I. *A Diſſertation concerning the Figure of the Earth. Part the Second. By the Reverend* J. T. Deſaguliers, *LL. D. F. R. S.*

SINCE my * Paper concerning the Figure of the Earth was read before the Royal Society, I met with a Diſſertation of Monſ. *Mairan* (in the Memoirs of the Royal Academy of *Paris*, for the Year 1720.) wherein the learned and ingenious Author has taken a great deal of Pains to reconcile the Obſervations made on Pendulums, (found to be ſhorter at the Æquator than at *Paris*, when they ſwing Seconds) with the oblong ſpheroidical Figure of the Earth, deduced from Monſ. *Caſſini*'s Meaſures. And tho' upon a ſtrict Examination of his Conjectures, and what he gives for Demonſtrations, I do not find Reaſon to alter my Opinion concerning the oblate or flatted Spheroid, which Sir *Iſaac Newton* has ſhewn to be the Figure of the Earth; yet ſince it might be thought by ſome, who have read Monſ. *Mairan*'s Treatiſe, and afterwards may read mine, that I have not conſider'd all the Circumſtances that He has done, and that I have not been exact enough in the Mathematical Part of my Diſſertation, becauſe I have drawn ſome Concluſions from ſuppoſing the Figure of the Earth ſpherical, when I ſhould have ſuppos'd it an oblong Spheroid; I beg Leave to ſhew here, wherein I think Monſ. *Mairan* is miſtaken, and to give thoſe additional Proofs of my Aſſertions, which I promis'd the Society when I gave in my laſt Paper.

* *Vid.* Philoſ. Tranſ. N°. 386, 387.

Firſt then I begin with the Conjectures.

Monſ. *Mairan* ſays, that it is as reaſonable to ſuppoſe the Earth (if it was once fluid) to have been an oblong Spheroid at firſt, as a Sphere; and that, in ſuch a Caſe, the Centrifugal Force of the ſeveral Parts of the Earth, ariſing from its Revolution about its Axis, which might convert a Sphere into an oblate Spheroid, wou'd only change an oblong Spheroid into one leſs oblong.

If the Earth was at firſt a Fluid, (ſuppoſed homogeneous, and of any given Form,) and left to thoſe Laws, which we find to obtain at preſent; it muſt put on a ſpherical Figure, for the ſame Reaſon that Drops of Mercury, of Water, and other Fluids, put on ſuch a Figure. And to ſuppoſe any Change made in that Figure from the Preſſure of an external Fluid, filling up all Space, is contrary to what has been demonſtrated by Sir *Iſaac Newton* in his *Principia Lib.* 2. *Prop.* 19. where he ſhews, *That if any Portion of a Fluid be compreſs'd by the ſame or any other homogeneous Fluid, that Portion will not have its Figure alter'd by that Preſſure.*

And indeed we ſee, that in the Receiver of the Air-Pump, Lumps of Butter, coagulated Oil, or Honey, Drops of Quickſilver or Water, *&c.* have the ſame Figure, whether the Preſſure of the Air acts upon them, or be taken off by exhauſting the Receiver.

That a fluid Subſtance, of any Figure, will by the Gravity of its Parts become ſpherical, is plain by the following

DEMONSTRATION. *Fig.* I,

Let A B C D E be a Portion of an homogeneous Fluid, whoſe Parts tend towards one another, and whoſe Figure is

is not ſpherical. If in ſuch a Fluid we ſuppoſe a Syphon as ACE (or which is the ſame thing, if all the Fluid ſhou'd be frozen, except the Canal ACE) whoſe Legs AC and CE are unequal, and meet at C, the Center of the Fluid, towards which there is the greateſt Tendency; the Fluid will run out at A in the Leg AC, till it be come down as far as *g* in the Leg CE, ſuppoſing C*g* equal to AC. But if the Leg AC be lengthened as far as *c*, then the Fluid will only come down as far as *e* in the Leg CE, and at the ſame time riſe up to *a* in the Leg C*a*, C*a* being equal to C*e*.

If ſuch another Canal or Syphon be ſuppos'd at BCD, the Fluid in it will come down from D to *d*, and riſe from B to *b*. And ſince ſuch Syphons may be ſuppos'd all over the Fluid ABDE; that Fluid, by the mutual Tendency of its Parts towards one another, muſt be reduc'd to the ſpherical Figure *a b d e*. *Which was to be demonſtrated.*

Now, without conſidering the Unreaſonableneſs of the Suppoſition, let us imagine the Earth to have been an oblong Spheroid at firſt, and then to have a diurnal Revolution given to it, which ſhou'd by Degrees ſhorten its Axis, to bring it to what Meſſieurs *Caſſini* and *Mairan* ſuppoſe it at preſent to be. If in ſuch a Caſe the Earth be ſuppos'd fluid enough to change its Figure, by the Revolution about its Axis, why ſhould it ſtop when the Æquatorial Diameter comes to want juſt one 96th Part of the Length of the Axis? ſince two Powers act upon it to ſhorten its Axis, *viz.* Gravity, and the Centrifugal Force; the firſt of which has already been ſhewn capable to reduce it to a Sphere, and the Centrifugal Force is acknowledged by Monſ. *Mairan* to be (as Sir *Iſaac Newton* has prov'd it) at the Æquator equal to $\frac{1}{289}$ Part of the Gravity there. Certainly the Alteration of Figure wou'd not have ſtopp'd, before the

Earth came to be a Sphere; nay, and it muſt have riſen at the Æquator; and how much, I have already ſhewn in my former Paper.

Again, if we ſuppoſe the Earth of an heterogeneous Fluid, before the diurnal Revolution, the heavieſt Parts wou'd go towards the Center, and the lighter towards the Surface; and that Way the Terraqueous Globe wou'd alſo become a Sphere. Then if, when the Central Parts are fix'd, and the ſuperficial *Strata* are ſtill fluid, the Earth receives a diurnal Motion; it will riſe at the Æquatorial Parts, and that to a greater Height than what I have ſhewn in my former Paper, where I ſuppos'd the Earth of uniform Matter. And that ſomething like this muſt be the Caſe, appears from what Sir *Iſaac Newton* has ſaid upon this Subject. For after having ſhewn, from ſuppoſing the Earth of uniform Matter, that the Centrifugal Force of all its Parts wou'd bring it to be $17\frac{1}{8}$ *Engliſh* Miles higher at the Æquator than at the Poles, and after having given a Table of the proportionable Decreaſe of the Length of the Degrees of a Meridian of the Earth, going from the Poles to the Æquator, in ſuch a Figure of the Earth, with the Lengths that Pendulums muſt have to ſwing Seconds in ſeveral Latitudes; from a Compariſon of the Lengths of Pendulums (obſerv'd by different Perſons to be ſhorter towards the Æquator, than in greater Latitudes (when they ſwing Seconds) he ſhews that the Earth muſt be $31\frac{7}{12}$ Miles higher at the Æquator than at the Poles; and therefore that it muſt be denſer towards the Central than the Superficial Parts to produce a flatted Spheroid, where the Æquatorial Diameter muſt exceed the Axis ſo much more; that is, be longer ſomething more than $\frac{1}{578}$ Part.

Laſtly, let us ſuppoſe the Earth, at its firſt Creation, to have been made of Land and Water, the firſt as ſolid, and

and the laſt as fluid as it is now, but of Monſ. *Caſſini*'s Figure, and examine the Conſequence. Since in that Figure the Axis is $\frac{1}{78}$ Part longer than the Æquatorial Diameter; the Gravity will be ſo much greater at the Æquator than at the Poles, that the Waters will all flow to the Æquatorial, and leave the Polar Regions; which will happen ſtill more by the Centrifugal Force, which the Earth in its diurnal Motion will give to the Fluid; and therefore the Sea wou'd be $43\frac{85}{100}$ Miles (reckoning 5000 Feet to a Mile) higher at the Æquator than at the Poles, which muſt overflow all the Torrid Zone, and leave the Polar Regions dry.

I am very well aware, that it may be objected by ſuch as have read Monſ. *Mairan*'s Diſſertation, and have not read Sir *Iſaac Newton*'s *Principia*, or have not read that Book with due Attention — "That I have not argued fairly in drawing Conſequences from a greater Gravity at the Æquator than at the Poles, in an oblong Spheroid; becauſe Monſ. *Mairan* has ſhewn, that, in ſuch a Figure of the Earth, the Gravity is greater at the Poles than at the Æquator; and that I ſhou'd have drawn my Conſequences from theſe Principles." To which I anſwer, that his Demonſtrations about Gravity are built upon wrong Suppoſitions, as I ſhall ſhew by and by. Nevertheleſs, ſuppoſing that Gravity was greater towards the Poles than towards the Æquator, in the Proportion that he aſſigns, namely of the Ray of Curvature drawn into the Perpendicular to the Curve, terminated at the Axis; let us conſider what will follow from his Principles.

* Let us then ſuppoſe the Earth at firſt in a fluid State; A A the Axis, *d* Æ the Æquatorial Diameter, *e b* a Ray of Curvature, *d n* another, *a c* and *d* C two Lines

* Fig. II.

of

of Tendency or Perpendiculars to the Curve, intercepted by the Axis at *c* and C; and *d* C, A C, two Tubes or Canals of the Fluid, gravitating towards, and communicating at C. I ſay that, according to Monſ. *Mairan*'s Principles of Gravity, the Earth cannot preſerve its oblong ſpheroidical Figure. For ſince the Gravity at *a* : Is to the Gravity at *d* :: As $d n \times d C$: to $a b \times a c$, it will follow (from the Nature of the Ellipſe) that the Gravity at A : will be to the Gravity at *d* :: As $A C^4$: to $d C^4$: and therefore the Forces, with which the Columns of Fluid A C and *d* C tend towards C, will be as their Maſſes drawn into the Forces driving towards C, that is, as $A C \times A C^4$ to $d C \times d C^4$. Now by the Principles of Hydroſtaticks, it is evident that the Fluid, in the Canal A C, will cauſe the Fluid in the Canal *d* C to run out at *d* as long as $A C \times A C^4$ is greater than $d C \times d C^4$: And if the Canal C *d* be continued quite to δ, the Surface of the Fluid in A C will ſink to α, whilſt the Surface of the Fluid in *d* C riſes up to δ, in which Caſe as $\alpha C = C \delta$, the Point A will come to α, and the Point *d* to δ, and the Curve A *d* being chang'd into $\alpha \delta$, the oblong Spheroid will be chang'd into a Sphere, the only Figure conſiſtent with the *Æquilibrium* of the fluid Parts, according to Monſ. *Mairan*'s own Principles; becauſe then you will have $A C^4 = d C^4$, and $A C \times A C^4 = d C \times d C^4$. If we make uſe of Sir *Iſaac Newton*'s Principles in this Reaſoning, we ſhall alſo ſhew, that an oblong, ſpheroidical, fluid Earth will be chang'd into a Sphere; but not ſo faſt as it does by Monſ. *Mairan*'s Laws; for, according to Sir *Iſaac Newton*, the Gravity at A : Is to the Gravity at *d* :: As $\sqrt[5]{C d}$: $\sqrt[5]{A C}$. *Q. E. D.*

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* Fig. II.

NB. *Here*

NB. *Here we have ſuppos'd no diurnal Revolution, for as ſoon as that begins, the Centrifugal Force will raiſe the Æquatorial Parts, and change the Sphere into a flatted Spheroid, as has been before ſhewn, and is allow'd by Monſ.* Mairan.

Now if we ſuppoſe the ſame Figure of the Earth, but the Land (at its firſt Creation) as firm as it is now; it will in that Caſe follow from Monſ. *Mairan*'s Principles, that the Sea muſt riſe and overflow all the Æquatorial Regions, tho' the Earth had no diurnal Revolution; and much more ſo, when the Centrifugal Force, ariſing from the diurnal Motion, helps to carry the Water the ſame Way.

DEMONSTRATION.

Let P *æ* P Æ * repreſent the Plane of a Meridian, P P the Axis of the Earth (ſuppos'd an oblong Spheroid) *æ* Æ the Diameter of the Æquator, *d e a æ* Part of the Surface of the Earth, *æ* A and *e* B two Perpendiculars to the Surface of the Earth (which are here two Rays of Curvature) *f c* the Surface of the Sea, and *f d e g*, *b a æ c* two Cylinders of Sea-Water of equal Baſes and equal Heights.

Since Gravity acts on the two equal Columns of Water *b a c æ*, *f d e g* in the reciprocal Ratio of the Ray of Curvature (at the reſpective Places of the Columns) drawn into that Part of it which Monſ. *Mairan* calls the Line of Tendency, (that is, in the Ratio of *e* B × *e* Z to *æ* A × *æ* C) the Weight of *f e* : will be to the Weight of *b æ* : : As *æ* A × *æ* C : to *e* B × *e* Z. Therefore if there be a Communication between the fluid Co-

* Fig. III.

lumns

lumns *f e* and *b æ*, there cannot be an *Æquilibrium*, till the Quantity of Matter in *f e*, becomes to the Quantity of Matter in *b æ*, reciprocally as the Gravity at the Place *æ* is to the Gravity at *e*; and in that Caſe the Height *g e* will be reduc'd to *k e*, if *k e* : *c æ* :: *e* B × *e* Z : *æ* A × *æ* C. And conſequently the Surface of the Sea will go thro' the Points *i k b c*, where *b c* under the Æquator is higher than *i k* towards the Poles. *Q. E. D.*

NB. *That the Centrifugal Force will ſtill add to the Height of the Sea at* b c, *is plain from what we have ſaid before. And if we apply theſe Principles to determine the differeut Lengths of Pendulums, ſwinging Seconds at* Paris *and at the Æquator; from the Gravity at* Paris, *compar'd to the Gravity at the Æquator (in this Suppoſition of the Action of Gravity and Figure of the Earth) a Pendulum muſt be ſhorter at the Æquator by more than* 10 *Lines, without conſidering the Centrifugal Force; and if the Centrifugal Force be taken into Conſideration, the Pendulums muſt be ſhortened near a whole Inch. But this being about five Times more than agrees with Obſervation; what proves too much, proves nothing at all.*

Having thus ſhewn, that Monſ. *Mairan*'s Account of the Action of Gravity, on ſeveral Places upon the Earth's Surface, can be of no Service for reconciling the Experiments made on Pendulums, with the Figure of the Earth deduc'd from Monſ. *Caſſini*'s Meaſures: I proceed to ſhew that his Demonſtrations are founded upon wrong Principles. And firſt, in Relation to Gravity.

This Gentleman has follow'd Sir *Iſaac Newton*, in ſaying, that Gravity increaſes in a duplicate reciprocal

Proportion of the diminiſh'd Diſtance from the Center of the Force, and ſo *vice versâ*; but he has follow'd Sir *Iſaac Newton* no farther than ſerv'd his preſent Purpoſe; otherwiſe he wou'd have known.—That in reſpect to a Central Body (as a Planet) towards which others are (*attracted* or) impell'd by Gravity, this Law obtains only, as Bodies attracted, are remov'd from the Surface of the Planet, to greater Diſtances from the Center compar'd with that Diſtance; or as from greater Diſtances they approach nearer to the Planet. —That the greateſt Action of Gravity is at the Surface of the Planet.—That afterwards in advancing towards the Center, the Force of Gravity, on the Body attracted, continually grows leſs, decreaſing directly as the Diſtance; and that this holds true in a Spheroid as well as a Sphere. —That on different Parts of the Surface of the Earth (in the Condition it is now) the Gravity on Bodies is reciprocally as their Diſtance from the Center of the Earth. —That though at a conſiderable Diſtance we look upon the Earth, or any Planet, or even the Sun, as a Point (in the Center of the Forces tending towards it) endued with an abſolute Force, proportional to its Quantity of Matter; yet when we come ſo near the Body as to conſider the Space it takes up, we are to take notice, that the whole Attraction or Gravity of the Body, is made up of the Sum of the Attraction of all its Parts properly combin'd; and therefore, that when a Corpuſcle, or Body attracted, comes to be within the Planet, or Body attracting, the Matter above it draws it back in ſuch a Manner, that it leaves it only a Force to go on towards the Center, which is directly as the Diſtance, as we have already ſaid; juſt as if a Body concentric to the Planet (whether ſpherical or ſpheroidical) had its Surface juſt where the Corpuſcle is, and all the exterior Cruſt or Shell was annihilated.

I do not doubt but Monſ. *Mairan* will be of this Opinion, when he has carefully and impartially examin'd the 12th and 13th *Sections* of the Firſt Book of Sir *Iſaac Newton*'s *Principia*, and the 18th, 19th, and 20th *Prop.* of the Third Book. And if he will be at the Pains to compare the 38th and 39th *Propoſition* of the Third Book with the 66th of the Firſt, he will find that the Preceſſion of the Æquinoxes is owing to the broad ſpheroidical Figure of the Earth; and that if it had Monſ. *Caſſini*'s Figure, the Æquinoctial Points wou'd move *in Conſequentia* faſter than they do now *in Antecedentia.*

Further, Monſ. *Mairan* demonſtrates, that in an oblong Spheroid, the Diminution of Gravity, by the Centrifugal Force, encreaſes faſter in going from the Poles to the Æquator, than it wou'd do in a Sphere, and faſter in a Sphere than it wou'd do in a broad Spheroid; and therefore wou'd ſhew, "That notwithſtanding the Sur-"face of the Earth is nearer to the Center in Monſ. *Caſ-*"*ſini*'s Figure than in Sir *Iſaac Newton*'s, yet the "Centrifugal Force will diminiſh the Gravity ſo faſt in "going from *Paris* to the Æquator, that the ſhortening "of Pendulums, to make them ſwing Seconds at the "Æquator, may very well be accounted for that Way."

Now let us examine into this Matter, to ſee whether the Cauſe is adequate to the Effect.

If the Diſtance from the Surface of the Earth at the Pole to the Center be 96, and the Diſtance of the Surface at the Æquator be 95, the Diſtance of the Surface at *Paris*, in the Latitude of 48° 50′, will be 95,562, *&c.* by the Property of the Ellipſe. Now ſince the Force of Gravity, in different Places on the Earth's Surface, is reciprocally as the Diſtance from the Center, and the Lengths of Pendulums, that perform their Vibrations in the ſame Time, are directly as the Force of Gravity; therefore

therefore the Length of Pendulums at *Paris*, will be to their Length at the Æquator, as 95 to 95,562, *&c.* that is, as 440,555, *&c.* to 443,165, *&c.* and conſequently they muſt be lengthen'd 2,61 *&c.* Lines. But as from Monſ. *Mairan*'s Principles, the Diminution of Gravity by the Centrifugal Force, is greater at the Æquator than at *Paris*, hardly $\frac{1}{440}$ Part of the whole Gravity at the Æquator, the Pendulums muſt be ſhortened in that Proportion; ſo that then the Length of a Second-Pendulum, will be 440,555 + 2,61 — 1 Lines. But as that Quantity is greater than 440,555, *&c.* therefore the Pendulums upon the Whole muſt be lengthen'd: Nay, though we ſhou'd allow a ſhortening of two Lines; ſince by Obſervation Pendulums are found to be about two Lines ſhorter at the Æquator, the oblong ſpheroidical Figure of the Earth cannot be conſiſtent with the Experiments on Pendulums.

I beg Leave to ſet down Monſ. *Mairan*'s aforeſaid Demonſtration here; that we may ſee whether he has aſſum'd true Principles.

PROPOSITION V.

" * XI. *The Centrifugal Force at any Degree of*
" *Latitude, taken upon the oblong Spheroid, between*
" *the Æquator and the Pole, is leſs in Compariſon*
" *to the Centrifugal Force at the Æquator, than it*
" *wou'd be at the ſame Degree of Latitude taken upon*
" *a Sphere; or, which is the ſame thing, the Centri-*
" *fugal Force encreaſes more, going from the Poles*
" *towards the Æquator, upon an oblong Spheroid,*
" *than upon a perfect Sphere; and conſequently Gra-*
" *vity diminiſhes more, and a Pendulum muſt be more*

* *See Monſ.* Mairan's *Diſſertation, Article* XI. &c.

" *ſhortened under the Æquator, in the Hypotheſis of* " *the oblong Spheroid, than in that of a perfect* " *Sphere.*

' Having deſcrib'd an oval Curve of any Kind, as " for Example, the Ellipſe * ADBE abovementioned, " and inſcrib'd the Circle DHE, whoſe Radius is DC " = half the ſhorter Axis DE; upon AD take any " Point as R, between the Æquator and the Pole, and " from that Point to the *Evoluta* OTX draw the *Ray* " *of Curvature* RT, which gives the *Line of Tendency* " RP (*Art.* IV.) Draw likewiſe from the common Cen- " ter C, to the Circumference of the Circle DH, a Ra- " dius CV, parallel to PR, and meeting the Circle at V; " then from the Points R, V, draw the Lines RN, VZ, " perpendicular to the Axis AB.

" It muſt be obſerv'd, *Firſt*, That as the Ellipſe AD " repreſents a Meridian of the oblong Spheroid, the " Circle DH repreſents a Meridian of a Sphere in the " ſame Plane.

" *Secondly*, That the Point V, on the Circular Me- " ridian, anſwers to the ſame Degree of Latitude as " the Point R, upon the elliptical Meridian; becauſe " the Lines PR, CV, being parallel to each other, and " perpendicular, the one to the Ellipſe and the other " to the Circle (*by Conſtruction*) the touching Planes, " or Horizons of the Points R, V, will alſo be pa- " rallel.

" *Thirdly*, Whence it follows that the Diminution of " the Centrifugal Force (acting againſt Gravity) on ac- " count of its Obliquity to the Horizon (*Art.* X.) of

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Fig. IV.

" the

" the ſame Degree of Latitude on the Elliptical and on " the Circular Meridian, is the ſame in both Caſes, and " in the ſame Ratio as the abſolute Centrifugal Forces " repreſented by the Perpendiculars R N, V Z, (*Art.* IX.) " Therefore to know whether the Centrifugal Force " (whether abſolute or relative) of the Point R, upon the " oblong Spheroid A D B E, be leſs or greater in reſpect " to the Centrifugal Force under the common Æquator " D E, than the Centrifugal Force (whether abſolute or " relative) of the correſpondent Point V upon the Sphere; " nothing more is requir'd than to ſee which is the " longeſt of the two Perpendiculars, namely, R N in " the oblong Spheroid, or V Z in the Sphere; ſince " theſe two Lines expreſs the Radii of the Circles of " Revolution, and conſequently the abſolute Quantity " of the Centrifugal Forces.

" *4thly and laſtly*, That the Ratio of the Centrifugal " Forces of two correſpondent Points upon the oblong " Spheroid A D B E, and the inſcrib'd Sphere D H E, to the " Centrifugal Force of their Æquators is the ſame, ſuppo- " ſing the Sphere of any other Bigneſs; and that it has " been determin'd here of the Diameter D E, only to " render the Demonſtration eaſier, by giving the ſame " Conſequent to the Antecedents R N and V Z. For " if about the Center C and with the Radius C *d*, the " Circle *d h e* be deſcrib'd equal (for Example) to a " Meridian of a Sphere of the ſame Solidity as the ob- " long Spheroid A D B E; and the Radius C V be pro- " duc'd till it meet the Circle *d h* at the Point *u*, and " *u z* be let fall perpendicular to the common Axis of " Revolution, and parallel to V Z: It is plain, that " we ſhall always have V Z : D C :: *u z* : *d* C, or " $\frac{VZ}{DC} = \frac{uz}{dC}$, and conſequently $\frac{RN}{DC}$ will have the

" ſame

" ſame Ratio to $\frac{VZ}{DC}$ as to $\frac{uz}{dC}$.

" Therefore, in order to demonſtrate that the Centri-
" fugal Force of a Point, taken in any Latitude upon
" the oblong Spheroid, is leſs when compar'd to the Cen-
" trifugal Force of the like Point, taken upon a Sphere
" in reſpect to the Centrifugal Force at the Æquator;
" there is nothing more requir'd than to ſhew that RN
" $\lhd$ VZ, becauſe by that means we ſhall have $\frac{RN}{DC}$
" $\lhd \frac{VZ}{DC}$.

" This being obſerv'd; from the Point R, draw the
" Line RI, parallel to the Axis AB, and meeting the
" Circle DH at K, and the Diameter DE of the Æqua-
" tor at the Point I. From the Point K having let fall
" the Perpendicular KL = RN, upon the Axis AB,
" and drawn KC to the Center C; the Queſtion will be
" brought to this, *viz.* To know whether the Point V
" coincides with the Point K; or whether it is above it
" towards D, or below towards H.

" But CK = CV = CD $\rhd$ PR (*Art.* VIII.) there-
" fore CK and PR being both between the Parallels
" AC, RI, the greateſt CK is more inclin'd to them
" than the leaſt PR, and the Angle KCA is leſs than
" the Angle RPA = VCA. And ſince theſe two
" Angles have each of them one of their Sides coinciding
" with the Line AC, namely, the Side AP of the Angle
" RPA, and the Side AC of the Angle KCA, it fol-
" lows that the Side VC of the Angle VCA = RPA
" $\rhd$ KCA, will go above CK between CK and CD,
" and meet the Line RI at the Point G, between K and
" I, and the Circle DH at the Point V, which conſe-
" quently

" quently will be above R I, between K and D. There-
" fore C V = C G + G V is = P R + G V, and con-
" ſequently V Z, which meets R I at the Point F, is
" = Z F + F V = R N + F V; and therefore R N
" = V Z — F V. Therefore R N ≺ V Z.

" And becauſe the ſame Thing may be demonſtrated
" in reſpect of any other Point, taken between the Æ-
" quator and the Pole; and that Gravity, and conſe-
" quently the Length of a Pendulum diminiſhes, as the
" Centrifugal Force encreaſes. Therefore *&c. Q. E. D.*

COROLLARY.

" XII. From what has been demonſtrated, and from
" *Prop.* 3. *Art.* VIII. it follows, that the Perpendicular
" which is drawn from any Point of an oval Meridian
" to the Axis, will be ſo much ſhorter, in Compariſon to
" the Perpendicular drawn from the correſpondent Point
" of an inſcrib'd circular Meridian, as the Latitude is
" greater; and conſequently (by *Art.* XI. *Num.* 3.)
" the Centrifugal Force will be ſo much the leſs, and
" Gravity ſo much the greater, upon the oblong Sphe-
" roid, in reſpect to the Centrifugal Force, and the Gra-
" vity under the Æquator.

" For as the Line R P does always decreaſe, as the
" Point R is taken nearer to the Pole A, it is evident,
" that the Angle V C K will continually encreaſe, in
" reſpect to the Angles V C A, K C A, as it is their Dif-
" ference, and conſequently that the Perpendicular V Z
" will be ſo much greater than the Perpendicular
" K L = R N.

I paſs over the Demonſtration of the latter Part of his Propoſition above-mentioned, which he deduces juſtly from his Conſtruction, if what he ſays (*Num.* 2.) be right; becauſe in ſuch a Caſe it cannot be call'd in Queſtion;

ſtion, and proceed to an Obſervation that he makes afterwards, *viz.* " *We muſt take care to obſerve in the* " *foregoing Propoſitions and Corollaries, that the* " *Compariſon is always made between two ſimilar* " *Points of Latitude, taken upon the two Spheroids,* " *or upon one of the Spheroids and the Sphere,* " *between the Æquator and the Poles, in reſpect to* " *the Centrifugal Force upon the Æquator of any* " *one of theſe Spheroids, or of the Sphere. For if* " *we only compar'd abſolutely the Centrifugal Force* " *of a Point of the Æquator of the one, to the Cen-* " *trifugal Force of a correſpondent Point of the Æ-* " *quator of the other, it is plain that it wou'd be* " *greater upon a flatted Spheroid than upon a Sphere,* " *or than upon an oblong Spheroid of the ſame Soli-* " *dity, in the Ratio of the great Axis of the gene-* " *rating Ellipſe of the flatted Spheroid, to the Di-* " *ameter of the Sphere, or to the ſhorter Axis of the* " *generating Ellipſe of the oblong Spheroid. And in* " *all Likelihood, this muſt be the Reaſon that has* " *made others, who have treated of this Subject, to* " *imagine the very contrary of what I have demon-* " *ſtrated.*

As Monſ. *Mairan* conſiders the Earth at reſt, in the Conſtruction for his Demonſtration above quoted, and afterwards obſerves what Effect the Centrifugal Force will have upon Bodies on its Surface, to diminiſh the Gravity, with which they endeavour to deſcend in their Line of Tendency R P: He ſhou'd not only have taken notice (as he has done) that the whole Centrifugal Force N R is not to be ſubſtracted from the Gravity at R, as the whole Centrifugal Force C D is to be ſubſtracted from the whole Gravity at D, becauſe of the Obliquity of R N to P R; but he ſhould have obſerv'd alſo, that the Obliquity of the Plane of the Parallel N R, in which

the Centrifugal Force acts, muſt alter the Line of Tendency R P, and change the Direction R P into R W, ſomewhere between the Point P and the Center C; for if there be a heavy Body as a Plummet, hanging by a Thread in the Line S R, or S P, the Line of Tendency which has been ſuppos'd perpendicular to the Curve A R D, without taking in the Effect of the Centrifugal Force; as ſoon as the Spheroid revolves about its Axis, the Body which wou'd fall in the Line S R, acted upon only by one Force, namely, that of Gravity, will now be acted upon by another Force, at the ſame Time puſhing it in the Line S *s* (which is the ſame as R *r*) and conſequently will move in the Line S *r*, diagonal of the Parallelogram *s* S R *r*; or, which is all one, a Body plac'd at R will have its Line of Tendency in R W, as I have already ſhewn in my firſt Diſſertation on this Subject; only I did not ſuppoſe the Earth a Spheroid before the diurnal Motion, and therefore made uſe of the Line Z V inſtead of the Line N R; ſo that it may be objected that the Angle *r* S R will not be ſo great in a Spheroid as in a Sphere, becauſe the Centrifugal Force which acts with the ſame Obliquity (ſince N R P = Z V C) is as much leſs in the Spheroid as N R is leſs than Z V: But I was aware of that, and therefore made the Angle R S *r* only of 5 Minutes, when it really appears to be of almoſt ſix Minutes, when the Earth is ſuppos'd ſpherical; and therefore, without coming to give the exact Quantity of the ſaid Angle, one may eaſily perceive, that Monſ. *Caſſini*'s Difference of the Axis and Æquatorial Diameter will produce a Figure, in which the Angle R S *r*, will not be leſs than of 5 Minutes.

Such an Obliquity, caus'd in the Direction of Gravity, will render the oblong ſpheroidical Figure of the Earth impoſſible, becauſe then Fluids wou'd not have the Lines of their Gravity perpendicular to the Horizons of the

Places where they are, (ſuppoſing the Horizons of Places to be Planes touching the Curve of the Earth in thoſe Places) and Plumb Lines wou'd be ſo far out of the Perpendicular to Lines of Level, as to make an Angle eaſy to be obſerved, as I have ſhewn in my former Paper.

But if the ſame Cauſe be ſuppos'd to act upon the Sea to make it level, as makes heavy Bodies to fall (which certainly muſt) then indeed Lines of Level will be perpendicular to Plumb Lines, and the Level of the Sea, taken always for the Horizon of a Place, will not be a Plane touching the Earth, but cutting it towards the Poles, and conſequently the Water will be carried towards the Æquator, as was before ſhewn.

Beſides, the Difference of the Action of the Centrifugal Force wou'd not be ſo great between correſpondent Points of the ſame Latitude in the Spheroid and in the Sphere; for when the Line of Tendency R P is by the Centrifugal Force chang'd into R W, the Point R upon the Spheroid does no longer correſpond in Latitude with the Point V upon the Sphere, but muſt be taken nearer to V, ſo that the Line R W may become parallel to V C, and R W A = V C A.

If it be alledged here, that Monſ. *Mairan* ſuppoſes the Earth in Motion, and takes in the Effect of the Centrifugal Force, when he makes the Line of Tendency to be R P; I anſwer, that if he had conſider'd the Earth as revolving upon its Axis, he wou'd not have made V C the Line of Tendency of a ſpherical Earth in Motion, ſince it is the Line of Tendency of ſuch an Earth at reſt.

In Monſ. *Mairan*'s Obſervation above-mentioned, he ſays, " that we are not to compare the Centrifugal Force at the Æquator of an oblong Spheroid, with the Centrifugal Force at the Æquator of a Sphere, or at the Æquator

" Æquator of a flatted Spheroid of the ſame Solidity ; " allowing that then it wou'd be greater in the Sphere, " and ſtill greater in the flatted Spheroid: but only the " Centrifugal Forces in ſeveral Latitudes upon the ſame " Figure." —But I beg Leave to differ from him for the following Reaſons.

Firſt, Becauſe the Force of Gravity is not the ſame at the Æquator of the flatted Spheroid, as it is at the Æquator of the Sphere, or as it is at the Æquator of the oblong Spheroid.

Secondly, Becauſe it is not the ſame in different Latitudes, in either of the Spheroids. (See Sir *Iſaac Newton* Lib. 3. Prop. 19 and 20.) And Monſ. *Mairan*'s Way of arguing will only ſerve, in Caſe the Gravity ſhou'd be the ſame in all the Points of the Surface of the Earth in his Figure, and alſo in the two other Figures.

For Example, let the uniform Gravity be call'd g; and *Firſt*, let the Centrifugal Force at the Æquator of the flatted Spheroid be call'd $c + 2$; and the Centrifugal Force in any Latitude, as for Example, the Latitude of *Paris* (as it is diminiſhed on Account of a ſhorter Co-ſine of Latitude, and likewiſe on Account of its Obliquity to the Line of Tendency,) be call'd $c + 2 - l$; the Difference of the Diminution of Gravity at *Paris*, and at the Æquator will be $\overline{g - \overline{c+2}} - \overline{g - \overline{c+2-l}} = l$.

Secondly, Let the Centrifugal Force at the Æquator of the Sphere be call'd $c + 1$, and the Centrifugal Force at the Latitude of *Paris* be call'd $c + 1 - \overline{l+m}$; the Difference of the Diminution of Gravity at

Paris and at the Æquator in a ſpherical Earth, will be $\overline{g - \overline{c + 1}} - \overline{g - \overline{c + 1 - \overline{l + m}}} = l + m$.

Thirdly, Let the Centrifugal Force at the Æquator of the oblong Spheroid be call'd c, and the Centrifugal Force at *Paris* be call'd $c - \overline{l + m + n}$; the Difference of the Diminution of Gravity at *Paris*, and at the Æquator, in an oblong ſpheroidical Earth, will be $g - c - \overline{g - \overline{c - \overline{l + m + n}}} = l + m + n$.

Now, if Gravity ſhou'd in every Caſe be equal to g, it is evident, that the ſhortening of Pendulums, at the Æquator, wou'd be greater in the oblong Spheroid, than in the Sphere, or in the flatted Spheroid; becauſe as the Lengths of Pendulums diminiſh with the Gravity, thoſe Lengths will be at *Paris* and at the Æquator, when compar'd, as $g - \overline{c + 2 - l}$ to $g - \overline{c + 2}$ in the flatted Spheroid; as $g - \overline{c + 1 - \overline{l + m}}$ to $g - \overline{c + 1}$ in the Sphere, and as $g - \overline{c - \overline{l + m + n}}$ to $g - c$ in the oblong Spheroid; and conſequently, from what M. *Mairan* has demonſtrated this Ratio of $g - \overline{c - \overline{l + m + n}}$ to $g - c$, being greater than either of the others, the Pendulums muſt be ſhortened in the oblong Spheroid.

But as the Force of Gravity is leſs at the Æquator of the flatted Spheroid, than at the Æquator of the Sphere, or of the oblong Spheroid of the ſame Solidity: let us expreſs its Quantity in the three Caſes by $g - s, g$; and $g + s$, and we ſhall then find the Lengths of the Pendulums, at the Æquator of the three Solids, as $g - s - \overline{c + 2}$, $g - \overline{c + 1}$, and $g + s - c$; conſequently the Lengths of Pendulums

Pendulums will be greateſt at the Æquator of the oblong Spheroid, becauſe $g + s - c$ is the greateſt Quantity.

Laſtly, To compare the Lengths of Pendulums at the Æquator of the oblong Spheroid, thus found, with their Lengths at the Latitude of *Paris* upon the ſaid Spheroid — Let us expreſs the Exceſs of Gravity at the Æquator, whereby it is greater than at *Paris* (becauſe in this Figure, *Paris* is farther from the Center of the Earth, than the Æquator, by $\frac{1}{230}$ Part) by the Letter s, and the Exceſs of the Centrifugal Force at the Æquator, above that Part of it which acts directly againſt Gravity at *Paris*, by $l + m + n$, the Gravity at *Paris* by g, and the Centrifugal Force at the Æquator by c; then $g + s - c$ will ſtill repreſent the diminiſh'd Gravity, and anſwer to the Length of Pendulums at the Æquator, whilſt $g - \overline{c - l + m + n}$ or $g - c + l + m + n$ repreſents the diminiſh'd Gravity, and conſequently the Length of Pendulums at *Paris*. If s be equal to $l + m + n$, Pendulums will be as long at the Æquator as at *Paris*; and if s be greater than $l + m + n$, Pendulums will be longer at the Æquator. But making all poſſible Allowance, in Favour of Monſ. *Mairan*'s Hypotheſis, no Calculation will bring $l + m + n$ to be greater than, or ever equal to s. Therefore Monſ. *Mairan*'s Demonſtrations, above-mentioned, are of no Force to prove the Earth to be an oblong Spheroid.

And now, I think, I have anſwer'd all that relates to the Figure of the Earth in Monſ. Mairan's *Diſſertation*; *in ſhewing, That his Conjectures can neither be ſupported by thoſe Phyſical Principles which Sir* Iſaac Newton *has Mathematically deduc'd from unqueſtioned*

queſtioned Obſervations and Experiments accurately made; nor even by thoſe Principles which He (M. Mairan) *has aſſum'd to ſerve his intended Purpoſe — That his Demonſtrations, relating to the Difference of the Action of the Centrifugal Force, are of no Service to him, for reconciling the Experiments made on Pendulums, with Monſ.* Caſſini's *Meaſures; — becauſe, when applied to Sir* Iſaac Newton's *Principles, they will make Pendulums longer at the Æquator than at* Paris, *and when applied to Monſ.* Mairan's *own Principles, they will make them a whole Inch ſhorter at the Æquator than at* Paris, *contrary to all Obſervations, which, at a Medium, make Pendulums but about two Lines or* $\frac{166}{1000}$ *of an Inch longer at the Æquator than at* Paris. *— That he has built his Demonſtrations upon a wrong Notion of Gravity — And that he has not conſider'd what is moſt material in the Effect of the Centrifugal Force, acting on Bodies deſcending by their Gravity, between the Æquator and the Poles, namely, the Alteration of their Line of Direction, which wou'd make them fall out of the Perpendicular towards the Æquator.*

I ſhall add one more Philoſophical Argument, given me by a Friend, to whom I communicated my Thoughts on this Subject; becauſe it is wholly independent on thoſe Principles of Philoſophy, concerning which, ſome of the Gentlemen that believe the oblong ſpheroidical Figure of the Earth, and the *Engliſh* Philoſophers, are not yet agreed; and it is this.

If the Earth was of an oblong ſpheroidical Figure, higher at the Poles than the Æquator; the Axis of its Revolution, wou'd either go thro' one of its ſhort Diameters, or be continually changing unleſs the ſaid Axis did exactly coincide with the Axis of the Figure.

DEMONSTRATION.

Suppoſe ſuch an oblong Figure as A *a* * fix'd to the Axis P *p* at the Center C, but capable of moving freely round it towards P or towards *p*, yet ſo as to be oblig'd to move with the Axis, when it is turned round. Suppoſe now the Poles P and *p* to be fix'd, and the Body, thus conſtituted, to be turn'd ſwiftly round the Axis P *p*; then if the Angle A C P be oblique, and the Figure A D *a* E be oblong, the Parts A C and C *a* will acquire a Centrifugal Force, which will enlarge the Angle *p* C A, till it comes to be a right one. Beſides this, a Velocity will be generated in the Motion, while A is going towards the Perpendicular *a* C, which will make it go farther on towards P, as to B, with a Motion which will after that be retarded, till the Centrifugal Force has Strength enough to ſend it back again the contrary Way; and ſo it will move continually with a reciprocal Motion, like the Oſcillation of a Pendulum; and if a little of this Motion be loſt at every Oſcillation, then the oblong Figure A D *a* E will at laſt move quietly about its leſſer Axis D E coinciding with P *p*.

If A a did not at firſt exactly coincide with P p, the Centrifugal Force will have the above-mentioned Effect; and that this is not the Caſe in the Earth is more than probable, becauſe the unequal Diſtribution of Sea and Land, beſides the Phænomena *of the Tides muſt make the Axis of its Gravity, and conſequently the Axis of its Revolution, to differ from the Axis of the oblong Spheroid, if the Earth had ſuch a Figure; without conſidering that every Earth-quake wou'd alter ſo nice an* Æquilibrium, *which once loſt, wou'd never be recover'd again.*

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* Fig. V.

To

To leave nothing unexamin'd, relating to the Controverſy, I have again conſider'd the Meaſures and Obſervations, mentioned in the Account of the Meridian drawn thro' *France*, in the Memoirs of the *Royal Academy*, for the Year 1720; and I find them to want a great deal of the Accuracy requir'd in ſo nice a Point, as determining the different Lengths of Degrees upon the Surface of the Earth. To prove my Aſſertion, I beg that the Reader will examine the following Tables, whereby it appears, that if any thing certain can be deduc'd from the ſaid Obſervations and Meaſures, (either taken as they are, or reduc'd to the Level of the Sea, by the Rules given by Monſ. *Caſſini* *) it will be in Favour of Sir *Iſaac Newton*'s Figure of the Earth, rather than theirs.

In the following Table, the firſt Column gives the Names of Places; the ſecond, the Diſtances from *Paris*, according to the Meaſures taken by the *French* Gentlemen; the third, the Latitudes obſerv'd by the ſame; the fourth, the Latitudes, ſuch as the meaſur'd Diſtances will give them, ſuppoſing the Earth ſpherical; the fifth, the Differences between theſe and the Latitudes obſerv'd, expreſs'd in Seconds of a Degree, where when the Latitude computed, exceeds the Latitude obſerv'd, the Letter N (North) ſhews that Difference to be in Favour of Monſ. *Caſſini*'s Figure, and the contrary Difference mark'd by the Letter S (South) is in Favour of Sir *Iſaac Newton*'s Figure.

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* *Memoirs for the Year* 1720. Vol. I. P. 1. Ch. 13.

Names of Places.	Diſtances from *Paris* meaſur'd.	Latitudes obſerv'd.			Latitudes in a ſpherical Earth computed from the meaſur'd Diſtances.			Differences in Seconds.	
I.	II. Toiſes.	III.			IV.			V.	
Dunkirk.	125552	51°	2′	25″½	51°	2′	25″½	0″	
Amiens.	60370	49	53	48	49	53	48	0″	
Sourdon.	4997c½	49	42	42	49	42	52,1	10,1	N
Paris.		48	50	10	48	50	20,3	10,3	N
Malvoiſine.	18838	48	30	47	48	30	32,1	14,9	S
Vouſon.	67962	47	39	17	47	38	53,6	23,4	S
Bourges.	100192	47	4	31	47	04	58,7	27,7	N
S. Sauvier.	139934	46	23	24	46	23	12	12,0	S
Croc.	169540	45	51	43	45	52	4,6	21,6	N
Bort.	196484	45	23	27	45	23	45,2	18,2	N
Aurillac.	223606	44	55	13	44	55	14,5	1,5	N
Rodès.	256575	44	20	54	44	20	35,1	19,9	S
Alby.	280612	43	55	32	43	55	19	13,0	S
Carcaſſone.	321430	43	12	56	43	12	24,5	31,5	S
Collioure.	360604	42	31	13⅔	42	31	13,8	0.	

In this Table it is to be obſerv'd that there is an equal Number of Differences mark'd N (North) and S (South) and if the Differences on each Side be added together, there will be 89″,4 on the North Side, and 114,″7 on the South: This laſt agrees beſt with Sir *Iſaac Newton*'s Figure, which muſt be ſuppoſed for the Correction of ſo great a Difference.

In the next Table, the firſt Column gives the Names of Places; the ſecond, the Latitudes obſerv'd; the third, the Diſtances in the Meridian from *Paris*, reduc'd to the Level of the Sea; the fourth, the Differences of the ſecond Column expreſs'd in Seconds of a Degree; the fifth, the Differences of the Numbers in the third Column; and the ſixth, the Meaſure of a Degree by the fourth and fifth Columns compar'd.

I. Names of Places.	II.			III. Toiſes.	IV. Seconds of a Degree.	V. Toiſes.	VI. Toiſes.
Dunkirk.	51°	2′	19″	125454			
Amiens.	49	53	56	60444	4103″	65010	57040
Clermont.	49	22	57	31028	1859	29416	56965
The R. Obſervatory.	48	50	10	0	1967	31028	56787
Vouſon.	47	39	17	67959	4253	67959	57525
☞ S. Sauvier.	46	23	24	139937	4553	71978	56912
Croc.	45	51	43	169539	1901	29602	56058
Bort.	45	23	46	196480	1677	26941	57834
Aurillac.	44	55	13	223616	1713	27136	57028
Rodès.	44	20	53	256474	2060	32858	57422
Alby.	43	55	32	280612	1521	24138	57131
Carcaſſone.	43	12	55	321430	2557	40818	57468
Collioure.	42	31	13	360614	2502	39184	56380

In this Table in the third Column, over-againſt *St. Sauvier*, the Number which was 139944 is corrected to make it 139937, to the Advantage of the oblong Figure. In the ſixth Column, the Numbers appear ſo irregular, as to be unfit to decide this Controverſy. Then if a Compariſon be made between *Dunkirk*, *St. Sauvier* (which is very near the Middle of *France*, and almoſt in the Meridian of *Paris*) and *Collioure*, the Meaſurement is abſolutely in Favour of Sir *Iſaac Newton*'s Theory; the mean Degree between *Dunkirk* and *St. Sauvier* being larger by about 64 Toiſes, than between *S. Sauvier* and *Collioure*; and to reduce them even to an Equality, there muſt be a greater Alteration made in the Situation of thoſe three Places, than it is reaſonable to ſuppoſe their Obſervations to be capable of admitting. Here follows the Compariſon.

Dunkirk and *Collioure*	A mean Degree is	57061
Dunkirk and *Paris*		56960
Paris and *Collioure*		57097
Dunkirk and *S. Sauvier*		57090,4
S. Sauvier and *Collioure*		57026,5
According to Monſ. *Picard*,		57060

To conclude, I will propoſe a Method of obſerving the Figure of the Shadow of the Earth in Lunar Eclipſes, whereby the Difference between the Diameters in the oblong ſpheroidical Figure, if there be ſuch an one as Monſ. *Caſſini* affirms (*viz.* of 96 to 95) may be diſcover'd.

Let P Æ P Æ * repreſent the Earth, ſeen from the Sun at the Time of the Summer Solſtice; it is evident, that the ſame Figure will expreſs the Section of the Earth's Shadow at the Moon's Diſtance, as ſeen from the Earth. If E E repreſents the Ecliptick, Æ Æ will be the ſhorteſt Diameter of the Section; and if L L be taken for the Moon's Way, in a total and central Eclipſe of the Moon, by obſerving the Time which is ſpent in the Paſſage of the Center of the Moon, thro' the Shadow, and reducing that Time to Seconds of a Degree of a great Circle of the Heavens, we ſhall have the leaſt Diameter of the Shadow.

Again, let the ſame Letters † repreſent the ſame Things, only here the Section of the Shadow is ſuch, as the Earth will caſt at the Æquinox, and the Eclipſe of the Moon is here ſuppoſed partial, its Center juſt touching the Shadow. When the Moon's Center is got to *c*, if the Latitude of its Center or its Diſtance from the Ecliptick be obſerv'd, we ſhall have the Length *c* C nearly equal to the longeſt Semi-diameter of the Shadow.

Now, comparing *c* C * in this Figure to L C * in the former (the Difference between *c* C and C P (*Fig.* 7.) and between C L and C Æ (*Fig.* 6.) not being worth notice) they ought to be to one another, as 96 to 95, which in ſuch a Shadow will give a Difference of about 25″ at a Medium, ſenſible enough to be obſerved, notwithſtanding the *Penumbra*. If therefore thoſe A-

* Fig. VI. † Fig. VII. * Fig. VII. * Fig. VI.

ſtronomers who have Inſtruments nice enough, and ſufficient Skill in the Management of them, to take Angles to 3 or 4 Seconds of a Degree, will obſerve what I have been mentioning in total and partial Eclipſes of the Moon; by ſuch Obſervations they will eaſily convince us, that the Figure of the Earth is ſuch as Monſ. *Caſſini* ſuppoſes it, or convince him that he has been miſtaken.

The Semi-diameter of the Earth's Shadow, when the Earth is in Perihelio, *and the Moon in* Apogæo *is* 38′, *or* 2280″, *without conſidering the Encreaſe of the Shadow, on account of the Atmoſphere of the Earth, which wou'd make it* 39′ or 2340″ (*allowing one Second for a Mile*;) *and the Semi-diameter of the Shadow, when the Earth is in* Aphelio, *and the Moon in* Perigæo *is* 46′, 20″, *or* 2780″, *which encreaſed on account of the Atmoſphere of the Earth, will bring it to* 47′, 20″ *or* 2840″. *Now if the Proportion of* 95 *to* 96 *be taken in both Caſes you will have theſe Analogies,* $\left\{\begin{array}{l} 95 : 96 :: 2340'' : 2364''.6 \\ 95 : 96 :: 2840'' : 2869'',8 \end{array}\right\}$ *So that* 2364″,6 — 2340″ = 24″,6 *will be the Difference of the Semi-diameters, when the Section of the Shadow is the leaſt, and* 2869″,8 — 2840″ = 29″,8 *will be the Differenee of Semi-diameters, when the Section of the Shadow is the greateſt; the Sum of thoſe Differences* 24″,6 + 29″,8 *halved, will give the Difference, when the Section of the Shadow is at a Medium* = 27″ 4; *from which if we take* 2″,4 *becauſe in* Fig. 7. C c *is a little leſs than* C P, *and in* Fig. 6. L C *is ſomething greater than* Æ C, *we ſhall have* C *c in* Fig. 7. *to compare with* L C *in* Fig. 6. *which will exceed it by* 25″, *if Monſ.* Caſſini's *Figure of the Earth be the true one.*

Fig. 1

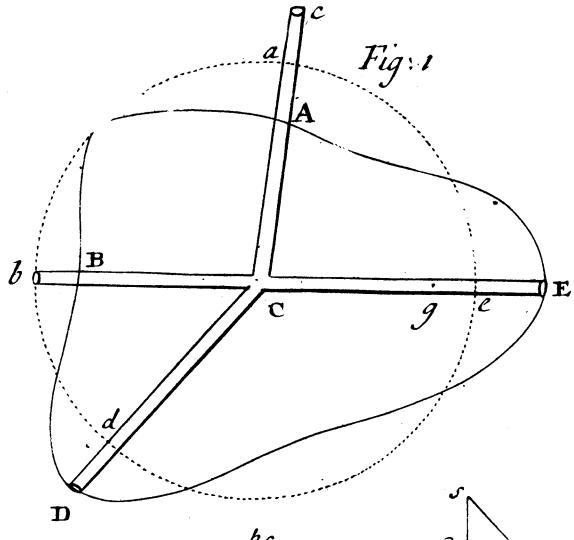


Fig. 2.

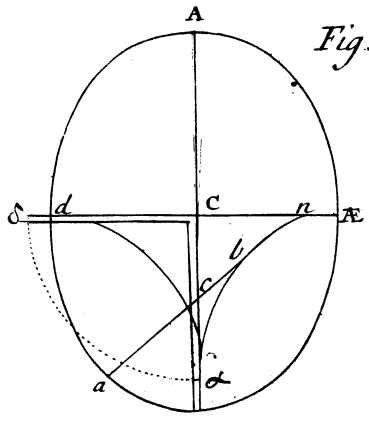


Fig. 3.

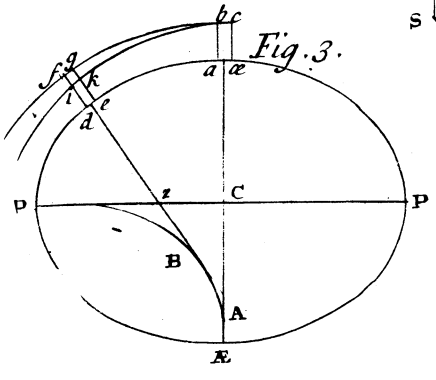


Fig. 4

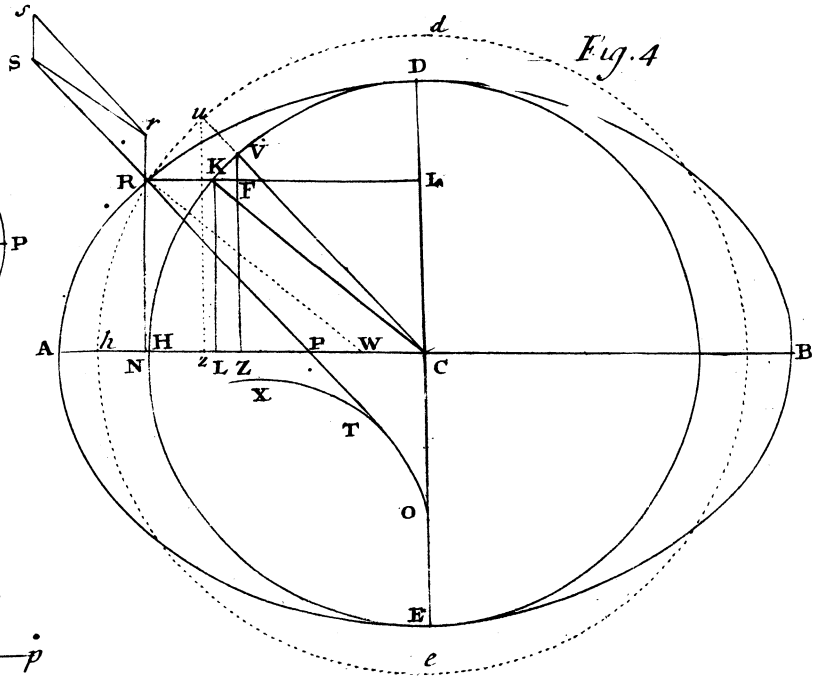


Fig. 5

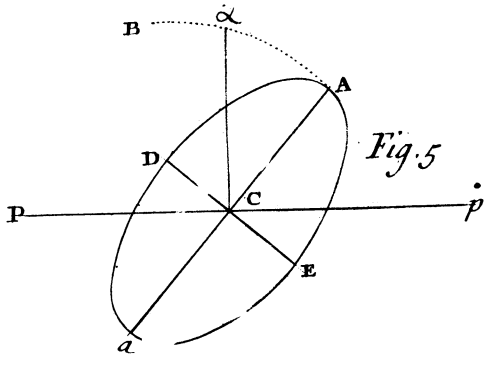


Fig. 6

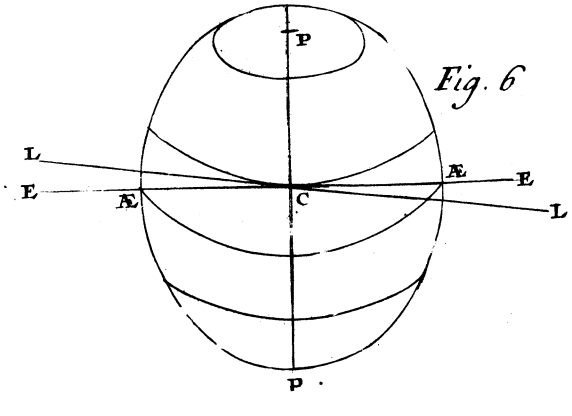
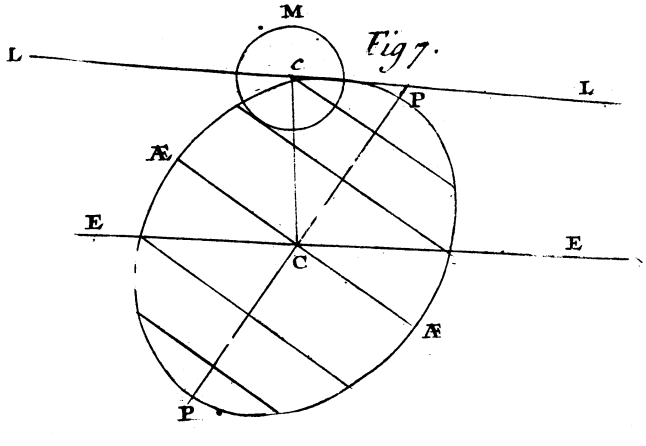


Fig 7.



S. Parker Sculp.