same impressions of velocity; when ever the acceleration and retardation is made by gentle and uniform proportion. But in the Straights and Bays that for a great length distend themselves from East to West, the acceleration and retardation is more notable and more uneven, for that one of its extreams shall be much retarded in motion, and the other shall at the same time move very swiftly: The reciprocal libration or levelling of the water proceeding from the impetus that it had conceived from the motion of its container. The which libration, as hath been noted, hath its undulations very frequent in small Vessels; from whence ensues, that though there do reside in the Terrestrial motions the cause of conferring on the waters a motion onely from twelve hours to twelve hours, for that the motion of the conteining Vessels do extreamly accelerate and extreamly retard but once every day, and no more; yet neverthelesse this same second cause depending on the gravity of the water which striveth to reduce it self to equilibration, and that according to the shortnesse of the Vessel hath its reciprocations of one, two, three, or more hours, this intermixing with the first, which also it self in small Vessels is very little, it becommeth upon the whole altogether insensible. For the primary cause, which hath the periods of twelve hours, having not made and end of imprinting the precedent commotion, it is overtaken and opposed by the other second, dependant on the

waters own weight, which according to the brevity and profundity of the Vessel, hath the time of its undulations of one, two, three, four, or more hours; and this contending with the other former one, disturbeth and removeth it, not permitting it to come to the height, no nor to the half of its motion; and by this contestation the evidence of the ebbing and flowing is wholly annihilated, or at least very much obscured. I passe by the continual alteration of the air, which disquieting the water, permits us not to come to a certainty, whether any, though but small, encrease or abatement of half an inch, or losse, do reside in the Straights, or receptacles of water not above a degree or two in length.

I come in the second place to resolve the question,The reason given, why the ebbings and flowings, for the most part, are every six hours. why, there not residing any vertue in the primary principle of commoving the waters, save onely every twelve hours, that is to say, once by the greatest velocity, and once by the greatest tardity of motion; the ebbings and flowings should yet neverthelesse appear to be every six hours. To which is answered, that this determination cannot any wayes be taken from the primary cause onely; but there is a necessity of introducing the secondary causes, as namely the greater or lesse length of the Vessels, and the greater or lesse depth of the waters in them conteined. Which causes although they have not any operation in the motions of the waters, those operations belonging to the sole primary cause, without which no ebbing or flowing would happen, yet neverthelesse they have a principal share in determining the times or periods of the reciprocations, and herein their influence is so powerful, that the primary cause must of force give way unto them. The period of six hours therefore is no more proper or natural than those of other intervals of times, though indeed its the most observed, as agreeing with our Mediterrane, which was the onely Sea that for many Ages was navigated: though neither is that period observed in all its parts; for that in some more angust places, such as are the Hellespont, and the Ægean Sea, the periods are much shorter, and also very divers amongst themselves; for which diversities, and

their causes incomprehensible to Aristotle, some say, that after he had a long time observed it upon some cliffes of Negropont, being brought to desperation, he threw himself into the adjoyning Euripus, and voluntarily drowned himself.

The cause why some Seas, though very long, suffer no ebbing and flowing. In the third place we have the reason ready at hand, whence it commeth to passe, that some Seas, although very long, as is the Red Sea, are almost altogether exempt from Tides, which happeneth because their length extendeth not from East to West, but rather transversly from the Southeast to the Northwest; but the motions of the Earth going from West to East; the impulses of the water, by that means, alwayes happen to fall in the Meridians, and do not move from parallel to parallel; insomuch that in the Seas that extend themselves athwart towards the Poles, and that the contrary way are narrow, there is no cause of ebbing and flowing, save onely by the participation of another Sea, wherewith it hath communication, that is subject to great commotions.

Ebbings and flowings why greatest in the extremities of Gulphs, and least in the middle parts.In the fourth place we shall very easily find out the reason why the fluxes and refluxes are greatest, as to the waters rising and falling in the utmost extremities of Gulphs, and least in the intermediate parts; as daily experience sheweth here in Venice, lying in the farther end of the Adriatick Sea, where that difference commonly amounts to five or six feet; but in the places of the Mediterrane, far distant from the extreams, that mutation is very small, as in the Isles of Corsica and Sardinnia, and in the Strands of Rome and Ligorne, where it exceeds not half a foot; we shall understand also, why on the contrary, where the risings and fallings are small, the courses and recourses are great: I say it is an easie thing to understand the causes of these accidents, seeing that we meet with many manifest occurrences of the same nature in every kind of Vessel by us artificially composed, in which the same effects are observed naturally to follow upon our moving it unevenly, that is, one while faster, and another while flower.

Why in narrow places the course of the waters is more swift than in larger.Moreover, considering in the fifth place, that the same quantity of Water being moved, though but gently, in a spatious Channel, comming afterwards to go through a narrow passage, will of necessity run, with great violence, we shall not finde it hard to comprehend the cause of the great Currents that are made in the narrow Channel that separateth Calabria from Sicilia: for that all the Waters that, by the spaciousnesse of the Isle, and by the Ionick Gulph, happens to be pent in the Eastern part of the Sea, though it do in that, by reason of its largeness, gently descend towards the West, yet neverthelesse, in that it is pent up in the Bosphorus, it floweth with great violence between Scilla and Caribdis, and maketh a great agitation. Like to which, and much greater, is said to be betwixt Africa and the great Isle of St. Lorenzo, where the Waters of the two vast Seas, Indian and Ethiopick, that lie round it, must needs be straightned into a lesse Channel between the said Isle and the Ethiopian Coast. And the Currents must needs be very great in the Straights of Magellanes, which joyne together the vast Oceans of Ethiopia, and Del Zur, called also the Pacifick Sea.

A discussion of some more abstruse accidents observed in the ebbing and flowing.It follows now, in the sixth place, that to render a reason of some more abstruse and incredible accidents, which are observed upon this occasion, we make a considerable reflection upon the two principal causes of ebbings and flowings, afterwards compounding and mixing them together. The first and simplest of which is (as hath often been said) the determinate acceleration and retardation of the parts of the Earth, from whence the Waters have a determinate period put to their decursions towards the East, and return towards the West, in the time of twenty four hours. The other is that which dependeth on the proper gravity of the Water, which being once commoved by the primary cause, seeketh, in the next place, to reduce it self to Æquilibrium, with iterated reciprocations; which are not determined by one sole and prefixed time; but have as many varieties of times as are the different

lengths and profundities of the receptacles, and Straights of Seas; and by what dependeth on this second principle, they would ebbe and flow, some in one hour, others in two, in four, in six, in eight, in ten, &c. Now if we begin to put together the first cause, which hath its set Period from twelve hours to twelve hours, with some one of the secondary, that hath its Period verb. grat. from five hours to five hours, it would come to passe, that at sometimes the primary cause and secondary would accord to make impulses both one the same way; and in this concurrency, and (as one may call it) unanimous conspiration the flowings shall be great. At other times it happening that the primary impulse doth, in a certain manner, oppose that which the secondary Period would make, and in this contest one of the Principles being taken away, that which the other would give, will weaken the commotion of the Waters, and the Sea will return to a very tranquil State, and almost immoveable. And at other times, according as the two aforesaid Principles shall neither altogether contest, nor altogether concur, there shall be other kinds of alterations made in the increase and diminution of the ebbing and flowing. It may likewise fall out that two Seas, considerably great and which communicate by some narrow Channel, may chance to have, by reason of the mixtion of the two Principles of motion, one cause to flow at the time that the other hath cause to move a contrary way; in which case in the Channel, whereby they disimbogue themselves into each other, there do extraordinary conturbations insue, with opposite and vortick motions, and most dangerous boilings and breakings, as frequent relations and experiences do assure us. From such like discordant motions, dependent not onely on the different positions and longitudes, but very much also upon the different profundities of the Seas, which have the said intercourse there do happen at sometimes different commotions in the Waters, irregular, and that can be reduced to no rules of observation, the reasons of which have much troubled, and alwayes do trouble Mariners, for that they meet with them without seeing either impulse of winds, or other eminent aereal alteration that might occasion the same; of which disturbance

of the Air we ought to make great account in other accidents, and to take it for a third and accidental cause, able to alter very much the observation of the effects depending on the secondary and more essential causes. And it is not to be doubted, but that impetuous windes, continuing to blow, for example, from the East, they shall retein the Waters and prohibit the reflux or ebbing; whereupon the second and third reply of the flux or tide overtaking the former, at the hours prefixed, they will swell very high; and being thus born up for some dayes, by the strength of the Winds, they shall rise more than usual, making extraordinary inundations.

We ought also, (and this shall serve for a seventh Probleme) to take notice of another cause of motion dependant on the great abundance of the Waters of great Rivers that discharge themselves into Seas of no great capacity,The cause why, in some narrow Channels, we see the Sea-waters run alwayes one way. whereupon in the Straits or Bosphori that communicate with those Seas, the Waters are seen to run always one way: as it happeneth in the Thracian Bosphorus below Constantinople, where the water alwayes runneth from the Black-Sea, towards the Propontis: For in the said Black-Sea by reason of its shortnesse, the principal causes of ebbing and flowing are but of small force. But, on the contrary, very great Rivers falling into the same, those huge defluxions of water being to passe and disgorge themselves by the the straight, the ** Or current. course is there very notable and alwayes towards the South. Where moreover we ought to take notice, that the said Straight or Channel, albeit very narrow, is not subject to perturbations, as the Straight of Scilla and Carybdis; for that that hath the Black-Sea above towards the North, and the Propontis, the Ægean, and the Mediterranean Seas joyned unto it, though by a long tract towards the South; but now, as we have observed, the Seas, though of never so great length, lying North and South, are not much subject to ebbings and flowings; but because the Sicilian Straight is situate between the parts of the Mediterrane distended for a long tract or distance from West to East, that is, according to the course of the fluxes and refluxes; therefore in this the agitations are very great; and

would be much more violent between Hercules Pillars, in case the Straight of Gibraltar did open lesse; and those of the Straight of Magellanes are reported to be extraordinary violent.

This is what, for the present, cometh into my mind to say unto you about the causes of this first period diurnal of the Tide, and its various accidents, touching which, if you have any thing to offer, you may let us hear it, that so we may afterwards proceed to the other two periods, monethly and annual.

Simpl.In my opinion, it cannot be denied, but that your discourse carrieth with it much of probability, arguing, as we say, ex suppositione, namely, granting that the Earth moveth with the two motions assigned it by Copernicus:The Hypothesis of the Earths mobility taken in favour of the Tide, opposed. but if that motion be disproved, all that you have said is vain, and insignificant: and for the disproval of that Hypothesis, it is very manifestly hinted by your Discourse it self. You, with the supposition of the two Terrestrial motions, give a reason of the ebbing and flowing; and then again, arguing circularly, from the ebbing and flowing, draw the reason and confirmation of those very motions; and so proceeding to a more specious Discourse, you say that the Water, as being a fluid body, and not tenaciously annexed to the Earth, is not constrained punctually to obey every of its motions, from which you afterwards infer its ebbing and flowing, Now I, according to your own method, argue the quite contrary, and say; the Air is much more tenuous, and fluid than the Water, and lesse annexed to the Earths superficies, to which the Water, if it be for nothing else, yet by reason of its gravity that presseth down upon the same more than the light Air, adhereth; therefore the Air is much obliged to follow the motions of the Earth: and therefore were it so, that the Earth did move in that manner, we the inhabitants of it, and carried round with like velocity by it, ought perpetually to feel a Winde from the East that beateth upon us with intolerable force. And that so it ought to fall out, quotidian experience assureth us: for if with onely riding post, at the speed of eight or ten miles an hour in the tranquil Air, the

incountering of it with our face seemeth to us a Winde that doth not lightly blow upon us, what should we expect from our rapid course of 800. or a thousand miles an hour, against the Air, that is, free from that motion? And yet, notwithstanding we cannot perceive any thing of that nature.

Salv.To this objection that hath much of likelihood in it,The answer to the objections made against the motion of the Terrestrial Globe. I reply, that its true, the Air is of greater tenuity and levity; and, by reason of its levity, lesse adherent to the Earth than Water so much more grave and †† Corpulenta. bulky; but yet the consequence is false that you infer from these qualities; namely, that upon account of that its levity, tenuity, and lesse adherence to the Earth, it should be more exempt than the Water from following the Terrestrial Motions; so as that to us, who absolutely pertake of of them, the said exemption should be sensible and manifest; nay, it happeneth quite contrary; for, if you well remember, the cause of the ebbing and flowing of the Water assigned by us, consisteth in the Waters not following the unevennesse of the motion of its Vessel, but retaining the impetus conceived before, without diminishing or increasing it according to the precise rate of its diminishing or increasing in its Vessel. Because therefore that in the conservation and retention of the impetus before conceived, The Water more apt to conserve an impetus conceived, then the Air. the disobedience to a new augmentation or diminution of motion consisteth, that moveable that shall be most apt for such a retention, shall be also most commodious to demonstrate the effect that followeth in consequence of that retention. Now how much the Water is disposed to maintain such a conceived agitation; though the causes cease that impress the same, the experience of the Seas extreamly disturbed by impetuous Winds sheweth us; the Billows of which, though the Air be grown calm, and the Wind laid, for a long time after continue in motion: As the Sacred Poet pleasantly sings,

Qual l'alto Egeo, &c.————

Light bodies easier to be moved than heavy, but less apt to conserve the motion.And that long continuing rough after a storm, dependeth on the gravity of the water: For, as I have elsewhere said, light bodies are much easier to be moved than the more grave, but yet are so much the less apt to conserve the motion imparted, when once the moving cause ceaseth. Whence it comes that the Aire, as being of it self very light and thin, is easily mov'd by any very small force, yet it is withall very unable to hold on its motion, the Mover once ceasing. Therefore, as to the Aire which environs the Terrestrial Globe, I would fay, that by reason of its adherence, it is no lesse carried about therewith then the Water; and especially that part which is contained in its vessels; which vessels are the valleys enclosed with Mountains.Its more rational that the Air be commoved by the rugged surface of the Earth, than by the Celestial motion. And we may with much more reason affirm that this same part of the Air is carried round, and born forwards by the rugged parts of the Earth, than that the higher is whirl'd about by the motion of the Heavens, as ye Peripateticks maintain.

The revolution of the Earth confirmed by a new argument taken from the Air.What hath been hitherto spoken, seems to me a sufficient answer to the allegation of Simplitius; yet nevertheless with a new instance and solution, founded upon an admirable experiment, I will superabundantly satisfie him, and confirm to Sagredus the mobility of the Earth. I have told you that the Air, and in particular that part of it which ascendeth not above the tops of the highest Mountains, is carried round by the uneven parts of the Earths surface: from whence it should seem, that it must of consequence come to passe, that in case the superficies of the Earth were not uneven, but smooth and plain, no cause would remain for drawing the Air along with it, or at least for revolving it with so much uniformity. Now the surface of this our Globe, is not all craggy and rugged, but there are exceeding great tracts very even, to wit, the surfaces of very vast Seas, which being also far remote from the continuate ledges of Mountains which environ it, seem to have no faculty of

carrying the super-ambient Air along therewith: and not carrying it about, we may perceive what will of consequence ensue in those places.

Simpl.I was about to propose the very same difficulty, which I think is of great validity.

Salv.You say very well Simplicius, for from the not finding in the Air that which of consequence would follow, did this our Globe move round; you argue its immoveablenesse. But in case that this which you think ought of necessary consequence to be found, be indeed by experience proved to be so; will you accept it for a sufficient testimony and an argument for the mobility of the said Globe?

Simpl.In this case it is not requisite to argue with me alone, for if it should so fall out, and that I could not comprehend the cause thereof, yet haply it might be known by others.

Salv.So that by playing with you, a man shall never get, but be alwayes on the losing hand; and therefore it would be better to give over: Nevertheless, that we may not cheat our third man we will play on. We said even now, and with some addition we reitterate it, that the Ayr as if it were a thin and fluid body, and not solidly conjoyned with the Earth, seem'd not to be necessitated to obey its motion; unlesse so far as the cragginess of the terrestrial superficies, transports and carries with it a part thereof contigious thereunto; which doth not by any great space exceed the greatest altitude of Mountains: the which portion of Air ought to be so much less repugnant to the terrestrial conversion, by how much it is repleat with vapours,The vaporous parts of the earth, partake of its motions. fumes, and exhalations, matters all participating of terrene qualities, and consequently apt of their own nature to the same motions. But where there are wanting the causes of motion, that is, where the surface of the Globe hath great levels, and where there is less mixture of the terrene vapours, there the cause whereby the ambient Air is constrained to give entire obedience to the terrestrial conversion will cease in part; so that in such places,

whilst the Earth revolveth towards the East, there will be continually a wind perceived which will beat upon us, blowing from the East towards the West: and such gales will be the more sensible, where the revolution of the Globe is most swift; which will be in places more remote from the Poles, and approaching to the greatest Circle of the diurnal conversion. But now de facto experience much confirmeth this Phylosophical argumentation; for in the spatious Seas, and in their parts most remote from Land, and situate under the Torrid Zone, that is bounded by the Tropicks, where there are none of those same terrestrial evaporations,Constant gales within the Tropicks blow towards the West. we finde a perpetual gale move from the East with so constant a blast, that ships by favour thereof sail prosperously to the West-India's. And from the same coasting along the Mexican shore, they with the same felicity pass the Pacifick Ocean towards the India's; which to us are East, but to them are West.The course to the West-India's easie, the return difficult. Whereas on the contrary the Course from thence towards the East is difficult and uncertain, and not to be made by the same Rhumb, but must vere more to Land-ward, to recover other Winds, which we may call accidentary and tumultuary, produced from other Principles, as those that inhabit the continent find by experience. Of which productions of Winds, the Causes are many and different, which shall not at this time be mentioned.Winds from Land make rough the Seas. And these accidentary Winds are those which blow indifferently from all parts of the Earth, and make rough the Seas remote from the Equinoctial, and environed by the rugged Surface of the Earth; which is as much as to say environ'd with those perturbations of Air, that confound that primary Gale. The which, in case these accidental impediments were removed, would be continually felt, and especially upon the Sea. Now see how the effect of the Water and Air seem wonderfully to accord with the Celestial observations, to confirm the mobility of our Terrestrial Globe.

Sagr.I also for a final close will relate to you one particular,Another observation

taken from the Air in confirmation of the motion of the Earth. which as I believe is unknown unto you, and which likewise may serve to confirm the same conclusion: You Salviatus alledged, That Accident which Sailers meet with between the Tropicks; I mean that perpetual Gale of Winde that beats upon them from the East, of which I have an account from those that have many times made the Voyage: And moreover (which is very observable) I understand that the Mariners do not call it a Wind, but by another ** Which Wind with our English Mariners is called the Trade-wind. name, which I do not now remember, taken haply from its so fixed and constant Tenor; which when they have met with, they tie up their shrouds and other cordage belonging to the Sails, and without any more need of touching them, though they be in a sleep, they can continue their course. Now this constant Trade-wind was known to be such by its continual blowing without interruptions; for if it were interrupted by other Windes, it would not have been acknowledged for a singular Effect, and different from the rest: from which I will infer, That it may be that also our Mediterranean Sea doth partake of the like accident; but it is not observed, as being frequently altered by the confluence of other windes. And this I say, not without good grounds, yea upon very probable conjectures whch came unto my knowledge, from that which tendred it self to my notice on occasion of the voyage that I made into Syria, going Consul for this Nation to Aleppo,The voiages in the Mediterrane from East to West are made in shorter times than from West to East. and this it is: That keeping a particular account and memorial of the dayes of the departure and arrival of the Ships in the Ports of Alexandria, of Alexandretta, and this of Venice; in comparing sundry of them, which I did for my curiosity, I found that in exactness of account the returns hither, that is the voiages from East to West along the Mediterrane, are made in less time then the contrary courses by 25. in the Hundred: So that we see that one with another, the Eastern windes are stronger then the Western.

Salv.I am very glad I know this particular, which doth not a little make for the

confirmation of the Earths mobility. And although it may be alledged, That all the Water of the Mediterrane runs perpetually towards the Straits-mouth, as being to disimbogue into the Ocean, the waters of as many Rivers, as do discharge themselves into the same; I do not think that that current can be so great, as to be able of it self alone to make so notable a difference: which is also manifest by observing that the water in the Pharo of Sicily runneth back again no less towards the East, than it runneth forwards towards the West.

Sagr.I, that have not as Simplicius, an inclination to satisfie any one besides my self, am satisfied with what hath been said as to this first particular: Therefore Salviatus, when you think it sit to proceed forward, I am prepared to hear you.

Salv.I shall do as you command me, but yet I would fain hear the opinion also of Simplicius, from whose judgement I can argue how much I may promise to my self touching these discourses from the Peripatetick Schools, if ever they should come to their ears.

Simp.I desire not that my opinion should serve or stand for a measure, whereby you should judge of others thoughts; for as I have often said, I am inconsiderable in these kinde of studies, and such things may come into the mindes of those that are entered into the deepest passages of Philosophy, as I could never think of; as having (according to the Proverb) scarce kist her Maid: yet nevertheless, to give you my sudden thoughts, I shall tell you, That of those effects by you recounted, and particularly the last, there may in my judgement very sufficient Reasons be given without the Earths mobility, by the mobility of the Heavens onely; It is demonstrated inverting the argument, that the perpetual motion of the Air from East to West cometh from the motion of Heaven.never introducing any novelty more, than the inversion of that which you your self propose unto us. It hath been received by the Peripatetick Schools, that the Element of Fire, and also a great part of the Aire is carried about according to the Diurnal conversion from East to West, by the contact

of the Concave of the Lunar Orb, as by the Vessel their container. Now without going out of your track, I will that we determine the Quantity of the Aire which partaketh of that motion to distend so low as to the Tops of the highest Hills,It is demonstrated inverting the argument, that the perpetual motion of the Air from East to West, cometh from the motion of Heaven. and that likewise they would reach to the Earth, if those Mountains did not impede them, which agreeth with what you say: For as you affirm, the Air, which is invironed by ledges of Mountains, to be carried about by the asperity of the moveable Earth; we on the contrary say, That the whole Element of Air is carried about by the motion of Heaven, that part only excepted which lyeth below those bodies, which is hindred by the asperity of the immoveable Earth. And whereas you said, That in case that asperity should be removed, the Air would also cease to be whirld about; we may say, That the said asperity being removed, the whole Aire would continue its motion. Whereupon, because the surfaces of spacious Seas are smooth, and even; the Airs motion shall continue upon those, alwaies blowing from the East: And this is more sensibly perceived in Climates lying under the Line, and within the Tropicks, where the motion of Heaven is swifter; and like as that Celestial motion is able to bear before it all the Air that is at liberty, so we may very rationally affirm that it contributeth the same motion to the Water moveable, as being fluid and not connected to the immobility of the Earth:The motion of the Water dependeth on the motion of Heaven. And with so much the more confidence may we affirm the same, in that by your confession, that motion ought to be very small in resect of the efficient Cause; which begirting in a natural day the whole Terrestrial Globe, passeth many hundreds of miles an hour, and especially towards the Equinoctial; whereas in the currents of the open Sea, it moveth but very few miles an hour. And thus the voiages towards the West shall come to be commodious and expeditious, not onely by reason of the perpetual Eastern Gale, but of the course also of the Waters; from which course also perhaps the Ebbing and Flowing may come, by reason of the different scituation of

the Terrestrial Shores:The flux and reflux may depend on the diurual motion of Heaven. against which the Water coming to beat, may also return backwards with a contrary motion, like as experience sheweth us in the course of Rivers; for according as the Water in the unevenness of the Banks, meeteth with some parts that stand out, or make with their Meanders some Reach or Bay, here the Water turneth again, and is seen to retreat back a considerable space. Upon this I hold, That of those effects from which you argue the Earths mobility, and alledge it as a cause of them, there may be assigned a cause sufficiently valid, retaining the Earth stedfast, and restoring the mobility of Heaven.

Salv.It cannot be denied, but that your discourse is ingenious, & hath much of probability, I mean probability in appearance, but not in reality & existence: It consisteth of two parts: In the first it assignes a reason of the continual motion of the Eastern Winde, and also of a like motion in the Water. In the second, It would draw from the same Sourse the cause of the Ebbing and Flowing. The first part hath (as I have said) some appearance of probability, but yet extreamly less then that which we take from the Terrestrial motion. The second is not onely wholly improbable, but altogether impossible and false.A reason of the continual motion of the Air and Water may be given, making the Earth moveable, then by making it immoveable. And coming to the first, whereas it is said that the Concave of the Moon carrieth about the element of Fire, and the whole Air, even to the tops of the higher Mountains. I answer first, that it is dubious whether there be any element of Fire: But suppose there be, it is much doubted of the Orbe of the Moon, as also of all the rest; that is, Whether there be any such solid bodies and vast, or elss, Whether beyond the Air there be extended a continuate expansion of a substance of much more tenuity and purity than our Air, up and down which the Planets go wandring, as now at last a good part of those very Phylosophers begin to think:Its improbable that the element of Fire should be carried round by the Concave of the Moon. But be it in this or in that manner, there is no reason for which the Fire, by a simple contract

to a superficies, which you your self grant to be smooth and terse, should be according to its whole depth carried round in a motion different from its natural inclination; as hath been defusely proved, and with sensible reasons demonstrated by †† A Treatise of our Author formerly cited. Il Saggiatore: Besides the other improbability of the said motions transfusing it self from the subtilest Fire throughout the Air, much more dense; and from that also again to the Water. But that a body of rugged and mountainous surface, by revolving in it self, should carry with it the Air contiguous to it, and against which its promontaries beat, is not onely probable but necessary, and experience thereof may be daily seen; though without seeing it, I believe that there is no judgement that doubts thereof. As to the other part, supposing that the motion of Heaven did carry round the Air, and also the Water; yet would that motion for all that have nothing to do with the Ebbing and Flowing. For being that from one onely and uniform cause, there can follow but one sole and uniform effect; that which should be discovered in the Water, would be a continuate and uniform course from East to West; and in that a Sea onely, which running compass environeth the whole Globe. But in determinate Seas, such as is the Mediterrane shut up in the East, there could be no such motion. For if its Water might be driven by the course of Heaven towards the West, it would have been dry many ages since: Besides that our Water runneth not onely towards the West, But returneth backwards towards the East, and that in ordinal Periods: And whereas you say by the example of Rivers, that though the course of the Sea were Originally that onely from East to West, yet nevertheless the different Position of the Shores may make part of the Water regurgitate, and return backwards: I grant it you, but it is necessary that you take notice my Simplicius, that where the Water upon that account returneth backwards, it doth so there perpetually; and where it runneth straight forwards, it runneth there alwayes in the same manner; for so the example of the Rivers shewes you. But in the case of the ebbing and flowing, you must finde and give us some reason why it doth in the self same place run one while one way,

and another while another; Effects that being contrary & irregular, can never be deduced from any uniform and constant Cause: And this Argument, that overthrows the Hypothesis of the motion contributed to the Sea from the Heavens diurnal motion, doth also confute that Position of those who would admit the sole diurnal motion of the Earth, and believe that they are able with that alone to give a reason of the Flux and Reflux: Of which effect since it is irregular, the cause must of necessity be irregular and alterable.

Simp.I have nothing to reply, neither of my own, by reason of the weakness of my understanding; nor of that of others, for that the Opinion is so new: But I could believe that if it were spread amongst the Schools, there would not want Phylosophers able to oppose it.

Sagr.Expect such an occasion; and we in the mean time if it seem good to Salviatus, will proceed forward.

Salv.All that which hath been said hitherto, pertaineth to the diurnal period of the ebbing and flowing; of which we have in the first place demonstrated in general the primary and universal Cause, without which, no such effect would follow: Afterwards passing to the particular Accidents, various, and in a certain sort irregular, that are observed therein: We have handled the secondary and concommitant Causes upon which they depend. Now follow the two other Periods, Monethly, and Annual, which do not bring with them new and different Accidents, other than those already considered in the diurnal Period; but they operate on the same Accidents, by rendring them greater and lesser in several parts of the Lunar Moneth, and in several times of the Solar Year; as if that the Moon and Sun did each conceive it self apart in operating and producing of those Effects; a thing that totally clasheth with my understanding, which seeing how that this of Seas is a local and sensible motion, made in an immense mass of Water, it cannot be brought to subscribe to Lights, to temperate Heats, to predominacies by occult Qualities, and to

such like vain Imaginations, that are so far from being, or being possible to be Causes of the Tide; that on the contrary, the Tide is the cause of them, that is, of bringing them into the brains more apt for loquacity and ostentation, than for the speculation and discovering of the more abstruse secrets of Nature; which kind of people, before they can be brought to pronounce that wise, ingenious, and modest sentence, I know it not, suffer to escape from their mouths and pens all manner of extravagancies. And the onely observing, that the same Moon, and the same Sun operate not with their light with their motion, with great heat, or with temperate, on the lesser reeeptacles of Water, but that to effect their flowing by heat, they must be reduced to little lesse than boiling, and in short, we not being able artificially to imitate any way the motions of the Tide, save only by the motion of the Vessel, ought it not to satisfie every one, that all the other things alledged, as causes of those effects, are vaine fancies, and altogether estranged from the Truth. I say,The alterations in the effects argue alteration in the cause. therefore, that if it be true, that of one effect there is but one sole primary cause, and that between the cause and effect, there is a firm and constant connection; it is necessary that whensoever there is seen a firm and constant alteration in the effect, there be a firm and constant alteration in the cause. And because the alterations that happen in the ebbing and flowing in several parts of the Year and Moneths, have their periods firm and constant, it is necessary to say, that a regular alteration in those same times happeneth in the primary cause of the ebbings and flowings.The causes at large assigned of the Periods Monethly and Annual of the ebbing and flowing. And as for the alteration that in those times happens in the ebbings and flowings consisteth onely in their greatness; that is, in the Waters rising and falling more or lesse, and in running with greater or lesse impetus; therefore it is necessary, that that which is the primary cause of the ebbing and flowing, doth in those same determinate times increase and diminish its force. But we have already concluded upon the inequality and irregularity of the motion of the Vessels containing the Water to be the primary

cause of the ebbings and flowings. Therefore it is necessary, that that irregularity, from time to time, correspondently grow more irregular, that is, grow greater and lesser. Now it is requisite, that we call to minde, that the irregularity, that is, the different velocity of the motions of the Vessels, to wit, of the parts of the Terrestrial Superficies, dependeth on their moving with a compound motion, resulting from the commixtion of the two motions, Annual and Diurnal, proper to the whole Terrestrial Globe; of which the Diurnal conversion, by one while adding to, and another while substracting from, the Annual motion, is that which produceth the irregularity in the compound motion; so that, in the additions and substractions, that the Diurnal revolution maketh from the Annual motion, consisteth the original cause of the irregular motion of the Vessels, The monethly and annual alterations of the tide can depend upon nothing, save on the alteration of the additions & substractions of the diurnal period from the annual. and consequently of the Ebbing and Flowing: insomuch that if these additions and substractions should alwayes proceed in the same proportion, in respect of the Annual motion, the cause of the Ebbing and Flowing would indeed continue, but yet so as that they would perpetually return in the self same manner: But we are to finde out the cause of making the same Ebbings and Flowings in divers times greater and lesser: Therefore we must (if we will retain the identity of the cause) find the alteration in these additions and substractions, that make them more & less potent, in producing those effects which depend thereupon. But I see not how that potency and impotence can be introduced, unlesse by making the same additions and substractions, one while greater, and another while lesser; so that the acceleration and the retardment of the compound motion, may be made, sometimes in greater, and sometimes in lesser proportion.

Sagr.I feel my self very gently led, as it were, by the hand, and though I finde no rubs in the way, yet neverthelesse, like a blind man, I see not whether your Clue leadeth me, nor can I imagine where such a Journey will end.

Salv.Though there be a great difference between my slow pac't Philosophy, and your

more nimble Reason, yet neverthelesse, in this particular which we are now upon, I do not much wonder, if the apprehensivenesse of your wit be a little obscured by the dark and thick mist that hides the mark, at which we aime: and that which lesseneth my admiration is, the remembrance of the many hours, many dayes, yea more, many nights that I have consumed in this contemplation, and of the many times that, despairing to bring it to a period, I have, for an incouragement of my self, indeavoured to believe, by the example of the unfortunate Orlando, that that might not possibly be true, which yet the testimony of so many credible men set before my eyes: wonder not, therefore, if this once, contrary to your custome, you do not foresee what I intend: and if you will needs admire, I believe that the event, as far as I can judge unexpected, will make you cease your wonderment.

Sagr.I thank God, that he did not permit that desperation of yours to end in the Exit that is fabled of the miserable Orlando, nor in that which haply is no lesse fabulously related of Aristotle, that so neither my self nor others should be deprived of the discovery of a thing, as abstruse as it was desirable: I beseech you, therefore, to satisfie my eager appetite as soon as you can.

Salv.I am ready to serve you: We were upon an inquiry in what manner the additions and substractions of the Terrestriall conversion from the Annual motion, could be made, one while in a greater, and another while in a lesser proportion; which diversity, and no other thing, could be assigned for the cause of the alterations, Monethly and Annual, that are seen in the greatnesse of the Ebbings and Flowings. I will now consider how this proportion of the additions and substractions of the Diurnal Revolution,Three wayes of altering the proportion of the additions of the diurnal Revolution to the annual motion. and Annual motion may grow greater and lesser three several wayes. One is by increasing and diminishing the velocity of the Annual motion, retaining the additions and substractions made by the Diurnal conversion in the same greatnesse, because the Annual motion being about three times greater, that is, more velocious than the Diurnal motion (considered likewise

in the Grand Circle) if we increase it anew, the additions and substractions of the Diurnal motion will occasion lesse alteration therein: but, on the other side, making it more slow, it will be altered in greater proportion, by that same diurnal motion, just as the adding or substracting four degrees of velocity from one that moveth with twenty degrees, altereth his course lesse, than those very four degrees would do, added or substracted from one that should move onely with ten degrees. The second way would be, by making the additions and substractions greater and lesser, retaining the annual motion in the same velocity; which is as easie to be understood, as it is manifest, that a velocity v. gr. of 20 degr. is more altered by the addition or substraction of 10. deg. than by the addition or substraction of 4. The third way would be, in case these two were joyned together, diminishing the annual motion, & increasing the diurnal additions and substractions. Hitherto, as you see, it was no hard matter to attain, but yet it proved to me very hard to find by what means this might be effected in Nature.That which to us is hard to be understood, is with Nature easie to be effected. Yet in the end, I finde that she doth admirably make use thereof, and in wayes almost incredible: I mean, admirable and incredible to us, but not to her, who worketh even those very things, which, to our capacity, are of infinite wonder, with extraordinary facility and simplicity: and that which it is hard for us to understand, is easie for her to effect. Now to proceed, having shewn that the proportion between the additions and substractions of the Diurnal conversion and Annual motion may be made greater and lesser, two wayes, (and I say two, because the third is comprized in the two first) I adde, that Nature maketh use of them both: and farthermore, I subjoyn, that if she did make use but of one alone, it would be necessary to take away one of the two Periodical alterations.If the Diurnal motion should not alter, the annual Period would cease That of the Monethly Period would cease, if the annual motion should not alter. And in case the additions and substractions of the diurnal revolution should continually be equal, the alterations of the annual Period would fail.

Sagr.It seems then, that the Monethly alteration of ebbings and flowings dependeth on the alteration of the annual motion of the Earth? And the annual alteration of those ebbings and flowings do, it seems, depend on the additions and substractions of the diurnal conversion? And here now I finde my self worse puzzled than before, and more out of hope of being able to comprehend how this intricacy may be, which is more inextricable, in my judgment, than the Gordian knot. And I envy Simplicius, from whose silence I argue that he doth apprehend the whole businesse, and is acquit of that confusion which greatly puzzleth my brains.

Simp.I believe verily, Sagredus, that you are put to a a stand; and I believe that I know also the cause of your confusion, which, if I mistake not, riseth from your understanding part of those particulars but even now alledged by Salviatus, and but a part. It is true likewise that I find my self free from the like confusion; but not for that cause as you think, to wit, because I apprehend the whole, nay it happens upon the quite contrary account; namely, from my not comprehending any thing, and confusion is in the plurality of things, and not in nothing.

Sagr.You see Salviatus, how a few checks given to Simplicius in the dayes preceding, have rendered him gentle, and brought him from the capriol to the amble. But I beseech you without farther delay, put us both out of suspence.

Salv.I will endeavour it to the utmost of my harsh way of expressing my self, the obtusenesse of which, the acutenesse of your wit shall supply. The accidents of which we are to enquire the causes are two: The first respecteth the varieties that happen in the ebbings and flowings in the Monethly Period; and the othr relateth to the Annual. We will first speak of the Monethly, and then treat of the Annual; and it is convenient that we resolve them all according to the Fundamentals and Hypothesis already laid down, without introducing any novelty either in Astronomy, or in the Universe, in favour of the ebbings and flowings; therefore let us demonstrate that of all the several accidents in them observed, the causes reside in

the things already known,The true Hypothesis may dispatch its revolutions in a shorter time, in lesser circles than in greater; the which is proved by two examples. and received for true and undoubted. I say therefore, that it is a truly natural, yea necessary thing, that one and the same moveable made to move round by the same moving virtue in a longer time, do make its course by a greater circle, rather than by a lesser; and this is a truth received by all, and confirmed by all experiments,The first example. of which we will produce a few. In the wheel-clocks, and particularly in the great ones, to moderate the time, the Artificers that make them accomodate a certain voluble staffe horozontally, and at each end of it they fasten two Weights of Lead, and when the time goeth too slow, by the onely removing those Leads a little nearer to the centre of the staffe, they render its vibrations more frequent; and on the contrary to retard it, it is but drawing those Weights more towards the ends; for so the vibrations are made more seldome, and consequently the intervals of the hours are prolonged.

The second example.Here the movent vertue is the same, namely the counterpoise, the moveables are those same Weights of lead, and their vibrations are more frequent when they are neerer to the centre, that is, when they move by lesser circles. Hanging equal Weights at unequal cords, and being removed from their perpendicularity, letting them go; we shall see those that are pendent at the shorter cords, to make their vibrations under shorter times, as those that move by lesser circles. Again, let such a kind of Weight be fastened to a cord, which cord let play upon a staple fastened in the Seeling, and do you hold the other end of the cord in your hand, and having given the motion to the pendent Weight, whilst it is making its vibrations, pull the end of the cord that you hold in your hand, so that the Weight may rise higher and higher: In its rising you shall see the frequency of its vibrations encrease, in regard that they are made successively by lesser and lesser circies.Two particular notable accidents in the penduli and their vibrations. And here I desire you to take notice of two particulars worthy to be observed. One is that the vibrations of

one of those plummets are made with such a necessity under such determinate times, that it is altogether impossible to cause them to be made under other times, unlesse it be by prolonging, or abreviating the cord; of which you may also at this very instant ascertain your selves by experience, tying a stone to a pack-threed, and holding the other end in your hand, trying whether you can ever by any artifice be able to swing it this way and that way in other than one determinate time, unlesse by lengthening of shortening the string, which you will find to be absolutely impossible. The other particular truly admirable is, that the self same pendulum makes its vibrations with one and the same frequency, or very little, and as it were insensibly different, whether they be made by very great, or very small arches of the self-same circumference. I mean that whether we remove the pendulum from perpendicularity one, two, or three degrees onely, or whether we remove it 70. 80. nay to an entire quadrant, it being let go, will in the one case and in the other make its vibrations with the same frequency, as well the former where it is to move by an arch of but four or six degrees, as the second, where it is to passe arches of 160. or more degrees. Which may the better be seen, by hanging two weights at two strings of equal length, and then removing them from perpendicularity, one a little way, and the other very far; the which being set at liberty, will go & return under the same times, the one by arches very small, & the other by very great ones, from whence followeth the conclusion of an admirable Problem;Admirable Problems of moveables descending by the Quadrant of a Circle, and of those descending by all the cords of the whole Circle. which is, That a Quadrant of a Circle being given (take a little diagram of the same, [in Fig. 3.]) as for instance: AB erect to the Horizon, so as that it rest upon the plain touching in the point B. and an Arch being made with a Hoop well plained and smoothed in the concave part, bending it according to the curvity of the Circumference ADB. So that a Bullet very round and smooth may freely run to and again within it (the rim of a Sieve is very proper for the experiment) I say, that the Bullet being put in any what ever place, neer or far

from the lowest term B. As for instance, putting it in the point C, or here in D, or in E; and then let go, it will in equal times, or insensibly different arrive at the term B, departing from C, or from D, or from E, or from whatever other place; an accident truly wonderfull. We may add another accident no less strange than this, which is, That moreover by all the cords drawn from the point B to the points C, D, E; and to any other whatsoever, taken not onely in the Quadrant BA, but in all the whole circumference of the Circle the said moveable shall descend in times absolutely equal; insomuch that it shall be no longer in descending by the whole Diameter erect perpendicularly upon the point B, then it shall in descending by B. C. although it do sublend but one sole degree, or a lesser Arch. Let us add the other wonder, which is, That the motions of the falling bodies made by the Arches of the Quadrant AB; are made in shorter times than those that are made by the cords of those same Arches; so that the swiftest motion, and made by a moveable in the shortest time, to arrive from the point A, to the term B, shall be that which is made, not by the right line A, B, (although it be the shortest of all those that can de drawn between the points A. B.) but by the circumference ADB. And any point being taken in the said Arch; as for example: The point D. and two cords drawn A D, and D. B. the moveable departing from the qoint A, shall in a less time come to B, moving by the two cords A D and D B. than by the sole cord A, B. But the shortest of all the times shall be that of the fall by the Arch A D B. And the self same accidents are to be understood of all the other lesser Arches taken from the lowermost term B. upwards.

Sagr.No more, no more; for you so confund and fill me with Wonders, and distract my thoughts so many several wayes, that I fear I shall have but a small part of it left free and disingaged, to apply to the principal matter that is treated of, and which of it self is but even too obscure and intricate: So that I intreat you to vouchsafe me, having once dispatcht the business of the ebbings and flowings, to do this honour to my house (and yours) some other dayes, and to discourse upon the so many other Problems that we have left in suspence; and which perhaps are no less curious and

admirable, than this that hath been discussed these dayes past, and that now ought to draw to a conclusion.

Salv.I shall be ready to serve you, but we must make more than one or two Sessions; if besides the other questions reserved to be handled apart, we would discusse those many that pertain to the local motion, as well of natural moveables, as of the rejected: an Argument largely treated of by our Lyncean Accademick. But turning to our first purpose, where we were about to declare, That the bodies moving circularly by a movent virtue, which continually remaineth the same, the times of the circulation were prefixt and determined, and impossible to be made longer or shorter, having given examples, and produced experiments thereof, sensible, and feasible, we may confirm the same truth by the experiences of the Celestial motions of the Planets; in which we see the same rule observed; for those that move by greater Circles, confirm longer times in passing them. A most pertinent observation of this we have from the Medicæan Planets, which in short times make their revolutions about Jupiter: Insomuch that it is not to be questioned, nay we may hold it for sure and certain, that if for example, the Moon continuing to be moved by the same movent faculty, should retire by little and little in lesser Circles, it would acquire a power of abreviating the times of its Periods, according to that Pendulum, of which in the course of its vibrations, we by degrees shortned the cord, that is contracted the Semidiameter of the circumferences by it passed. Know now that this that I have alledged an example of it in the Moon, is seen and verified essentially in fact. Let us call to mind, that it hath been already concluded by us, together with Copernicus,The Earths annual motion by the Ecliptick, unequal by means of the Moons motion. That it is not possible to separate the Moon from the Earth, about which it without dispute revolveth in a Moneth: Let us remember also that the Terrestrial Globe, accompanyed alwayes by the Moon, goeth along the circumference of the Grand Orb about the Sun in a year, in which time the Moon revolveth about the Earth almost thirteen times; from which revolution it followeth,

that the said Moon sometimes is found near the Sun; that is, when it is between the Sun and the Earth, and sometimes much more remote, that is, when the Earth is situate between the Moon and Sun; neer, in a word, at the time of its conjun¦ction and change; remote, in its Full and Opposition; and the greatest vicinity differ the quantity of the Diameter of the Lunar Orb. Now if it be true that the virtue which moveth the Earth and Moon, about the Sun, be alwayes maintained in the same vigour; and if it be true that the same moveable moved by the same virtue, but in circles unequal, do in shorter times passe like arches of lesser circles, it must needs be granted, that the Moon when it is at a lesse distance from the Sun, that is in the time of conjunction, passeth greater arches of the Grand Orb, than when it is at a greater distance, that is in its Opppsition and Full. And this Lunar inequality must of necessity be imparted to the Earth also; for if we shall suppose a right line produced from the centre of the Sun by the centre of the Terrestrial Globe, and prolonged as far as the Orb of the Moon, this shall be the semidiameter of the Grand Orb, in which the Earth, in case it were alone, would move uniformly, but if in the same semidiameter we should place another body to be carried about, placing it one while between the Earth and Sun, and another while beyond the Earth, at a greater distance from the Sun, it is necessary, that in this second case the motion common to both, according to the circumference of the great Orb by means of the distance of the Moon, do prove a little slower than in the other case, when the Moon is between the Earth and Sun, that is at a lesser distance. So that in this businesse the very same happeneth that befals in the time of the clock; that lead which is placed one while farther from the centre, to make the vibrations of the staffe or ballance lesse frequent, and another while nearer, to make them thicker, representing the Moon. Hence it may be manifest, that the annual motion of the Earth in the Grand Orb, and under the Ecliptick, is not uniform, and that its irregularity proceedeth from the Moon, and hath its Monethly Periods and Returns. And because it hath been concluded, that the Monethly and Annual Periodick alterations of the ebbings and

flowings, cannot be deduced from any other cause than from the altered proportion between the annual motion and the additions and substractions of the diurnal conversion; and that those alterations might be made two wayes, that is by altering the annual motion, keeping the quantity of the additions unaltered, or by changing of the bignesse of these, reteining the uniformity of annual motion. We have already found the first of these, depending on the irregularity of the annual motion occasioned by the Moon, and which hath its Monethly Periods. It is therefore necessary, that upon that account the ebbings and flowings have a Monethly Period in which they do grow greater and lesser. Now you see that the cause of the Monethly Period resideth in the annual motion; and withal you see how much the Moon is concerned in this business, and how it is therewith interrupted apart, without having any thing to do with either, with Seas or Waters.

Sagr.If one that never had seen any kinde of Stairs or Lader, were shewed a very high Tower, and asked if ever he hoped to climb to the top of it, I verily believe that he would answer he did not, not conceiving how one should come thither any way except by flying; but shewing him a stone of but a foot high, and asking him whether he thought he could get to the top of that, I am certain that he would answer he could; and farther, that he would not deny, but that it was not onely one, but ten, twenty, and an hundred times easier to climb that: But now if he should be shewed the Stairs, by means whereof, with the facility by him granted, it is possible to get thither, whither he a little before had affirmed it was impossible to ascend, I do think that laughing at himself he would confess his dulness of apprehension. Thus, Salviatus, have you step by step so gently lead me, that, not without wonder, I finde that I am got with small pains to that height which I despaired of arriving at. 'Tis true; that the Staircase having been dark, I did not perceive that I was got nearer to, or arrived at the top, till that coming into the open Air I discovered a great Sea, and spacious Country: And as in ascending one step, there is no labour; so each of your propositions by it self seemed to me so plain, that thinking I heard but little or

nothing that was new unto me, I conceived that my benefit thereby had been little or none at all: Whereupon I was the more amazed at the unexpected exit of this discourse, that hath guided me to the knowledge of a thing which I held impossible to be demonstrated. One doubt onely remains, from which I desire to be freed, and this it is; Whether that if the motion of the Earth together with that of the Moon under the Zodiack are irregular motions, those irregularities ought to have been observed and taken notice of by Astronomers, which I do not know that they are: Therefore I pray you, who are better acquainted with these things than I, to free me from this doubt, and tell me how the case stands.

Salv.You ask a rational question, and answering to the Objection, Many things may remain as yet unobserved in Astronomy.I say; That although Astronomy in the courses of many ages hath made a great progress in discovering the constitution and motions of the Celestial bodies, yet is it not hitherto arrived at that height, but that very many things remain undecided, and haply many others also undiscovered. It is to be supposed that the first observers of Heaven knew no more but one motion common to all the Stars, as is this diurnal one: yet I believe that in few dayes they perceived that the Moon was inconstant in keeping company with the other Stars; but yet withal, that many years past, before that they distinguished all the Planets: And in particular, Saturn for its slowness, and Mercury for its rareness of appearing were amongst those that were last observed. I conceit that Saturn by its slowness, and Mercury by reason of its seldom appearing, were the last that were observed to be wandring and errant. It is to be thought that many more years run out before the stations and retrogradations of the three superiour Planets were known, as also their approximations and recessions from the Earth, necessary occasions of introducing the Eccentrix and Epicicles, things unknown even to Aristotle, for that he makes no mention thereof. Mercury, and Venus, with their admirable apparitions; how long did they keep Astronomers in suspence, before that they could resolve (not to speak of any other of their qualities) upon their situation? Insomuch that the very order

onely of the Mundane bodies, and the integral structure of the parts of the Universe by us known, hath been doubted of untill the time of Copernicus, who hath at last given us notice of the true constitution, and real systeme, according to which those parts are disposed; so that at length we are certain that Mercury, Venus, and the other Planets do revolve about the Sun; and that the Moon revolveth about the Earth. But how each Planet governeth it self in its particular revolution,Particular structures of the Orbs of the Planets not yet well resolved. and how precisely the structure of its Orb is framed; which is that which is vulgarly called the Theory of the Planets, we cannot as yet undoubtedly resolve. Mars, that hath so much puzled our Modern Astronomers, is a proof of this: And to the Moon her self there have been assigned several Theories, after that the said Copernicus had much altered it from that of Ptolomy. And to descend to our particular case, that is to say, to the apparent motion of the Sun and Moon; touching the former, there hath been observed a certain great irregularity, whereby it passeth the two semicircles of the Ecliptick,The Sun passeth one half of the Zodiack nine days sooner than the other. divided by the points of the Equinoxes in very different times; in passing one of which, it spendeth about nine dayes more than in passing the other; a difference, as you see, very great and notable. But if in passing small arches, such for example as are the twelve Signs, he maintain a most regular motion, or else proceed with paces, one while a little more swift, and another more slow, as it is necessary that it do, in case the annual motion belong to the Sun onely in appearance, but in reality to the Earth in company with the Moon, it is what hath not hitherto been observed,The Moons motion principally sought in the account of Eclipses. nor it may be, sought. Touching the Moon in the next place, whose restitutions have been principally lookt into an account of the Eclipses, for which it is sufficient to have an exact knowledge of its motion about the Earth, it hath not been likewise with a perfect curiosity inquired, what its course is thorow the particular arches of the Zodiack. That therefore the Earth and Moon in running through the Zodiack, that is round the Grand Orb, do somewhat accellerate

at the Moons change, and retard at its full, ought not to be doubted; for that the said difference is not manifest, which cometh to be unobserved upon two accounts; First, Because it hath not been lookt for. Secondly, Because that its possible it may not be very great. Nor is there any need that it should be great, for the producing the effect that we see in the alteration of the greatness of ebbings and flowings.Ebbings and flowings are petty things in comparison of the vastness of Seas, and of the velocity of the motion of the Terrestrial Globe. For not onely those alterations, but the Tides themselves are but small matters in respect of the grandure of the subjects on which they work; albeit that to us, and to our littleness they seem great. For the addition or subduction of one degree of velocity where there are naturally 700, or 1000, can be called no great alteration, either in that which conferreth it, or in that Which receiveth it: the Water of our Mediterrane carried about by the diurnal revolution, maketh about 700 miles an hour, (which is the motion common to the Earth and to it, and therefore not perceptible to us) & that which we sensibly discern to be made in the streams or currents, is not at the rate of full one mile an hour, (I speak of the main Seas, and not of the Straights) and this is that which altereth the first, naturall, and grand motion; and this motion is very great in respect of us, and of Ships: for a Vessel that in a standing Water by the help of Oares can make v. g. three miles an hour, in that same current will row twice as far with the stream as against it: A notable difference in the motion of the Boat, though but very small in the motion of the Sea, which is altered but its seven hundredth part. The like I say of its rising, and falling one, two, or three feet; and scarcely four or five in the utmost bounds of a streight, two thousand, or more miles long, and where there are depths of hundreds of feet; this alteration is much less than if in one of the Boats that bring us fresh Water, the said Water upon the arrest of the Boat should rise at the Prow the thickness of a leaf. I conclude therefore that very small alterations in respect of the immense greatness, and extraordinary velocity of the Seas, is sufficient to make therein great mutations in relation to our smallness, and to our accidents.

Sagr.I am fully satisfied as to this particular; it remains to declare unto us how those additions and substractions derived from the diurnal Vertigo are made one while greater, and another while lesser; from which alterations you hinted that the annual period of the augmentations and diminutions of the ebbings and flowings did depend.

Salv.I will use my utmost endeavours to render my self intelligible,The causes of the inequality of the additions and substractions of the diurnal conversion from the annual motion. but the difficulty of the accident it self, and the great attention of mind requisite for the comprehending of it, constrains me to be obscure. The unequalities of the additions and substractions, that the diurnal motion maketh to or from the annual dependeth upon the inclination of the Axis of the diurnal motion upon the plane of the Grand Orb, or, if you please, of the Ecliptick; by means of which inclination the Equinoctial intersecteth the said Ecliptick, remaining inclined and oblique upon the same according to the said inclination of Axis. And the quantity of the additions importeth as much as the whole diameter of the said Equinoctial, the Earths centre being at the same time in the Solstitial points; but being out of them it importeth lesse and lesse, according as the said centre successively approacheth to the points of the Equinoxes, where those additions are lesser than in any other places. This is the whole businesse, but wrapt up in the obscurity that you see.

Sagr.Rather in that which I do no not see; for hitherto I comprehend nothing at all.

Salv.I have already foretold it. Neverthelesse we will try whether by drawing a Diagram thereof, we can give some small light to the same; though indeed it might better be set forth by solid bodies than by bare Schemes; yet we will help our selves with Perspective and fore-shortning. Let us draw therefore, as before, the circumference of the Grand Orb, [as in Fig. 4.] in which the point A is understood to be one of the Solstitials, and the diameter AP the common Section of the Solstitial

Colure, and of the plane of the Grand Orb or Ecliptick; and in that same point A let us suppose the centre of the Terrestrial Globe to be placed, the Axis of which CAB, inclined upon the Plane of the Grand Orb, falleth on the plane of the said Colure that passeth thorow both the Axis of the Equinoctial, and of the Ecliptick. And for to prevent confusion, let us only draw the Equinoctial circle, marking it with these characters DGEF, the common section of which, with the plane of the grand Orb, let be the line DE, so that half of the said Equinoctial DFE will remain inclined below the plane of the Grand Orb, and the other half DGE elevated above. Let now the Revolution of the said Equinoctial be made, according to the order of the points DGEF, and the motion of the centre from A towards E. And because the centre of the Earth being in A, the Axis CB (which is erect upon the diameter of the Equinoctial DE) falleth, as hath been said, in the Solstitial Colure, the common Section of which and of the Grand Orb, is the diameter PA, the said line PA shall be perpendicular to the same DE, by reason that the Colure is erect upon the grand Orb; and therefore the said DE, shall be the Tangent of the grand Orb in the point A. So that in this Position the motion of the Centre by the arch AE; that is, of one degree every day differeth very little; yea, is as if it were made by the Tangent DAE. And because by means of the diurnal motion the point D, carried about by G, unto E, encreaseth the motion of the Centre moved almost in the same line DE, as much as the whole diameter DE amounts unto; and on the other side diminisheth as much, moving about the other semicircle EFD. The additions and subductions in this place therefore, that is in the time of the solstice, shall be measured by the whole diameter DE.

Let us in the next place enquire, Whether they be of the same bigness in the times of the Equinoxes; and transporting the Centre of the Earth to the point I, distant a Quadrant of a Circle from the point A. Let us suppose the said Equinoctial to be GEFD, its common section with the grand Orb DE, the Axis with the same inclination CB; but the Tangent of the grand Orb in the point I shall be no longer

DE, but another which shall cut that at right Angles; and let it be this marked HIL, according to which the motion of the Centre I, shall make its progress, proceeding along the circumference of this grand Orb. Now in this state the Additions and Substractions are no longer measured by the diameter DE, as before was done; because that diameter not distending it self according to the line of the annual motion HL, rather cutting it at right angles, those terms DE, do neither add nor substract any thing; but the Additions and Substractons are to be taken from that diameter that falleth in the plane that is errect upon the plane of the grand Orb, and that intersects it according to the line HL; which diameter in this case shall be this GF and the Adjective, if I may so say, shall be that made by the point G, about the semicircle GEF, and the Ablative shall be the rest made by the other semicircle FDG. Now this diameter, as not being in the same line HL of the annual motion, but rather cutting it, as we see in the point I, the term G being elevated above, and E depressed below the plane of the grand Orb, doth not determine the Additions and Substractions according to its whole length, but the quantity of those first ought to be taken from the part of the line HL, that is intercepted between the perpendiculars drawn upon it from the terms GF; namely, these two GS, and FV: So that the measure of the additions is the line SV lesser then GF, or then DE; which was the measure of the additions in the Solstice A. And so successively, according as the centre of the Earth shall be constituted in other points of the Quadrant AI, drawing the Tangents in the said points, and the perpendiculars upon the same falling from the terms of the diameters of the Equinoctial drawn from the errect planes by the said Tangents to the plane of the grand Orb; the parts of the said Tangents (which shall continually be lesser towards the Equinoctials, and greater towards the Solstices) shall give us the quantities of the additions and substractions. How much in the next place the least additions differ from the greatest, is easie to be known, because there is the same difference betwixt them, as between the whole Axis or Diameter of the Sphere, and the part thereof that lyeth between the Polar-Circles; the

which is less than the whole diameter by very near a twelfth part, supposing yet that we speak of the additions and substractions made in the Equinoctial; but in the other Parallels they are lesser, according as their diameters do diminish.

This is all that I have to say upon this Argument, and all perhaps that can fall under the comprehension of our knowledge, which, as you well know, may not entertain any conclusions, save onely those that are firm and constant, such as are the three kinds of Periods of the ebbings and flowings; for that they depend on causes that are invariable, simple, and eternal. But because that secondary and particular causes, able to make many alterations, intermix with these that are the primary and universal; and these secondary causes being part of them inconstant, and not to be observed; as for example, The alteration of Winds, and part (though terminate and fixed) unobserved for their multiplicity, as are the lengths of the Straights, their various inclinations towards this or that part, the so many and so different depths of the Waters, who shall be able, unless after very long observations, and very certain relations, to frame so expeditious Histories thereof, as that they may serve for Hypotheses, and certain suppositions to such as will by their combinations give adequate reasons of all the appearances, and as I may say, Anomalie, and particular irregularities that may be discovered in the motions of the Waters? I will content my self with advertising you, that the accidental causes are in nature, and are able to produce many alterations; for the more minute observations, I remit them to be made by those that frequent several Seas: and onely by way of a conclusion to this our conference, I will propose to be considered, how that the precise times of the fluxes and refluxes do not onely happen to be altered by the length of Straights, and by the difference of depths; but I believe that a notable alteration may also proceed from the comparing together of sundry tarcts of Sea, different in greatness; and in position, or, if you will, inclination; which difference happeneth exactly here in the Adriatick Gulph, lesse by far than the rest of the Mediterrane, and placed in so different an inclination, that whereas that hath its bounds that incloseth it on the

Eastern part, as are the Coasts of Syria, this is shut up in its more Westerly part: and because the ebbings and flowings are much greater towards the extremities, yea, because the Seas risings and fallings are there onely greatest, it may probably happen that the times of Flood at Venice may be the time of low Water in the other Sea, which, as being much greater, and distended more directly from West to East, cometh in a certain sort to have dominion over the Adriatick: and therefore it would be no wonder, in case the effects depending on the primary causes, should not hold true in the times that they ought, and that correspond to the periods in the Adriatick, as it doth in the rest of the Mediterrane. But these Particularities require long Observations, which I neither have made as yet, nor shall I ever be able to make the same for the future.

Sagr.You have, in my opinion, done enough in opening us the way to so lofty a speculation, of which, if you had given us no more than that first general Proposition that seemeth to me to admit of no reply, where you declare very rationally, that the Vessels containing the Sea-waters continuing stedfast, it would be impossible, according to the common course of Nature, that those motions should follow in them which we see do follow; and that, on the other side, granting the motions ascribed, for other respects, by Copernicus to the Terrestrial Globe, these same alterations ought to ensue in the Seas, if I say you had told us no more, this alone in my judgment, so far exceeds the vanities introduced by so many others, that my meer looking on them makes me nauseate them, and I very much admire, that among men of sublime wit, of which nevertheless there are not a few, not one hath ever considered the incompatibility that is between the reciprocal motion of the Water contained, and the immobility of the Vessel containing, which contradiction seemeth to me now so manifest.

Salv.It is more to be admired,One single motion of the terrestrial Globe sufficeth not to produce the Ebbing & Flowing that it having come into the thoughts of some to refer the cause of the Tide to the motion of the Earth, therein shewing a more than

common apprehension, they should, in afterwards driving home the motion close with no side; and all, because they did not see that one simple and uniform motion, as v. gr. the sole diurnal motion of the Terrestrial Globe, doth not suffice, but that there is required an uneven motion, one while accelerated, and another while retarded: for when the motion of the Vessels are uniforme, the waters contained will habituate themselves thereto, without ever making any alteration. To say also (as it is related of an ancient The opinion of Seleucus the Mathematician censured.Mathematician) that the motion of the Earth meeting with the motion of the Lunar Orb, the concurrence of them occasioneth the Ebbing and Flowing, is an absolute vanity, not onely because it is not exprest, nor seen how it should so happen, but the falsity is obvious, for that the Revolution of the Earth is not contrary to the motion of the Moon, but is towards the same way. So that all that hath been hitherto said, and imagined by others, is, in my judgment, altogether invalid. But amongst all the famous men that have philosophated upon this admirable effect of Nature,Kepler is with respect blamed. I more wonder at Kepler than any of the rest, who being of a free and piercing wit, and having the motion ascribed to the Earth, before him, hath for all that given his ear and assent to the Moons predominancy over the Water, and to occult properties, and such like trifles.

Sagr.I am of opinion, that to these more spaculative persons the same happened, that at present befalls me, namely, the not understanding the intricate commixtion of the three Periods Annual, Monethly, and Diurnal; And how their causes should seem to depend on the Sun, and on the Moon, without the Suns or Moons having any thing to do with the Water; a businesse, for the full understanding of which I stand in need of a little longer time to consider thereof, which the novelty and difficulty of it hath hitherto hindred me from doing: but I despair not, but that when I return in my solitude and silence to ruminate that which remaineth in my fancy, not very well digested, I shall make it my own. We have now, from these four dayes Discourse, great attestations, in favour of the Copernican Systeme, amongst which these three

taken: the first, from the Stations and Retrogradations of the Planets, and from their approaches, and recessions from the Earth; the second, from the Suns revolving in it self, and from what is observed in its spots; the third, from the Ebbing and Flowing of the Sea do shew very rational and concluding.

Salv.To which also haply, in short, one might adde a fourth, and peradventure a fifth; a fourth, I say, taken from the fixed stars, seeing that in them, upon exact observations, those minute mutations appear, that Copernicus thought to have been insensible. There starts up, at this instant, a fifth novelty, from which one may argue mobility in the Terrestrial Globe, by means of that which the most Illustrious Signore Cæsare,Sig. Cæsare Marsilius observeth the Meridian to be moveable. of the noble Family of the Marsilii of Bologna, and a Lyncean Academick, discovereth with much ingenuity, who in a very learned Tract of his, sheweth very particularly how that he had observed a continual mutation, though very slow in the Meridian line, of which Treatise, at length, with amazement, perused by me, I hope he will communicate Copies to all those that are Students of Natures Wonders.

Sagr.This is not the first time that I have heard speak of the exquisite Learning of this Gentleman, and of his shewing himself a zealous Patron of all the Learned, and if this, or any other of his Works shall come to appear in publique, we may be aforehand assured, that they will be received, as things of great value.

Salv.Now because it is time to put an end to our Discourses, it remaineth, that I intreat you, that if, at more leasure going over the things again that have been alledged you meet with any doubts, or scruples not well resolved, you will excuse my oversight, as well for the novelty of the Notion, as for the weaknesse of my wit, as also for the grandure of the Subject, as also finally, because I do not, nor have pretended to that assent from others, which I my self do not give to this conceit, which I could very easily grant to be a Chymæra, and a meer paradox; and you Sagredus, although in the Discourses past you have many times, with great applause,

declared, that you were pleased with some of my conjectures, yet do I believe, that that was in part more occasioned by the novelty than by the certainty of them, but much more by your courtesie, which did think and desire, by its assent, to procure me that content which we naturally use to take in the approbation and applause of our own matters: and as your civility hath obliged me to you; so am I also pleased with the ingenuity of Simplicius. Nay, his constancy in maintaining the Doctrine of his Master, with so much strength & undauntedness, hath made me much to love him. And as I am to give you thanks, Sagredus, for your courteous affection; so of Simplicius, I ask pardon, if I have sometimes moved him with my too bold and resolute speaking: and let him be assured that I have not done the same out of any inducement of sinister affection, but onely to give him occasion to set before us more lofty fancies that might make me the more knowing.

Simp.There is no reason why you should make all these excuses, that are needlesse, and especially to me, that being accustomed to be at Conferences and publique Disputes, have an hundred times seen the Disputants not onely to grow hot and angry at one another, but likewise to break forth into injurious words, and sometimes to come very neer to blows. As for the past Discourses, and particulatly in this last, of the reason of the Ebbing and Flowing of the Sea, I do not, to speak the truth, very well apprehend the same, but by that slight Idea, what ever it be, that I have formed thereof to my self, I confesse that your conceit seemeth to me far more ingenuous than any of all those that I ever heard besides, but yet neverthelesse I esteem it not true and concluding: but keeping alwayes before the eyes of my mind a solid Doctrine that I have learn't from a most learned and ingenuous person, and with which it is necessary to sit down; I know that both you being asked, Whether God, by his infinite Power and Wisdome might confer upon the Element of Water the reciprocal motion which we observe in the same in any other way, than by making the containing Vessel to move; I know, I say, that you will answer, that he might, and knew how to have done the same many wayes, and those unimaginable

to our shallow understanding: upon which I forthwith conclude, that this being granted, it would be an extravagant boldnesse for any one to goe about to limit and confine the Divine Power and Wisdome to some one particular conjecture of his own.

Salv.This of yours is admirable, and truly Angelical Doctrine, to which very exactly that other accords, in like manner divine, which whilst it giveth us leave to dispute, touching the constitution of the World, addeth withall (perhaps to the end, that the exercise of the minds of men might neither be discouraged, nor made bold) that we cannot find out the works made by his hands. Let therefore the Disquisition permitted and ordain'd us by God, assist us in the knowing, and so much more admiring his greatnesse, by how much lesse we finde our selves too dull to penetrate the profound Abysses of his infinite Wisdome.

Sagr.And this may serve for a final close of our four dayes Disputations, after which, if it seem good to Salviatus, to take some time to rest himself, our curiosity must, of necessity, grant him the same, yet upon condition, that when it is lesse incommodious for him, he will return and satisfie my desire in particular concerning the Problemes that remain to be discust, and that I have set down to be propounded at one or two other Conferences, according to our agreement: and above all, I shall very impatiently wait to hear the Elements of the new Science of our Academick about the natural and violent local Motions. And in the mean time, we may, according to our custome, spend an hour in taking the Air in the Gondola that waiteth for us.

FINIS.

Dialogue Concerning the Two Chief World Systems