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1794

LETTERS

ON

PHILOSOPHICAL SUBJECTS;

PARTICULARLY

THE CREATION,

THE DELUGE, VEGETATION, &c.

THE POWERS PRODUCING THESE OPERATIONS ARE HERE SHEWN TO BE

HEAT, COLD, AIR AND WATER.

Since the Edition of these Letters printed at Plymouth, the late Experiments in the new Chymistry, have confirmed the above Theory. These Experiments prove, that Heat and Light, together with *Oxygen* or Cold, are the Powers which carry on both Animal and Vegetable Life: Light, Heat, Vital Air, and inflammable Gas, are thereby proved to be substances of the first class, and approach nearest to simplicity.

By J. Pennoyer

THE SECOND EDITION.

LONDON:

PRINTED FOR J. DEIGHTON, OPPOSITE GRAYS-INN, HOLBORN.

1794.

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A Solar Diagram
For A.D 1786.

F. Penrose

Q
57
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1789

ADVERTISEMENT.

THE firſt Edition of theſe Letters were printed at Plymouth, under the Title of Letters Philoſophical and Aſtronomical; but being informed, by ſome of my Friends, that the Title Page had prevented many Perſons from reading them, ſuppoſing that none but Adepts in thoſe Sciences could underſtand them, the contrary is the fact. The greater Part of theſe Letters may be fully comprehended by any Perſon of common underſtanding.

Theſe Letters were reviewed by the Critical Reviewers in December 1788, who give the following Account of them: they say, "That the Moſaic Account of the Creation "is explained and defended, as well as the "Deluge; and Gravity accounted for by hot

"and

"and cold Ether; and that every ingenious "man, and our Author's Ingenuity, we do "not queſtion, when he ſteps out of the com-"mon way, will neceſſarily expect atten-"tion."

The Analytical Reviewers noticed them in April, 1789: they obſerve, "That the Au-"thor (when differing on vegetation) ex-"hibits a conſiderable Degree of Ingenuity:" And the very great improvements in the new Chymiſtry have proved the Author's ſentiments to be right.

F. PENROSE.

STONEHOUSE,
Plymouth, Jan. 1794.

To Sir Joſeph Banks, Preſident,

AND TO THE

Fellows of the Royal Society, London,

SIRS,

THE following Letters contain many new Obſervations in Aſtronomy and Philoſophy, which appear to be of ſufficient Importance to be inquired into, in Order to aſcertain whether they be Facts or not.—On that Perſuaſion, I have taken the Liberty to addreſs them to you, and hope they will meet with an impartial Examination; and that they will not be diſcarded becauſe they contain ſome Things which differ from Opinions generally received and taught.—Was this *always* to be the Caſe, there would be

be an End to Improvements in the Sciences; for every Thing *new muſt differ* from what was before known.

It would have given me great Satisfaction, could I have obtained the Honour for ſome of the moſt important Matters in them, to be read at a Meeting of your Society; I ſhould then have been properly informed whether they were of ſufficient Importance to trouble the Publick with or not; but, as I had not Intereſt enough to get that done, I take this Method to crave your liberal Deciſion on them.

I am,

With great Deference and Reſpect,

Your moſt obedient, humble Servant,

F. PENROSE.

STONEHOUSE.
Plymouth, June 30, 1788.

An Explanation of the SOLAR DIAGRAM, for the Year of our Lord, 1786, (anſwering to the Year of the World, 5793, and to the Year of the Julian Period, 6499) ſhewing the Place of the Sun, Moon, and Earth, every Day in the Year, according to the Julian Calendar.

S.—*The* Sun *in the Centre of the Syſtem.*—a, a— Meridians, *going from the* Equator, *through the Ecliptick, to the twelve Signs, or fixed Stars in the* Equinoctial; *ſhewing the Day of the Julian Month, when the Sun comes into theſe Meridians, or enters theſe twelve Signs.*

B. B.—*The* Equatorial Circle *divided into* 360 *Degrees.—If the* Plane *of the Equator be produced to the Heavens, it will there mark out a Circle, called the Equinoctial, marked* E. E. *which will divide the Earth and Heavens into two Halves or Hemiſpheres.*

C. C.—*The* Ecliptick, *an* Ellipſe, *which is found to be inclined to the Equinoctial, at an Angle of* 23° 28′, *which Angle is called the* Obliquity

liquity of the Ecliptick, *and ſince the Ecliptick and Equinoctial are both great Circles, they muſt biſect each other; as it is found they do, in the Beginning of* Aries *and* Libra; *ſo that ſix of theſe Signs lye on the North Side of the Equinoctial, and are called the* Northern Signs; *and the other Six, on the South Side of it, and are called the* Southern Signs.—*This Ecliptick is divided into* 365¼ *Parts, anſwering to the Number of Meridian Altitudes of the Sun, during the Revolution of the Earth thro' it, correſponding to the Number of ſolar Days or Rotations the Earth makes during that Time. As the elliptical Figure of the Ecliptick makes it five Degrees, and almoſt a Quarter longer than the Equinoctial, which is a Circle; ſo we find the Earth requires ſo much longer Time to traverſe it, than ſhe would require, did ſhe go round the Sun in a Circle,* at the ſame Diſtance from the Sun, *ſhe is at the Equinoxes; as the Earth makes equal Areas in equal Times. See Introduction, P.* 16.

☽.—New Moons; *ſhewing the Day of the Month,*

Month, according to the Julian Calendar, when the Sun and Moon are in Conjunction.

O.—Full Moons; *pointing out the Day of the Month when ſhe is in Oppoſition to the Sun, in her Paſſage through the Ecliptick.*

S.—Sunday, *or every Seventh or Sabbath-Day throughout the Year.*

●.—The Earth, *in the Meridian of the twelve Signs, in her Orbit, or Path through the Ecliptick, viz. when ſhe has the Sun and theſe Stars in Conjunction, in her annual Orbit. Aſtronomers tell us that the Ecliptick is* equally divided *into twelve Signs of* 30 *Degrees each. But it is not ſo.—It is the Equinoctial which is divided* equally *by theſe twelve Signs.—Some of theſe Signs are of ſuch a Length, as to require the Earth to make more than* 31 *Rotations while ſhe is paſſing through them, while others require little more than* 29; *and the ſix Northern Signs are ſo much longer than the ſix Southern, that*

the Earth takes more than a Week longer in traverſing them, than ſhe does in traverſing the others.—See Introduction, P. 16, 19.

E E—The Equinoctial, *divided into twelve equal Parts, by the twelve fixed Stars, which are called* Signs, *each Sign into* 30 *Degrees; the whole Equinoctial containing* 360 *Degrees, anſwering to the ſame Number of Degrees on the Equator.*

D D. — The Anticipation of Time. — This is not in Nature, *but occaſioned from the Julian Year not anſwering exactly in Length of Time, to the Length of Motion the Earth takes to perform her annual Orbit round the Sun, viz. the Julian Year contains* 365¼ *Days, whereas the Earth compleats her Revolution round the Sun, in* 365 *Days,* 5 *Hours,* 49 *Minutes.—Hence, as we calculate according to the Julian Reckoning, the Earth will finiſh her annual Orbit eleven Minutes of Time before the Julian Reckoning ends. Introduct. P.* 3, 97, 105.

Thus

Thus the Motion of the Earth anticipates Time, according to the Julian Calendar, eleven Minutes every Year, and throws it back.—*See P.* 98.—*Let us postulate that Motion and Time, began, according to the Julian Period, at the autumnal Equinox,* 706, *(which is the Time the best Interpreters of Moses's History, say he placed it) from that Year to this,* 1786, *(which is the* 6499*th, according to that Period,) the Earth will have made* 5793 *annual Revolutions; by which Means, Motion will have anticipated Time* 44 *Days,* 6 *Hours,* 3 *Minutes, according to O. S. viz. from Oct.* 25, *to Sept.* 11, *or according to the N. S. from Oct.* 25, *to Sept.* 22.

F. F.—The Precession of the Equinoxes. *According to the last Article, the solar or true Time, has fallen short of the Time, (as reckoned according to the Julian Calendar,)* 11 *Minutes every Year.—Hence, the Sun will appear eleven Minutes more forward in the Ecliptick, every Year, than she ought to do.—Thus, in* 5793 *Revolutions,*

Revolutions, ſhe will not appear to be in the Beginning of Aries, *as ſhe was obſerved to be A. I. P.* 706, *but in the third Degree of* Taurus, *(if we reckon by the N. S.) and in the* 14*th according to O. S. See Introduction, P.* 98.

Hence it may be obſerved, that the fixed Stars and Equinoxes, are juſt in the ſame Places in the Heavens, they were 5793 *Years ago, and that the Anticipation of Time, and Preceſſion of the Equinoxes, are not in Nature, but occaſioned by an erroneous Calculation of the exact Length of the ſolar Year and the lunar Cycle. See P.* 97, 105.—*This may be obſerved by* G. G.—*The* Difference *between O. S. and N. S. made A. D.* 1752.

An Explanation of the LUNAR DIAGRAM, for A. D. 1786, (anſwering to the Year of the World, 5793, and to the Year of the Julian Period, 6499,) ſhewing the Place of the Sun, Earth, and Moon, every Day in the Year, according to the Julian Calendar.

A.—*The* Sun *in the Centre of the Syſtem.*

B. B.—*The* Equinoctial Circle, *divided by the twelve Stars or Signs, into twelve equal Parts, of* 30 *Degrees each.—The Whole into* 360 *Degrees.*

(E) (E) *The* Earth, *in her Place in the Ecliptick, when the Moon is at Full, or in Oppoſition.*

C. C.—*The annual Path of the* Earth *round the Sun, which is divided into Days, Weeks, and Months, according to the Julian Calendar. It is an Ellipſe, within the Equinoctial, and forms an Angle of* 23 *Days,* 28 *Minutes, with it;—and is divided into* 365¼ *of Parts or Degrees*

grees, anſwering to the Number of Rotations the Earth makes during her Revolution round the Sun.—Was the Earth, throughout her annual Revolution, to keep at the ſame Diſtance from the Sun, which ſhe is at the Equinoxes, ſhe would then go round that Luminary in a Circle, and perform and meaſure it in 360 *Days or Rotations.—But now, as it is performed by Nature, ſhe goes ſo far beyond the Periphery of the Circle, at the Summer Solſtice, as to require* $5\frac{1}{4}$ *more Rotations to do it.*

m. m.—Meridians, *which paſs from the Sun in the Centre, to the firſt Point of each Sign, in the Equinoctial.—As the Circle of the Equinoctial and the Elliptical Path of the Earth, anſwer each other geometrically, ſo theſe Meridians cut the Julian Calendar at the* true *Day, and Month, when the Sun will be found to enter them; and thereby ſhew the Places of the Sun and Moon every Day throughout the Year.*

D. D.—*The* Moon's Orbit *round the Earth,*

E. going

EXPLANATION

Of the LUNAR DIAGRAM.

E going forward through the Ecliptick.—This View is as it may be seen from a Planet or Star, without that Orbit, and perpendicular to the Plane of the Ecliptick.—By this Side View may be observed the Loops *the Moon makes, in her Orbit round the Earth, in her Passage through the Ecliptick, (in the same Manner as other Satellites do round their Planets,) being sometimes a Semi-diameter of her Orbit before the Earth, and sometimes the same Distance behind her, always keeping about* 240,000 *of Miles from her, and going round the Ecliptick with her.— She is kept in her Orbit by two Forces, viz. the* Light *proceeding from the Sun, and the* Light *reflecting from the Earth.—— This is the Power,* (Light) *which expands and projects her towards the Extremities;—the other is the* Ether *proceeding from the Extremities, which Sir Isaac Newton calls* Spirit.—*He often makes use of* Attraction, *to express the first, and* Gravitation *the last, without enquiring into the Causes of these Phenomena; therefore, to be short, clear, and better understood, I shall do the same.—See Let. IV. P.* 165, *XIV. P.* 283.

EXPLANATION

Of the LUNAR DIAGRAM.

In her Orbit round the Earth, (which is about 240,000 *Miles, from her,) these two Powers or Forces ballance each other.—Thus, here all is* still, calm, *and neither prevails.—Here also the projectile Force, which carries the Earth from West to East, through the Ecliptick, meets the gravitating Power, which carries the Moon from North to South, round the Earth. See Let. XVII.—As these two Powers act perpendicularly to each other neither prevails; but they act jointly, and they force the Moon round the Earth in a* Diagonal *between them.—Thus, at her Change, she goes N. W. till she comes to* 1, *(her first Quarter,) at which Place she is Half the Diameter of her Orbit behind the Earth.—Here, instead of going on N. W. she changes her Course, and goes nearly E.N.E. till she comes to her Opposition or Full, when she is due North of the Earth.—She continues still to go Eastward, but changes from E. N. E. to N. N. E. till she arrives at* 3, *(the End of her third Quarter,) where she is at the East Point of her Orbit, and a Semi-diameter*

of

of her Orbit before the Earth.—From hence she goes Westward at S. W. till she comes to her Change, where she is due South of the Earth. See Let. XXII.

Besides the above described Forces, there is another which goes from West to East,—the ethereal Current of the Eclipses.—*This Current goes from West to East, and round the Ecliptick, in a progressive Circle, but so slow as to require* 18 *Julian Years,* 10 *Days,* 19 *Hours,* 46 *Minutes,* 0 *Seconds,* 15 *Thirds, to compleat it, and to meet the Moon again, exactly in the same Point of the Ecliptick from which they parted, when the Cycle began.—Hence, as Observations prove, at the End of this Cycle, there is a Return of all the Eclipses which touch the Earth.—Let. XXII.*

Thus the Moon performs her Orbit, round the Earth, in 29 *Days,* 12 *Hours,* 44 *Minutes,* 1 *Second,* 45 *Thirds, (which is called a Lunation,) in which Time the etherea Current of Eclipses has moved forward and Eastward,*

EXPLANATION

of the LUNAR DIAGRAM.

1 *Day*, 14 *Hours*, 6 *Minutes*, 11 *Seconds*, 19 *Thirds*.—*By which Means the Moon crosses that Current, before she comes to the Star.—This occasioned Astronomers to imagine that the Nodes moved backward to the Westward.—The Point where the Moon crosses the Current of Eclipses is called her* Node.—*At the End of every sixth* Node, *or* 172 *Days*, 12 *Hours*, 59 *Minutes, this Path of the Nodes crosses the ecliptick Path of the Earth, and if that Point is then within* 17 *Degrees of the Sun, it causes an Eclipse, but if farther from it, the Shadow of the Earth or Moon will not reach each other.*

F F.—*The* Moon's Path, *as observed from the Earth.—At the End of the first Quarter, she is Half illuminated.—At the End of her Second, she is wholly so.—At the End of her Third she is again Half illuminated; and at her last Quarter or Change, she appears quite dark.*

S S.—*The* Sabbath, *or Seventh Day throughout the Calendar.*

The following is a Description of the Eclipses

EXPLANATION

Of the LUNAR DIAGRAM.

Eclipses for the Year 1786.—*January* 14, *at Noon, the astronomical Day ends, and January* 15 *begins; at this Point the Moon's Node was in the Ecliptick; and* 44 *Minutes after the Moon was opposite the Sun, and caused an Eclipse of the Moon.—To January* 15, *add six Nodes, or* 172 *Days,* 12 *Hours,* 59 *Minutes, and it will make* 187 *Days,* 12 *Hours,* 59 *Minutes; from this substract the* 181 *Days from the Calends of January, and it will leave July* 6*th Day,* 15*th Hour,* 59*th Minute, the exact Place of the Node.—Six Nodes are short of six Lunations,* 4 *Days,* 15 *Hours,* 25 *Minutes;—this Node therefore will be in the Ecliptick so much before the Sun; and as the Nodes are diametrically opposite to each other, so the other will want just as much, and therefore meet the Moon in the Ecliptick, July* 11*th Day,* 4*th Hour,* 24*th Minute.—If we add six Lunations, or* 177 *Days,* 4 *Hours,* 24 *Minutes, to Jan.* 15*th Day,* 0 *Hour,* 44*th Minute, it will give July* 11, 5, 8, *for the Moon's Opposition, which is* 44 *Minutes only from the Node, and will cause a total Eclipse of the Moon, but, as*

it

it happens about five o'Clock in the Afternoon, must be invisible to us.—In 14 *Days,* 9 *Hours,* 4 *Minutes, (Half the Length of a Node,) the other Node will get round the Earth into the Ecliptick, which added to July* 11*th Day,* 4*th Hour,* 24*th Minute, brings it to July* 25*th Day,* 13*th Hour,* 28*th Minute.—In Order to find when the Moon will be in Conjunction, add Half a Lunation,* 14 *Days,* 18 *Hours,* 22 *Minutes to July* 11*th Day,* 5*th Hour,* 8*th Minute, (the Time when the Moon was in Opposition,) it will cause an Eclipse, but not visible to us.*

In Order to find when the Node will again cross the Ecliptick, add 345 *Days,* 1 *Hour,* 58 *Minutes, (the Quantity of twelve Nodes,) to Jan.* 15.*—It will bring it to Dec.* 26*th Day,* 1*st Hour,* 58*th Minute, when the Node will again be in the Ecliptick; but as neither Node will then be within* 20 *Degrees of the Sun, no Eclipse can happen.*

a, a, a.—The Path of the ascending Node.
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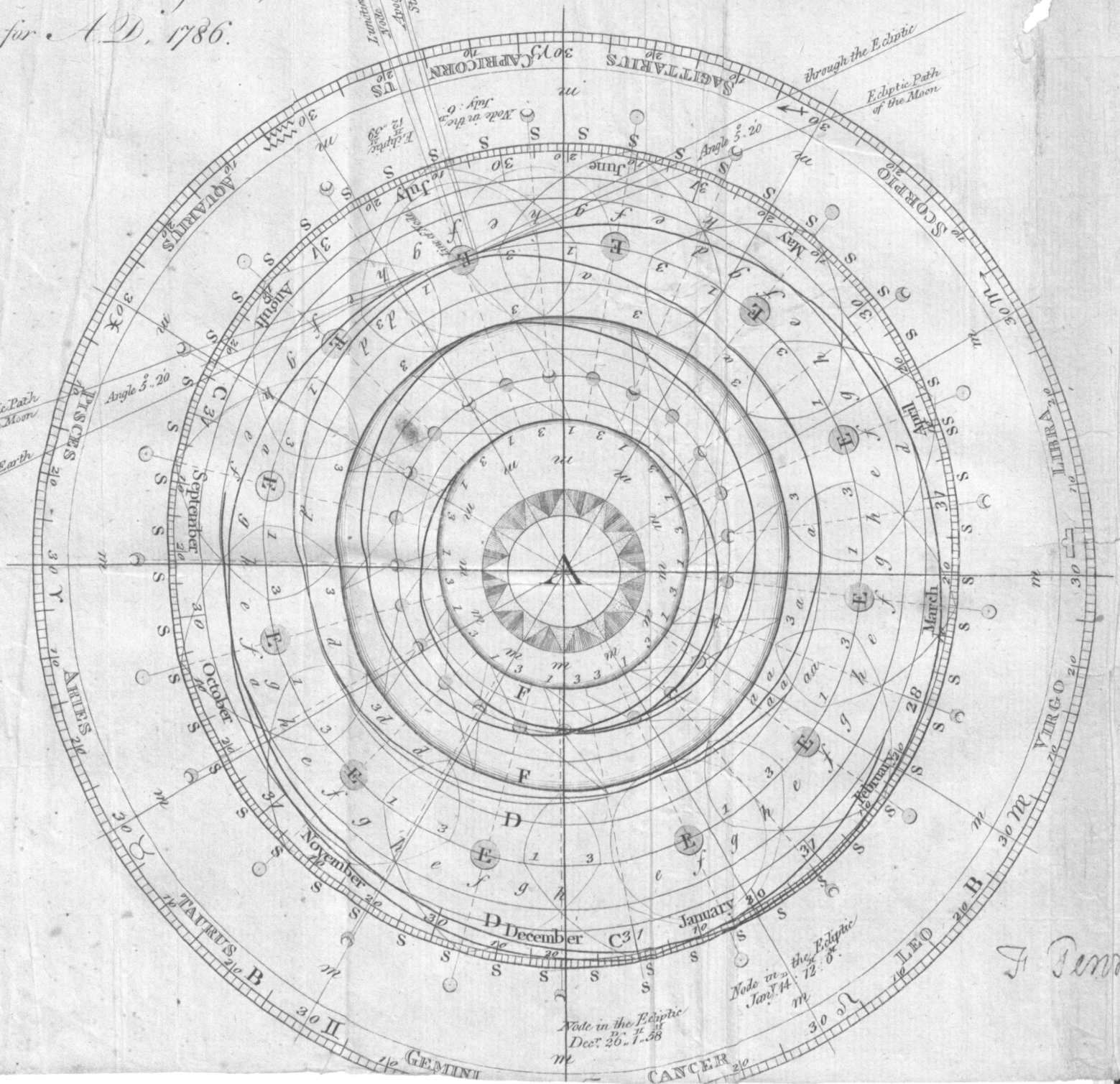
Introduction.

A Lunar Diagram, for A.D. 1786.



J. Penrose

The INTRODUCTION.

THE following Letters are real Copies of genuine ones, which paſſed between me and an intimate Friend, for our own Amuſement, according to their Dates; but not with the moſt diſtant View that they ſhould ever appear before the Public.—The Gentleman,* who was the firſt Beginner of this Correſpondence, died about the Middle of laſt February.— Some Days before his Death, he deſired his Son to write me, that

 "He

* JOHN HEAVISIDE, Eſq. of Princes's-Street, Cavendiſh-Square; a Gentleman whoſe Loſs is already experienced by many of his Acquaintance, who were very numerous; his whole Attention, for many Years paſt, having been employed to ſerve his Friends and Neighbours, particularly thoſe in Diſtreſs; this was his greateſt Pleaſure! and he had Inclination, Fortune, and Abilities to do it.—Therefore, as a Perſon of his unbounded Benevolence is ſo rarely to be met with, his Loſs will be the more ſeverely felt.

" He was paſt all Hopes of Recovery, and " begged to know what I would have done " with thoſe very valuable Papers which he " had of mine, his Health having made him " unable to attend to them as he wiſhed." About ten Days after this, the Son wrote me a ſecond Letter, " to let me know that his " Father was dead, and that he had found " the Letters of mine which his Father or- " dered ſhould be ſent me."

Some Time after this, I mentioned his Death to ſome of our Friends, with the Circumſtance of his Son's ſending me ſome Letters which had paſſed between us.—They deſired to read them; after which they returned them to me again, with a Requeſt that they might be printed; I conſented thereto, and hope they will receive the Approbation of the Public.

As ſome of the Notions in theſe Letters are contrary to *general received Opinions*, I truſt they will not be diſcarded on that Account, without being firſt examined, and the Evidence

Evidence I produce tried, if ſufficient to ſupport theſe Notions or not; which are, principally,

Firſt, That the Equinoctial, or great Circle of the Heavens, is equally divided by the twelve Signs, of 30 Degrees each, making in the Whole 360°.

Secondly, That the annual Orbit of the Earth muſt be meaſured by the Earth's rotary Motion, which is abſolutely, and without any Exception, the true Meaſure of Time.

Thirdly, That the Anticipation of Time, and the Preceſſion of the Equinoxes, have not any Foundation in Nature, but are occaſioned by the Calendar Computation, not anſwering exactly to the Length of the annual Orbit.— According to our Calendar Meaſure, the ſolar Year contains 365¼ Days, or Six Hours; but the ſolar tropical Year, or the Time ſhe is performing her annual Orbit, is only 365 Days, 5 Hours, 49 Minutes, which

which is 11 Minutes ſhort of her Quadrant, or ſix Hours. Therefore the Earth precedes, beyond the Meridian, where it began, 11 Minutes in equatereal Time, or 2° 45′ in Meaſure. Hence, as the Earth goes, every Year, 11 Minutes beyond the Place where it began; ſo it had occaſioned, (in the Year 1753) the Equinoxes to have preceded forward 44 Days, and the Calendar Computation to fall back the ſame Number; and thereby to anticipate Time ſo much. For the Autumnal Equinox, in the Year 706, of the Julian Period (which was the Year of the Creation, according to the Moſaic Chronology) fell on October 25th; but in A. D. 1753, which was the 6466th of the Julian Period, it was obſerved to enter Libra, Sept. 11, O. S. ſo that in 5760 Years, the Calendar Meaſure had *anticipated* the true 44 Days.

At the Council of Nice, which was held A. D. 325, the Sun was obſerved to enter Libra, Sept. 22; therefore in order to bring the Calendar Meaſure back to that Time, and ſo to commemorate the Feſtival of Eaſter, at

at a more exact Season; an Act of Parliament was passed, A. D. 1752, to throw 11 Days out of the Calendar Computation for that Year; *so that this Year contained only* 354 Days, instead of 365. By this Means the Equinox was brought back from the 14th of *Taurus* to which it was got, (from the first of Aries,) to the third of the same Sign, and the Sun entered Libra that Year, Sept. 22, N. S. *instead of* Sept. 11, O. S. *which was* the Time it entered it the Year before. (a)

Fourthly; The general Opinion is, that Moses, in his History of the Creation, does not point out, or give us any Instruction, in what Place of the Heavens the Sun and Moon were at the Creation.

First.—In answer to this I observe, that he has told us, 1st, That they were placed there on the fourth Day of the Creation Week.

2dly

(a) See Letter XII. XIV. and Diagram.

2dly.—That the Moon could not give her Light till the going down of the Sun: As the Sun was in the Meridian of the Place where it began to ſhine; ſo the Earth muſt have made one Quadrant of her Rotation, before the Moon could enlighten Her.— As ſoon as that was performed, the Sun ſat in the Weſt, and the Moon roſe directly after in the Eaſt, when they both together enlightened the whole Earth from Pole to Pole. Hence, it may be remarked, that the Rotation of the Earth meaſured one Quadrant of ſolar Time, before ſhe began to meaſure the lunar; therefore as the Sun and Moon were, jointly, to point out the Seaſons, the Days, and the Years; ſo the Chronology of Time muſt begin at this Period, as Moſes tells us it did. (b) 3dly.— In Regard to the Place of the Sun and Moon in the Heavens, Moſes informs us, that the Feaſt of Ingathering at the End or Revolution of the Year, was to commemorate the Creation, which happened at

(b) Levit. XXIII, 32.

at that Seaſon.—That the Feaſt was to be kept at the autumnal Equinox.—That the Moon muſt begin to ſhine in the Evening, at the going down of the Sun, being fifteen Days old, and juſt paſſed her Oppoſition or Full.—Here then we have a Point to begin our Calculations from, viz. the firſt Degree or Point of Libra; the Epact 15, (the Moon then being fifteen Days old) the fourth Day of the Week; and, as one Quadrant of ſolar Time was to be added to the Beginning of the Year, viz. from twelve o'Clock Midday, to Six in the Evening; ſo it muſt be the ſecond Year of the ſolar Quadriennium.—Had we not had theſe *Data*, we muſt be in the Dark for a Point where to begin our Calculations from; for, as Dr. *Keil* obſerves, Lect. XXVIII. "As there are certain Points from "which Aſtronomers begin their Computa-"tions of the Planets Motions, ſo alſo there "muſt be certain Points, as Inſtants of Time, "from which, as from Roots, all Calcula-"tions muſt begin."

Now, I have poſtulated that my Interpretation

pretation of the Mosaic History is true; and I find by Calculation, that all the Equinoxes, Solstices, new Moons, full Moons, and Eclipses, will be pointed out by these Calculations, according to the observed Times. Here then we have two Points to measure from, 1st. the postulated Point of the full Moon, at the autumnal Equinox 706, according to the Julian Period; and 2dly. the observed Time, when the Sun entered Libra, A. D. 1786, which Year we know answers to the Year 6499 of that Period; during that Time the Earth has made 5793 annual Revolutions through the Ecliptic, and 2115849 Rotations round her Axis. Therefore, it must be allowed, that if the Number of the Earth's Rotations (or natural Days) and the Number of Years, or annual Revolutions, measure the exact Length between these two Points, it must be mathematically true.—Now, I prove by Calculations (c) that they do.—These Calculations have

(c) See Letter, No. XVII.

have alſo this farther Evidence, *viz.* That you may begin them, either at the autumnal Equinox, 706, A. I. P. or when, (by Obſervation,) the Sun was ſeen to enter Libra, A. D. 1786, and the Calculations will come out the ſame to a Minute, which no aſtronomical Tables, yet extant, will do.—During this Time, the Moon will have made 71647 Lunations or Revolutions round the Earth, and Half another, when She interſected the Earth's Orbit, through the Ecliptic, and cauſed an Eclipſe of the Sun, A. D. 1786, July 25 D. 8 H. 43 M. P. M.

If, after this, any one ſhould diſpute the Point, whether Moſes has given proper Inſtructions concerning the Place of the Sun and Moon, the Day of the Week, *&c.* at the Creation.—He muſt allow that we have been very lucky in getting Information for doing it. (d)

Theſe Notions being different from those

(d) See Letter, No. XVII.

adopted by Writers on the Subject, I remained diffident of my own Opinions, notwithſtanding my Calculations of the Motions of the Heavenly Bodies, confirmed me they were true, till I deſired Mr. Heaviſide, who had ſome Friends among the Royal Society, eminent in Aſtronomy and Philoſophy, to ſhew them theſe Letters, with my Diagram, and to get their Opinions and Remarks on them.

The Gentlemen returned him for anſwer, that I had proved, to Demonſtration, that the Sun and Moon were in the ſame Places in the Heavens, in the Year 706 of the Julian Period, (as they muſt have been in the Year in which the Creation happened, according to the Moſaic Chronology,) and that the Earth had made juſt the ſame Number of Rotations, which I had poſtulated it had. But with Regard to thoſe Points in the Diagram, wherein I differed from the general received Opinions, they did not determine.(e) That

(e) See Letter VII.

That they liked my Letters ſo well, that they would have read them before the Royal Society, had they not been joined with Religion, which was contrary to one of their Rules to enter on.

Not receiving the Satisfaction from thoſe Gentlemen I hoped for, concerning the Points wherein I differed from general received Opinions, I got another Friend, who was intimately acquainted with an eminent Aſtronomer, to requeſt his Remarks thereon; to whom I alſo ſent one of my Diagrams.— After ſome Time, he ſent his Remarks in the following Words, " I have examined " ſome Parts of it, and find it to be ſufficient- " ly exact; I muſt however obſerve, that the " Method of repreſenting the Sun's Place, " and alſo the new and full Moons, for a " given Year, by a Diagram, is by no Means " new; ſince not only that has been done, " but, by certain moveable Circles, the Lu- " nations and Seaſons of the Eclipſes have " been ſhewn for a given Number of Years. " There are, however, ſeveral Aſſertions in

" the

" the Explanation which accompanies the
" Diagram, which, I believe, will not be
" readily granted.—The Conſtructor of the
" Diagram, ſays—*Aſtronomers, tell us, that*
" *the Ecliptic is equally divided into* 12 *Signs,*
" *of* 30 *Degrees each; but it is not ſo.*—Now
" the Truth is, that the Ecliptic is equally
" divided by the twelve Signs, and when
" theſe twelve Signs are *referred* to the Equa-
" tor, they neceſſarily occupy unequal Por-
" tions of that Circle, from the Inclination
" of the *two Circles.* (f) Beſides, the Ecliptic
" *cannot with any Propriety,* be called an
" Elipſe.—It is *only* the Line deſcribed ap-
" parently by the Centre of the Sun, viewed
" from the Earth, during the annual Revo-
" lution of that Planet round that great Lu-
" minary.—That I am not at all diſpoſed to
" enter into any Diſcuſſion concerning the
" Accuracy either of the ancient Iſraelites, or
" the modern Jews, in calculating the Times
" of their Feaſts.—I muſt however obſerve,
" that the Length of the tropical Year is not
" exactly

(f) The Equator is a Circle——The Ecliptic an Elipſe.

"exactly 365 D. 5 H. 49 M. but is at present a few Seconds shorter, and has been continually diminishing, somewhat unequally, for several Centuries past; and will, in all Probability, continue to diminish for many Ages to come."—On this I beg Leave to remark, that there, certainly, have been formed very exact Diagrams, representing the Sun's Place, &c. for a given Year—But then these have been made by the Assistance of Equations and Anomilies, to make the 365 Rotations of the Earth, to tally with the 360 Degrees of the Equator.—Thus, as he has very justly observed, when the 365 Rotations of the Earth, through the Ecliptic, is referred to the Equator, they necessarily occupy unequal Portions of that Circle, so unequal as 365 is to 360. From which it is agreed, that a Diagram has been formed to shew the Sun's Place, &c. in a given Year, by the *artificial* Means of *Equations* and *Anomilies*; but mine, on the contrary, is formed according to Nature; that is, by the Rotations of the Equator *only*, *the sole Measure of Time*, without Equations or Anomilies.—I will

will now beg leave to remark, that Moſes in his Hiſtory tells us, that the Sun and Moon were *both* placed in the Heavens, to meaſure and point out the Seaſons, the Days, and Years: (g) Hence the Reaſon why thoſe Nations who have made Uſe of one of them *only*, have never yet been able to keep the appointed Seaſons of the Year they were deſigned or inſtituted for.

The only ancient People, whoſe Hiſtory can be confirmed by true Chronology, and proved by Aſtronomy, were the Iſraelites, whoſe Years were formed by the Sun and Moon, jointly.—That is, the Moon, by interſecting the Earth's Orbit, prevented the Beginning of the ſolar Year going from the appointed Seaſon; their Year always ended at the firſt full Moon which happened either upon, or, the firſt which ſucceeded, after the

(g) Gen. I. 14. Moſes ſays, that the Sun and Moon were jointly appointed to meaſure, mark, or point out the Times and Seaſons; for God ſaid, let them (in the Plural) be for Signs, and for Seaſons, and for Days, and Years.—The Scriptures farther inform us, Pſalm LXXXIX. 37, and CIV. 19. That the Moon is eſtabliſhed in Heaven as a faithful Witneſs, to point out the Seaſons.

the autumnal Equinox.—In Imitation of this, were formed the Olympiads of the Greeks, who followed the Posterity of Abraham in this Particular, *viz.* by governing the Seasons of the solar Year, by the Moon's Intersections of the annual Orbit of the Earth; indeed they differed from them in ending their solar Year at the Summer Solstice; whereas the Israelites finished theirs at the autumnal Equinox.—Thus the Chronology of Years was truly recorded by the Olympiad Games, which were celebrated every four Years, on the first full Moon which happened upon or after the Summer Solstice.—By this Means they kept the Beginning of their Years at the true Seasons; and this no other Nation has been able to do, notwithstanding the great Improvements which have been made in Opticks and other Sciences; neither will it be done *now*, by the *Gregorian* Calendar, which will vary more than an Hour in one Hundred Years.

With Regard to the Measure of the Earth's annual Orbit, through the Ecliptic, whether

or

or not it is equally divided by the twelve Signs, of 30 Degrees each; let it be remembered, that the rotary Motion of the Earth is the *only* Meaſure of Time, and that every Rotation of the Equator is 360 Degrees, *in Meaſure*, and 24 Hours *in Time*.— Now when the Sun is in Conjunction with any one of the Signs, ſuppoſe *Libra*.—The annual Orbit is meaſured by the Number of Rotations the Earth makes during her Paſſage through the Ecliptic, or till the Sun is in Conjunction with the ſame Star, *Libra*, again.

Had the annual Orbit of the Earth been a Circle, inſtead of an Elipſe, (as the Earth performs equal Areas in equal Times,) theſe twelve Signs would have equally divided the annual Orbit, as well as the great Circle of the Heavens, and all concentrick Circles; but as it is not a Circle, but an Elipſe, and that Part of the eliptic Orbit which the Earth traverſes in Summer, being much larger and farther from the Sun, than the other Half which it traverſes in Winter, muſt, of Conſequence,

ſequence, make a greater Number of Rotations in going through that Half than the other; indeed by Obſervation we find it to be more than ſeven.

The Earth meaſures the Orbits of all the Heavenly Bodies, as well as her own annual Orbit, by the Number of Rotations ſhe makes during thoſe Orbits, and adding the Overplus of Degrees beyond the laſt Rotation.—For this Purpoſe, the whole Equator, or Circumference of the Earth, is, as has been obſerved, divided into 360 Degrees in Meaſure, whilſt ſhe makes one Rotation round her Axis, from Sun to Sun, and is called a ſolar or natural Day; which 360 Degrees in Meaſure, are divided into 24 Hours, by a well regulated Clock.—Hence it may be obſerved, that, as every Rotation of the Equator contains exactly 360 Degrees, whilſt a well regulated Clock points out 24 Hours in Time, *preciſely*; ſo Time may be turned into Meaſure, and Meaſure into Time, reciprocally.—This has been evinced to Demonſtration by the Trials of Mr. *Harriſon*'s Time

Piece.—While the Earth is performing this Rotation or natural Day, She is carried forward, four Minutes of Time, in her annual Orbit. viz. That Space of Time which She takes in going from the Star She ſat off from the Day before, (which was then in Conjunction with the Sun) till She comes in Conjunction with the Sun again, is juſt four Minutes.—But this is a different and diſtinct Motion of the Earth's, *forward*, in its annual Orbit, which has no other Connection with the diurnal Rotation, than that it is meaſured by a ſtated Part of that Rotation.—In this Manner the Earth meaſures the Length of her annual Orbit, or ſolar tropical Year; the Period of a Lunation, or the Time while the Moon is going from one Oppoſition or Conjunction of the Sun, to her next Oppoſition or Conjunction.—The Length of a Lunar Year, or twelve Lunations.—The Length of the Orbits of the Planets, Comets, &c.—And alſo the Times when the Eclipſes are to happen, or that particular Time, when the Moon croſſes the Earth's annual Orbit, either in Conjunction with

with the Sun, and in a direct Line between the Earth and the Sun; or in Oppoſition, when the Earth is in a direct Line between the Sun and Moon.—The Moon does not meaſure her own Orbit, but, points out the Seaſons, by Her Interſections of the annual Orbit of the Earth.

Let us now examine whether the annual Path of the Earth is equally divided, by the twelve Signs, or not.—She goes from *Libra* to *Aries*, or the ſix Winter Signs, or Winter Half, in 178 D. 17 H. 58 M. But the Summer Half, or ſix Signs, viz. from the Vernal to the autumnal Equinox, require 186 D. 11 H. 51 M. to compleat it; which ſhews us She is more than a Week longer in traverſing the Summer ſix Signs, than She is in traverſing the Winter ſix Signs.—From whence it may be obſerved, that She increaſes her Diſtance from the Sun, greatly, after She has paſſed the vernal Equinox, and that She muſt be many thouſands of Miles farther from the Sun, at the Summer Solſtice, than She is at the Winter Solſtice.—She is alſo

31 D.

31 D. 5 H. 0 M. in going through the Sign *Virgo*, and but 29 D. 4 H. 35 M. going through the Sign *Capricorn*; which ſhews, that, notwithſtanding the twelve Signs or Stars, divide the great Circle of the Heavens into twelve *equal* Parts, yet the Path of the Earth's Orbit, (which is an Elipſe within that great Circle,) is ſo much enlarged when She is paſſing through the Sign *Virgo*, that it requires more than two Rotations of the Equator, to meaſure it, than it does to meaſure the Sign *Capricorn*.—Thus, it is evident, that She traverſes more than 720 Degrees, or more than forty-nine thouſand Miles, in going through the *Sign Virgo*, than She does in going through the *Sign Capricorn*.—Hence alſo it is evident, that the Earth's Path or Orbit through the Ecliptic, is certainly an Elipſe; which, I believe, few will diſpute. *

We will now endeavour to try whether the following Aſſertion of his is true or not, viz. "That the tropical Year is not exactly 365 D. "5 H.

* "The Orbits of all the Planets are Elipſes, very little different from "Circles; but the Orbits of the Comets are very long Elipſes; and the "lower Horns of them all are in the Sun."—See Ferguſon's Aſtronomy, S. 155.

" 5 H. 49 M. but *at present* a few Seconds " shorter, and has been continually decreas- " ing, somewhat unequally, for some Years " past, and in all Probability will continue " to diminish for some Ages to come."— This appears to be an Assertion without Evidence to support it.—It is true, that different Astronomers, by their Observations, have made the annual Orbit of different Lengths, hardly any two agreeing about what is the Length of it, except those who have made it 365 D. 5 H. 49 M.—The Length of it, according to Sir *Isaac Newton*, is 365 D. 5 H. 48 M. 57 S.—Hence is *partly* the Reason why the ancient Eclipses, of more than two thousand Years standing, cannot be calculated by the present Tables, which come short of them.—This Error, has been attributed, to the Moon's being nearer the Earth now than She was then; but, in Fact, the Cause does not arise from this, but from the erroneous tabular Measure.

The measuring the annual Orbit of the Earth, by two Observations, only *one* Year between

between is ſo precarious, that almoſt every Aſtronomer will make a different Obſervation this Year from that he does the next; hence it may be obſerved, that different Aſtronomers will not only vary from one another, but alſo the ſame Aſtronomer will differ from Himſelf.—Dr. Keil tells us, [h] that "by "Obſervations that are made at the Diſtance "of one Year, we *cannot ſafely* rely upon the "Quantity of the Year collected from them; "for a ſmall Error of one Minute, being "conſtantly increaſed, and multiplied by "the Number of Years, in Proceſs of Time, "would amount to a prodigious Miſtake in "the Place of the Sun, therefore the Aſtron-"omers more accurately determine the Quan-"tity of the Year, by taking the Obſervati-"ons of two Equinoxes, at *many* Years Diſ-"tance from one another; and dividing the "Time, by the Number of Revolutions the "Sun has made, the Quantity will ſhew the "Time of one Revolution, or *nearly* the "Period of the Earth in her Orbit.—For, "by

(h) Lect. 22. P. 271.

"by this Means, if there be any Miſtake "made in the Obſervation, it will be divid-"ed into ſo many Parts, according to the "Number of Years, that it will be inſenſible "for the Space of one Year."

Dr. Keil, as above, having remarked the great Difficulty there is, in obſerving when the Sun is in the Plane of the Meridian; of the Place of Obſervation; and alſo the Uncertainty of it was ſuch, that he calls the Error of a *Minute* a *ſmall Error*; and, therefore, in order to come *near* the Truth, we are to take the Obſervations of two Equinoxes, at many Years Diſtance from one another, and dividing the Time by the Number of Revolutions the Sun has made, the Quantity will ſhew the Time of one Revolution *nearly*.

Now in Order to find the Length of the tropical Year, Mr. Kennedy took Dr. Keil's Direction, and tried it by the Obſervations of two remarkable great and exact Aſtronomers, which were made 168 Years Diſtance from each other,—The firſt Obſervation was made by

by *Tycho Brake*, at *Uraniberg*, A. D. 1585, and the laſt by Dr. *Bradley*, at *Greenwich*, 1753. By this he found the Length of the ſolar tropical Year to be exactly 365 D. 5 H. 49 M. (i) From which may be deduced, that 365 D. 5 H. 49 M. is the exact Length of the ſolar tropical Year, and alſo, that it is no ſhorter now than it was 168 Years ago. (k)

A natural Day, or one Rotation of the Equator, contains 24 Hours in Time, or 1440 Minutes; theſe may be called equatoreal Minutes, as there are Terminations, in Meaſure, on the Equator, which anſwer to every one of them.—The Equator precedes forward 11 of theſe Minutes, every ſolar Year; and in 1440 Years, it paſſes through all its meridional Variations, and at the End of that Period, it returns again to the original Point of the Day, in the ſame Place or Meridian, where it began, but not on the ſame Day of the Week.—As this is an exact Cycle

(i) Kennedy, P. 159.—— (k) Introduction, Page 23.

cle of the Sun, ſo all the Multiples of this Number will be ſo too, as 2880, 3420, 5760, &c. will compleat ſolar Cycles; therefore if you know the Time when the Sun enters *Libra*, or any other Point in the Heavens, on any one of the Years of any Cycle; by that you will alſo know the Time when the Sun enters *Libra*, the ſame Year, in all other Cycles. (1)

The fourth Cycle ended A. D. 1783.—Here we have 5760 Revolutions to try the exact Length of the ſolar tropical Year by; and throughout all this Period of Time, the Sun will be found to enter *Libra* at the Times calculated, according to the Length of the ſolar Year being exactly 365 D. 5 H. 49 M. Thus let the autumnal Equinox 706, of the Julian Period, be one Point, and the autumnal Equinox, 6466 of the ſame Period, be the other Point.—Between theſe two Points, the Earth has made 5760 Revolutions; and by an accurate Obſervation that Dr. Bradley made that Year, A. D. 1753, at Greenwich,

D. which

(1) See Letter, No. 8, 10.

which was the Year in Connection with 6466, of the Julian Period, the Sun was obſerved to enter Libra at the Day, Hour, and Minute it did 5760 Years before, and Calculations, according to this Length of the Year, will be found to agree with the Obſervations made every Year throughout this Period, and alſo all ſucceeding ones. (m) Is not this Demonſtration, that this Length of the Year is perfectly right?

In Order to underſtand ſome Parts of theſe Letters the better, I ſhall give a Deſcription of the patriarchal or iſraelitiſh Year, according to the Calendar of it, as it is found in the Scriptures, or as it was obſerved by the ancient Iſraelites.

It appears clear, that the Seaſons in which Moſes ordered the Feaſts to be kept, and the Directions which he gave to the Iſraelites for keeping them, were pointed out by a well known and ſimple Calendar; which, at that Time,

(m) See Letter, No. 6.

Time, may be ſuppoſed to be underſtood by all; therefore, there was no Occaſion to deſcribe it.—This Calendar ſeems to be formed in a moſt ſimple, clear, and exact Manner. They calculated their Months *aſtronomically*, by the Number of Rotations made by the Earth, (in Appearance) as mechanically as a Clock points out the Hours of the Day.—They did not ſeem to have any Regard to the Motions of the heavenly Bodies, any more than if they had no Motion at all.—Thus, we may remark, that the Patriarchs, inſtead of being left to find out, by Obſervations on the Heavenly Bodies, the Length of the Years, whereby their Feſtivals and Seaſons were to be calculated and obſerved, they were inſtructed by a Calendar of *integral Days*, and Quadrants, to calculate aſtronomically the Times appointed for keeping of them, and thereby to record the Ages of the Patriarchs, and therewith the Age of the World; this they were to do by the ſolar tropical Year, but to record Events by Days and Months of the lunar.—Indeed had not Moſes, at the Time he ordered them to keep theſe Feſtivals

at

at their particular Seaſons, given them Directions how to know when theſe Seaſons came, it would be very abſurd to expect it from them.—But he inſtructed them to meaſure both the ſolar and lunar Year, by a certain Number of the Rotations of the Earth, or natural Days.—In this Manner the Patriarchs and the Iſraelites always expreſſed their Ages, viz. by *Days of Years*, to ſhew that their Years were meaſured by Days.—Thus when *Pharoah* aſked *Jacob* how old he was. (n) In the Engliſh Text it is, "*And Pharoah* "*ſaid unto Jacob, how old art thou.*"—In the Margin, you have a literal Tranſlation of the Hebrew.—"*How many are the Days of the Years of thy Life;*" Jacob anſwered him in the ſame Stile—"*The Days of my Years, &c.*

Thus it may be infered, that their annual Calendars contained a certain Number of Days, and that their Years were meaſured by thoſe Days.

They began to count the Beginning of their

(n) Gen. XLVII. 8, 9.

their Days, at Six o'Clock in the Evening, (o) at the going down of the Sun, (which it always did in the Latitude where Paradiſe is ſuppoſed to be placed, and, nearly ſo, in Egypt and the Wilderneſs.)—Thus, as ſoon as the Sun was out of Sight, they added that Day to the former Number; and the next Day immediately began.—Six Days of the Week they were to work, which ſixth Day ended at the going down of the Sun that ſame Evening, when the ſeventh or Sabbath began; and at the going down of the Sun, the Evening of the Sabbath, their Week, or Cycle of ſeven Days ended, and the firſt Day of the next Week began; and, in Order to keep and to commemorate their Sabbath, they had a holy Convocation thereon, which was their firſt and principal Feſtival.

Their Day was divided into four Quadrants or Quarters, and had four cardinal Points; the firſt began at Six o'Clock in the Evening, and ended at Mid-night; the ſecond ended at Six in the Morning; the third at Mid-day, and

(o) Levit. XXIII. 32.

and the fourth at Six in the Evening; when the next Day began.—This is the Method which Moſes ordered Time to be meaſured and recorded by, and the Method that the Sun and Moon do it, viz. by the Number of the Earth's Rotations.

Thus, notwithſtanding in Appearance they meaſured mechanically by Calendar Numbers only, yet at certain Times, theſe Numbers met the Motions of the Heavenly Bodies, and their Calculations turned out aſtronomically true.—They made Uſe of two Years to meaſure and record Times and Seaſons by; the one by the apparent Motions of the Sun, (or more properly the Motions of the Earth,) and the other by Lunations or the Revolutions of the Moon; which two Years, being meaſured by Days *only*, prevented the Times appointed, at particular Seaſons of the Year, from ever altering; and to prevent their forgetting or miſtaking the appointed Seaſons, when theſe Tranſactions began and ended; Moſes ordered Feſtivals and holy Convocations to be kept at theſe appointed Times, to commemorate them.

Their lunar Year consisted of 354¼ Days; and was divided into twelve Months; the first Month of the Year began at the new Moon before the Feast of Tabernacles. The first Day of the Feast of Tabernacles, or the Ingathering of the Fruits of the Earth, was appointed to commemorate the Place of the Sun and Moon at the Creation, and was always to be celebrated on the 15th Day of this Month, or (as expressed in the Hebrew) the Moon; which was at its first Appearance, on the going down of the Sun, after the full, in Commemoration that that was the Place of the Moon, on the fourth Evening of the Creation; as the autumnal Equinox was the Point where the Sun was first placed, at that Time.* As has been already observed, they began

* As this was the first Day that the Chronology of the World commenced, the Israelites, (which is still continued amongst the Jews to this Day,) "on their Return from the Synagogue, salute each other with saying, "to a good Year shall you be writ, for according to Tradition, this is the "Day that God created the World, so it is that on which God judges it; "and therefore (says David Levi) (p) in our Prayers, on this Festival; we "pray to God, to renew unto us a good Year."—As Trumpets were always made use of on the first Day of this Feast, so it was called the Feast of Trumpets, a Memorial of blowing of Trumpets. (q) David Levi tells us, (r) "that their Trumpets are always made of a Ram's Horn, in Re-

(p) P. 75.—(q) Levit. XXIII. 24.—(r) P. 79.

began their Days at Six o'Clock in the Evening; their lunar Year began at the ſame Point, and confiſted of 354¼ Days; ſo the firſt lunar Year began, at the ſame cardinal Point with the Day, and it ended at the cardinal Point of the next Quadrant, viz. at Mid-night; the ſecond ended at Six in the Morning; the third at Noon, and the fourth at Six in the Evening; at which Point of the Day, the lunar Year was compleated and ended; and was then added to the End of the fourth Year, which contained 355 Days, whereas, the firſt three of this Cycle of four Years, contained only 354.

This lunar Year was divided into twelve Months, and was calculated by the Patriarchs, and ancient Iſraelites, by Calendar Numbers only, and continued to be ſo till after the Captivity

" membrance of Abraham offering his Son Iſaac, when the Angel of the " Lord called to him out of Heaven, and ſaid, lay not thine Hand upon " the Lad—and Abraham ſeeing a Ram, caught by the Horns, in a " Thicket, he went and offered Him up for a Burnt Offering, inſtead of " his Son; our Traditions inform us, that happened on this Day, (s) we " therefore make Uſe of a Trumpet, made of Ram's Horn, as a Memorial " of it."

(s) Gen. XXII. 8. 9.

Captivity of the Jews, when they learned and introduced a different Method of pointing out, and of calculating this lunar Months. It is ſuppoſed they learned their Method during their Captivity amongſt the Babylonians and Greeks; from that Time, to this Day, they calculate their Months by the Appearance of the Moon, next after the Change, and by 29 and 30 Days, according as it appeared; but they never made their Months to contain more than thirty Days. But, according to the Calendar Numbers of the Iſraelites, their firſt eleven Months contained 30 Days each, and their twelfth 24 Days only; and at the End of their Cycle of four Years, 25 Days.—At this Point, their Calendar Numbers met the Lunations aſtronomically.

The firſt Day of every lunar Month was called the Month or Moon-day; on this Day they had a Feſtival, and holy Convocation, as a Memorial that the laſt Month was ended, and another began.—By theſe lunar

Months, all Events and Tranſactions were recorded.

The ſolar Year, (by which the Ages of the Patriarchs were recorded, whoſe Ages were always made to begin and end at the autumnal Equinox, and thereby to run parallel with the Years of the World,) contained 365¼ Days; but then this Quadrant at the End of the Year, like the Lunar, did not come into the Reckoning till at the End of the Quadriennium, or Cycle of four Years, was compleated; ſo that the firſt three Years of the Quadriennium conſiſted of 365 Days each, and the fourth of 366.—The ſolar Day began at Noon, as it did on the fourth Day of the Creation, therefore it anticipates the lunar one Quadrant of a Day, as that did not begin till Six in the Evening.—Thus, as this Quadrant reached from Noon to Sunſetting, ſo it ſhews us that the firſt Year of the World muſt be reckoned as the ſecond of the Quadriennium; therefore, when we would know the Quadriennium of the World's

Age,

Age, we muſt add 1 to A. M. and then divide by 4—this will always give you the Quadriennium ſought.—The ſolar Day was divided into Quadrants, as the lunar, at the four cardinal Points.

Hence, it may be obſerved, that the lunar Year conſiſted of 354¼ Days, and the ſolar 365¼.—If we ſubſtract the lunar from the ſolar, it leaves 11 Days, (the Difference in Length between the two Years;) which is called the *Epact*, and is a great Means to diſtinguiſh one Year from another.

As the two Years were carried on together, and both meaſured by integral Days; ſo they regulated each other in the following Manner; the firſt ſolar Year was one Quadrant and eleven Days longer than the lunar; this odd Quadrant was occaſioned by the ſolar Time beginning ſo long before the lunar.—The two firſt ſolar Years contained 730½ Days, while the two lunar contained only 708½, ſo that the *Epact*, at the End of this Year,

Year, was 22¼ Days, the lunar Year being ſo far ſhort of the ſolar.—The firſt Day of the Month, of the lunar Year, was on the firſt Appearance of the Moon, after the Conjunction, which was nearest to the autumnal Equinox, and came before it: Now, as the Moon was 15 Days old, or paſſed its Full, on the firſt Year of the Creation, ſo if we ſubſtract 15 from 22, it will leave 7 for the Epact; and ſo much the new Moon Year will precede the Solar.—The next lunar Year, added to theſe two, will make 1096 Days, while the three lunar contain 1062¾ Days only, which are 33¼ ſhort of the ſolar.—Now as the twelfth lunar Month contained no more than 24 Days, ſo it over-ran the full Moon 9 Days; therefore as the firſt Day of the Feaſt of Ingathering was to be on the full Moon which happened either upon the autumnal Equinox, or the next which followed, they added a Month of 30 Days, and the next new Moon, lunar Year, began 6 Days after the ſolar Year ended. The Number of Days contained in the ſolar Quadriennium,

driennium, are 1461, while the lunar have but 1417; to which add the Month of 30 Days, and it makes 1447; which ſubſtract from 1461; the Days of the ſolar, leave 14, and ſo many Days the full Moon, lunar Year, precede the next ſolar.

Hence it may be obſerved, that both Years are meaſured by integral Days, and that the annexed Quadrant was not reckoned till the Day was compleated, which it always was at the End of every four Years.—At firſt View, this annexed Quadrant, at the End of each Year, has the Appearance as if it would cauſe a Confuſion between them; but the contrary is found to be the Fact; for it may be obſerved, that the Quadrant, annexed to both Years, rectify each other in ſo exact a Manner, that it appears to be appointed by God himſelf, as the Medium or Bond of Connection between them.

From what has been ſaid, it may be remarked, that take any four Years of the World,

World, the lunar Computation is not only included in the ſolar, but is equal to it.

For firſt, every four ſolar Years in Succeſſion, include firſt four lunar Years, three of which conſiſt of 354, and one of 355 Days, whoſe Sum is 1417. Secondly. They include four lunar Epacts, three of which conſiſt of 11 Days, and one of 10 Days, whoſe Sum is 43 Days, which being added to 1417, make 1460. Thirdly. They include four Quadrants, which make one Day; to 1460 add that one Day, and the whole Amount of lunar Days will be 1461, the ſame as the Solar.

The ſolar Year, like the Lunar, was divided into twelve Calendar Months;—the firſt eleven contained the ſame Number of Days that the Lunar did, viz. of 30 Days each; but the twelfth had 35 Days.—Theſe twelve ſolar Months began and ended at the ſame Point of Time with the twelve Signs—they began when the Sun entered Libra, till after

after the Exodus of the Iſraelites out of Egypt, when they altered the Beginning of the Year by God's expreſs Command, from the autumnal Equinox, to the Vernal; their firſt Month was altered to the ſeventh, and their ſeventh to the firſt; (t) their Sabbath was altered from the ſeventh Day to the ſixth.— The Iſraelites counted theſe Months by Calendar Numbers, in the ſame Manner they did their lunar Months, but at the End of every Quadriennium they met the Sun *Aſtronomically*, at the ſame Point of the Day, in the ſame Sign.

The Uſe which the Iſraelites made of the Months of the ſolar tropical Year, was for the coming in and going out of the twelve Courſes of Military Officers, and of the 24 Courſes of Prieſts, (u) who waited in the Temple; theſe Prieſts went in and came out every Sabbath Day; ſo that it came to the Turn of each Prieſt (v) to wait two Courſes in the Year, beſides the three Feſtivals; when all

(t) Exod. XII. 1.

(u) 1 Chron. XXIV. 7.— XXVII. 1.— (v) 2. Kings, XI. 5, 7.

all the Courſes waited. (w) They began their Year at the Feaſt of the Paſſover, which laſted till the Morrow after the Sabbath, when the wave Sheaf was offered, after which they began to count the ſeven Weeks, between that and Pentecoſt, or the Feaſt of Weeks; the third Feaſt was the Feaſt of Tabernacles, or Ingathering, which laſted eight Days. Theſe Feaſts made four Weeks, when all the Courſes waited; and the 24 Courſes twice over, made 48 Weeks; which, with the four Weeks of the Feſtivals, make in the Whole 52 Weeks, with one Day for all the Courſes to go out and come in, will compleat the ſolar tropical Year, which contains 52 Weeks and one Day.

After the Exodus of the Iſraelites, from their Bondage out of Egypt, they kept their Feaſt of Tabernacles and Ingathering, according to Moſes's Directions, as do the Jews to this Day, (x) *on the fifteenth Day of the ſeventh Month*, (from the vernal Equinox) *when*

(w) 2 Chron, V. 11.—— (x) Levit. XXIII. 39.

when ye have gathered in the Fruit of the Land, ye ſhall keep a Feaſt unto the Lord, ſeven Days. On the firſt Day ſhall be a Sabbath, and on the eighth Day ſhall be a Sabbath.—And ye ſhall take you on the firſt Day, the Boughs of goodly Trees, and ye ſhall rejoice before the Lord your God; ye ſhall dwell in Booths *ſeven Days.*

It is worthy of Obſervation, (ſays Mr. Kennedy) (y) that when the Jews celebrate the Feaſt of Tabernacles, as above directed, in Remembrance of the Creation of the World, which they never fail to do at the appointed Seaſon; they celebrate at the ſame Time, not only the Birth-day of the World, but of the promiſed Meſſiah too, who was born on the firſt Day of the Feaſt of Tabernacles, and circumciſed on the eighth, or great Day of the ſame.—But as this is a Seaſon of the Year, contrary to the general received Opinion, when Chriſt was born; I ſhall endeavour to find the real and true Seaſon when that hap-

(y) Kennedy's Introductory Diſcourſe, P. 19.

pened.—In order to do this, let us examine the Scriptures, and try what Assistance may be received from them, for when they are examined carefully, and with a good Intention, we often find that they contain more than we expected to find in them.—It is generally agreed, that the Ceremonies and Works of the Law were typical of those Things which were fulfilled in the Gospel; both Testaments being a Counter-part to each other, as our Saviour told the Jews; *search the Scriptures, for in them ye think ye have eternal Life; they are which testify of me. If ye had believed Moses, ye would have believed me: for he wrote of me.* (z) That the Temple typified the Body of Christ we are certain, for our Saviour himself told us so. (aa) The Feast of Dedication of Solomon's Temple, was kept on the Feast of Tabernacles, (bb) in the seventh Month,—and on the eighth Day they made a solemn Assembly for its Dedication. If this was a Type of Christ, there

(z) John V. 39. 46.—(aa) John II. 19. 21.— (bb) II. Chron. V. 3. 7. 8.

there is no Doubt but that it was fulfilled by its Antitype.

St. Luke tells us, (cc) *That in the Days of Herod the King, of Judea, that a certain Priest named* Zacharias, *of the Course of Abia. And it came to pass, that as soon as the Days of his Ministration were accomplished, that he departed to his own House; and that after those Days, his Wife Elizabeth, conceived and hid herself five Months— And in the sixth Month, the Angel Gabriel was sent from God, to a Virgin, and said unto her— behold thy Cousin Elizabeth, she has also conceived a Son in her old Age, and this is the sixth Month with her.*

In order to know the Season of the Year when this happened, St. Luke tells us, that it was directly after *Zacharias's* Days of Ministration were accomplished—And that *Zacharias* was of the Course of *Abia.*—And in Chronicles (dd) we are informed that *Abia* belonged

(cc) Luke I. 1. 23, &c.—(dd) I. Chron. XXIV. 16.

longed to the eighth Courſe. — Now the Prieſts began theſe Courſes of Miniſtration after the Sabbath (which followed the Paſſover) was over.—During the Feaſt of the Paſſover, or Feaſt of Unleavened Bread, (which was ſeven Days,) all the Courſes of the Prieſts miniſtered together.— That the Beginning of the fifty Days, between the Feaſt of the Paſſover, and the Feaſt of Weeks, was to commence on the Morrow after the Sabbath, when the wave Sheaf was offered (ee) ſo that the firſt Courſe were to begin their Miniſtration on the ſecond Sabbath after the Paſſover, which was (ff) *Jehajorib*; the ſecond *Jedaiah*; the third *Horim*; the fourth *Searim*; the fifth *Milchijah*; the ſixth *Mijamin*; the ſeventh *Habbez*—the next Week came the Feaſt of Weeks or Pentecoſt.— Hence the Courſe of *Abiah*, (which was the *eighth*) did not come in till the Week after Pentecoſt.— Now if we count the Weeks they will be, the Paſſover two Weeks, between that Feaſt and Pentecoſt ſeven Weeks, Pentecoſt

(ee) Levit. XXIII. 15.—(ff) I. Chron. XXIV. 7 to 10.

Pentecoſt one Week, and *Abias*, the Week after, one Week; in all eleven Weeks.—So that the Week after his Miniſtration muſt be the twelfth after the Paſſover Day.—Subſtract 12 from 52, the Number of Weeks in a ſolar tropical Year; and there will remain 40 Weeks, the exact Time of Geſtation, to which add one Day for the Day of the Birth, and that will bring it to the Paſſover Day, when John Baptiſt was born.—Add to this ſix Months, (the Difference between the Conception of Elizabeth, and when the Angel Gabriel was ſent to the Virgin) and it will bring it to the 15th of the ſeventh Month, when Chriſt was born.

Now multiply the 40 Weeks by 7, and the Product will be 280; add 1 for the Day of the Birth, and it will make 281 Days, (as theſe are lunar Months) ſubſtract 266 Days for the nine Months of Geſtation, and the Remainder 15 will expreſs the true aſtronomical Day when the Baptiſt and Meſſiah were born.—John the Baptiſt was born on the

the 15th of the first Month, or Passover Day, and the Messiah on the 15th of the seventh Month, when the Feast of Tabernacles commenced.

The vulgar Era of Christ's Birth was not settled till A. D. 527, when it was done by Dionisius, a Roman Abbot, since which it has been generally received and followed by Christians.—Had this Era began in the Time of the Apostles, there is no Doubt but it had been right, but as it did not become an Era till the sixth Century, it is not at all to be wondered at, if it should be found to be not exactly right, as it certainly is not.—As there is no Certainty in Chronology, without it is confirmed by Astronomy, I shall endeavour to settle it according thereto.

We are told in the Gospel (gg) that Christ was born while Herod was King of Judea; who sought to kill Him, as soon as he heard of his Birth; but *Joseph*, being warned of God,

(gg) Matthew II. 16.

God, fled into Egypt with him, where he remained till he heard of Herod's Death, which happened in the Year 4711 of the Julian Period; but the vulgar Era, ſettled by Dioniſius, makes his Birth to have happened in the Year 4713 of that Era.

Joſephus informs us (hh) that Herod died in the 26th Year of Auguſtus Cæſar, and a little before the Paſſover, and that there was an Eclipſe of the Moon during his laſt Illneſs.— Now, if we calculate that Eclipſe of the Moon, it muſt ſettle aſtronomically the Year when Herod died.

This Eclipſe is not to be found amongſt the Catalogue of Eclipſes, but Mr. Fergufon (ii) ſays, "It appears by our Aſtronomical "Tables to have been in the Year of the Ju- "lian Period, 4710, March 13th, at 3 "Hours paſt Mid-night, at Jeruſalem."—

At the End of this Introduction (kk) I ſhall add

(hh) Joſephus lib. XVII. Cap. 8 and 11. — (ii) Fergufon, P. 385, S. 396.
(kk) Page

add a Calculation of this Eclipſe, by which it will appear, that Mr. Ferguſon has made a Miſtake of one Year in his Calculation, for you may obſerve, from my Calculation, that this Eclipſe muſt have happened A I P 4711, and not 4710, and that it happened according to Mr. Ferguſon's Time, March 13, N. S. 3 H. 40 M. 33 S. It could not be on the 13th of March, 4710, becauſe the Full Moon, in that Year, happened on the 23d Day of March, inſtead of the 13th, when the Moon's Node was too far Diſtant, at that Time, from the Sun, to cauſe an Eclipſe.

As it may be obſerved from theſe Calculations, that our Saviour was born on the firſt Day of the Feaſt of Tabernacles, in the 26th of Auguſtus Cæſar, on a Sunday, the ſeventh Day of the Week from the Creation, in the Year of the World, (according to the Moſaic Chronology) 4005, about five Months before Herod died, which *Joſephus* tells us was a little before the Paſſover Day, or the 14th of Niſan, which happened that Year on April

11,

11, of the Julian Calendar.—This corrects the vulgar Era, two Years and 89 Days: It was then propoſed to bring the Beginning of the Year, from the autumnal Equinox, (nearly the Place it had got by irregular Intercalations,) back to the Calends of January.

Soon after the Feaſt of Tabernacles, when Chriſt was born, and Herod ſought his Death by ordering all the young Children in Bethlehem, of two Years old and under, to be ſlain; Joſeph carried him into Egypt, where he remained till after Herod's Death, which happened about five Months after.

As the Reader may be deſirous to know the Reaſon why Chriſtians kept the Feſtival of Chriſt's Birth, at the Winter Solſtice, inſtead of the Autumnal Equinox, which appears to be the true Seaſon; and, as Hiſtory is ſilent hereon, I ſhall give the moſt probable Account I can concerning it.—In order to do this, it appears proper to examine the Method of recording Events at that Time.

In the firſt Place, it muſt be obſerved, that the Romans were Maſters of the then known World, and that they obliged all the conquered People to obey their Laws.

Forty-ſix Years before the vulgar Era, Julius Cæſar, finding great Inconveniencies to proceed from the Irregularity of the Roman Calendar then in Uſe, which was of a lunar Year, and required an Intercalation every Year to make it agree with the Solar; and that by the bad Management of the *Pontifices*, who had the ordering of it, the Calends of January were got from the Winter Solſtice, (to which they had been placed by Numa, about 560 Years before,) nearly to the autumnal Equinox; he therefore, to make a more perfect Calendar of the Year, called to his Aſſiſtance an Aſtronomer from Alexandria; who, in order to put the Seaſons into their right Places, very carefully obſerved the Sun's Place in the Ecliptic; and by reckoning the greater Part of October, November, and December, twice over, he effected it.—Thus, when by the old Calendar,

dar, the Year was got to the Calends of January, he brought it back and began it again nearly to the autumnal Equinox; by this Means, the Winter Solſtice of the new Calendar, (as *Ovid* informs us,)* was made the Point where the old Year ended, and where the new one began.

Other Roman Writers alſo inform us the ſame; but *Pliny* and *Columella* tell us, that the Calends of January, with the other Equinox, and the Solſtices, were placed in the 8th Degree of each Sign, and were much perplexed to account for it; but the Fact appears to be, that the Alexandrian Aſtronomer, finding that the Equinoxes had preceded the Calendar Meaſure, he ordered the Beginning of the political Year to be placed in the 8th Degree of *Capricorn*, inſtead of the firſt, thinking thereby to place the Calendar Computation where it might agree with the Solar.

About ten Years before our Saviour was born,

* *Bruma noui prima eſt veteriſque Noviſſimus Anni,*
Principium capiunt Phœbus et Annus idem. OVID.

born, they found that an Error had been committed, by adding the Day of the Leap Year to every third Year, instead of every fourth, whereby three supernumerary Days had got into the Calendar; but by *August Cæsar*'s ordering that no Leap Year should be again put into the Calendar for the twelve Years next ensuing, brought it right again; and then imagined that the Calendar would never more want any farther Correction.—This was believed so late as the Council of Nice, which was held, according to vulgar Era, A. D. 325. For by their paschal Canons, they erroneously fixed the 21st of March for the Sun's Entry into the Equinoctial Point, and took it for granted, that it would be immoveably fixed to that Day of the Julian Calendar.—For it does not appear that Astronomers were capable of observing the exact Time of the Sun's entering the Equinoctial Points, till *Tycho Brahe*, by his Improvements in Astronomy, did it.—After this Reformation by Julius and Augustus Cæsar, to prevent Confusion by different Calendars, *Strauchas* informs us, (11) that severe Laws were made to punish any

(11) Book XV. Chap. 42, (Salt's Translation.)

any People who did not conform thereto, or who made Uſe of any other.

Now the above was the State of Calendar Computation at the Coming of Chriſt.—All the Roman Empire knowing what Pains Julius Cæſar had taken to ſet all the Seaſons in their true Places, and to make a true Calendar of the Year, it would have been ſtrange, and have the Appearance of great Obſtinacy, for any one to have acted in Contradiction to it; and therefore, the Chriſtians, no doubt, did conform to it, and made Uſe of it; for, it was one of the Principles of Chriſtianity, taught by St. Peter himſelf, (mm) "to ſubmit "themſelves to every Ordinance of Man for "the Lord's Sake, whether it be to the "King as Supreme, or unto his Governors."

Thus it may be obſerved in what a State of Confuſion the Calendar Computation had been in, about the Birth of Chriſt; and what Pains had been taken, by the Roman Emperors, to ſet it upon a right Foundation.—

Ho

(mm) I. Peter, II. 13.

He was born amongst the Jews, who, with the Patriarchs and Israelites, from the very Beginning to this Time, have always believed, that the Creation happened at the Full Moon nearest after the Autumnal Equinox, and that the Feast of Ingathering was appointed by God, and ordered by Moses to be kept in Commemoration of it.—The Feast of Tabernacles was ordered to be kept at the same Time; but as that was to be a Memorial of their Deliverance from the Egyptian Bondage, when they dwelled in Tabernacles, so they were ordered to dress their Habitations with green Boughs, to commemorate it; (nn) Christ being born amongst the Jews, on *the first Day of this Feast*, the Christians dressed their Houses also with green Boughs, for a Memorial that Christ was born on that Day.

Now as Christ was born on *New Year's Day*, and as St. Paul tells us (oo) that in his Time, "there were many unruly and vain "Talkers and Deceivers, especially they of "the

(nn) See P. 41.—(oo) Titus, I. 10.

" the Circumcision," (soon after which the Circumcision and Uncircumcision separated themselves from each other); it would have been astonishing had the Christians observed their Seasons by any other Calendar than that which Julius Cæsar and Augustus had taken so much Pains to make compleat: But though they kept the Festival in Commemoration of the Birth of Christ, on *New Year's Day*, according to the Julian Computation, yet still they continued their Custom of dressing their Habitations with green Boughs, to show that it was on the Feast of Tabernacles that He was born.—It may be observed, that they also settled every other Feast and Festival according to the Julian Calendar.—The Names of the twelve Signs begin in the Latin Language, it appears probable they were given to them at this Time.—For though they are the same with the solar Months of the Israelites, yet the Knowledge and Use of them were almost lost.—It does not appear that any People besides the Jews and Greeks made Use of the solar Year, all others had the lunar, with Intercalations; this was *Numa*'s Year.

For

For the Reasons before-mentioned, Julius Cæsar, with the Assistance of an Alexandrian Astronomer, altered it to the solar; and they then believed they had settled the Calendar in so exact a Manner, that the Seasons would always thereafter be kept to their true Places. The Israelites distinguished their solar Months, as well as their lunar, by Numerals; but, it seems, (as Julius Cæsar was not willing to make so great an Alteration in all the civil Months, as to make them to tally exactly with the Signs in the Heavens,) that the Astronomer gave Names to the Signs, expressive of the Season of the Year which they pointed out.

Thus *Aries*, the *Ram*, the Point when the Sun enters the Vernal Equinox, was represented by a Ram, the Horns of Animals being always made Use of to shew the Strength of the Sun; so the Ram, the Head of the Flock, was a proper Emblem to exhibit to us, by his *Horns*, the increasing Strength of the Sun's Heat.

The

The 2d was *Taurus*, the Bull, the ſtrongeſt of all domeſtic Animals! who, together with *his Horns*, gave us a proper Idea of the great Strength of the Sun, whilſt it paſſed through this Sign, which it entered about the 13th of April.

The 3d was *Gemini* or *Twins*, informing us, that at the End of this Sign, the *Heat* of the Sun, and his twin Brother, the *cold* Ether, then bore an equal Share in the Government of Nature. The Sun ended this Sign about June 21, when

The 4th began, which was repreſented by *Cancer*, a Crab, to inform us, that as the Crab went backwards, whilſt other Animals walked forward, ſo this Animal exhibited to us the retreating Power of the Sun at this Seaſon.

The 5th is *Leo*, the Lion, the moſt powerful Beaſt of the Foreſt! and is very expreſſive of the violent Heat of the Sun, whilſt it paſſes through this Sign, which it enters a-

bout July 21.—Notwithſtanding the Aſtronomer did not alter the civil Months, to begin and end according to the Signs in the Heavens, yet he named one of theſe Months, which anſwered nearly to this Sign, *Julius*, in Honour to his Patron *Julius Cæſar*, letting us know, that as the Heat of the Sun was then at the greateſt, ſo it commemorated the greateſt Emperor of the World.

The 6th Sign was *Virgo*, repreſented by a young Woman, into which the Sun enters about the 22d of Auguſt: a young Woman grown to Puberty, is the Inſtrument by which the Increaſe of the Human Species is brought forth! during this Sign, the Trees and Vegetables produce their Fruit and Seed.—Hence, the Aſtronomer thought it proper to exhibit the Reign of Auguſtus Cæſar; in whoſe Time Peace and Plenty reigned, and Arts and Sciences flouriſhed.

The 7th is *Libra*, into which the Sun enters about Sept. 22d, where one Year ends, and another begins! Here alſo the Twin-

Brothers,

Brothers, *Heat* and *Cold*, ballance each other; what can more properly represent these than a Pair of Scales?

The 8th Sign is *Scorpio*, a Scorpion; a destructive Animal! who does its Mischief by his hinder Part or Tail; representing to us the Injury done by the *cold Ether following* the departing Heat.— The Sun enters this Sign about Oct. 22, and on Nov. 21 comes

The 9th, *Sagittarius*, the Shooter, to exhibit to us the great Power of the *cold Ether*, during this Sign; which greatly hurts, kills, or destroys a large Part of the Productions of Nature; whose Arrows are so subtile and piercing as to enter the Pores of all Matter.

The 10th Sign is *Capricornus*, a horned Goat; an Animal who gets his living by climbing Hills and Precipices! A very proper Emblem to represent the rising Strength of

of the Sun! which it begins to do about the 21ſt of December, when the Sun enters this Sign.

The 11th is *Aquarius*, repreſented by flowing Water, to denote this watery Seaſon.

The 12th and laſt is *Piſces*, Fiſhes; the moſt prolific of all Animals! repreſenting to us the approaching Fertility of the Seaſon; when Seeds and Plants are made to vegetate by the growing Power of the Sun.

From the above Account of the Signs, it may be remarked, that *Heat* and *Cold* were then believed to be the Agents which governed the *Mechaniſm* of Nature.—In this they agreed with the ancient Philoſophers; for *Plato* tells us, "that they maintained "that *Fire* and *Heat* govern all other Things," and "that *Fire expands* all Bodies outward, "and that *Air compreſſes* them together in-"ward, and counteracts the *internal Fire*: By "the *Miniſtry of theſe Cauſes* a perpetual Cir-"culation is kept up." Theſe, (ſays he), "are

" are *secondary and co-operating* Causes, which " *God* makes use of as his Ministers." And *Cicero*, in describing the Tenets of the ancient *Platonists*, does it in the following Words.—" *De Naturâ* autem ita dicebant, " ut eam dividerent in *Res duas:* ut altera " esset efficiens, altera autem, quasi *huic se* " *prebens*.—Neque enim Materiam ipsam " cohærere potuisse, si nulla vi contineretur; " neque vim sine aliquâ Materiâ.—Illa Initia " Elementa dicuntur, e quibus *Aer & Ignis* " movendi vim habent & efficiendi, reliquæ " Portes *accipiendi* & quasi *patiendi*, *Aquam* " dico & *Terram*." *Acad* Quæst. lib. 1, or in English thus.—" That they divided Na- " ture into two Parts, one of which was " *active*, and the other *passive*.—They held " it impossible for Bodies to *cohere*, unless " they were kept together by some Force; " and that it was necessary this Force should " be exerted *by some Matter*.—In distinguish- " ing the several Uses of the Elements, they " attributed to *Air* and *Fire*, the Power of " giving Motion, and *causing* Effects; to

" *Earth*

" *Earth* and *Water* a *Passiveness*, or Disposi-
" tion to receive their Impressions."

Hence we are taught the Doctrine of ancient Philosophers; which they received, by Tradition, from their Ancestors, and from their Observations on the *Phænomena* of Nature.—Perhaps if we divest ourselves of the Prejudices imbibed by our Education, we shall find it to be true.—It is probable, that these Philosophers received their Traditions from Noah and the Patriarchs, as it appears to be the same taught by Moses, who informs us, (pp) that God created the Heavens and the Earth; " that the *Heavens* and *Skies* " were in continual *Conflict*, *Motion*, and " *Expansion*; to which he gave the Name of " the *Placers*, the *Disposers*, or *Governors*, " *under God*, of all Nature."—We are told in Samuel, (qq) that the Vegetable is *pushed out of the Earth by a shining Light and by Rain*; and in the 19th Psalm we are informed, *that the Mechanical Circulations of the Heavens represent the Glory of God*; *and the Firmament*

(pp) Gen. I. Chap. 1.— (qq) II. Samuel, XXIII. 4.

Firmament (Expanſion) his handy Work; and that their Fulneſs and Influence reach unto the End of the World.—That in them he has placed the Tabernacle of the Sun's Light, which coming out like a ſtrong Man, prevails to the Extremities of them, and nothing is hid from the Heat thereof. To return from this Digreſſion,

In regard to the Death of Chriſt, it is agreed, that he died on a Friday, the Full Moon Day, on the 14th of Niſan.—Hence it is no difficult Matter, to calculate the Year when this happened; as, two Paſſover Days could not happen on *a Friday* for many Years following.

The Time of this Paſſover, or the Death of the Meſſiah, was foretold by the Prophet Daniel, 562 Years before. (rr) In the firſt Year of the Reign of *Darius* I. Daniel prophesied, (ss) "That ſeventy Weeks (of Years) "are determined upon thy People, and upon "thy holy City, to finiſh Tranſgreſſions, "and to make an End of Sin, and to make "Reconciliation

(rr) Daniel, IX. 1.——(ss) Daniel, IX. 24, 25, 26, 27.

" Reconciliation for Iniquity, and to bring
" in everlasting Righteousness, and to seal
" up the Vision and Prophecy.— Know
" therefore that from the going forth of the
" Commandment, to restore and build Je-
" rusalem, unto Messiah the Prince, shall be
seven Weeks; and three-score and two Weeks
" the Street shall be built again.—And after
" three-score and two Weeks, shall Messiah
" be cut off, but not for Himself.—And the
" People of the Prince that shall come, shall
" destroy the City and the Sanctuary, and he
" shall confirm the Covenant with many for
" one Week; and in the *midst* of the Week
" he shall cause the Sacrifice and the Obli-
" gation to cease, and *(as in the Margin)*
" upon the Battlements shall be the Idols of
" the Desolator."

Josephus, who was a Jew, and lived to see these Things accomplished, could not help giving the Prophet Daniel, the following Character, (tt) " That Daniel did not only
" foretell *Things to come*, which was common
" to

(tt) Joseph, lib. X. C. 12.

" to him with other Prophets, but alſo *ſet a* " *Time* for their coming to paſs."—He did not only foretell the Calamity that befell our Nation, from *Antiochus*, before it happened; but he alſo wrote of " the *Dominion of the* " *Romans*, and of the *great Deſolation* they " ſhould hereafter bring upon the People." And St. Matthew tells us, (uu) " That the " Diſciples came unto Jeſus privately, ſaying, " when ſhall theſe Things be," Jeſus anſwered, " When ye therefore ſee the Abo- " mination of Deſolation ſpoken of by Da- " niel, the Prophet, *ſtand in the Holy Place*, " (whoſo readeth, let him underſtand.) Let " them which be in Judea, flee into the " Mountains.—For then ſhall be great Tri- " bulation, ſuch as was not ſince the Begin- " ning of the World to this Time —And " they ſhall fall by the Edge of the Sword, " (ww) *(in Number* 1,100,000, *ſays Joſephus)* " and they ſhall be led Captive, *(in Number* " *ſays Joſephus*, 97,000) into all Nations, " and Jeruſalem ſhall be trodden *(or inhabit-* " *ed by Gentiles)* until the Time of the Gen-

(uu) Matthew XXIV, 3, 15, and 21.—(ww) Luke XXI, 24.

" tiles be fulfilled."—Ver. 32, " Verily I " ſay unto you, *this Generation* ſhall not paſs " until all be fulfilled," *which it was in the 70th Year of the vulgar Era.* For

Joſephus, who was an Eye Witneſs of the miſerable Deſolation by the Romans, tells us, (xx) of the Accompliſhment of all theſe Predictions; when *Titus* laid Siege to the City; when Jeruſalem was encompaſſed with the *(Roman)* Armies; when they caſt a Trench about it, and encloſed it in on every Side; and when they cauſed the daily Sacrifices and Oblations to ceaſe; and when *Titus*'s Soldiers, in Spite of all his Endeavours to prevent it, ſet the Temple on Fire; and whilſt it was in Flames, they ſet up the Standards of the Legions, on the Eaſtern Porch, and there they ſacrificed before them after their idolatrous Manner. He alſo records the Month and Day of the Month when Jeruſalem was taken and plundered, and the Temple deſtroyed; and remarks, that the ſecond Temple was burnt by the Romans the

(xx) Lib. XI. Chap. 47.

the ſame Month, and Day of the Month, on which the firſt Temple was burnt by the Babylonians. Lib. VII. Chap. 9, 10.

Sixty-three Years after Daniel had made the above Prophecy of the Commandment, for the Return of the Jews, and for the reſtoring the Polity of Jeruſalem, both civil and eccleſiaſtical, *Artaxerxes Longimanus* gave forth, (in the ſeventh Year of his Reign, A. M. 3550, which anſwers to A.I.P. 4256) his Decree and Command to *Ezra*, the Prieſt, (yy) " to go up to Jeruſalem, and with " him all the Prieſts and Levites, and all the " People of Iſrael, which are minded of their " own free Will, to go with him, and to " carry in his Hand the Silver and Gold, " which the King and his Counſellors had " offered unto the God of Iſrael, and all the " Silver and Gold, the free will offering of " the People and the Prieſts, and whatſoever " more ſhall be needful for the Houſe of thy " God, which thou ſhalt have occaſion to " beſtow."

Now

(yy) Ezra VII. 11 to 27.

Now let it be obſerved that the ſeventh Year of the Reign of Artaxerxes, begins and ends aſtronomically at the Vernal Equinox, as all Kings Reigns recorded in Scripture, after the Exodus of the Iſraelites out of Egypt, do.—Here begins the firſt Point of the Period of 70 Weeks, or 490 Solar Years, containing 365 D. 5 H. 49 M. each—and we are informed by Moſes, (zz) that they numbered by Sabbaths of Years.

Now theſe 490 Years begin in the ſolar tropical Year of the World, 3550, when the ſixth Year of the Reign of Artaxerxes Longimanus, King of Perſia, ends, and the ſeventh Year of his Reign begins.—Now if to A.M. 3550 the 490 Years are added, it will make 4040, the Paſſover when the Meſſiah was cut off, as is proved by the Calculation at the End of this Introduction.—(1) Alſo, as the Moſaic Chronology places the Creation in the 706th Year of the Julian Period; ſo, if we add that Number to it, it will ſhew us that it was the 4746th Year of that Period when Chriſt ſuffered.

Ezra

(zz) Levit. XXV. 8.—(1) Page .

Ezra informs us, (a) it was in the Month of Nisan, in the Beginning of the seventh Year of Artaxerxes, in the solar tropical Year of the World, 3550, when he set off from Babylon to restore the ecclesiastical and political State of Jerusalem.—And as may be observed by the Calculations at the End of this Introduction, it was on the 14th of Nisan, A. M. 4040, just 490 Years after Ezra received this Commandment, that the Messiah was cut off A.I.P. 4746, on the 3d of April, on a Friday, in the 19th Year of the Reign of Tiberius Cæsar, when Pontius Pilate was Procurator of Judea; when Daniel's Prophecy of seventy Weeks was completed, by the Death of Christ, who died on the Cross, on the Day, Hour, and Minute that the paschal Lamb was ordered to be Slain; for God directs it to be killed on the *fourteenth Day of the Month, between the two Evenings.* (b)

That the exact Time may be known when the paschal Lamb was ordered by Moses to be slain, I will give you the Time according to

(a) Ezra VII.— (b) Exod. XII. 6.

to *David Levi*, who cannot be ſuppoſed to give a partial Account of it in Favour of Chriſt.—He tells us (4) the Manner of ſolemnizing the Paſſover while the firſt Temple ſtood.—" It muſt be obſerved, (ſays he) that " the Lamb was to be without Blemiſh, a " Male, of the firſt Year, from the Sheep or " the Goats, and brought to the Temple, " and there to be killed on this fourteenth Day " of Niſan, between the two Evenings, that " is, according to the common and very an- " cient Tradition, betwixt the Time of the " Sun's declining from his Meridian Alti- " tude, till three o'Clock in the Afternoon, " and from Three till Six: after which, the " Sun going below the *Horizon*, the fifteenth " Day commences."—St. Matthew (5) and St. Mark (6) both tell us, that Chriſt gave up the Ghoſt the ninth Hour, which was at Three o'Clock in the Afternoon, or between the two Evenings, the Time preciſely when the paſchal Lamb was to be ſlain.—Thus, Chriſt died on a Friday, lay in the Grave all Saturday, or the Jewiſh Sabbath, and was raiſed

(4) Page 45.—(5) Matthew XXVII. 50.—(6) Mark XV. 34.

raiſed again on Sunday, the Morrow after the Sabbath, when the original ſeventh Day was again reſtored, and kept as ſuch by Chriſtians ever ſince, which was the Day appointed to wave the Sheaf before the Lord, explaining and fore-ſhewing the Reſurrection, which both our Saviour (7) and St. Paul tell us was typical, and gave us an Idea of it; for as the Grain was the firſt Fruits of the Earth, ſo was the Reſurrection of Chriſt the firſt Fruits of the Spirit.

The firſt Chriſtians were Jews; therefore, in order to keep a Memorial of the Birth of Chriſt, which happened as has been obſerved, at the Feaſt of Tabernacles; they took the *Boughs of green Trees*, to dreſs up their Houſes and Churches, or Places of Worſhip, in the ſame Manner as the Iſraelites and Jews were commanded and uſed to do, and to dwell therein, and to rejoice therein, till the eighth Day, or Chriſt's Circumciſion, or of the great Feaſt.—(8) This Cuſtom, this Memorial of the Birth of Chriſt, has been kept by Chriſtians,

(7) John XII. 24, and Corint. XV. 26, 23, 36.—(8) Levit. XXIII. 39.

tians, without Interruption, from the Birth of our Saviour to this Time; and though now almoſt left off, except in our Churches, and amongſt the common People, who do not think it Superſtition to commemorate the Birth of Chriſt; but our faſhionable Gentry are now ſo wiſe in their own Conceit, (9) that they think it Fooliſhneſs to believe any Myſteries at all; and Superſtition to make uſe of Memorials or Ceremonies,—They are alſo ſo charitable to give the Name of Enthuſiaſts to all thoſe who do; believing nothing but what they can explain, according to their own Reaſon or Imagination.—But this is contrary to the Inſtruction which St. Paul gives us, (10) that without Controverſy, (ſays he) great is the Myſtery of Godlineſs: God was manifeſt in the Fleſh — that by Grace we are ſaved through Faith—(11) that Faith is the Subſtance of Things hoped for; the Evidence of Things not ſeen, (12) for we are ſaved by Hope; but Hope that is ſeen, is not Hope. (13)

Now,

(9) Proverbs XXVI, 12.—(10) I. Tim. III. 16.—(11) Epheſians II. 8.
(12) Hebrews XI. 1.—(13) Romans VIII. 24.

Now, as I am going to conclude this Introduction, and begin my Calculations, with ſome critical Remarks on the Holy Scriptures, let the Reader join with me in Prayer to our God Jehovah, that he will open our Eyes, that we may behold wondrous Things out of thy Law, (14) and that his Holy Spirit may aſſiſt us with Grace, whereby we may ſerve God acceptably with Reverence and Godly Fear. (15)

F. Penroſe.

Stonehouſe, Plymouth, Sept. 22.

In the Year of our Lord, 1787, (according to the Vulgar Era)
In the Year of the World, 5794.
In the Year of the Julian Period, 6500.

N. B. To prevent any ſpurious Editions being impoſed on the Public, I ſhall ſign my Name at the Bottom of the Diagrams, and at the Concluſion of the Introduction in each Book.

F. Penroſe

(14) Pſalm CXIX, 18.—(15) Hebrews XII. 28.

Having now concluded my Introduction, I ſhall add ſome Calculations of Equinoxes, new, full Moons, and Eclipſes, to confirm what has been obſerved therein.— All of theſe begin at the Point wherein Moſes places the Sun and Moon at the Creation, and they come out at the obſerved Time when they happened. Now,

If the unbelieving Deiſt, or the doubting Sceptic is not ſatisfied herewith, I call on either one of them, in the friendly Words of *Horace*, to find out one Equinox, full, new Moon, or Eclipſe, which do not confirm it; if he cannot, let him ſhew Cauſe why he withholds his Aſſent to it; as the Sun and Moon bear Witneſs that it is as true as that they are in Heaven.

Si quid noviſti rectius iſtis,
Candidus imperti; ſi non, his utere Mecum.
HORACE.

The Point I begin the following Calculations from, is the Autumnal Equinox, in the

the Year 706, of the Julian Period. The Sun, the Earth, Moon and her Node being then all in the firſt Point of Libra, when an Eclipſe of the Moon muſt have happened, had they been in Being.—This is an exact Point to begin my Calculations, and from that Point, to the preſent Time, I calculate with a Mathematical Exactneſs.—I ſay, that Moſes, (in his Account of the Creation, together with his Directions for keeping the Feſtivals, in Commemoration of that great Event,) has informed us, where the Sun and Moon were placed at that particular Inſtant of Time.—If my Calculations are true, you muſt admit that I received my Inſtructions either from Moſes, or that I obtained them ſome other Way.—Now, it does not appear, that this can be obtained otherwiſe than either by Calculation, Obſervation, or Revelation.—As to the firſt it is impoſſible to be done; and, it could not be obtained by the ſecond, as there was no Human Being to obſerve it; but Moſes ſays, it was revealed by God, and to confirm his Hiſtory and Chronology, he tells us the Places of the

Sun

Sun and Moon at that Time, which was 2370 Years before he was born; and this alſo at a Period of Time, when, (as the generality of People think) that all Sciences were in their Infancy.—But the following Calculations prove that his Relation is true. Is not this ſufficient Evidence to prove any other Hiſtory to be true; if ſo, why ſhould Moſes's Hiſtory be excluded?

I have dated this Introduction, Sept. 22, A. D. 1787, which agrees with the 6500th Year of the Julian Period.—This is the real Day I have finiſhed it; but, had it not been ſo, it would have been a very proper Day to have dated it from; as this Day, at 46 Minutes paſt Five in this Afternoon, (16) the Earth will have made and finiſhed 5794 Revolutions through the Ecliptic, in the firſt Meridian; and in the Meridian of Greenwich Obſervatory, at ten Minutes paſt Four To-morrow Morning.—This is the preciſe Point of Time when A. M. 5794 ends, and 5795 begins, according to the Moſaic Chronology

(16) See Page 88.

nology of the World.—But as Moſes directed the Iſraelites to meaſure Time by the Sun and Moon jointly, (whoſe Motions were to be a Check on each other, and by that Means to prevent any Miſtake in keeping the Seaſons) ſo it was meaſured by the Sun; and the Seaſons were pointed out by the Moon. (17) Thus, as the Moon was fifteen Days old at the Creation, or a little paſt its Oppoſition or Full, ſo this Feaſt of Ingathering, (which was ordered to be obſerved in Commemoration of it,) was not to be kept, till the 15th Day of the Moon, next after the Sun had entered Libra.——Now, as has been obſerved, the Sun will enter Libra this Day, but the Moon will not be Full, or in Oppoſition to the Sun, at Greenwich, till Thurſday the 27th Inſtant, at 22 Minutes paſt One in the Morning; and the Jews will begin their Feaſt of Tabernacles at Six o'Clock in the Evening. And with it they muſt celebrate the Birth of Chriſt, who was born on the firſt Day of that Feaſt, and circumciſed on the eighth or the great Day; at which Time

(17) Pſalm CIV. 19.

Time the Moon will have made 71662 Lunations or Revolutions round the Earth.—The Length between these two Points has been measured by 2116214 Rotations of the Equator round its Axis, which being divided by 7, make 30216 Weeks, and leave in Remainder two Days, to which add the four Days of the Creation Week, (before the Sun and Moon were placed in Heaven to measure and point out the Seasons, the Days, and the Years,) and it will bring it to the Sixth Day of the Week, or Saturday, regularly from the Creation.—This proves, besides thousands of others, that Sunday was the original Seventh or Sabbath-Day.—The Saturdays Sabbath can claim no higher than the Exodus of the Israelites out of Egypt.

If this is not mathematical Demonstration that the Sun and Moon, in the Year 706, A. I. P. where in the Places which Moses informs us; I shall be glad to know in what it falls short of it.

CALCULATION

CALCULATION

Of the Eclipſe which happened in the Year 4711, of the Julian Period; which was the 26th of Auguſtus Cæſar, during Herod's laſt Illneſs.

The Moſaic Chronology places the Year of the Creation in the 706th of the Julian Period; therefore if we ſubſtract 706 from 4711, it will give 4005. The Year of the World anſwering to the 26th of Auguſtus Cæſar.

Subſtract One to find where A. M. 4004 ends, and 4005 begins.

SOLAR.

A. M. 4004 Julian Years
Minutes × 11 Julian Excess

4004
4004

Minute in a Day } ÷ 1440) 44044 (30 Days
4320

844
Hours in a Day × 24

3376
2688

÷ 1440) 20256 (14 Hours
1440

5856
5760

96
Minutes in an Hour × 60

÷ 1440) 5760 (4 Minutes
5760

(0)

SOLAR.

S O L A R.

```
        4004
      × 1461 Quadrants in a Year
      ------
        4004
       24024
      16016
      4004
      -------
                    Days      H. M.
Quadrants } ÷4 )5849844 (1462461   6  0 Julian Years
in a Year  }          (0)(     30 14  4 Julian Excess
                         -------------
                         1462430  9 56 Sun in Libra, 1st
                                       Meridian
Add to bring Merid. of Jerusalem 13  4
                         -------------
                         1462430 23 00 Sun in Libra, Je-
                                       rusalem.
Add, to Oct. 25.          298
                         -------------
                         1462728 23 00
Julian Bissext. 4004     1462461
                         -------------
                             267 23 00
Aug. 31                      243
                         -------------
Sept. O. S.                  24 23 00 at Jerusalem, P·M
                                 that is Sept. 25 11 0 O.S.
                         -------------
                         1462728 23 00
add to bring to Aries        178 17 58
                         -------------
                         1462907 16 58
Julian Bissext. 4005     1462826  6
                         -------------
                             81 10 58
Feb. 28                      59
March 22 O.S.                22 10 58 Sun in Aries, Je-
                                       rusalem.
```

LUNAR CALCULATION, A. M. 4005.

A. M.

Years in a Cycle ÷19)4004(210 Cycles
38

20
19

14
Lunations in a Year × 12

28
14

168
Intercatory Lunations 5

173

210 Cycles
235 Lunations in a Cycle

1050
630
420

49350
Lunations 173

49523 Lunations

LUNAR CALCULATION, A. M. 4005.

	Days	H.	M.	S.
In 40,000 Lunations are—	1181223	00	46	40
9,000 Ditto —	265775	4	22	30
500 Ditto —	14765	6	54	35
20 Ditto —	590	14	40	35
3 Ditto —	88	14	12	5
	1462442	16	56	25
Subſtract 1 Day for 49680 Lunations	1			
Moon full 1ſt Meridian, Libra	1462441	16	56	25
add to bring to Merid. of Jeruſalem		13	4	
Moon full Jeruſalem	1462442	6	00	25
To bring to Oct. 24.	297			
	1462739	6	00	25
Julian Biſſextile 4004	1462461			
	278	6	00	25
Sept. 30	273			
Oct.	5	6	00	25
and one Day for Apparition	7 Feaſt of Tabernacles when Chriſt was born			

LUNAR CALCULATION, A. M. 4005.

	Days	H.	M.	S.
Moon full in Libra	1462442	6	00	25
add 5 Lunations to bring to Pisces	147	15	40	8
Moon full in Pisces	1462589	21	40	33
To bring to Oct. 24.	297			
	1462886	21	40	33
Julian Bissextile 4005	1462826	6		
	60	15	40	33
Feb.	59			
March O. S.	1	15	40	33
To N. S.	11			
	12	15	40	33 P.M.

Eclipse of the Moon in Herod's last Illness, March 12 D. 15 H. 40 M. 33 S. that is March 13 D. 3 H. 40 M. Morn.

	D.	H.	M.	
add Half Lunation	14	18	22	
March N. S.	27	10	2	New Moon
Apparition	1	12	2	of Nisan
	28	22	2	
Add	14			of Nisan
	42	22	2	
March	31			
April	11	Passover Even.		

CALCULATION SOLAR, A. M. 4040.

*Of CHRIST's Death on the Crofs.**

```
          )4039 (Julian Years
Minutes   )×11  (Julian Excefs
          ----
           4039
           4039
          -----
1440)  44429(30 Days
       4320(
       -----
          1229
Hours    ×24
         -----
          4916
         2458
         -----
1440   )29496(20 Hours
       )2880(
       -----
           696
Minutes  ×60
         -----
1440   )41760(29 Minutes
       )2880(
       -----
         12960
         12960
        ------
           (0)
```

* In the firft Year of Darius the firft, which anfwers to A. M. 3488, Daniel prophefied, (18) that a future Decree fhould be made for the Reftoration of the Jews, (who were then in Captivity,) again to Jerufalem; and from the going forth of that Commandment, to the cutting off of theMeffiah, fhould be 70 Weeks,or 490 Years.—63 Years after; and, after two

(18) Daniel IX. 24, 25, 26, 27.

CALCULATION SOLAR, A. M. 4040.

Of CHRIST's Death on the Crofs.

```
        4039
        1461
        ----
        4039
       24234
      16156
      4039
      -------
÷4 )5900979 (1475244  18  0. Julian Reduction
        (3)\     30  20  29 Julian Excefs
```

	D.	H.	M.	
Solar Reduction	1475213	21	31	Sun in Libra, 1ft Meridian
add to bring to Jerufalem		13	4	
	1475214	10	35	Sun in Libra, Jerufalem
add to bring to Aries	178	17	58	
	1475393	4	33	Sun in Aries, Jerufalem
add to bring to Oct. 25	298			
	1475691	4	33	
Julian Reduction 4040	1475610			
	81	4	33	
Feb.	59			
March O. S.	22	4	33	Sun in Aries, Jerufalem

two future Kings Reign, this Commandment was iffued by Artaxerxes Longimanus, at the End of the Sixth and Beginning of the Seventh Year of his Reign, A. M. 3550, to Ezra, (19) to reftore the ecclefiaftical and political State of Jerufalem.——Now if we fubftract 3550 from 4040, it will leave the 490 Years exactly, between iffuing that Decree, to the cutting off of Chrift. See Page 21.

(19) Ezra, Chap. VII.

CALCULATION, LUNAR, A. M. 4040.

```
                          A. M.
Years in a Cycle ÷ 19)4039(212 Cycles
                      38
                      ---
                       23
                       19
                      ----
                        49
                        38
                      ----
                        11
Lunations             × 12
                      ----
                       132
Intercatory Lunations    4
                      ----
                       136


                 212 Cycles
                 235
                ----
                1060
               636
              424
              -----
              49820
Lunations       136
              -----
              49956 Lunations


1st of Nisan        1475391
before the Sun, extra. D.      4
                    ---------
                 7)1475395 (210770
                        (5)  Friday
to 14th of Nisan          14
                    ---------
                 7)1475409 (210772
                        (5)  Friday
```

CALCULATION, LUNAR, A. M. 4040.

	Days	H.	M.	S.	
In 40,000 Lunations are	1181223	00	46	40	
9,000 Ditto	265775	4	22	30	
900 Ditto	26577	12	26	15	
50 Ditto	1476	12	41	27	
5 Ditto	147	15	40	8	
½ Ditto	14	18	22		
	1475214	16	19	0	Moon New, 1 Merid. Libra
Subſ. 1 for 49680 Lunations	1				
	1475213	16	19	0	
add to bring to Meridian of Jeruſalem		13	4		
	1475214	5	23		Moon New, Jeruſalem, Libra
add to bring to Aries	177	4	24		
	1475391	9	47		New Moon 1 Niſan
add to bring to Oct. 24	297				
	1475688	9	47		
Julian Reduction 4040	1475610				
	78	9	47		
Feb.	59				
March O. S.	19	9	47		1 Niſan
		12			
	14	21	47		
	83	21	47		
March	31				
April P. M.	2	21	4		14 Niſan, Paſſover when Chriſt died

Days from the Creation, to the 14th of Niſan, when Chriſt died.

	1475405		
4 Days before the Sun	4		
	7)1475409	(2107722	
	(5)		5th Day, Friday

I ſhall add one Calculation more in order to confirm what I have obſerved; which will alſo be an Explanation to ſome of the following Letters.

In A. D. 1715 there was a remarkable and total Eclipſe of the Sun, which was ſeen in London, about Ten o'Clock in the Morning. According to Mr. *Whiſton*'s Calculations, the Middle of it was April 22 D. 9 H. 51 M.—Therefore as this Eclipſe was ſo well obſerved and recorded, there can be no Miſtake about it; and as it is ſo certain a Point, I ſhall calculate that Eclipſe from the original Point at the Creation, when the Moon was Full and in her Node, and the Sun in the firſt Degree of *Libra*.—I ſhall then calculate from that Eclipſe, to the Full Moon next Thurſday Sept. 27, 1787.—This, if it comes out right, will be Demonſtration, that the Point we calculate from, according to Moſes's Chronology, is true, and that the Length of the Solar Year is exactly 365 D. 5 H. 49 M. and the Length of a Lunation 29 D. 12 H. 44 M. 1 S. 45 T. as we have aſſigned it.

The vulgar Era of Christ is placed in A. M. 4007, to which add A. D. 1715, and it will make A. M. 5722, to which add 706, the Number of Years the Julian Period begins before that Time; and it will bring it to the 6428th of that Period.

Substract 1 from A. M. 5722, to make the Calculations at the End of that Year.

SOLAR CALCULATION.

A. M. 5721 Julian Years
× 11 Julian Excess

5721
5721

Minutes in a Day 1440) 62931 (43 D.
5760

5331
4320

1011

Hours × 24

4044
2022

1440) 24264 (16 H.
1440

9864
8640

1224

Minutes × 60

1440) 73440 (51 M.
7200

2440
1440

(0)

SOLAR CALCULATION.

5721 Julian Years
×1461 Quadrants in a Julian Year

5721
34326
22884
5721

Quadrants in a Day } ÷ 4) 8358381 (1) (2089595 Days 6 H. 0 Julian Reduction
43 16 51 Julian Exc.

Sun in Libra, 1st Meridian	2089551	13	9
add to bring to Aries	178	17	58
Sun in Aries, 1st Meridian	2089730	7	7
add Meridian of Greenwich		10	24
	2089730	17	31
add for Oct. 25	298		
	2090028	17	31
Julian Reduction, 5722	2089960		
	68	17	31
To Feb. 28	59		
March O. S.	9	17	31

P. M. that is March 10, 31 M. past 5 Morning.

CALCULATION SOLAR, A. I. P. 6500. A. D. 1787.
A. M. 5794.

```
      5794
    ×   11
    ------
      5794
     5794
    ------
1440)63734(44 D
     5760
    ------
      6134
      5760
    ------
       374
      ×24
    ------
      1496
      748
    ------
1440)8976(6 H.
     8640
    ------
       336
      ×60
1440)20160(14 M
     1440
    ------
      5760
      5760
    ------
       (00)
```

A. D. 1787.

CALCULATION SOLAR, A. I. P. 6500.

```
   5794
 × 1461 Quadrants
 ------
   5794
  34764
 23176
 5794

                Days    H.
 ÷ 4)8465034  2116258  12  0 Julian Reduction
        (2)(        44   6 14 Julian Excess
             -------------------
             2116214   5 46 Sun in Libra, 1 Merid.
add Meridian }          10 24 P. M. 5 H. 46 M. Af-
of Greenwich }                                ternoon
             -------------------
             2116214  16 10 P. M. 4 10  Morning
to Oct. 25       298
             -------------------
             2116512  16 10
Julian Reduction 2116258
             -------------------
                 254  16 10
To the End of August 243
             -------------------
Sept. O. S.       11  16 10
      N. S.       11
             -------------------
Sept. N. S.       22  16 10 P. M. that is Sept. 23,
                                10 M. past 4 Morning

Days since the Creation.
 2116215
       4
 -------
7)2116219(302317 Weeks since the Creation
        0(
        7  Sunday

 1794
    1
 ----
4)1795(448
    3(  Year of Quadrienium
```

LUNAR CALCULATION.

A. M.

Years in a Cycle ÷ 19) 5721 (301
57

21
19

2

Lunations 12

24

Intercalary 6

(25)

301 Cycles
× 235 Lunations in a Cycle

1505
903
602

70735
25

70760 Moon Full in Libra

to bring to Aries 6½

Lunations in a Year } ÷ 12 (70766½ (Moon New in Aries
60 5897 Lunar Years

107
96

116
108

86
84

(2) ½ Lunations

LUNAR CALCULATION.

Years in a Period ÷ 30)5897(196
30
289
270
197
180
(17) Years

2089774
Extra Days 4

7)2089778(298539 Weeks
(5) Friday

	Days	H.	M.	S.
In 138 Periods are	1467078	(24)	9	00
50 Ditto—	531550	8	45	00
8 Ditto—	85048	1	24	00
17 Years are	6024	5	41	57
2 Lunations	59	1	28	3
½ Ditto	14	18	22	
New Moon, 1st Merid. Aries	2089774	11	50	0
add for Meridian Greenwich		10	24	
	2089774	22	14	
add for Oct. 24.	297			
	2090071	22	14	
Julian Reduction, 5722	2089960			
	111	22	14	
To March 31	90			
April O. S.	21	22	14	P. M. that is

April 22 D. 10 H. 14 M. in the Morning

LUNAR CALCULATION.

From the Eclipse A. D. 1715, New Moon Aries, and add 895½ Lunations. to bring to Full Moon in Libra, 1787.

		Days	H.	M.	S.	
To 70766½ Lunations		2089774	22	14	0	
add 800 Ditto		23624	11	3	20	
90 Ditto		2657	18	2	37	
5 Ditto		147	15	40	8	
½ Ditto		14	18	22		
		2116219	13	22	5	
add to bring to Oct. 24		297				
		2116516	13	22	5	
Substract Julian Reduction, 5794		2116258				
		258	13	22	5	
Calends of Jan. to the End of Aug.		243				
Sept. O. S.		15	13	22	5	Moon Full in Libra
add N. S.		11				
N. S.		26	13	22	5	P. M.

that is Sept. 27 D. 11 H. 22 M. 5 S. in the Morning

A. M.
5794
1

4)5795(1443
3 of Quadriennium

2116219
Extra Days 4

7)2116223(302317 Weeks
(4) Thursday.

By our Calculations, both from the original Point of the Full Moon at the Creation, and also from the Eclipse which happened at London, 1715, there have been 71662 Lunations since the Moon was Full at the Creation, and that the last will end with a Full Moon next Thursday Morning, Sept. 27, at 22 M. past One.

The

Of the Method made Use of in the foregoing Calculations.

The above Calculations of Equinoxes and Solſtices are made in a different Manner from the Method generally uſed; which is, firſt to find the Places of the Sun and Moon in the Ecliptic, and then, by Equations and Anomilies, to make the 360 Degrees of the Equator to agree with the 365½ Rotations of the Earth, through the Ecliptic.

Theſe Calculations are not made in that Manner, but from the Method obſerved by Nature, viz. by the Number of Rotations the Earth makes between each of them; in the ſame Manner as Moſes taught the Iſraelites to calculate their Seaſons; and that in the moſt ſimple, eaſy, and (I will add) exact Manner, and requires no farther Knowledge in the Sciences, than the firſt four Rules of Arithmetic—and this Method I ſhall explain in as clear and conciſe a Manner as I can.

The Julian Period is a certain Meaſure of Time, for that Reaſon I calculate by that

Period.—But, as the Julian Year contains 11 Minutes more than the Solar Tropical, so we must substract that Sum from every Julian Year, to make it agree with it.—Dr. Keil, in his XXVIIIth Lecture, has explained this in so clear a Manner, that I shall give it in his own Words.—" It must be acknowledged, " says he, that the Time appointed by Julius " Cæsar, for the Solar Year, is too much; " for the Sun finishes his Course in the Eclip- " tic, in 365 Days, 5 Hours, and 49 Mi- " nutes; and therefore he begins again his " Round 11 Minutes before the Solar Year " is ended: so that if the Sun in any Year " has entered the Equinox upon the 20th of " March, at Noon Day; after four Years " he will arrive at the Equinox 44 Minutes " before Noon; and so every Year, 11 " Minutes sooner than by this Reckoning; " so that in 131 Years, he will *anticipate*, or " enter the Equinox a whole Day before the " 20th of March; and therefore the *Celestial*

" *Equinox*

Of the Method made Use of in the foregoing Calculations.

" *Equinox* will not always fall upon the ſame
" Day of the Month, but by Degrees it will
" move towards the Beginning of the Year."(a)

Hence, you may obſerve, in our firſt Calculation on the Birth of Chriſt, that we multiply A. M. 4004, by 11 Minutes.—The Product of which is the Number of Minutes that 4004 Julian Years contain more than 4004 Tropical Solar.—Then, in Order to bring theſe Minutes to Days, we divide that Sum by 1440, the Number of Minutes in a natural Day, or whilſt the Equator compleats one Rotation from Sun to Sun.—The Remainder we multiply by 24, to bring it to Hours, and that Remainder by 60, to bring it to Minutes.

In Order to find the Number of Days, we multiply 4004 by 1461, the Number of Quadrants, or Quarters of a Day in a Julian Year.—We then divide the Product by 4, which

(a) See Diagram and Calculations.

which brings them to Days.—If there is any Remainder, it is Quadrants.—Hence we have the Number of Days and Quadrants in 4004 Julian Years; from this Sum we Subſtract the Days, Hours, and Minutes of the Retroceſſion, and the Remainder gives the exact Quantity of Days, Hours, and Minutes, in the ſame Number of tropical ſolar Years; and this, by Obſervation, will be always found exactly true, from the Creation to this Time.—Hence we can calculate the Day when the Sun will enter *Libra*, in any Meridian, but not the Hour and Minute.—This appeared the greateſt Difficulty to get over, but by a lucky and accurate Obſervation of Dr. *Bradley*, A. D. 1753, it has anſwered our Purpoſe ſo far, as that all our Calculations made by it come out true.

1440 is the Number of Minutes in a Day, which has the ſame Number of Points or Terminations, on the Equator, anſwering to every one of them; ſo that in 1440 Years, the

the tropical ſolar Year will have began on every one of them, and at the End of that Period, the Sun will again begin a new Cycle, in the ſame Meridian, and on the ſame Point of the Day it did 1440 Years before, but not on the ſame Day of the Week, which is the Characteriſtick of each Cycle.

A. D. 1753 is in Connection with A. M. 5760, and A. I. P. 6466, when the fourth Cycle of the Sun was finiſhed; and the Sun entered Libra on the ſame Point of the Day, the ſame Hour and Minute it began it 1440 Years before. (b)

Dr. Bradley obſerved it to enter Libra that Year, at Greenwich, Sept. 22d Day, 10th Hour, 24th Minute.—Now, as the Sun was placed in Libra, at the Creation, at Noon, in the firſt Meridian; but, at the Time when he made his Obſervation, it was paſſed on 10 Hours, 24 Minutes to the Weſtward; by turning Time into Meaſure, the firſt Meridian

(b) See Page 24.

dian will be found to be 156 Degrees to the Westward of Greenwich Observatory.—We have accordingly made this the Root, and postulated it as true, and have found all our Calculations to turn out right on that *Postulatum*.—As Jerusalem is 35° 20 M. of Longitude, East of Greenwich; so if we turn this Measure into Time, it will produce 2 Hours, 40 Minutes, which added to 10 Hours, 24 Minutes, (the Meridian of Greenwich) it will make 13 Hours, 4 Minutes.—On this Principle the above Calculation was made; and by it the Sun was found to enter Libra that Year at Jerusalem, Sept. 24th D. 23d H. 0 M. P. M. that is Sept. 25th Day, 11th Hour, 00 Minutes, Morning.— To which we add 178 Days, 17 Hours, 58 Minutes, the Distance between the first Point of Libra, and the first Point of Aries; by which the Sun was found to enter Aries at Jerusalem, March 22d Day, 5th Hour, 58th Minute, P. M. or Afternoon.—As the Sun was placed in Libra, Oct. 25th, A. I. P. 706,

706, according to the Julian Calendar, so, in all our Calculations, we add 298 Days to the Sum, (the Number of Days from the Calends of January, to Oct. 25, when Time began) and then substract the Julian Reduction from it.—The Remainder will give the Day of the Julian Month sought.—Hence, as the first of the Month was not to be counted from the *Synod*, but from the Apparition, we postulate that the Moon, if she had been in Being, would be in one of her Nodes, and exactly opposite to the Sun, on the third Day of the Week, just 24 Hours, or one whole Day, before the Sun entered Libra.—This is a most exact Point, and from it we begin all our Calculations, and they always come out according to the observed Times; this we call the original Radix or Root, and from this Root we calculate by Years and Lunations, and those Years and Lunations, are measured by Days.—In all these Calculations we make the tropical solar Year to contain 365 Days, 5 Hours, 49 Minutes

nutes precisely, and a Lunation 29 Days, 12 Hours, 44 Minutes, 1 S. 45 T.

It may be observed by these Calculations, that in every 49680 Lunations, we throw off one Day.—This Day is thrown off for much the same Reason that 11 Minutes were thrown off every Year from the solar Computation.—For in a Period of 30 Years, the Reckoning over-runs the compleat Days, 10 Minutes and 30 Seconds.—In this determinate Proportion, the Moon makes a slow, gradual, and uniform Progression quite round the Ecliptic, and in 49680 Lunations, gets a Day, in the same Manner as the Sun gets one Day in 131 Years, according to the Julian Reckoning; therefore it must be discharged, otherwise we shall count one Day more than is performed by Nature.

Before the late Regulation, it had been observed, that the lunar Reckoning had *anticipated* the Astronomical four Days, and so much

much Difference there were between the Ecclesiastical and Astronomical Full Moons.—This Anticipation was attributed to the Moon being now nearer the Earth than she was some Years ago, and that she performed her Lunations in less Time now than she did formerly; and what appears the more extraordinary is, that Astronomers should ascribe these lunar Anticipations to the Moon's coming to the End of the lunar Cycle of 19 Years, one Hour and Half before the Sun; whereas, it may be observed, by comparing the 19 Years Cycle of the Sun and Moon together, that instead of the Moon coming to the End of that Cycle an Hour and Half before the Sun, the contrary is the Fact; for the Sun comes to the End of the Cycle 1 H. 55 M. 51 S. 15 T. before the Moon.——

Here it follows.

	Days	H.	M.	S.	T.
A Lunar Cycle containing 235 Lunations	6939	16	26	51	15
A Solar Cycle of 19 Tropical Solar Years	6939	14	31	00	00
Excess of Lunar Computation above the Solar		1	55	51	15

Of the Method made Use of in the foregoing Calculations.

From the above it may be remarked, that the Contrary to what Aſtronomers maintain is true, viz. that the Moon comes to the End of the Cycle before the Sun; ſhe indeed departs from the Sun at the End of every Cycle, but then it is by a Progreſſion Eaſtward, and not by a Retroceſſion Weſtward; for the New Moons and Full Moons in that Space of Time fall out almoſt two Hours later, and not an Hour and Half ſooner.

On comparing 19 Julian Years with 19 Luniſolar, we ſhall find that the Julian Reckoning over-runs the Lunar 1 H. 33 M. 8 S. 45 T. juſt in the ſame Manner as it was obſerved the Julian Year over-runs the Tropical Solar; and muſt be expunged for the ſame Reaſon.—Here follows the Compariſon.

	Days.	H.	M.	S.	T.
19 Julian Years contain ———	6939	18	00	09	0
19 Luniſolar Years contain ———	6939	16	26	51	15
Exceſs of the Julian above the Lunar—		1	33	8	45

Hence

Of the Method made Use of in the foregoing Calculations.

Hence appears the Reason why Astronomers maintain, that in 19 Lunisolar Years, the mean New Moons and Full Moons happen an Hour and Half sooner, than they did at the Beginning of the Cycle.—Instead of which, it is found, on comparing 19 Solar with 19 Lunar, that the Sun comes to the Point where they set out from together, 1 H. 55 M. 51 S. 15 T. (which wants but 4 M. 8 S. 45 T. of two Hours) before the Moon. But that the Julian Reckoning over-runs the Lunar, 3 M. 8 H. 45 T. more than an Hour and Half in every Cycle; which, (like the 11 Minutes Difference between the Julian and tropical solar Year) has been the Occasion of the *apparent Anticipation*; which has no Foundation in Nature, but owes its Existence entirely to a mistaken Computation.

Having premised thus much, I shall finish this Explanation with giving an Account of the Method used in the Lunar Calculations, and for that Purpose, shall explain the Calculation,

culation, P. 94, where the total and central Eclipse of the Sun, which was observed in London, A. D. 1715, is calculated from the original Point of the Full Moon, the third Day of the Creation; to that very Point when it was observed at London; and from that Point, to the Full Moon next Thursday Morning, Sept. 27th.

The Year of the World answering to 1715, has been found to be A. M. 5722, from which we throw off One, as was observed in the Solar Reckoning, and then divide 5721 by 19, the Number of Years in a Cycle, which gives 301 Cycles, and leaves in Remainder $\frac{2}{19}$ of another; we then multiply the Remainder 2 by 12, the Number of Lunations in a Year; which make 24 Lunations.—And, as about one Month is intercalated every three Years, to make the Computation agree with the Solar, we add One to this Sum, which makes 25 Lunations.—We then multiply these 301 Cycles, by 235, the

the Number of Lunations in a Cycle, which give 70735; to which we add the 25 remaining Lunations, these make 70760, which brings it to the Full Moon at the autumnal Equinox; but, as this Eclipse happened at a New Moon, near the vernal Equinox, we add Six Lunations to bring it thereto, and Half a Lunation to bring it from the Full of the Moon, (at which Point all these Lunations end, as they began at that Point at the Creation) to the New.—These make in the Whole 70766½.—We then divide these Lunations by twelve, (the Number contained in a Year) and that gives 5897 lunar Years, and leaves 2 Lunations and Half in Remainder. To bring these to Periods of 30 Years, we divide 30, which gives 196 Periods, and 17 Years of another Period.—We then add the Periods and Lunations together, which makes 2089774 Days, 11 H. 50 M. which is the Distance between the Full Moon at the Creation, and the Eclipse of the Sun, which happened in 1715, in the first Meridian; but in

Order

Order to bring it to the Meridian of Greenwich Obſervatory, we add 10 H. 24 M. which makes 2089774 Days, 22 H. 14 M. for the New Moon at Greenwich.—Then, as the Calends of January are 297 D. before Oct. 24, we add that Sum to it, as we did 298 in the ſolar Computation, to bring from the Calends of Jan. to Oct. 25, which is one Day ſhort of the Solar Reckoning, as the Moon was Full one whole Day before the Sun began to meaſure Time at the Creation. With this Addition to the above Sum it makes 2090071 Days, 22 H. 14 M.—From which we ſubſtract the Number of Days of the Julian Reduction, for A. M. 5722, which leaves 111 Days, 22 H. 14 M. from the Calends of January; from thence, to the laſt Day of March incluſive, are 90 Days, which we ſubſtract from the above Sum; and then find that the Point of Time, when the Moon interſected the Path of the Earth, in Conjunction with the Sun, was April 21 Days, 22 H. 14 M. P. M. that is April 22 D. 10 H. 14 M.

14 M. in the Morning.—Thus it may be obſerved, that our Calculation differs only 23 Minutes from Mr. Whiſton's; which, ſuppoſing Mr. Whiſton's to be preciſely true, is but a very little, conſidering the Length of Time of 70766 Lunations, or 5722 tropical ſolar Years.

In Order to know the Day of the Week when this Eclipſe happened, we divide 2089774 Days, the Number of Rotations the Equator has made between the fourth of the Creation, and that Point, (when the Moon interſected the Earth's Path) by 7, the Number of Days in a Week, firſt adding 4 for the firſt 4 *extra* Days, before the Sun began to meaſure Time; and it will give 298539 Weeks, and leave in Remainder 5, *(Friday)* the fifth Day of the Week.

Between that Eclipſe and the Full Moon which will happen next Thurſday, Sept. 27, there will have paſſed 895½ Lunations — We

Of the Method made Use of in the foregoing Calculations.

We therefore add the Quantity of these Lunations together, and find it to contain 2116219 Days, 13 H. 22 M. 5 S We then add 297 Days, to bring it to Oct. 24, after substracting the Julian Reduction for this Year, A. M. 5794, it leaves 258 D. 13 H. 22 M. 5 S. from which we substract 243, the Number of Days from the Calends of January, to the End of August inclusive; and we shall have Sept 15 D. 13 H. 22 M. 5 S. P. M. for the Full Moon this Year, in *Libra*, which is according to our Reckoning, Sept. 16 D. 1 H. 22 M. 5 S. P. M. O. S. to which we add 11, to bring to N. S. and then it will be Sept. 27th, at 22 Minutes, 5 Seconds past One in the Morning.

For the Day of the Week 2116219 Days
Extra Days 4

÷ 7)2116223 302317 Weeks
(4) Thurday

I now hope I have given *demonstrative* Evidence that what I asserted is true, viz. that Moses

Of the Method made Use of in the foregoing Calculations.

Moſes has given us an Account of the Place of the Sun and Moon at the Creation; which, according to his Chronology, happened at a Full Moon, at the autumnal Equinox, in the 706th Year of the Julian Period.

I am now willing to join Iſſue with the doubting Sceptic, and bring my Cauſe to be tried and determined by the diſcerning Public.—I ſhall beg Leave to ſum up the Evidence of this laſt Calculation *only*.

The Matter at Iſſue is, whether Moſes in his Hiſtory of the Creation, has given us Inſtruction, where the Sun and Moon were placed at that Time.—It appears to me that he has done it, and I poſtulate it as true, viz. that the Sun was placed in *Libra*, on Oct. 25, according to the Julian Reckoning, at Noon, in the firſt Meridian, on Thurſday the fourth Day of the Week.—That the Moon was 15 Days old; that had ſhe been in Being, ſhe would have been directly in

Oppoſition to the Sun, on Wedneſday Noon, the third Day of the Week, and in her Node, Oct. 24, according to the Julian Reckoning, and that ſhe would then be totally and centrally eclipſed; and that this happened in the Year 706, of the Julian Period.—This is the *firſt* or *original* Root or Point from whence I begin all my Calculations.—The Point I meaſure to is a moſt certain One; and was obſerved by many Thouſands of People.—It is the Eclipſe of the Sun which happened at London, on a Friday, April 22. The Middle of which, according to Mr. Whiſton's Calculations, was at nine Minutes before Ten in the Morning.—This was in A. D. 1715, and we know this Year was in Connection with 6428 of the Julian Period. Now as the Moſaic Chronology places the Year of the Creation in A. I. P. 706; if we ſubſtract 706 from 6428, it will give 5722, the Number of the annual Revolutions which the Earth has made between theſe two Points; which this Eclipſe proved to be exactly true.

From

Of the Method made Use of in the foregoing Calculations.

From this Point to next Thursday, Sept. 27, at twenty-two Minutes past One in the Morning, there will have passed 26444 Rotations of the Equator, and as much as measured 15 H. 8 M. 5 S. besides.—Now the first Point of this second Calculation begins at London, at the central Point of the total Eclipse, 1715, and ends at 22 Minutes past One in the Morning, on Thursday, Sept. 27. Between these two Points, the Moon will have made 895½ Lunations—that is, from her Conjunction with the Sun, A. D. 1715, to her Opposition, 1787.—This is the lunar Measure between these two Points.— The solar Measure will be found to agree with it. Our first Point of solar Measure is Oct. 25, at Noon, A. I. P. 706, when the Sun entered *Libra*, in the first Meridian, on Thursday the 4th Day of the Week.—Our next Point is this Day, Sept. 22, when the Sun will be found to enter *Libra* in the Meridian of Greenwich, at ten Minutes past Four Tomorrow Morning, A. I. P. 6500.—Between these

these two Points, the Earth will have made 5794 annual Revolutions through the Ecliptic, which she has performed in 2116214 D. 16 H. 10 M. and will end To-morrow Morning, the 7th Day of the Week or Sunday, at ten Minutes past Four.

The first lunar Calculation began at the original Point, at the Creation, and ended at the total Eclipse of the Sun, A. D. 1715.—The second began at the Point where the first ended, and finished at the Full Moon, Sept. 27, at 22 Minutes past One in the Morning.—By comparing the Sum of these two lunar Calculations, we shall find them to agree exactly with the solar Measure, begun at the original Point, at the Creation, and ending To-morrow at ten Minutes past Four in the Morning.——Here they follow.

	Days.	H.	M.	
Lunar Measure	2116219	13	22	Sunday
Solar Ditto	2116214	16	10	Thursday
	4	21	12	

It

Of the Method made Use of in the foregoing Calculations.

It may be obſerved, that the Difference between the ſolar and lunar Meaſure is 4 D. 21 H. 12 M. and wants but 2 H. 48 M. of five Days Difference between the lunar and ſolar Reckoning; but between Sunday and Thurſday, there are only four Days — It muſt be remarked, that the Moon was Full one whole Day before the Sun began to meaſure Time, therefore one Day muſt be ſubſtracted from the lunar Computation, which makes the exact Difference to be 3 D. 21 H. 12 M. as appears by theſe Calculations.— Does not this prove to Demonſtration, that what I have poſtulated is true?

Advertiſement.

Advertiſement.

THE following Letters were occaſioned by a Tour of Mr. Heaviſide and Mr. Penroſe, through Cornwall, A. D. 1783, *to view and examine, the Nature of the Mines, Cliſts, Druid Monuments, and other Antiquities found there:—This, as may be imagined, occaſioned many Obſervations and Remarks, in Order to account for the different* Phenomena *ſeen.—Hence, Mr. Heaviſide, in his Letter to Mr. Penroſe, after his Return to London, from Plymouth, ſent him ſome Obſervations he made as he paſſed over the Mendipp Hills, with ſome Queries.—The firſt Letter is an Anſwer to them.*

LETTER I.

To JOHN HEAVISIDE, Esq.

An Answer to some Queries proposed by Mr. Heaviside; whether Ore, Metal, or Coal were ever found under Chalk?—Observations where Ore and Metals are found, with Remarks on the Formation of the terraqueous Globe.—How Metals, Salts, &c. were dissolved, and reformed at the Deluge; together with the Method by which the different Strata *were formed.—The Flood described.*

DEAR SIR,

YOUR Favour, with your judicious Observations on the Mendipp Hills, I received; with your *Quere* whether Ore, Metal, or Coals are ever found under Chalk?—In Answer to which, I observe, that I have not met with any Account that either of the above have ever been found under such a *Stratum*; Coals, as you remark, are found under *Strata* of Stone and Clay.—Ore and Metals

Metals are generally (though not always) in Fiſſures of large hard Strata of Stone; which *Strata* were formed and *cracked before* the Metals were depoſited in theſe Fiſſures and Cracks; indeed, Lead is often found in crumbling Ground; and Iron ſometimes in Floats—the philoſophical Cauſe of which require more Room to diſcuſs, than can be contained in a common Letter.— Beſides, Philoſophers are not yet agreed, how, and in what Manner, or by what Agent or Agents, this terraqueous Globe was formed—therefore, it will be no eaſy Matter for me to explain it in ſuch a Manner as to gain a general Aſſent; ſuppoſing my Theory to be true—and however ſatisfactory it may be to myſelf, it may not be ſo to others.—One great Difficulty is, that the *Stratum* of the greateſt ſpecific Gravity is not always the lowermoſt; but, when we ſuppoſe, that before theſe different *Strata* ſubſided, every Thing was in the greateſt Confuſion; and alſo, that the greateſt Part of every *Stratum*, as deep as has been examined, (if not the Whole) was in a State of Solution; ſo it may appear likely, that

that it remained in this Manner till it met with a Fluid, of quite a different Nature; (which from the great Disturbance and Confusion this would occasion,) it would let fall its earthly Contents, in the same Manner as we often see performed in Chymical Operations; particularly in the making of *Magnesia Alba*.—The acid Salt being dissolved in Water, is quite clear and transparent; as is also the Alcaline Salt dissolved in the same Manner;—these will continue clear and transparent nearly as long as you choose, if you keep them separate and apart, but mix them together, and they will immediately become very turbid, and let fall a large Sediment or *Stratum*; and after a Time, the incumbent Liquor will become clear again; but if this Liquor is not entirely freed from all its saline Parts, whether they be acid or alkaline, add to it a Solution of the other, they will again become turbid, and let fall their Contents, and this *toties, quoties*, as often as this is done, till all the earthly Parts are subsided. Operations of this Kind give us an Idea of the Solution of the earthly Parts, which were

diſſolved at the Deluge, and again ſubſided in different *Strata*, as we obſerve them at this Day: Hence we may underſtand the Cauſe why every *Stratum* is not found to have ſettled *exactly* according to its ſpecific Gravity. Hence alſo we muſt imagine, that if any *Exuviæ* of Animals or Vegetables were mixed with theſe Fluids, that they would be carried down together with the earthly Matter, and be mixed throughout the *Stratum*, in the Manner we find them at this Day.

From Obſervation we alſo find, that Metals of all Sorts will diſſolve in particular Fluids, as Gold in *Aqua Regia*, other Metals in *Aquafortis*; there are alſo Solvents that will diſſolve all Sorts of Salts and precious Stones; theſe Liquids, after the Solution, appear as clear as pure Water; but on being mixed with a Fluid of a different Quality, become turbid, and let fall their Contents.—Hence we may eaſily conceive how the different *Strata* of the Earth were formed, and by what Means ſome of the Strata of Stone, Clay, &c. were loaded and filled with the different

different Exuviæ of Animals and Vegetables. But then perhaps the following Queſtion will be aſked—if it was ſo? how comes it that Metals did not ſubſide in the ſame Manner, and not remain ſuſpended, till after the earthy *Strata* were ſo far hardened as to be cracked in different Fiſſures; after which the different Metals filled theſe Fiſſures together with Spar and other ſaline Concretions of the ſame Kind? To anſwer this Queſtion we muſt again have Recourſe to the different Effects produced by Chymical Operations; but it will be proper firſt to explain how theſe different Cracks were produced.—It appears by the Account Moſes gives of the coming on of the Flood, that they were occaſioned, in a great Meaſure, by breaking up the Fountains of the great Deep, and opening the Windows of Heaven. (a) Now it is obſervable, that God ſays to Noah, *I, even I,* (b) *do bring a Flood of Waters upon the Earth,* thereby letting him know that it would be a Miracle, performed by God himſelf,

(a) Gen. VII. 11.—(b) Gen. V. 17.

ſelf, and brought about contrary to the *Mechaniſm* of Nature.—But then, notwithſtanding it was brought on by his Order, and contrary to the Mechaniſm of Nature; yet, he would now, as he did at the Formation, make the material Agents perform it.—Thus he made the *internal* Expanſion act with greater Power; and by this Means force out the Water of the great Deep, through the Fountains and Windows of Heaven; (c) by this Means the Place or Centre of Gravity being altered, and the Cauſe of the Attraction of Coheſion being taken away, they were made to diſſolve and cover the Earth.—Now the Power of the internal Expanſion being ordered by God to be of a *juſt Strength, to throw out the Waters, ſo as to cover the Hills fifteen Cubits upwards, and no farther.* And being then reſtrained by the Agency of the outward Expanſe or Preſſure of the Ethers and Air—theſe two Powers acted much in the ſame

(c) Theſe Windows of Heaven, according to the Hebrew, are the Cracks and Holes in the Earth, which, before this Event happened, were filled with the ſame Ethers as fills the Heavens, but were now ſo enlarged, as to admit the Water through them.

ſame Manner they did at the Formation.—And the Power or Effect of Gravity was made to act both within and without the Waters, which were then a compleat Globe, covering all the earthy Parts.—The internal Expanſion, acting in this Manner, in the Midſt of the Globe, forced Gravity to effect the ſame outward, from the Centre, as it did on the Outſide towards the Centre; by theſe Means a ſolid Shell of the earthy Parts was formed between the outward Surface of the Waters, and the inward Surface.—After this the internal Expanſion ſtill increaſing, and by the Cloſeneſs of the earthy Shell, being prevented from finding its Way outward, its expanſive Force gradually diſtended, the incumbent *Strata*, (like a Bladder forceably blown) and opened the Cracks and Fiſſures more and more, till a violent Exploſion enſued, which tore the Globe into Millions of Fragments, and threw them into every poſſible Degree of Confuſion; ſome of them more elevated, and others more depreſſed: Hence aroſe an indefinite Number of ſubterraneous Caverns, for many Miles, and ſome for many

Hundreds

Hundreds of Miles.—After this *God remembered Noah,* (d) (and uſed the ſame Agent then as he did at the Formation) and *cauſed a Wind,* or Etherial Spirit to paſs over the Earth, which quieted the Waters, and *made them recede,* (e) and by this Agent he alſo made Gravity to act again, towards the Centre, till the Waters were forced to their proper Place, where the gravitating Ethers, (as God commanded) (f) *ſhut the Sea with Doors, when it brake forth, it had iſſued out of the Womb; when he made thick Darkneſs a ſwadling Bond for it;* and ſaid, *hitherto ſhalt thou come, and no farther:* Here *ſhall thy proud Waves be ſtayed: Here is a Bound ſat that they may not paſs over; that they turn not* again *to cover the Earth.*

Having in ſhort explained the coming on the Waters of the Deluge, the Deſtruction of the Earth thereby, and its Reformation; I ſhall now endeavour to anſwer your Queſtion, why the Metals did not ſubſide with the earthy

(d) Gen. VIII. 1.—(e) This is a literal Tranſlation of the Hebrew.

(f) Job. XXXVIII. 8, 9.

earthy Matter, but were placed in the Fiſſures we now find them, which muſt have been done after theſe Fiſſures were formed?

In the firſt Place it muſt be obſerved, that Metals require a ſtronger *Menſtruum* than mere Water, to diſſolve and take up their Parts; and alſo that they are ſeparated from one another with greater Difficulty; and Salts or Gems, require ſome of the watery Parts to be evaporated, before they will run into Chryſtals, or ſeparate from the Liquid; beſides as they require a *Menſtruum ſaturated with proper Salts*, before they will be diſſolved, and ſuſtained in them; ſo they muſt alſo meet with another Menſtruum, well ſtocked with Salts of an oppoſite Nature, before they will let their Contents fall again, and perhaps might require the additional Heat which the Waters received from the internal Fire to do it.—Hence the metalline and chryſtalline Particles, might not ſeparate till the greater Part of the Water was run off the Earth, when they were forced into the Cracks and Fiſſures.— Thus, we obſerve, that

that Gold is diſſolved by *Aqua Regia, a particular ſaline Fluid!* whilſt all other Metals are diſſolved by *Aqua-fortis.*—Hence, Gold is found often in the Earth or Sand, pure, and without the Mixture of other Metals; but Silver, Tin, Lead, Copper, &c are often found mixed, and incorporated in the ſame Maſs; to which generally is added Spar, which from its Tranſparency, angular Form, &c. appears to have Shot, and to be formed in the ſame Manner as (other) Salts.—Quere, Are not Diamonds formed after the ſame Manner?—Now, if the different *Strata* of the Earth were formed as above deſcribed, it ſeems natural to imagine, that they would carry down with them the different *Exuviæ*, as Shells, Vegetables, Wood, Bones, &c. which were contained therein, though of different ſpecific Gravities to the *Strata when formed*; and there remain mixed with the *Strata*, in the ſame Manner as they are now found.

According to your Deſire, I have ſent you ſome ſhort Hints of my *Ideas* concerning the Deſtruction

Deſtruction and Reformation of this terraqueous Globe; the Errors you find therein, your ſuperior Judgment will eaſily correct; and what they are, let me know in your next Epiſtle.

I am,

DEAR SIR,

Your obliged,

And obedient,

Humble Servant,

F. Penroſe.

STONEHOUSE,
Aug. 1, 1783.

To F. PENROSE, Esq.

Mr. Heavifide's Anſwer to the former Letter, with his Remarks thereon; together with his Theory of the Deluge.—That he cannot think that the Earth underwent a general Diſſolution, at that Time; that he believed the central Nucleus *was Fire; with Objections to the Diſſolution of the Earth at the Deluge.*

DEAR SIR,

I Am much obliged to you for your Anſwer to the Quere in my laſt; it was a ſudden Queſtion which aroſe in my Mind on ſeeing thoſe Hills; and I neither did, nor do, recollect ever to have met with it in the Courſe of my reading; and if it has never been touched upon by any Naturaliſt, it ſeems very ſurpriſing, for it appears to me to be well worthy the Obſervation of one.—To give a Reaſon why Metals may not be equally found under Chalk, as under Stone, may not indeed be ſo eaſy, as 'tis to make the Obſervation.—

I

I muſt alſo thank you for the Trouble you ſuffered that Quere to cauſe you, by explaining your Theory of the Earth, and deſiring my Opinion of it.— But, really, Sir, my Opinion in theſe Matters is of very little Value; for to tell you a Truth, my reading has always been deſultory and varied; for as Objects preſented themſelves to my Mind, I purſued them either till I was tired of them, or new ones ſtarted to turn the Current of my Thoughts another Way: But I never ſtudied any Science methodically or ſcientifically, nor ever had any one to encourage or aſſiſt me in any Purſuit I entered upon; ſo that you muſt not expect any regular, well-digeſted Syſtem from me: However, as you deſire it, I will give you my Thoughts juſt as they ariſe at this Moment of my Writing; but, not having Leiſure to digeſt them, will probably be confuſed enough.—Firſt, then, I muſt tell you, that I agree to your Theory *in Part*, but not wholly; becauſe I do not think that the *general* Diſſolution of the Earth, at the Deluge, (which you ſuppoſe) either did or could take Place; nor could it

have

have produced the present Appearances, if it had.—But that a partial Dissolution of the *earthy* Parts, Sand, Gravel, &c. &c. was caused by it, I readily assent to; yet I cannot think that the immense Bodies of Rocks that now exist in the World, were ever *in fluore* since they were first formed at the Creation. My own Idea is in short this; when the World was first formed out of the chaotic Matter, the central *Nucleus* was Fire, and that it was enclosed in a Shell or Case, formed of some of the heaviest Particles, such as Marble, Stone, &c. and that the other component Particles took their Places, not indeed exactly according to their specific Gravities, but perhaps nearly so; that the Waters drained off into the hollows, or lowest Parts of the Surface, and formed the Sea.—That at the appointed Time, this central Fire burst its *stony Shell*, with a violent Explosion, and was *one* great efficient Cause of the Deluge.—And as this Earth or Crust must necessarily have been *thinnest*, where those deep Hollows had been made to receive the *Sea*, so probably those Parts would first

firſt yield to the Force of the Exploſion, and be thrown fartheſt from the Center, as being lighteſt, and conſequently form the *higheſt* Parts of our preſent Globe, ſuch as the Andes, Alps, &c. and (if you pleaſe) the Mountains of Cornwall; all of which are of Rock. That the violent Agitation of the Waters, cauſed by this Exploſion, would, *in many Parts*, waſh much of the earthy Particles which covered theſe Rocks in their priſtine Situation, from them; and thereby leave them in the naked State we now ſee them *in many Places*: but that in others, where the rocky Shell was not forced up quite ſo high, it remains covered with the different *Strata* of Sand, Shells, &c. much in the ſame Manner as it did when it originally made a Part of the great Baſon which contained the Sea; which ſeems to me to be a very natural Solution of the Phenomenon of Shells, &c. being found even on very high Mountains; and different Sorts of them in different Places; as we now find that the different Sorts of Shell-fiſh, as well as others, are found in much greater Quantities in ſome Parts of our Seas than in others.

On

On this Principle it is likewiſe eaſy to conceive, how thoſe Fiſſures were cauſed in the hard Rocks of Cornwall and Derbyſhire, &c. which are now filled with what they call the (Metallick) *Load:* but whether that *Load* was originally in the State it is now found, I very much doubt: My own Opinion being rather that they have been gradually formed by the Admixture of certain impregnated Fluids, with earthy Particles properly adapted to receive them, and become the Baſis of Mineral Subſtance.

And what inclines me to this Opinion, and confirms me in it, is my own Obſervation of the Formation of what are vulgarly called Plumb-pudding Stones; which I have ſeen in the State of *looſe Gravel*, and watched it through all the Gradations between that and the hardneſs of a Granite: I have alſo ſeen a ſmall *Ruby*, in the Center of a *Diamond*, which inconteſtably proves that the Ruby was formed before the conſtituent Parts of the Diamond, which muſt then have been in a Fluid or ſoft State, for otherwiſe they could not have ſurrounded and encloſed it.

But to return, and give you my Objections to *Part* of your Theory; if, as you ſuppoſe, all the terraqueous Globe was in a State of Solution at the Time of the Deluge, how could the Rocks of Marble and Granite, acquire ſuch great Hardneſs and Solidity, in ſo ſhort a Space as one Year, to admit of being cracked and ſplit as we now ſee them.—Would they not rather have admitted of being arched or bent, as being in a *ſofter* State? But, admitting for Argument's Sake, that they could have acquired ſufficient Hardneſs, what Force, or what Cauſe could have been applied to them *ſince then*, ſufficient to crack, break, and tumble them about in the wonderful Manner we now ſee them? You will obſerve, that we ſo far agree about the Formation of Ores, in theſe *Cracks*, as to ſuppoſe them formed there, ſubſequent to thoſe *Cracks:* But whether you will agree with me, that they were formed upon a Matrix of earthy Particles, by Impregnation from Fluids, I know not; but rather think you will, from the Inſtance you properly bring of Spars being found among them, which

every

every one knows are formed from aqueous Particles, loaded with what may properly enough be called Saline ones.

Thus, my Dear Sir, you have a hasty Sketch of my Philosophy, the Product of the first leisure Hour I have had since my Return to Town.

I am,

DEAR SIR,

Your very obedient,

And much obliged Servant,

J. HEAVISIDE.

Prince's-Street, Oct. 10, 1788.

To JOHN HEAVISIDE, Esq.

Facts which prove that all Parts of Europe, Asia, Africa, *and* America, *the* Exuviæ *of Animals and Vegetables, particularly Sea Shells, are found in different* Strata *of Stone, both on the Tops of the highest Mountains in the World, and also at the greatest Depths that have been dug below the Surface of the Earth.—Some farther Account of the Deluge.*

DEAR SIR,

THOUGH we cannot *exactly* agree in our Ideas about the Formation of the Earth, *at the Creation,* and the Destruction (as I suppose) and Reformation of it at the Deluge; yet the genteel and impartial Manner in which you mention your Objections, shews that Truth is your Object.—And, I am sure, that no one, who reads your Observations, but must think (notwithstanding what you say) that you have made some Proficiencies in the Study of Natural Philosophy,

I believe you have been teazed enough already, to know that it is my Hobby-Horſe. As Uncle Toby had his, ſo I have mine; for when Philoſophy is once made the Subject of Converſation, I dont know when to have done with it; and therefore, I ſuppoſe, you will deſire no more on the Subject; if ſo, throw this in the Fire, and trouble yourſelf no more about it.

It gave me great Satisfaction to find that your Ideas agreed in Part with mine; but you ſay you cannot think with me, "that "there was a *general Diſſolution* of the Earth "at the Deluge, and that the immenſe Bo-"dies of Rock that now exiſt, were ever in "a fluid State, ſince they were firſt formed "at the Creation."

The Way to come at the Truth of what we have not ſeen, or don't know for certain, is to apply to Matters of Fact, Experiments, and the natural *Phenomena* of Nature.—On examining this Earth, in *all Parts* of the World, in *America* as well as *Europe*; *Aſia*, and

and *America*; from the Tops of the highest Mountains, to the deepest Places that have been dug in the Earth; we find it is composed of different *Strata*, as Sand, Gravel, Stone, Clay, &c.—In all *these Strata* are found *Exuviæ* of Animals and Vegetables; particularly Sea Shells, in large Quantities.—Does not this prove, that these Shells, &c. *were mixed* with the Substance of the Stone and other *Strata*, when they were in a fluid State?

This could not happen at any Time, but at the general Deluge.—And (as was observed before) that, as they are to be found in great Part of the *Strata*, from the Tops of the highest Mountains, to the greatest Depths in the Earth; all must be dissolved.—The finding Skeletons of Elephants, and the Horns of the Mouse Deer, here in England, seems to prove that these *Strata*, wherein they are found, were in a State of Solution when these Relicks were there deposited; and also that the Deluge was universal.—How is it possible for a Flood of Water, many Feet deep,

deep, to be partial on any Part of the Earth; it is well known that Water will give Way to Preſſure, as may be obſerved by Pumps and Hydroſtatic Machines, &c.—Therefore, as the Preſſure of the Atmoſphere is univerſally alike all over the Globe, (allowing for the Difference between the Heat at the Equator, and the Cold at each Pole) the Water muſt be forced equally round it.—This being the Caſe, we may reaſonably ſuppoſe, that theſe Relicks muſt be brought from other Climates, to this Place; neither one of them being an Inhabitant here.—Large Trees are alſo found in ſome of the Northern Latitudes, which are ſo cold as not to admit a Shrub to grow.

Moſes, in his Hiſtory of the Flood, as before obſerved, tells us, that God ſaid, *I, even I,* do bring on a Flood of Waters on the Earth.—Hence we are informed, that it was brought on by *the immediate Act of God himſelf,* and *not according to the Agency of Nature.*

Nature.—Now though God brought it on *contrary* to that Agency, which he had eſtabliſhed; yet he made Uſe of his material Agents, both to bring it on, and to carry it off.—Thus we find that Moſes, in his Hiſtory tells us, that the Method God ordered was *to break up the Fountains of the great Deep, and open the Windows of Heaven.* (g)

The literal Tranſlation of the above Paſſage is, That all the Openings of the great Deep, through which the Fountains flowed, and the Holes and Cracks through which Air, Steam, or the internal *Expanſion* or *Heaven* paſſed, were enlarged, ſpread abroad, and broke up.—Alſo that there was a very great Rain.—From all which it may not be improbable, but that the Shells, and different Parts of Animals and Vegetables, ſo found, were appointed as an undeniable Evidence, to the *lateſt Poſterity*, that Moſes's Hiſtory of the Flood is true.

The Method made Uſe of was, (as he informs us) to increaſe the internal Expanſion and

(g) Gen. VII. 11.

and Rarefaction, ſo as to force out the Water from the Deep, through thoſe Openings which became larger continually, and reſiſted leſs, as the Centre of *Gravity* was altered, by leſſening the compreſſing Force without, and increaſing the expanſive Force within.— Thus the *Attraction of Coheſion* was taken away; hence the Parts of Stone, &c. became looſe and eaſily diſſolved, and were moved, and *by the Force of the Water below*, mixed with it and carried away.—The *Expanſion* below continuing and increaſing, till it had forced the Water fifteen Cubits upwards, above the higheſt Hills, which were covered and hid.

By this Deſcription of the Agents, you may obſerve, that I agree with you in thinking, that there is a central Fire within this Globe, which I take to be the firſt Agent in all the Operations of Nature.— The late Earthquakes have ſhewed us ſomething of its Effects, by which were thrown out hot Water, and burning Sand, &c.—Is it not probable that this central Fire may be made, by God,

God, the Agent, which, at the laſt Day, may deſtroy this terraqueous Globe, with its Inhabitants?—Indeed this central Fire, which you mention, appears to be the cauſe of our Lakes and Springs, (h) both hot and cold — Is it not probable that it aſſiſts to increaſe the Fertility of the Earth in ſome Places more than in others.—The Parts of Italy ſo much damaged by the late Earthquakes, as well as by former ones, are allowed to be ſome of the moſt fertile Places on Earth:— Can there be a Doubt but that Earthquakes are brought on by Steam ariſing from this central Fire. (i) It is obſerved, that after long continued Froſts, that the Thaw, generally, if not always, proceeds from below:—Do not theſe *Effluvia* from below, cauſe the Drains, &c. to ſmell before Rain? Has it not alſo an aparent Effect in ſinking the Quickſilver of the Barometer, by its Force upwards, abating the Preſſure of the Atmoſphere? Without this, how will you account for the Difference of Cold under the ſame Latitudes, as *Newfoundland*, *Hudſon's Bay*,

(h) See Letter XVI. (i) Michel, on Earthquakes, Part 2.—Whithurſt, C. XII

Bay, &c. which are in the ſame Latitude as England, and yet the Cold much more intenſe?— Unleſs you will ſuppoſe that the Shell of the Earth, under theſe Places in *America*, is thicker and cloſer than it is here in England, and thereby the Heat of the Fire and Steam below, are prevented from having ſo great an Effect on it.

I have now given you a ſhort Narrative of my Theory of the Deluge, and how it was brought on.—Moſes in his Hiſtory gives but a ſhort Relation about its going off, and the Reformation of the terraqueous Globe; which indeed he had no Occaſion to do, as he had been ſo particular before in his Hiſtory of the Creation and Formation of the antidiluvian Earth; which I ſhall explain in my next Letter, as I have already run this to a great Length.—He only lets us know that God did not forget Noah, or ſuffer him to be deſtroyed, but that he cauſed a *Wind or gravitating Ether* to paſs over the Earth, by which the Waters were aſſuaged, or as it is in the Hebrew, the Waters were *forced down*.

Adieu,

Stonehouſe, Sept. 27, 1783. F. PENROSE.

To JOHN HEAVISIDE, Esq.

Original Names ideal.—The Reason why it has been asserted, and generally believed, that the Scriptures do not speak strictly true, with Regard to Philosophy, on the Motion of the Sun, Earth, &c. but is accommodated to vulgar Apprehensions.—The Mosaic Account of the Creation, and Formation, of this System; describing the Agents, which carry on the mechanical Operations of Nature; together with some Extracts from Sir Isaac Newton, *to shew that he supposed the Agents of Nature to be the same as those revealed in the Scriptures.*

DEAR SIR,

ACCORDING to the Promise in my last Letter, I have herewith sent you my Theory of the Creation and Formation of this terraqueous Globe.— The Instruction for doing it, I have taken from the Mosaic History, which Moses tells us came from *Jehovah* himself.—Indeed we have no other

Account of this grand Affair, therefore let us examine it with the ſame critical Strickneſs we would any other Hiſtory.—If we find this Hiſtory confirmed by all the Parts of the terraqueous Globe, and alſo by all the Phenomena of the Sun and Moon, &c. why ſhall we not believe it? *

It is agreed by the learned in general, and by Antiquarians in particular, that original Names, (in all Languages) were ideal, and gave an emblematical Repreſentation of the Thing ſignified thereby.—Thus in Latin, Candelabrum ſignifies a Candleſtick.—This Word is compounded of *Candela*, a Candle, and *Labrum*, a Ciſtern or Socket to contain a Candle; ſo that it was expreſſive, that this Inſtrument was to contain a Candle:—In Engliſh it is a *Candle-ſtick*, denoting that it was then made of a *Stick* or *Wood*, and not of Silver or other Metal as it is now.—We are informed by Moſes, that the Names given by God, by Adam, by the Patriarchs, or by Himſelf,

* See Introduction.

Himſelf, were all *ideal*, and expreſſed the Reaſon why the Name was given.

Thus, when Moſes aſked the Lord, what he ſhould ſay was his Name, (k) *God ſaid unto Moſes, I am, that I am; thou ſhalt ſay, I AM has ſent me unto you,* JeHoVaH.—This is the incommunicable Name given by God himſelf; and though it contains but four Letters in the Hebrew, (the ſmall Vowels being added to aſſiſt the Sound) yet it is ſo comprehenſive and expreſſive, as to require a Sentence to explain it, which, with all Humility, I ſhall endeavour to do, viz. *The eternal ſelf-exiſting Being, who was, and is, and is to come.*—Moſes alſo informs us, that Adam called his Wife's Name HoVaH, *Eve.* This is a Participle paſſive, from HIaH *vixit*, to live, ſignifying *Life giving*, or, as we are told, becauſe ſhe was to be the Mother of all Living; or the Perſon from whom all Poſterity were to derive their Being.—We alſo find, that God not only gave ideal Names, but alſo that he ordered thoſe Names to be changed

(k) Exod. III. 13, 14.

changed on particular Occaſions, when the Alteration in Condition required it.—Thus *Abraham* from *Abram*, that is, from high Father, to the Father of a *great Multitude*, to expreſs and be a Memorial of the Promiſe which God made him.—That *He ſhould be the Father of many Nations.* (l) God alſo altered the Name of Jacob to Iſrael, &c. (m) If theſe Examples are not ſufficient to ſatisfy any Inquirer, let him conſult the Scripture Names at the End of *Cruden*'s Concordance, and, I believe, he will want no more Examples?

For the above Reaſon, I ſhall give, (together with the Moſaic Hiſtory of the Creation) a literal Tranſlation of the Meaning of the Hebrew Words as they occur.—If it don't give you Inſtruction, I think it will add to your Amuſement.—But before I do this, it will be proper to take Notice of a general Notion which has prevailed for about the three laſt Centuries, viz. That Moſes, when he gives an Account of the Creation, Deluge, or Motions of the Heavenly Bodies, does

(l) Gen. XVII. 5.—(m) Gen. XXXII. 28.

does not ſpeak philoſophically true, *but accommodates himſelf to the vulgar Apprehenſions of Men, to ſuch Points of natural Philoſophy as they were not able to comprehend.*

Now, in Anſwer to this, it is confeſt, in general, that there is a great deal of *Geography*, of authentic *Hiſtory*, and *Chronology*, in the Bible.—Its Hiſtory, its Chronology, or Philoſophy, muſt be in Fact as true as its Theology; for to ſpeak falſe in any Caſe whatſoever, or, if we ſuppoſe that any Part of the divine Word to be erroneous, it ſo far ſhakes the Authority of the reſt.—If we believe his Hiſtory of the Iſraelites to be true; why ſhould we diſbelieve his Hiſtory of the Creation? eſpecially if the Phenomena of the Sun and Moon, and all Nature confirm it.

Let us now enquire, why it was ſuppoſed that the Scriptures did not ſpeak ſtrictly true, with Regard to Philoſophy.—By this Inquiry we ſhall find, that about Three Hundred Years ago, *Copernicus* publiſhed his Account

count of the Solar Syſtem, (which was no other than a Recovery of what was before maintained by *Pythagoras*, and other ancient Philoſophers.)—For ſome Centuries before this, there had reigned an univerſal Ignorance, with Regard to the Sciences.—The Church, which was then that of Rome, had not, neither did they underſtand any other Scriptures but the vulgar Latin; which, according to their Apprehenſions, aſſerted, that the Earth ſtood ſtill, and that the Body of the Sun moved, roſe, and ſet.—*Copernicus* and his Followers proved beyond Diſpute, that it was not the Sun, but the Earth which moved. This being the Caſe, and theſe *learned Eccleſiaſticks not being able to read and underſtand the original Hebrew*, (which ſpoke the contrary) were forced to give up the Cauſe, and to ſave Appearances, to cover their Ignorance, and to prevent farther Inquiry, they contrived to get it aſſerted, and preached from the Pulpit, that the Scriptures did not ſpeak philoſophically true, but that Moſes did accommodate himſelf to the Apprehenſions of the Vulgar.—Mankind being thus educated

and

and taught with their firſt Ideas, no Body ſeemed to doubt it. *

Moſes, in the firſt Chapter of Geneſis tells us, that the World was not *eternal*, but that in *the Beginning* God created the Heavens and the Earth.—After this he goes on to let us know, what Time God was forming it, and what material Agents he made uſe of for that Purpoſe.—He tells us that the Earth was created *without Form*, and had a *Void* or *Hollow* in the *Midſt* of it.—That the Faces, (plural) or Outſides of it were covered with *Darkneſs*.—That the firſt Thing which God did, was for RUaCH, his Spirit, to cauſe a Motion, or Wind, or Preſſure, amongſt the Darkneſs on the Outſide of the Waters.—The next Word, MeRaCHaPHeT, deſcribing the Motion to be of the vibrating Kind, backwards and forwards, like the Waves of the Sea, preſſed by Wind, or the Breath of an Animal, or the Hovering of a Hawk over his Prey; and God *ſaid let there be Light*.—Here

* Hence appears the Abſurdity of Perſons explaining written Laws they cannot read and underſtand.

Here it may be obſerved, that it was not a *new* Creation, but God ſaid *let there be Light*; or let this expanſive Struggle or Conflict continue till it produced Light—and there was Light; and God ſaw that the Light was good, or according to the Hebrew Signification, *that it was compleat*, and fit to anſwer all the Purpoſes it was deſigned for.—The Hebrew Name is AUR, a Particle paſſive from JAR, to flow like a River, to irradiate, to expand; as a Subſtantive a Splendor, an Irradiation, a continual Flowing or Motion.—Thus we find that the Name given to this Subſtance, (which was before called CHeSHeC, *Darkneſs*, Stillneſs, Inertneſs, Sluggiſhneſs) was of a quite different Quality to what it had been before, which was Stillneſs, Inertneſs; but this, a continual Flowing, like a River, *Motion itſelf*, or the moving Agent.—Hence it may be obſerved, that the Darkneſs which ſurrounded the terraqueous Globe, was divided into two Parts, viz. RUaCH, Spirit, Wind, or Air, in Motion, which cauſed Gravity and Compreſſion, and AUR, Light, which gave Motion, and irradiated,

diated.—That God placed the Earth between the Light and Darkneſs, ſo that Light was on one Side of the Earth, and Darkneſs on the other.—That God called the Air on that Side of the Globe which was covered with Light, JOM, *Day*, or *Tumult*, from the violent Agitation or Struggle there carried on between the two Parts, Light and Darkneſs.—The State of the Air, on the oppoſite Side of the Earth, he called LaILaH, *Night*, *Inactivity*, *Laſſitude*: Hence, on that Side of the Earth which was Day, there was a continual Struggle, or Conflict; and on the contrary Side, Night, or *Inactivity*.—That by cauſing the Globe to make a Rotation all round, there was Evening and Morning, or one Day.

On the ſecond Day we are told that God ſaid, "Let there be a *Firmament* or *Expanſion* in the Midſt *(void)* of the Waters, and "let that be an Inſtrument and Cauſe to divide between the Waters and the Waters." Thus let the Motion between the Light and Darkneſs increaſe, and by their Struggle and

Conflict, cause an Expansion or Firmament; which Expansion, we are told, was the Instrument God made use of to separate or make to *gravitate* the earthy Parts from the Waters, and so form the Shell; which Shell of Earth when formed, separated and made a Division between the two Waters, viz. those on the Outside, under the outward Firmament, and these Waters on the Inside of the Shell, above the internal Expansion, in the *Midst* of the Waters.—After the Expansions between the Light and Darkness had begun to perform the Office they were designed for, God gave them new Names to denote their Office.—He now called them *Heavens*, (n) SHeMIM, that is the *Placers*, the *Disposers*, the *Agents*; also SHeCHeKIM the Conflictors.—These were God's Agents under him, whose Power he lets us know their Names represented.—Thus ended the second Day.*

(n) Psalm 89, 37.

On

* Saint Paul tells us, Rom. I. 20. *That the invisible Things of him from the Creation of the World, are clearly seen, being understood by the Things that are made, even his eternal Power and Godhead.*

On the third Day the Action of the Expanſion or Firmament, in the Midſt of the Waters, ſtill continuing and increaſing by being ſurrounded and pent up within the Shell

head.—In the Margin of our Bible, the Tranſlators have referred us to the XIX Pſalm, as the Place where the Scriptures have pointed out to us thoſe Parts of *created Nature* which do it; I ſhall therefore give the firſt ſix Verſes of that Pſalm, which differ little from the Engliſh Tranſlation, except being more literal.

Verſe 1ſt. "The Heavens, *as Books, repreſent to us, by* "*their Numbers in Circulation,* (a) the Glory of God; and the "Firmament ſheweth his handy Work, or his Strength and "Power."—(Thus, Job XXXVII, 18, we are told, that "the Skies or Heavens *are ſtrong as a Molten Looking-Glaſs.*)

2d. "Day unto Day cauſes his Decree to be ſpread abroad, "and Night unto Night *the Knowledge of Jehovah.* *

3d. "Neither Words or Speech are in them; let their Sound be attended to!"

4th. "Their *Ordinance* goes out over the whole Earth, and "their *Fulneſs* (b) unto the End of the World.—The Place "or Tabernacle for the ſolar Light (c) is ſpread out in them.

5th. "Which like a Bridegroom coming out of his "Chamber,

Shell of Earth and Waters, *it burst the Shell, and got Vent*, by which *the outward Waters*, (after the Rupture) were pressed down by the Firmament, to join those below, *within the Shell*

" Chamber, and triumphs as a strong Man, *(like the great* " *Man)* to run a Course."

6th. " His going forth is from the End of the Heavens, " and his *Circuit* unto the Ends of it; and there is no *Thing* " *nor Place* hid from the Heat thereof."

Observations on the Words which differ from the English Translation.

(a) The Hebrew Word translated *declare*, is MeSePRIM, not a Verb, but a plural Noun, agreeing with SHeMIM, *Heavens*, and derived from SaPeR, which according to *Avenarius's* Lexicon, signifies " *numeravit ordine, recensuit per Gyrum, et Circulum;*" to number according to Order, to declare, as in a Book, to number by a Circle.—As a Noun, a Book, a Numeration, a Scribe.

(b) MeLIHiM, translated Words are derived from MeLaH, which signifies *Fulness*, not Words.(*)—The Hebrew Words are DaGNoTH, JeHoVaH, which is literally the *Knowledge of Jehovah*; but in the English Translation it is, *sheweth* Knowledge.

(c) SHeMoSH in the English Translation is often rendered

Shell of the Earth, which was before occupied by the Expanſion, and thus, as Moſes informs us, the Waters were gathered to *one Place*; the Abyſs, but not to the Centre of the

dered *Sun*, as it is in this Place, though it never ſignifies the Body of the Sun throughout the whole Bible; but the Sun, Beams or Light proceeding from the Sun.—Whenever the ſolar Fire or Body of the Sun is mentioned in Scripture, it is called CHaMaH, and the Body of the Moon is called LIBNaH. Thus, Iſaiah XXX. 26.—"The Stream of Light "of LIBNaH, *the Moon*, ſhall be as the Stream of Light of "CHaMaH, *the Sun*, and the Stream of Light of CHaMaH "ſhall be ſevenfold."—The not making a proper Diſtinction between theſe two Hebrew Words, has been the Occaſion of great Confuſion, by attributing Motion to the Sun, and not to the Earth, (which is contrary to the Words of the Scriptures) and has given an Opportunity to the ſelf-ſufficient and conceited Deiſt, to ridicule them.—Thus in the Engliſh Tranſlation, the Sun is ſaid *to riſe* and *ſet*; but this is not found in the Hebrew; in thoſe Places it is SHeMoSH, the *Solar Light*, which is ſaid to *ſpring out*, and the *Solar Light to go off*.—Thus, *Joſhua*, X. 12. The SHeMoSH, the *Solar Light*, is ſaid to be ſilent, or not to go off, but to remain ſtill on Gibeon.—And IaReCH, the Lunar, or *reflected* Light (this Word ſignifies *Effluvia*, *Odour*, or reflected Light, from a Body, as Canticles II. 13—V. 10, and 1 Sam. XXVI. 19, is the very ſame Word, of the ſame identical Letters, which in the Margin of the Engliſh Bible is tranſlated *Smell*) from the Moon, in the Valley of *Ajalon*.

Hence,

the Earth, which Place (I think with you) was and is always occupied by Fire.—Hence, as Moſes informs us, by the going down of the Waters, the dry Land appeared.

I

Hence, we find, in this Miracle, that neither the Motion of the Sun, Moon, or Earth is mentioned, or at all concerned about it: It was only the *Solar Light* and the *Lunar Light* which remained in both thoſe Places, till *Joſhua* had deſtroyed his Enemies.—It was a ſupernatural Light that remained there! as a ſupernatural Darkneſs had before remained in Egypt for three Days, (a *Darkneſs that might be felt!*) whilſt the Children of Iſrael had Light in their Dwellings, Exod. X. 21, 22, 23. Yet we have not the leaſt Reaſon to ſuppoſe that the Earth ſtood ſtill all this while.—We are told the contrary, that this Miracle of Darkneſs remained three Days or whilſt the Earth made three Rotations round its Axis.—As the Earth did not remain ſtill or ſtop her Motion, whilſt this Miracle of Light and Darkneſs was performed in Egypt, why ſhould we ſuppoſe it did while a Miracle of the ſame Kind was performed on *Gibeon?* Had that been the Caſe, the whole ſolar Syſtem muſt have been diſordered! which would have anſwered no End; it was as much a Miracle without it.—That it did not is evident from our Aſtronomical Calculations of Eclipſes, Equinoxes, &c. for there is not one Minute of that Day deficient.

Thus we find that SHeMoSH, the ſolar Light, and IaReCH, the Lunar, or reflected Light, remained *ſtill*, without Motion, in both theſe Places, in a miraculous Manner, contrary

I ſhall now recapitulate what has been obſerved, from which it may be remarked, that this terraqueous Globe was created in a confuſed Maſs or a *Chaos*; that it had a *Hollow* or *Void* in the Midſt of it.——That this *Void* was filled with Darkneſs, and the Outſide of it was alſo covered with the ſame Subſtance.—That this Darkneſs was *inert* or *inactive Matter*, which afterwards had different Names given it by God, expreſſive of their Agency, till it was quite *good* or *compleat*, when it received the Name of *Heavens*, or the *Placers*, the *Agents*.—Thus God firſt cauſed a *Wind* Weight, or vibrating Motion or Agitation amongſt the Darkneſs, by which *Light*

contrary to the Mechaniſm of Nature.—But that CHaMaH, the ſolar Fire, or Body of the Sun, and LiBNaH, the Body of the Moon, were at the ſame Time in their Places in the Heavens; and that the Earth continued her uſual Motions, and no Difference was occaſioned on other Parts of the Globe, beſides upon *Gibeon*, and in the Valley of *Ajalon*.—And Verſe 13 it is ſaid, that "the SHeMoSH, the ſolar "Light, remained in that *Part* of the Heavens, (viz. over "*Gibeon*) it did not go off, (or *ſet*) it was like an entire or "perfect Day, and there was no Day like that before it or "after it."

Light ſprung out, to which he gave the Name of *Light*, *Iradiation*, Splendor, or flowing *Motion*.——That the Globe had Light, Day or Tumult on one Side, and *Night*, a *Laſſitude*, or a Decay of it, on the other Side.—That the terraqueous Globe was a Diviſion between them.—That by one Rotation there was Evening and Morning on all Parts of the Globe, which made the firſt Day.—That on the ſecond Day God cauſed an Expanſion amongſt the Darkneſs, in the Midſt of the Globe; which Expanſion cauſed a Separation of the earthy Parts from the Waters, and forced them outwards to join thoſe which were preſſed towards the Centre, by the outward Expanſion, and thus a firm Shell of Earth was formed, which was a Diviſion between the outward and the internal Waters.—On the third Day the internal Expanſion continually increaſing, and being confined by the Shell of Earth, it arrived to ſuch a Strength as to burſt the Shell, and get Vent; after that mixing with the outward Expanſion, the Waters were preſſed down into the Place lately occupied by it, by which Means

Means the Waters were in *one* Place, and the dry Land appeared; after they had performed this Action, God ſaw that they were good, or capable to perform the Agency he appointed for them; and he then gave them the Name of *Heavens*, the *Agents*, *Placers*; and deputed them to act.—And we find that they cauſed Vegetables, Trees, &c. to ſpring out of the Earth and grow.

Having now given you an Account of the Formation of this terraqueous Globe, as given by Moſes, who tells us that the Earth now brought forth Vegetables, Trees, &c. I ſhall endeavour to explain how the natural Agents performed theſe Operations, which the Scriptures tell us they do; but before that, I take the Liberty to make ſome Extracts from *Sir Iſaac Newton*, to ſhew that he ſuppoſed they did the ſame; and alſo that the *Phenomena* of *Projection* or *centrifugal* Force, together with the *Centripetal Gravity*, and all Kinds of Attractions are performed by the ſame Agents, *the HEAVENS*, the *ETHERS*; the Fluid which fills them.—This

will be a Confirmation, that he has properly applied his geometrical and mathematical Demonſtrations of theſe Effects, or *Phenomena*; which Demonſtrations, I doubt not, will ſtand the Teſt of Ages, as *Euclid's* has already done.

Sir *Iſaac Newton's* great Judgement and Skill in Geometry, was the principal Cauſe of excelling his contemporary Philoſophers, for God *comprehended the Duſt of the Earth in a Meaſure, and weighed the Mountains in Scales, and the Hills in a Ballance.* (o) Hence the moſt certain Method to aſcertain the Truth of an aſtronomical or philoſophical Hypotheſis, is by Geometry, by Numbers, Weights, and Meaſure.—This was the Method that great Mathematician purſued his Studies; for in a Book of *Deſ-cartes*, which he made uſe of when at College, there ſtill remain in many Places in the Margin, the following Remarks.—*Error*, not *geometrical.* But then great Care ſhould be taken in their Application, not to apply them to improper Subjects,

(o) Iſaiah XL, 12.

Subjects, for if applied improperly, we ſhall be miſlead by them.—Sir Iſaac himſelf has been guilty of this Error.—The Science of Geometry is derived from the Syſtem of Nature, which is a perfect *Automaton*, or a mechanical Machine, that has the Power of Moving within itſelf; but it was formed and ſet a going by the Creator, who ſaw that it was good, perfect, and compleat, and capable to perform all the Operations he deſigned it for, many of which are ſecret and wonderful.

Now let it be obſerved, that what Moſes calls HEAVENS, or the *material Agents* under God, *Sir Iſaac Newton* calls ETHERS, of which he gives the following Deſcription. "This Medium (ſays he) pervades all Bo-
"dies, and that there is *no Vacuum* but what
"it fills; that it readily pervades all Bodies,
"and by its elaſtic Force, is *expanded through*
"*the whole Heavens.* (p) And (q) that it is
"rarer within the Body of the Sun, than at
"its Surface; and rarer there than in the ce-
"leſtial

(p) Opt. P. 323.—(q) Opt. P. 325.

" leſtial Spaces; ſo that if the elaſtic Force
" of this Medium be exceeding great, it may
" ſuffice to *impel* Bodies from the denſer
" Parts of the Medium, towards the rarer,
" with all that Force or *Impulſe* which we
" call GRAVITY."—At the Concluſion of his *Principia* he tells the ſame. (r) He farther ſays, " We might add ſomething concerning
" a certain moſt *ſubtile Spirit*, which *pervades*
" and lies *hid* in all Bodies; by the *Force*
" and *Action* of *which Spirit*, the Particles
" of Bodies mutually *attract* one another, at
" near Diſtances, and where, if contiguous,
" the elaſtic Bodies operate at greater Diſ-
" tances, as well repelling as attracting the
" neighbouring Corpuſcles, and Light is
" *emitted*, refracted, inflected, and heat Bo-
" dies; and all *Senſation* is excited, and the
" *Members of animal Bodies move at the Com-*
" *mand of the Will*, namely, by the Vibrati-
" ons of this *Spirit*, mutually propagated,
" along the ſolid Filaments of the Nerves,
" from the outward Organs of Senſe, to the
" Brain, and from the Brain to the Muſcles."

Then

(r) Pemberton, P. 406.

Then in his Opticks, in Order to convey to us a Notion how this Agency was performed between the *Light proceeding* from the *Sun*, and the *Spirit* descending from the *Extremities*.— He has these Words. "The same "*great Weight* (or Spirit) may condense "those Vapours and Exhalations, as soon as "they shall at any Time begin to *ascend* from "the *Sun*, and make them presently fall "back *again into him*, and by that Action, "increase his Heat *much after the same Manner* that in our Earth the Air *increases* the "*Heat of a culinary Fire*. (f) But, says he, "it is difficult to explain how Rays can be "alternately in Fits of easy Reflection, and "easy Transmission; unless perhaps one "might suppose, that there are in *all Space*, "TWO, (*Light* and *Spirit* as he mentions "before) ethereal, vibrating Mediums."— Perhaps we may not get a more clear Description of the Agency of Nature than the above, from *Sir Isaac Newton*; the Truth of which all the *Phenomena* of Nature confirm, as well as the Scriptures; hence I shall take

(f) Opt. P. 339.

take the Liberty of adopting his two Agents, *Light* and *Spirit*; and, note, that whenever I make Uſe of either, I may be underſtood to mean the ſame by them, as has been above deſcribed from Sir *Iſaac Newton*.

Having now extended my Letter to a Length, that I think, will tire your Patience, and the next Thing coming on to be explained being Vegetation, which will require another long Letter, I ſhall now conclude this, with a Promiſe that you ſhall receive another in a few Days.

I am,

DEAR SIR,

Your Friend,

And humble Servant,

F. PENROSE.

STONEHOUSE,
Oct. 4, 1783.

To JOHN HEAVISIDE, Esq.

Vegetation when it first began:—The Agents which carry it on described; together with the Method Nature makes use of for that Purpose.—The Vegetation of a Seed and Bud. Experiments from Dr. Hales, to ascertain the Effects of Heat and Cold on that Operation of Nature.

DEAR SIR,

MY last Letter I finished with the Waters being gathered together in *one Place*, and the dry Land appeared; and God said, let *the Earth bring forth Grass, the Herb yielding Seed, and the Fruit Tree yielding Fruit after his Kind, whose Seed is in itself, upon the Earth: and it was so. And God saw that they were good.*—On this the third Day ended,

It may be observed, that God, on the first Day, caused a *Splendor*, an *Irradiation*, amongst the Darkness, which covered the Faces

Faces or Surfaces of the Waters. Theſe *Sir Iſaac Newton* obſerves, were the Agents, (which we find *afterwards* God called Heavens) to which he gives the Name Ethers, and filled all the celeſtial Space from the Sun to Saturn, and beyond.—Theſe Agents, by their continual Conflict, cauſed an Expanſion, and formed the terraqueous Globe.—Thus the Light by entering, opens and expands—and the Spirit, by preſſing, forces every Thing cloſer together.—We are now told, that theſe Agents had a free Acceſs to the Surface of the Earth, which by their Agency brought forth Graſs; the Herb yielding Seed, &c. whoſe Seed was in itſelf.——— Thus we find that Vegetation was the firſt Operation theſe Agents produced, after the forming of the terraqueous Globe.—And, perhaps, it is the *firſt in Dignity* that we ſhall be capable to underſtand—therefore, as it muſt be allowed, that the *Phenomena* produced by Nature, are much more *certain* and *leſs equivocal*, than what are obtained from Experiments of our own deviſing; ſo I ſhall endeavour to explain, in the beſt Manner I

can,

can, the Agents employed to perform it. Now let it be remembered, as we have already obſerved from Sir *Iſaac Newton*, that *Light*, and its perceivable *Effect*, *Heat*, and *Spirit* or *Cold*; together with the *Atmoſphere*, *Water and Earth*, are the Things required to produce and carry on Vegetation.

Boerhaave ſays, that *Fire* and *Motion* are ſynonymous Terms; which, as he obſerves, is proved thus; Fire by its entering Bodies, and producing *Heat*, their Parts are dilated, and muſt neceſſarily be moved farther aſunder; whether they be Solids or Fluids.—Thus, an Iron Bar, being heated, increaſes in all Dimenſions, and the more ſo as it is farther and farther heated; but on being again expoſed to the *Cold*, it contracts, and its Parts are forcibly *preſſed* together, and return through all the Degrees of Dilatation, till it comes to its firſt Bulk, or to the ſame Degree of Heat which it had when that additional one was firſt applied; being *never two Minutes of the ſame Dimenſions*.— Hence, ſays *Boerhaave*, "If there were the greateſt Degree of Cold,

" and all Fire were taken away, all Nature " would grow into one concrete Body, *ſolid* " *as Gold, and hard as Diamond.*—But, up- " on the Application of Fire, it would *re-* " *cover its former Mobility.*—Conſequently " every Diminution of Fire is attended with " a proportionable Diminution of Motion, " and *Vice Verſa.*"—Now, as we have the Authority of *Sir Iſaac Newton* and *Boerhaave,* to affirm that the Heavenly Spaces, and all Matter, are filled with an ethereal Fluid, which acts in two Capacities, viz. by *Light* or *Heat* entering their Parts, and expanding them, and by *Spirit* or *Cold compreſſing and forcing them together*; we ſhall endeavour to trace out the Method Nature makes uſe of to cauſe Vegetation from a Seed to a perfect Plant or Tree.

Every Year, nay every Day, Experience confirms us, that *Heat* and *Cold,* which are the *Signs* of *Light* and *Spirit,* are the operating Cauſes of Vegetation.—Thus, on the coming on of Winter, as the Heat of the Sun decreaſes, Vegetation languiſhes in Pro-

portion

portion as he withdraws his Warmth.—— Thus, if the Autumn proves warm, Vegetation is carried on with greater Vigour, and longer, than when, on the contrary, cold prevails.—And in the greateſt Cold, in our Winter, it is quite ſtop'd and at a Stand; and thus it continues, till by the Increaſe of Heat in the Spring, the vegetable Juices are again put into Motion, when Seeds, Plants, and Trees begin to vegetate.—Therefore, in Order to explain this Operation, I ſhall take the following Method.—1ſt I ſhall examine, after a Seed is put into the Ground, what are the Cauſes which make it vegetate, and to become a Plant:—2dly, what are the Cauſes, when Spring comes on, that make Plants and Trees to vegetate, and puſh forth their Buds and Leaves; and 3dly, when Summer advances, what occaſions Trees to grow, to bring forth their Fruits and Seeds to Perfection.

Thoſe Perſons who have been moſt converſant with, and who have made the greateſt Diſcoveries in microſcopical Obſervations, aſſert,

aſſert, that every Herb and Tree bear their own proper Seed, after their Kind.—Theſe, on being thrown into the Earth, which is of a proper Heat, Moiſture, &c. ſpread forth their Roots, and receive from thence their Nouriſhment and Support.—That the Lineaments of the future Plants, of every particular Kind, are in the Seed itſelf.—So is the Form of every Shoot of a Tree in the Bud, before it is forced open, and made to grow by the natural Agents acting thereon. Theſe Buds, on the coming on of the cold Weather in Autumn, are covered cloſe, and defended therefrom, by a thick mucilaginous and gummy Juice, very obſerveable in many Trees, eſpecially the Horſe Cheſnut, Aſh,&c. and thoſe Trees which ſhed their Leaves firſt, and are lateſt in the Spring before they Shoot. This gummy Subſtance continues thereon, till the Warmth of the Spring, or *ſome artificial Heat*, diſſolves it, and frees the Bud from this obſtructing Matter.— The ſame Heat which diſſolves the Gum, penetrates the Bark of the Tree, thins and makes fluid the Juices contained in the *vaſcular Series* of Veſſels,

Veſſels, between the Bark and the Wood, and expands them.—The Manner and Power of which may be underſtood by the Effect Warmth has on a Bottle of Ale, or other Liquor, which it expands with ſuch Force, that unleſs it finds a Paſſage by the Mouth of the Bottle, or ſome other Way, it burſts the containing Bottles.——This expanſive Force continually increaſing by the freſh addition of Heat, enters the Bud; (a Paſſage being made through the Rind for that Purpoſe;) where the Reſiſtance of the gummy Subſtance being taken away, it expands his Parts, and ſpreads open its Leaves.—When this is done, it becomes in a growing State; the Method of which will hereafter be explained; but before we do that, it will be proper to examine the Make and Form of the different Parts of a Plant or Tree which I ſhall now deſcribe.

1ſt. There is a thin outer Rind. 2dly. The *inner Rind* much thicker than the former, though both theſe Rinds are in general but thin, and of a *reticular* Form, with a Series of

of Veſſels between them; all theſe expand and dilate as the Tree increaſes in Size.—— Their Uſe ſeems to be for the ſame Purpoſe as the Skin of Animals, either to inhale or exhale, according to the Alterations of the Weather, and alſo to dilate for the Enlargement of the Tree.—The 3d is the *Blea*, of a *ſpungy Nature*; it is of a conſiderable Thickneſs, and Uniform in its Texture, compoſed of hexagenal Cells, which appear to be deſigned for Reſervoirs, for containing the watery and nouriſhing Particles, abſorbed from the Atmoſphere, under which lie the 4th Subſtance, called the *vaſcular Series*.— Its Structure is extremely Simple, being a ſingle Courſe of greeniſh Veſſels, lodged between two Membranes.—Theſe Veſſels have a free Communication with the Wood and *Blea*.—Here are found the greateſt Part of the Juices for the Support of the Plant or Tree, all theſe paſs upwards or downwards, according as the Heat or Cold, Moiſtneſs or Dryneſs prevail.—Here the Weather has a great Influence, for as the Heat from the Sun gets Strength, in the Spring of the Year,

Year, it thins and expands the mucilaginous Juices here contained, and forces out the Bud. On the contrary, as the Cold of Winter advances, these Fluids are condensed, thickened, and become mucilaginous.—We come next to the 5th, the Wood, and 6th, to the pyramidal Vessels contained therein; these pyramidal Vessels are not continued Tubes, are seldom found many Inches long, (as may be observed in Oak, Elm, and Horse Chesnut, &c.) and resemble these in the Bones of Animals.— A new circular Ring of these Tubes are formed every Year; these which are formed in Summer, are larger than those formed in Winter.—These Rings of Tubes, facing the South, are also larger than those towards the North; so that most Trees are *eliptical* instead of round, with the most prominent Side towards the South.— A new Root, a new Branch, and a new Circle of Fibres are formed every Year: Thus it may be observed, that a Root or Branch of the last Year, has only one Circle of Fibres, whilst the other Roots and Branches, as well as the Trunk, have as many Circles as they

are

are Years Growth.—The Roots are pushed forward, and formed from a Substance, found at the Extremity of every fibrous Root, in Form of a spungy Nipple.—The 7th is the *Pith*.—Whatever Part of the Plant we examine, we find these *seven* and no more.—The Root, the ascending Stalk, and descending Fibre, are one and the same, and not three Substances.— The Fibres of the Root *are supposed to be simple, capillary, Tubes*; but, upon a minute Inspection, we discover them to consist of the same component Parts of the Plant.

The only Part remaining necessary to be described are the Leaves, which are found to be formed of a Number of Vessels, interwoven amongst each other, in a net-like Form, very much resembling the Anastomosis of the Blood Vessels in the Lungs of Animals, and appear to be of the same Use to Vegetables, that the Lungs are to Animals, viz. to throw off the superfluous Moisture; these have innumerable Openings, which answer both for the Discharge of the superfluous Moisture,

Moiſture, and alſo for receiving the nutritious Particles from the Atmoſphere.—The Leaves are formed by the expanding and unfolding the Buds: theſe Buds make a Perforation through the ſeveral Integuments, whereby an eaſy Paſſage is given for the expanding Sap, to enter, to enlarge, and unfold the Leaves, which are ſpread out thereby, and being full of Pores, the Heat from the Sun has an eaſy Paſſage through them, and thereby to enter their Fluids, and expand them, till they are *ſpecifically lighter* than the ſurrounding Atmoſphere, and are forced off by it.—Theſe Pores alſo admit the deſcending Dew, when the Coldneſs of the Air is ſo far increaſed as to overpower the internal Heat of the Juices contained in the Plant.—Having given an anatomical Deſcription of the different Parts of a Tree or Plant, if you deſire any Thing farther on this Subject, I would adviſe you to conſult *Malpighi* and *Grew*, or a more late Author, the ingenious Dr. *Hunter*.

In Order to prove my Theory on Vegetation, it may be thought neceſſary to pro-

duce ſome Experiments, as well as the *Phenomena* of Nature, to confirm it.—As I cannot make, or find any more fit for this Purpoſe, than theſe already made by Dr. Hales, who, (as will be allowed by all) was accurate in making, and faithful in relating them, and had no farther Intention to anſwer, but that Truth might appear; for the above Reaſons I ſhall take the Liberty to tranſcribe ſome of them in his own Words.

Dr. Hales tells us, that in Order to be informed how far Heat and Cold anſwered the different Purpoſes of Vegetation, " He " made uſe of ſix Thermometers, the firſt of " which was above Ground, in the open Air; " the ſecond two Inches under Ground, in a " South Aſpect, the other four at different " Depths, till the ſixth was two Feet under " Ground; (he tells us) that he kept a " Regiſter of their Riſe and Fall, during the " Month of Auguſt, and obſerved, that in " the greateſt Noon-Tide Heat, the Spirit " in that Thermometer, which was expoſed " to the Sun, was riſen, ſince early in the " Morning,

" Morning, from 21 to 48 Degrees.—The
" ſecond Thermometer, whoſe Ball was two
" Inches under Ground, was at 45 Degrees,
" and the 3d, 4th, and 5th Thermometers
" were gradually of leſs and leſs Degrees of
" Heat, as they were placed lower in the
" Ground, to the ſixth Thermometer, which
" was two Feet under Ground, in which the
" Spirit was 31 Degrees high; the 5th and
" 6th Thermometers, kept nearly to the
" ſame Height both Night and Day, till to-
" wards the End of the Month; when, as
" the Days grew ſhorter and cooler, they
" then fell to 27 and 25 Degrees. (t)

" When in the coldeſt Day in Winter,
" the Froſt was ſo intenſe as to freeze the
" Surface of the ſtagnant Water, near an
" Inch thick; then the Spirit in the Ther-
" mometer, which was expoſed to the open
" Air, was fallen four Degrees below the
" freezing Point; the Spirit of that Ball
" which was two Inches under Ground, was
" four Degrees above the freezing Point;
" the

(t) Hales's Staticks, Vol. I. Ex. XX.

" the 3d, 4th, and 5th Thermometers were
" proportionally fallen, less and less, as they
" were deeper to the sixth Thermometer;
" which being two Feet under Ground, the
" Spirit was ten Degrees above the freezing
" Point.—In this State the Work of Vege-
" tation seemed to be at a stand, at least
" within the Reach of the Frost.—But when
" the Cold was so far relaxed, as to have the
" Spirit in the first Thermometer, but five
" Degrees above the freezing Point, the se-
" cond eight, and the sixth thirteen Degrees,
" though it was still very cold; yet this be-
" ing some Advance from Freezing towards
" *Warm*, and *there being consequently some*
" *Expansion in the Sap*, several Evergreens
" and hardy Plants grew."

The above Experiments of Dr. Hales, on the six Thermometers, from that in the Air, to that which was two Feet under Ground, show us the different Degrees of Heat at the different Depths, and also the Manner in which they retained it.—It must also be remembered, that Solids and Fluids acquire

their

their Heat ſooner, and retain it longer, in Proportion to their Denſity.—Thus, put a Piece of Metal in Water, and place it on the Fire; the Metal will be ſo hot as not to be touched, by the Time the Water is warm:—Alſo, if you ſit near the Fire, with a Key in your Pocket, the Key will be hot, and your Cloths hardly warm.

The ſame Thing may be obſerved, where the Sun ſhines upon a Piece of Metal; this, in a ſtrong Sun-ſhine, will be found to be much hotter than the ſurrounding Atmoſphere.—The ſame Effect may be obſerved with Regard to Cold, as has been by Heat, viz. by expoſing a Key to the *Cold Ether*, in a Froſt, it will be found to acquire a Degree of Coldneſs, much exceeding that of the Atmoſphere.—Hence, (as will be explained hereafter) as the Earth is 1500 Times denſer than the Air, ſo it will be found, by that Means, to be very uſeful in carrying on Vegetation.

From the above Facts, I ſhall endeavour to

to draw proper Conclusions: In Order to do this, I shall observe the different Changes a Vegetable undergoes, from the Seed to a perfect Plant.—For this Purpose I shall make Choice of a Kidney-Bean; as in that, these different Changes, which the Seed undergoes, will be more perceivable than in some others.

By putting a Kidney-Bean into the Ground, and covering it with a proper Quantity of Mould, at a proper Season of the Year; in a few Days, the warm ascending Vapour from the Earth enters its Pores, and forcibly expands the Lobes of the Bean:—This expanding Vapour, (from the make of the Bean,) is forced from these Lobes into the capillary Vessels of the Radicle, which, by continually receiving a fresh Supply, is forced out and elongated, which when extended to a certain Degree, resists more than the Power from above; at this Time, still receiving additional Nourishment from the Earth, the expanded Seed Leaves are forced out of the Ground; after this the *Plume* being uncovered, by the opening of the Lobes, the expansive

panſive Force opens and unfolds its Leaves, and when they are ſufficiently enlarged, ſo as to throw off the ſuperfluous Moiſture, becomes a perfect Plant, an hydraulic Machine, *Sui Generis*, and wants no more Aſſiſtance from the Lobes, which now drop off as uſeleſs.

Having now, according to my Propoſal, explained the Method whereby a Seed becomes a perfect Plant, and, as my Letter is already extended to a greater Length than, perhaps, you will like to read at one Time, I will leave the Conſideration of the Means and Cauſes of its Growth and Support, to my next Letter, which you may expect to receive ſoon after this.

Adieu,

F. PENROSE.

STONEHOUSE,
Oct. 11, 1783.

To JOHN HEAVISIDE, Esq.

Experiments from Dr. Hales, which prove that Vegetables inſpire and expire according to the Dryneſs and Moiſture, and the Heat and Coldneſs of the Air.—The Method Nature makes uſe of to perform Vegetation.—Trees and Vegetables grow in the Form of a Pyramid, unleſs prevented.—The Cauſe aſſigned why Plants in a Green-houſe, or other Room, point towards the Window.—The Juices of Vegetables always in Motion, but do not circulate like the Blood in Animals.— Some more Experiments from Dr. Hales, to explain the Method Nature makes uſe of in the Bleeding Seaſon, (in the Spring of the Year) to force out the Buds and Leaves.

Dear Sir,

I Finiſhed my laſt Letter with the Account of the Progreſs of a Vegetable from a Seed to a perfect Plant; and according to my Promiſe, I have ſent you an Account of the Methods

Methods Nature makes uſe for its future Growth and Support.

Having received the greateſt Information for doing it, from the Experiments of the judicious Dr. Hales, I ſhall now take the Liberty to make Uſe of ſome more of them, for confirming what I ſhall now ſend you.

The following Experiments were made in Order to obſerve the different Effects produced by the different Degrees of the Heat by Day, and the Cold by Night;—on the Growth of Vegetables; and alſo, the different Effects produced on them, by the different Changes of the Weather.—For this Purpoſe he planted a Cabbage and a Sunflower, each in a Pot, which he conſtantly weighed every Day, for a Month.–He found, " that ſome Days the Cabbage perſpired, " when the Weather was hot and dry, more " than a Pound and Half.—That the Sun- " flower, in twelve Hours, of a very warm " Day, perſpired one Pound and fourteen " Ounces; the middle Rate one Pound four

" Ounces;—The Perſpiration of a warm, dry
" Night, without any ſenſible Dew, was a-
" bout three Ounces; but when any ſenſible
" but ſmall Dew, then the Perſpiration was
" nothing.—When a large Dew, and ſome
" little Rain in the Night, it increaſed in
" the Weight two or three Ounces. (u)

From the above Experiments, it may be obſerved, that theſe Vegetables perſpired more or leſs, according to the State of the Atmoſphere which ſurrounded them, whether it was warm or cold, moiſt or dry;—That they *perſpired* moſt in a warm and dry Air; on the contrary, in moiſt Weather, or a large Dew, they *inſpired* very conſiderably from the Atmoſphere, as their Increaſe of Weight demonſtrates.

Hence it is clear, from the foregoing Experiments, that the Leaves of Plants are ſerviceable towards carrying on the Work of Vegetation, in bringing Nouriſhment from the

(u) Hales's Staticks, Vol. I. Exp. 1.

the lower Parts and Roots;—Plenty of Dew is imbibed by them, by which Means they receive a great Part of their Food from the Atmoſphere, which is always ſtocked with vegetable Nouriſhment.— Hence we find, that after the Plume of the Seed, and the Leaves are puſhed out, they perſpire or inſpire, *according to the Heat*, the *Coldneſs*, the *Dryneſs*, or *Moiſtneſs* of the Air; in the Day-Time, when the Air is hot and dry, it dilates, and expands their Pores, (more eſpecially when the Sun ſhines) and rarefies their Juices, whereby it aſcends in the Atmoſphere; thus a *Vacuum* is made, and Room is given, for the Sap aſcending from the Roots!

The ſmall fibrous Roots act the Part of *Syphons*, and the moiſt Vapour, aſcending from the Earth, is abſorbed or ſucked in, by the Roots, faſter or ſlower, more or leſs, in Proportion to the Number of Roots, and the Rarefaction of the Fluids in them; for theſe Juices will *recede* and *accede* according to the Heat and Rarefaction, or Cold and Compreſſion, till an Equilibrium is formed:—When that

that happens to be the Caſe, and every Pore and Veſicle is filled, then the Moiſture, Dew, or Rain will remain on the Leaves, in the ſame Manner as it may be obſerved to do on oiled Paper, when every Pore of the Paper is filled with Oil.—This may often be obſerved in a growing Seaſon, in the Morning, in the Spring of the Year.

Thus, ſo long as the Heat proceeding from the Sun, is powerful enough to rarefy the Juices, in the Leaves of the Plant, to a ſufficient Degree, they continue to perſpire the ſuperfluous Juices, aſcending from the Roots, and what they ſend up, as regularly continue to ſupply the Place of thoſe perſpired; unleſs (as it ſometimes happens) in a hot and ſultry Day, that there is more Moiſture perſpired by the Leaves, than the Roots can ſufficiently ſupply, during that Time.—When this happens to be the Caſe, we obſerve the Leaves of the Plant to flag, and to continue in that State till the Coldneſs and Moiſtneſs of the Air is ſo far increaſed as to prevent the Heat from rarefying more Juices than can be ſupplied in the ſame Time from the Roots.

As the Heat of the Sun goes off in the Evening, and the Air becomes colder, and loaded with Dew, the Perſpiration of the Leaves abates, till the Coldneſs and Denſeneſs of the Atmoſphere, together with the deſcending Dew, fill up the Pores of the Leaves, ſtop the Motion of the Sap upwards, and by its Increaſe of Gravity, makes the Sap to deſcend towards the Roots, and carry with it from the Dew, ſuch nutritious Particles of the Atmoſphere, as it may contain: thus it finds its Way to the moſt capillary Roots, forces out the Sap that Way, and elongates them!

The Difference of Denſity between the Earth and the ſurrounding Atmoſphere, adds greatly to the Growth or Elongation of the Roots of Trees and Vegetables: The Earth being ſo much denſer than the Atmoſphere, it retains the Heat, it receives from the Sun, a conſiderable Time longer; neither is it ſubject to the ſudden and great Changes often occaſioned in the Atmoſphere; indeed ſome little below the Surface (as was proved by the

the Thermometers) it retains the ſame Heat great Part of the Summer, Night and Day.

It is the Nature of Trees and Vegetables, (if their Growth is not prevented by other Trees or Vegetables ſtanding too near them) to take the Form of a Pyramid; the loweſt lateral Branches being longer than thoſe immediately above; and, as the Tree advances, the lateral Branches ſucceed in firſt, ſecond, and third Order, &c.—Thus they continue to grow in this Manner, unleſs the Rarefaction and Perſpiration of theſe lateral Branches are prevented by others growing too near them, as may be obſerved to be the Caſe in thick Woods, Groves, Corn, and other Vegetables, which ſtand ſo thick and cloſe to each other, as to ſhade and hinder the Expanſion and Condenſation by the Heat and Air, and of Conſequence the Perſpiration of the lateral Branches.—When this happens to be the Caſe, the Rarefaction and Perſpiration can only be carried on in the upper Part of the Tree or Plant:—Hence, by the Sap being perſpired from the top Branches only, the

the Tree is enlarged in no other Part, and grows in Height only; thus, by the Perſpiration being carried on no where but the Top, moſt, if not all, the lateral Branches, periſh for want of Perſpiration, and of Conſequence Nutrition. — Hence, the Reaſon why Trees grow upwards, for the Sun-Beams deſcend in ſtraight Lines to the Earth, and enter the Tree at its Top, whereby the greateſt Rarefaction will be there, and the Juices in the Tree, aſcending from the Root, will be forced thereto, and the Branches will there be enlarged and lengthened; but when Plants ſtand ſingle, or at a proper Diſtance, and ſurrounded with a Freedom of Air, the lateral Branches grow in a juſt Proportion to the Top, as *the Atmoſphere, and all Fluids, preſs equally every Way.*

Hence alſo is the Reaſon why Plants, in a Room or Houſe, where there is but one Window, (eſpecially if that Window faces the South;)—the Plants placed therein will always grow towards the Window, where the Sun-Beams and Light enter: Thus, Plants

Plants which perſpire very plentifully, as the Sun-flower, may be obſerved in Height of the growing Seaſon, to follow the Sun, with their Tops pointing to him; in the Morning they bend towards the Eaſt, at Noon South, and in the Evening towards the Weſt.—By the ſame Cauſe, Trees or Plants, near a Wall, always grow from it, pointing towards the Sun; nay if a Plant is placed in ſuch a Situation, that no Sun-Beams are ſent on it, its Growth will tend to the Place from whence the Light proceeds

Thus, during the Summer Seaſon, when there is Heat enough to make Vegetables grow, their Juices are in continual Motion, as well as the Blood in Animals, but with this Difference; that the Blood in Animals undergoes a continual Circulation, but the Motion of the Sap in Vegetables, is only from their Roots, through their whole Subſtance, where, at particular Places, the *plaſtick* Make of thoſe Parts abſorbs and retains ſuch Portions of the nutritious Juices, as are proper for their Support and Increaſe.—Thus it may

may be obſerved, particularly in a Grain of Wheat, which puts forth three different Succeſſions of Roots, for the different Periods of its Growth; firſt, after putting a Grain of Wheat in the Ground, three Fibres are ſhot from the Radicle; upon the Wheat ſpearing, freſh Fibres are ſtruck out; ſoon after they are eſtabliſhed, the three firſt Fibres, with their Branches, gradually decay.—As ſoon as it comes in Ear, freſh Fibres make their Appearance, ſoon after which the ſecond decay. The above Account of theſe *three* Sorts of Roots, made by *culmiferous* Plants, are given us by the ingenious Dr. *Cullen*, who tells us it was a Diſcovery of *Bennet's*, and are termed by him, the *Infancy*, the *Adoleſcence*, and *Maturity* of the Plant.

Now let the Unbeliever, who makes an *Idol* of his own Underſtanding, meditate on the Power given by God, to a Vegetable, to enable every Part thereof to cull and appropriate ſuch Parts only, of the nutritious Juices they receive, as are fitted for the Growth and Support of theſe only, whether it be for Leaves,

Roots, Stalks, Flowers, or Seeds.— If he cannot underſtand the Actions of this *ſimple Machine*, let it humble his Pride ſo far as not to be Wiſe above what is revealed!

Having explained the Method Nature makes Uſe of to cauſe the Vegetation and Growth of Plants, I ſhall now, as I propoſed, endeavour to explain the Means whereby Trees puſh forth their Buds, Leaves, Fruit, and Seeds.—In Order to do this, I ſhall again take the Liberty to make uſe of ſome more of Dr. *Hales*'s Experiments, which he made on Vines, to aſcertain the Strength of the Expanſion of the Sap, at the Bleeding Seaſon, in the Spring of the Year.—" April 6th, " at nine, A. M. Rain the Evening before, " he cut off a Vine, on a Southern Aſpect, " two Feet nine Inches from the Ground; " the remaining Stem had no lateral Branches; " he fixed on it a mercurial Gage.—At 11, " A. M. the Mercury was riſen 15 Inches.— " at 4, P. M. it was ſunk an Inch." (v)

" April 7th, at 8, A. M. riſen very little,

" a

(v) Hales's Staticks, Vol. I. Exper. XXXVI.

" a Fog:—At 11, A. M. 17 Inches high, " the Fog gone."

" April 10th, at 7, A. M. Mercury 18 Inches high; he then added more Mercury, so as to make the Surface 23 Inches high: *The Sap retreated a little into the Stem,* upon this additional Weight, *which shews with what an absolute Force it advances.*—At Noon it was sunk one Inch."

" April 11th, at 7, A. M. 24¾ Inches high, Sun-shine.— At 7, P. M. 18 Inches high."

" April 14th, at 7, A. M. 20¼ Inches high; at 9, A. M. 22½ fine warm Sun-shine.—*Here we see that the warm Morning Sun gives a fresh Vigour to the Sap.*—At 11, A. M. the same Day, 16½—*The great Perspiration of the Stem makes it sink.*"

" April 16th, at 6, A. M. 19½ Rain.—At 4, P. M. 13 Inches."—Though it had sunk since Morning, he found by Exp. 34, that

that it had risen since Noon two Inches.—*This Difference he says was accasioned, in the first, by the Perspiration of the Sap.*—The other Stem being *so very short*, there was little Room for it."

"April 17th, at 11, A. M. 24¼ high, Rain and Warm; at 7, P. M. 29½ fine warm rainy Weather, *which made the Sap rise all Day, there being little Perspiration by Reason of the Rain.*"

"April 18th, at 7, A. M. 32½ Inches high, *and would have risen higher, if there had been more Mercury in the Gage.—From this Time, to May the 5th*, the Force gradually *decreased.*—The greatest Height of the Mercury being 32½ Inches, *the Force of the Sap was equal to* 36 *Feet*, 5½ *Inches Height of Water.*

"Here the Force of the rising Sap in the Morning, is plainly owing to the Energy *(of the Sap)* in the Root and Stem.—In another mercurial Gage, (fixed under the Bottom

tom of the Vine, which ran twenty Feet high) the Mercury was raiſed by the Force of the Sap, 38 Inches, equal to 43 Feet, 3 Inches ½ of Water.—— As the greateſt Height the Atmoſphere will riſe Water is thirty-two Feet, ſo this Force was about *one Third greater* than the Preſſure of the Atmoſphere."

Dr. Hales tells us "That the Mercury conſtantly ſubſided in a Gage, fixed on a Branch of a large old Vine, by the Retreat of the Sap, about nine or ten in the Morning, when the Sun was hot; but in a moiſt, foggy Morning, the Sap was later before it retreated viz. till Noon, or ſome Time after the Fog was gone."— About four or five o'Clock, P. M. when the Sun went off the Vine, the Sap began to puſh afreſh into the Gages, but it always roſe faſteſt from the Sun Riſe, till nine or ten in the Morning.— The Sap on the Branch of a large old Vine played the moſt freely to and fro, and was therefore ſooneſt affected with the Changes from hot to cold, or from wet to dry, and

Vice

Vice versa."(w)—He obſerves that the great Force, exerted by the Branch of this large old Vine, "was not from the Root only, but muſt alſo proceed from ſome Power in the Stem and Branches."—After the Leaves are puſhed out, no Trees will then bleed, neither have they any Force to puſh out their Sap; *all* is then perſpired by the Leaves.—"Moiſture and Warmth made the Sap moſt "vigorous, Ex. 38, but the Vigour of the "Sap would immediately be greatly abated "by cold Eaſterly Winds." (x)

"If, in the Morning, while the Sap is in a riſing State, there was a cold Wind, with a Mixture of Sun-ſhine and Cloud; when the Sun was clouded, the Sap would immediately ſubſide, at the Rate of an Inch in a Minute, for ſeveral Inches, if the Sun continued ſo long clouded: But as ſoon as the Sun-Beams broke out again, it would immediately return to its then riſing State, juſt as any Liquor in a *Thermometer* riſes and falls with the Alternacies of Heat and Cold; whence, ſays he, it is probable, that the plentiful

(w) Hales's Exp. XXXVI.—(x) Exp. XXXVIII.

plentiful Rise of the Sap, in the Vine, in the Bleeding Season, is effected in the same Manner.—When, says he, three Tubes were fixed at the same Time to Vines on an *eastern*, a *southern*, and *western* Aspect, round my Porch, the Sap would begin to rise in the Morning, first in the eastern Tube, next in the southern, and last in the western Tube: and towards Noon it would accordingly begin to subside, first in the eastern Tube, next in the southern, and last in the western Tube."

"Rain and Warmth, after cold and dry, would make the Sap rise all the next Day, without subsiding, though it would rise then slowest about Noon.—The Sap begins to rise sooner in the Morning, in cool Weather, than after hot Days."

"When at the Distance of four or five Days, Tubes were fixed to two different Branches, which came from the same Stem, the Sap would rise highest in that which was last fixed; yet, if in the fixing the second

Tube,

Tube, there was much Sap loſt, the Sap would ſubſide in the firſt Tube."

"In very hot Weather, many Air-bubbles would riſe, ſo as to make a Froth an Inch deep, on the Top of the Sap in the Tube."

"But when towards the latter End of *April*, the Spring advances, and many young Shoots are come forth, and the Surface of the Vine is greatly increaſed and enlarged by the Expanſion of the ſeveral Leaves, whereby the Perſpiration is much increaſed, and the Sap more plentifully exhauſted, it then ceaſes to flow in a viſible Manner, till the Return of the following Spring."

"And as in the Vine, ſo is the Caſe the ſame in all the bleeding Trees, which ceaſe Bleeding as ſoon as the young Leaves begin to expand enough to perſpire plentifully, and to draw off the redundant Sap.

Exp. 44, "Since by other Experiments it is

is found, that the greateſt Part of the Sap is raiſed by the Warmth of the Sun on the Leaves, which ſeem to be made broad and thin for that Purpoſe; for the ſame Reaſon it is probable, it ſhould riſe alſo, in thoſe Parts which are moſt expoſed to the Sun, as the Bark is" ——— "It is found that the Trunk and Branches of Vines were always in an imbibing State, *cauſed by the great Perſpiration of the Leaves, except in the Bleeding Seaſon.*" (u)

Therefore to prove the great Power Seeds receive, (when ſown) from the expanſive Power of a warm Vapour — Dr. Hales put ſome Peas into an Iron Pot, with ſome Water, and then fixed on it a Cover, and on that 184 Pounds Weight, which the dilating Peas lifted up; he alſo found they would lift up any Weight that was not ſufficient to preſs them together. (w) "We ſee, ſays he, by this "Experiment, the vaſt Force with which "ſwelling Peas expand; and 'tis doubtleſs "the ſame *Force* which is exerted, not only "in *puſhing* the Plume upwards into the Air,

(u) Hales's Staticks, Vol. I. Exp. XLVI.— (w) Vol. I. Exp. XXXII.

" but alſo in enabling the firſt Shooting of
" the Radicle of the Pea, and all its ſubſe-
" quent tender Fibres, to penetrate and ſhoot
" into the Earth."

Having now given the Experiments I propoſed, with Regard to Vegetation, with ſome Obſervations thereon, in my next Letter, I ſhall endeavour to explain that Operation in as ſhort and eaſy a Manner as I can.

Adieu,

F. PENROSE.

STONEHOUSE,
Oct. 18, 1783.

To

To JOHN HEAVISIDE. Esq.

A Recapitulation of the Method Nature makes use of to carry on Vegetation.—The natural Agents hot and cold Ether.—Fire and Motion synonimous.—The Phenomenon of Vegetation a proper one to explain the Agency of Nature.—The Cause why Trees shed their Leaves in Autumn; and the Means made use of to push forth their Buds and Leaves in the Spring.—The Scripture Account of Vegetation perfectly agreeable with Nature. Cold and hot Ether, the Agents which support and carry on Animal as well as vegetable Life.

Dear Sir,

IN my three former Letters, I described the Agents, and the Method Nature made Use of to carry on Vegetation, which were long, and which, I imagine, you thought tedious, on Account of the many Phenomena and Experiments there related, to prove that what

what I ſaid was confirmed by Nature.—I ſhall now, in Order that you may have a more clear Perception of it, recapitulate that natural Operation in as ſhort and clear a Manner as I can.

A Recapitulation of what has been obſerved.

In the firſt Place I ſhewed from Sir Iſaac Newton's own Words, that he ſuppoſed there was an *ethereal Fluid, which filled the Pores of all Bodies*; and alſo that this Fluid filled all Space, from the Sun to the Orb of Saturn, and beyond.

Secondly, That this Fluid acted in *two* Conditions, one of which he called *Light* or Heat, and the other *Spirit* or Cold.—That theſe two were in continual Circulation and *Struggle*, from the Sun to the Extremities of the Syſtem.—The Light or Heat, aſcending from the Sun, *opening* and *expanding*; and, the Spirit deſcending to the Sun, *contracting* and *compreſſing* every Thing.—After this I gave *Boerhaave's* Account of what were the Agents Nature made Uſe of in

in her Operations, which was "That Fire "or Motion were *ſynonimous*," for, ſays he, "let an Iron Bar be heated, it increaſes in "all its Dimenſions, and the more ſo as it is "farther and farther heated; but on being "expoſed to the *Cold*, it contracts, and its "Parts are forcibly preſſed together, and re-"turn through all the Degrees of Dilatation, "till it comes to its firſt Bulk, or to the "ſame Degree of Heat which it had when "the additional one was applied, being never "two Minutes *of the ſame Dimenſions*.— "Hence, ſays he, if there were the greateſt "Cold, and all Fire were taken away, all "Nature would grow into one concreate "Body, *ſolid as Gold*, and *hard as a Diamond*. "But upon the Application of Fire *it would* "*recover its former Mobility*."

Finding that theſe two great Philoſophers, as well all the Ancients, attributed the firſt Agent in Nature to be Fire; and that all Nature were filled with an Ether, which acted in two Qualities, viz. Light and Heat, or Spirit and Cold; and imagining that the

Phenomina

Phenomina produced by natural Operations, were more ſimple, expreſſive, and leſs equivocal than Experiments produced by Art; I endeavoured to find one that would anſwer our Purpoſe; accordingly, that of Vegetation appeared to be moſt likely to do it.—Therefore I examined the Obſervations and the Explanations of different Philoſophers thereon; and found little Aſſiſtance from any but the ingenious Dr. Hales, who, from a Set of well choſen Experiments, accurately performed, and faithfully related, hath cleared this ſimple Operation from its Intricacy.

By which it appears, that a Seed is covered with an outward Shell, which is of ſuch a cloſe Contexture, as to prevent the common Atmoſphere from entering.

The Seed, by being put into the warm Ground, is acted upon by the *warm Vapour*, which is continually aſcending into the outward Atmoſphere.—The *Light* or *Heat* of this active Vapour enters the outward Shell, penetrates and expands the Lobes of the Seed

Seed (which Lobes anſwer the ſame Purpoſe to Seeds, that the *Placentia* does to Animals) expands and enlarges them; from hence, by the *plaſtick* Make of the Seed, it is forced into the Radicle, which it alſo extends and elongates, and puſhes into the Mould, and by being continually acted upon in the above Manner, it continually increaſes, till by its Number of Fibres, it receives a greater expanſive Force, by the warm Vapour it receives from below, than what is ſupplied by the Lobes, which now burſt the incloſing Shell, and by this Force, from below, are impelled above Ground, when the *Lobes* ſeparate, and the *Plume* appears, which is now enlarged, and its Leaves ſpread abroad, and becomes a perfect Plant, and the Lobes or *Secondines* drop off as uſeleſs.

A Plant and a Tree are hydraulick Machines, and are ſupported and made to grow by the two Agents *Light* or *Heat*, and *Spirit* or *Cold*.—As either one of theſe act upon the Parts of the Plant or Tree, ſo does its Growth and Increaſe go on.—A Tree is compoſed of a

Root

Root which is in the Ground, a Trunk above the Ground, and Branches which are ſpread in the Air, anſwering to the Roots below.— Now it is found by Experience, that you may pull up a young Tree by its Roots, plant the Boughs or Branches in the Ground, and let its Roots ſpread in the open Air, as its Boughs uſed to do, it will grow in this Form, puſh out Leaves, Bloſſoms, Fruit, and Seed.— The Leaves are formed wide, thin, and full of Pores, and anſwer the ſame Purpoſe to Plants, that the Lungs do to Animals, to perſpire the ſuperfluous Vapour ſent up from the Roots.—Thus, in warm Weather, when the Sun ſhines on the Leaves, the Light or Sun-Beams enters their Pores, expands their Juices, and as ſoon as they are ſpecifically lighter than the Atmoſphere, are forced off by it.—Hence a *Vacuum* is there formed, which is immediately filled up and ſupplied by freſh Vapour aſcending through the Tree or Plant, from the Roots.—In this Manner the Juices received by the Roots, are carried throughout the whole Plant or Tree; and, after it has

collected

collected ſuch a Portion of it as is fit for the Support of every Part, the ſuperfluous Moiſture is perſpired by the Leaves :—This continues all the Day, till the Heat of the Sun-Beams begin to decline in the Evening, and the Cold increaſes.—Thus, as that comes on, the Cold condenſes ſome of the Moiſture in the Atmoſphere, and preſſes it down towards the Earth, as the Heat goes off.—The cold, moiſt Air and Spirit enter the open Pores of the Leaves, and as they overpower the Heat, force the Juices through the whole Subſtance of the Plant, down to its ſmalleſt Roots, which they force out and elongate.—In this Manner the Plant grows and increaſes in Bulk, till the Cold is ſo very powerful, to contract or preſs the Juices into a *Concreate*, when all Vegetation ceaſes, and the Leaves drop off as uſeleſs.

Thus, as the Cold of Autumn comes on, the Juices of the Tree are inſpiſſated, the Buds and outer Rind are covered with a gummy Subſtance, in the ſame Manner as is uſed to cover the Silk of a Balloon, to pre-

vent the common Air from having any acceſs within.—As ſoon as this is done, the Trees which are uſed to ſhed their Leaves, drop them off as uſeleſs, and continue in a torpid State till the next Spring.—In April, the Sun-Beams have ſufficient Power to enter the Bark of the Tree, which then expand its Juices, and make them fluid; and, by the continual Increaſe it receives every Day, it acquires a Force one third greater than the Preſſure of the Atmoſphere.—The Wood of the Tree being of a cloſer Nature, and reſiſting more than the Rind, the Juices are made to expand in the *Series* of Veſſels between the Bark and the Wood, which communicates through every Part of the Tree, and particularly with the Buds, which have Openings made for that Purpoſe, through all the Integuments of the Bark, &c. where this expanſive Force enters, develops the Buds, and forces out the Leaves; and when they are quite expanded, the Tree becomes a perfect hydraulick Machine, as was before deſcribed, and grows, and is ſupported as above.—Thus, as ſoon as the Leaves are puſhed forth, the expanſive

expanſive Force of the Juices is gone, the Tree will no longer bleed, but inſpires or expires, and thereby keeps up a continual Motion of the Juices, till they are concreted by the coming on of the Winter cold.

Having explained the Operation of Vegetation, which Moſes tells us was performed on the third Day, by the natural Agents already found to be good, and capable to do the Office God aſſigned to them.—He now put them into Action, and by this Expreſſion, *let the Earth bring forth Graſs*, gave them Power to do it.—*Thus ended the third Day, or the third Revolution of the Earth.*

It gives me Satisfaction to find, that the Method and Agency of Vegetation above deſcribed, are repreſented to be the ſame in the Scriptures, and that in this Inſtance they ſpeak philoſophically true: For Moſes informs us, (w) that Vegetables could not grow, till the Earth was ſupplied with Water or Rain, and that they were made to grow by a moiſt

(w) Gen. II. 5, 6.

moist ascending Vapour, which watered the whole Face or Surface of the Ground; and that *to those who hearkened to the Voice of the Lord, he will open his good Treasure, the Heavens, to give Rain to the Land, in his Season, and to bless all the Work of their Hands*; (x) and Job informs us, that Vegetables are nourished and supported by Earth and Water; and the Agents which perform this Operation, are the solar Light and Heat of the Day, and the Dew and Moon Shine; for, says he, *can the Rush grow without Mire or Mould? can the Flag grow without Water?* (y) Thus Moses, in his Blessings on the Tribes of Israel, tells the Tribe of Joseph, *that the Blessings shall be on their Land, for the precious Things of Heaven, for the Dew, for the precious Fruits brought forth by the solar Light, and for the precious Things put forth by the lunar Light*; (z) and in Samuel we are informed, that *the tender Grass springeth out of the Earth, by clear shining after Rain.* (1) And Job tells us, that *though the Root*

(x) Deut. XXVIII, 12.—(y) Job. VIII, 11.—(z) Deut. XXXIII. 12, 13.
(1) 2 Samuel XXXIII, 4.

Root of a Tree wax old in the Earth, and the Stock thereof die in the Ground, yet there is Hope, if it be cut down, that it will ſprout out again, and *by the Scent of Water or Vapour, iſſuing from the Earth, it will bud and bring forth Boughs like a Plant.* (2)

It may be remarked, that Animal Life is carried on and ſupported by the ſame Agents which carry on and Support the Vegetable, viz. *Light or Heat*, and *Spirit or Cold.*

Some Years ago I had the Honour of being acquainted with a Lady of Fortune, who lived in a large Houſe, but did not keep a great deal of Company; ſhe had a large Parlour which was made but little Uſe of.—In October I was ſhewn a Bat, who had taken up his Winter Lodgings on one of the Cornices.—I ſaw him many Times afterwards, between that and Chriſtmas, when he appeared Motionleſs, as if dead.—At Chriſtmas I perſuaded the Lady to have a Fire in the Room, to ſee if it would procure Life to the Bat.

(2) Job. XIV. 7, 8, 9.

Bat.—She accordingly agreed that we ſhould ſpend one Day in that Room, and have a large Fire therein.–Some Time after Dinner, when we did not think of it, we were entertained with the Flight of the Bat, who flew round the Room with great Life and Vigour.—But we found, the next Day, after a cold Night, that he was returned again to a torpid State.—The ſame Thing may be obſerved by bringing Flies into the Warmth any Time in the Winter; but what puts this beyond Doubt is, the hatching of Chickens in Stoves.—The Egg, like the Seed of Vegetables, is covered with a Shell, and theſe Eggs may be preſerved in their preſent State, a long Time, if prevented from having only a proper Degree of Heat; but put them under a Hen, or in a Stove, of a proper Temperature, in three Weeks a Chicken will be produced, who will then break the Shell, live, breathe, and feed, and be ſo far a compleat Animal as to feed itſelf.

On the 4th Day we are informed, that God made two great Inſtruments of Light, and placed

placed them in the Firmament of Heaven, to regulate or rule the Day and the Night; that they were to divide between the Day and the Night—and that they were to be the *identical Inſtruments*, to point out and divide the Seaſons, the Days, and the Years.— Thus it may be obſerved, that on this fourth Day, the Motion of the Heavenly Bodies began, and was carried on by the natural Agents; for God tells us, that he ſaw that they were good, and *capable to perform the Offices aſſigned to them.*—Here then, (as it is natural he ſhould,) Moſes begins his Chronology. (3)— The firſt four Days, till the Sun and Moon were formed, the Rotation of the terraqueous Globe was under the immediate Direction of God; but, now it was an *Automaton*, under his deputed material Agents, the Sun, (the Moon, the Stars, and the Heavens,) unleſs he thought proper, at any Time, by a Miracle, to ſtop or to alter their Agency, and ſo to convince ſkeptical and unbelieving Men.

I am, dear Sir, with the greateſt Sincerity,
Your obliged Friend,
F. PENROSE.

STONEHOUSE,
Oct. 25, 1783.

(3) Introduction, P. 5.

To F. PENROSE, Esq.

Mr. Heavifide profeſſes a great Inclination for the Study of natural Philoſophy, though he had been prevented from attending to it ſo much as he wiſhed.—He then puts the following Quere.—*In that general Diſſolution of Subſtances, which you ſuppoſe at the Deluge, why where not* Shells, Bones, Shrubs, &c. *diſſolved, as well as Rocks, Stones, &c.*

DEAR SIR,

I Cannot but take Shame to myſelf, at Sight of the Dates of the Letters you favoured me with, which I am ſorry to ſay is above three Months ago; more eſpecially as they were ſuch as I felt, and ſtill feel myſelf ſo much obliged to you for.

The only Apology I have to make, (and I wiſh I had not had it to make) is, that I was not well during the whole Autumn.—I was firſt ſeized with a Diſorder in my Bowels, (the

(the firſt I ever had) which continued three Weeks, and left a low Fever upon me, which continued as many Months. — I, however, kept on Foot all the Time, but very uncomfortably; till being quite weary of ſo long and diſagreeable a Viſitor, I determined to take a Ramble, and try to loſe him, which I put in Execution, and with Succeſs: For having rambled, for three Weeks, thro' the North of England, I returned Home very much better, and have been very well, thank God, for above a Month paſt; though, perhaps the conſtant Hurry I have lived in, during that Time, may have contributed not a little, to keep me well.

I employ this, my firſt Hour of Leiſure, to acknowledge and thank you for the Trouble you have been ſo good as to give yourſelf, to explain your Ideas of the Cauſes of thoſe Appearances we now ſee on this terraqueous Ball.—But pray do not imagine, that becauſe I have not made it ſo much my Study as you have, that therefore I take no Pleaſure in Natural Philoſophy, or that I am ſo eaſily

tired of the Subject, as not to wish for the Sentiments of so ingenious and well-informed a Searcher into Nature, as you are.— Far otherwise; for though I have been debarred of proper Opportunities of Information, and my Habits of Life have been such, as to prevent me from any close Application to Study, yet I have always felt a Propensity to know and account for the Phenomena of Nature, and the Causes of those various Appearances, which every Moment, and every where, strike the Eye of the least attentive Observer.

But as my Inlets to Knowledge have been few, very few indeed, compared to yours, it would be extreme Folly in me to contend *seriously* with you on this Subject; and therefore would wish you to look on what I object to your System, as rather designed to draw out *Information*, than to produce *Conviction*. In this Light, give me Leave to ask you, why, in that general Dissolution of Substances, which you suppose to have taken Place at the Deluge, those Shells, Bones, Shrubs, &c. that are undoubtedly found (as you

you ſay) in all Parts of the World, both on the Summits of Mountains, and in the Depths of the Earth; *why were not thoſe Subſtances diſſolved likewiſe?* And what Reaſon can be given, why the Cauſe, (whatever it was) that could diſſolve Rocks, and Marble, ſhould not diſſolve thoſe Subſtances which are of ſo much looſer a Contexture? This is a Queſtion which has juſt now occured to me, on looking into the Beginning of your Letters; and I muſt confeſs, it ſeems to me as rather favourable to my Hypotheſis than yours.—I ſhall therefore be much obliged to you for your Thoughts upon it; and as my preſent Leiſure will not allow me to enter further into your Theory, at this Time, I ſhall beg Leave to defer my further Conſideration of it, till my Hurry is a little over, when I ſhall, with your Permiſſion, trouble you with what further Remarks may occur to me upon it.

I am,

DEAR SIR,

Your very obedient,

And faithful Servant,

PRINCE'S-STREET,

J. HEAVISIDE.

Sunday, Jan. 11, 1784.

To JOHN HEAVISIDE. Esq.

Prejudices of Education hard to be overcome, therefore many Things in Mr. Penrose's Theory may appear doubtful at first, as they differ from some which are generally taught: There may be Arcana *in Nature, which human Reason may not be able to explain.—Answer to Mr. Heaviside's last Query.—A Constitution and Custom observed by the Royal Society, concerning Disquisitions.—The Waters the Outside of this terraqueous Globe, not sufficient for the Flood.—Centre of Gravity altered at the Flood.—Causes assigned why Bones, Shells, &c. were not dissolved.*

DEAR SIR,

YOUR Mind being prepossessed with *Ideas* very different from many Things in my Theory, I doubt not but some will *stick* with you, *at first*, (whatever they may do afterwards) I am sure they did so with me; but as neither you or I are any further concerned

cerned than for the Amuſement of ourſelves, and the Inveſtigation of Truth; ſo we ſhall be more likely to agree about them, than the generality of Diſputants; whoſe Endeavours are often to explain the Truth away; and I truſt, we ſhall be both ready to embrace it, let it be found by either of us.

In Order to get at *Truth*, we ought to ſuſpect our own preconceived Opinions, to diveſt ourſelves as much as may be from our Prejudices, and make uſe of the greateſt Impartiality in Judgement; for we muſt obſerve, how greatly all People are *biaſſed* to the *Ideas* which have been ingrafted on their *Underſtanding, by Education and Cuſtom*; notwithſtanding ſome of them may be the greateſt Abſurdities.—Thus, for Inſtance, we find many of the Wives of the Indian Kings are brought to believe, that by Self Murder, *(a Crime which we think the greateſt, and moſt contrary to Nature!)* they ſhall inherit the greateſt Bliſs.—Under this Perſuaſion, many throw themſelves into the Funeral Pile with their dead Huſbands; encouraged and animated

mated to it, by thoſe who are believed to be the beſt and wiſeſt of their People.—We may alſo obſerve, that a Perſon educated in Italy, will be a Catholick; in England, a Proteſtant; in Turkey, a Mahometan; in India, a Gentoo.— *Errors*, from the ſame Cauſe, reign in Philoſophy as well as Divinity; our philoſophical Opinions are generally formed in the ſame Manner, *from Education, and the Company we keep*; and often under the Protection of ſome great *Name*, whoſe Notions few dare to oppoſe, or even to inveſtigate or examine. — Thus the Earth, Moon, and Planets were believed to circulate round the Sun, by the Ancients, down to *Pythagoras*.—After that the *Ptolemean* Syſtem took Place, then the *Tychonic*, and now the ancient Syſtem is again recovered by *Copernicus*, and his Followers, and demonſtrated to be true by the *immortal Newton*, and believed by nearly All.

The above Obſervations ſhew us how eaſily we are made to believe falſe Opinions by Education, and with what Difficulty they are

are eradicated afterwards.—A great many of them are often believed to be innate, and implanted in our Mind by God.—Hence, in Matters of Consequence, we should not receive *implicitly* those Opinions we have been taught, or are generally believed as true, *without Examination*; wherever this is the Case, it must be a great Obstacle to Improvements in Arts and Sciences.—For the above Reasons, though I may observe some Things which are contrary to your preconceived Ideas, or to general received Opinions, or what you may have been taught to be true; yet, I hope, from your known Impartiality, you will not discard them without Examination.

You have chosen a Question, the Answer to which will assist to elucidate my Theory, and I hope my Explanation of it may prove satisfactory to you; although, as you observe, it has a contradictory Appearance.—" Why " in that general Dissolution of Substances, " which you suppose to have taken Place at " the Deluge, those Shells, Bones, Shrubs, " &c. that are undoubtedly found (as you " (say

" ſay) in all Parts of the World, both on
" the Summits of Mountains, and in the
" Depths of the Earth; why were not theſe
" Subſtances diſſolved, and what Reaſon can
" be given, why the Cauſe (whatever it was)
" that could diſſolve Rocks and Marble,
" ſhould not diſſolve theſe Subſtances which
" are of a much looſer Contexture?"

In the firſt Place, I ſhall beg Leave to obſerve, that though the whole Operations of Nature are ALL carried on in a *mechanical Manner*, yet there may be ſome *Arcana* which may be out of human Power to explain.—But it is the Duty of every Searcher after Truth, not to evade the Queſtion.—But if he cannot explain it, to confeſs it.—I hope, from what follows, that you will think, that I do not make the above Obſervation with a Deſire to get rid of your *Query*, but only to lay in my Claim, leſt I ſhould want it hereafter.—However, you ſhall find that I will anſwer quite to the Point in Queſtion, without Evaſion.

I ſhall

I ſhall now purſue the ſame Method I did in my former Letter, firſt giving the hiſtorical Account of the Event, and then prove it to be true from Facts or Obſervations.

It may be obſerved, that Moſes, in giving us the Account of the Flood, (which in Fact is the only one we have, or can have) tells us, that God ſaid "*I, even I*, do bring a "Flood of Waters upon the Earth."—According to this Account, it was a *Miracle*, performed by God himſelf, by altering the Operations of Nature; but yet performed by material Agents, in a *mechanical* Manner.—Had it not been performed by material Agents, it could not be Evidence to our Senſes, neither could we underſtand it, whilſt our whole Machine, by which we receive our Ideas, is material.

In Order to explain theſe ſeeming Contradictions, I ſhall obſerve the Method directed by the Royal Society.—"The Con-"ſtitution and Cuſtom of which are, that "every Diſquiſition muſt either terminate in

" a mathematical Demonſtration, or be form-
" ed upon ſome one or more Experiments,
" Obſervations, or Hiſtories of Facts, for a
" Foundation of Reaſoning, and the Con-
" cluſions drawn, muſt neceſſarily appear to
" flow from the Premiſes; and the Danger
" of drawing general Concluſions in natural
" Philoſophy, and Phyſical Diſquiſitions, lies
" not in Arguments, *a Poſteriori*, from the
" Effect to the Cauſe; but in the *hypothetick*
" Way, that is, by Parity or Similitude; to
" Parity and Similitude of Effects, which
" muſt be often a fallacious Method, and the
" Source of many Errors; for this ſame
" Cauſe, acting by one and the ſame Power,
" according to the ſame Laws, is often made
" to produce not only different, but even
" contrary Effects, according to the ſpecifick
" Differences of the Subjects acted upon.—
" Thus Heat makes Clay hard, but ſoftens
" and melts Wax, Metals, &c."—The Caſe
before us is another Inſtance of the ſame
Kind.

Here we have two Facts open to our View,
(beſides

(beſides a Number of others of the ſame Original) viz. the hardeſt Rocks ſhew us, that they were in a State of Solution, when the Shells, Bones, &c. were mixed with their very Subſtance; on the contrary, that theſe Shells, Wood, and Parts of Vegetables, are almoſt in a perfect State, though of a much looſer Contexture.

I believe all Philoſophers, who have wrote on the Flood, have allowed, that there was not a ſufficient Quantity of Water on the Outſide of this Globe, to cover it a tenth Part ſo high above it, as we are told the Waters prevailed.—If this is ſo, and the Fact is true, we muſt ſearch ſome other Place for it? none will be found but within the Bowels of this Earth; accordingly Moſes tells us, that this Flood was brought on "by the breaking up the "Fountains of the great Deep, and opening "the Windows of Heaven."—(Or, as it is expreſſed in the Original) opening the Cracks and Chinks, whereby Air paſſes through the Earth.—That Steam or Vapour is continually paſſing through them, is at this Time obſerved by Miners. It

It appears, before this *Phenomenon* could ſucceed, that the Centre of GRAVITY (let it be a Power inherent in *Solids* or *ab extra)* and the Attraction of Coheſion muſt be altered.—Let us ſuppoſe (for ſuppoſe it we muſt, as we are not informed of it) that God by his own Act, (I even I, ſays Jehovah) altered the Place of the Centre of Gravity, from within the Earth, to ſuch a Diſtance on the Outſide; the Conſequence would be as Moſes has told us it was.—The Waters would flow outwards by all the Fountains, Openings, and Chinks of the Earth, Rocks, &c. (the Number of which will be more eaſily conceived by viewing our Cliffs of Marble, than can be deſcribed) which would make no Reſiſtance (Gravity being altered) but would be diſſoved and carried away by the Impetuoſity of the Efflux, and with many other Bodies, make one common *Colluvies*.

It may be obſerved in this common Deſtruction, that Earth, Rocks, Stone, &c. (which were kept or bound together by *Gravity or Attraction of Coheſion,)* on the Alteration

ation of the Centre of Gravity, and the Efflux, caufed thereby, of the Waters, muft be reduced, if not quite, *nearly* to their fmalleft Parts.— On the contrary, Shells, Bones, Shrubs, Leaves, &c. which are not held together by Gravity, or Attraction of Cohefion, but by Fibres, Sinews, Tubes, Membranes, &c. tied, twifted, and complicated together in a wonderful Manner, would not be affected by it; the Attraction of Gravity would not untwift their Fibres, therefore thofe Parts of Animals and Vegetables, notwithftanding their foft Texture, would remain as before.

After the Waters had prevailed God's appointed Time, Mofes tells us that God remembered Noah, and would not fuffer him to be deftroyed, which he muft have been, had the Waters not affuaged.—God, by his own immediate Act, by *his Spirit*, or what may be called Ether, (this is the fame Word as tranflated Spirit, Gen. 12.) reftored the Power of Gravity to the Place appointed to

it

it before the Flood; and the terraqueous Globe was again reſtored to its priſtine Form. (4)

From what has been obſerved, the following Concluſion ſeems naturally to ariſe, that Gravity was the Agent which forced off the Waters.—If ſo, is Gravity a material Power? If it is, does it lie in Solids or Fluids?—No great Difficulty ſeems to be in giving an Anſwer to the above Queſtions!

Farewell, my dear Friend, till I write you again, which I will do ſoon.

F. PENROSE.

STONEHOUSE,
Feb. 2, 1785.

(4) See Let. I. III.

To JOHN HEAVISIDE, Esq.

As the firſt material Agents cannot come within the Knowledge of our Senſes, ſo different Philoſophers have formed different Opinions. But Aſtronomy may be proved by mathematical Demonſtration.—Hiſtory is no more than a Romance without Chronology; which is not certain, unleſs proved by Aſtronomy.—Where to begin our Aſtronomical Epoch.—Moſes's Account of the Place of the Sun and Moon at the Creation, proved by Mathematical Demonſtration.—Firſt Meridian proved by an Obſervation of Dr. Bradley's.—As Mr. Penroſe is not fearful of being convicted of Error, Leave is given to Mr. Heaviſide to ſhew this Letter to any Proficient in Aſtronomy, and get their Criticiſms on it.

DEAR SIR,

I Thank you for your Preſent of the Book, on the Deluge, which I have read already—It is coming down in Betſey's Box, on

on board the Roſe; when it arrives, I ſhall give it another Reading, and doubt not but I ſhall receive Satisfaction from ſome Parts of it; and I ſhall, (which I aſſure you I always do) *endeavour* to diveſt myſelf of all preconceived Ideas.—As the firſt material Agents, have not, neither ever can they come under the Examination and Knowledge of our Senſes; ſo different Sects of Philoſophers have formed different Hypotheſes about them, which has been the Cauſe of ſuch a Variety of Opinions.—For ſome Years paſt, my principal Study has been Aſtronomy.—A moſt ſublime Science! The *Phenomena* of which may be proved from *mathematical Demonſtration*; but even this Proof will be of no Signification to thoſe who have *preconceived* Principles of a different Nature, and are thereby *prevented from examining* whether they be true or not.—There is another Thing againſt my Notions in Aſtronomy; it requires ſome Attention to underſtand them; therefore few will be proper Judges of them; ſome of them are contrary to the general preconceived Opinions, and as popular Prejudices are difficult to be overcome,

come, *ſo theſe Notions of mine will be oppoſed.*—This Study is certainly of great Uſe; for Hiſtory is no more than a Romance, without Chronology, and there can be no Certainty in Chronology, unleſs proved by Aſtronomy: Indeed without ſome fixed and aſtronomical *Era*, to which hiſtorical Narrations may be referred, however true in themſelves, they will be deemed very little preferable to Romance. — Tho' I have heretofore troubled you with ſome of my Notions on Philoſophical Subjects, which, perhaps, you may have thought both a Waſte of Time and Trouble to read over; yet, you ſee I am ſo fond of ſcribbling, that I cannot help perplexing you with a brief Account of ſome of my aſtronomical Ideas.

In the firſt Place, I muſt agree with *Keil*, who ſays, " As in the Heavens there are cer-
" tain Points, from which Aſtronomers be-
" gin their Computations of the Planets
" Motions, ſo alſo there muſt be certain
" Points, or Inſtants of Time, from which,
" as from Roots, all Calculations muſt begin;

" and all memorable Actions are diſpoſed and " recorded, according to the Series of Years " which follows from that Root. Theſe " Roots are called *Epochs* or Eras, from " which we generally count our Years or Times." (5)

The Beginning of Time may be conſidered as an *indiviſible Inſtant*; but Time is a *determinate ſucceſſive Duration*, meaſured by Motion; ſo that Motion and Time are cœtaneous. If we trace it back to the firſt Moment, it muſt be the Inſtant before planetary Motions had any Exiſtence, or were Nothing; and when planetary Motions ſhall ceaſe, then cometh the End of Time.

If we know any thing when planetary Motion or Time began, (as moſt Hiſtorians pretend to,) it muſt be diſcovered, either by Obſervation or Calculation, or be revealed from God. But as there was no human Witneſs to the Creation, it could not be diſcovered by Obſervation, neither could it be diſcovered by

(5) Introduction, Page 7.

by Calculation: But Moſes has revealed it; and I have certainly the Liberty to take Moſes's Account as true, if I hereafter prove, from Mathematical Demonſtration, that it is ſo.

Hence I begin my Epoch of Aſtronomy, on the fourth Day of the Creation, when, Moſes tells us, the Sun and Moon were formed and placed in the Heavens, *to point out Times and Seaſons, Days and Years.* — Here then we have one *Datum* or Root, viz. the fourth Day of the Week, twelve o'Clock, (which it muſt be on the Place in which the Sun was in the Meridian.) *Joſephus* tells us, the Jews reckoned their Years by the Sun, and their Months and Days by the Moon. Moſes alſo orders the Iſraelites (leaſt they ſhould be at a Loſs when to begin their Days) to keep their Sabbaths from Evening to Evening.[6] Hence we find that the Chronology of Time began, on the fourth Day, *at Evening*, which was the Day after the Moon's Oppoſition, or when ſhe was full; when they (viz.

(6) Levit. XXIII, 32.

(viz. the Sun and Moon) enlightened the whole Earth, as Moſes tells us. — That the Iſraelites, and their Poſterity, might not be at a Loſs to know the Time of the Year, and alſo the Diſtance of the Moon from the Sun, Moſes inſtituted the Feaſt of Ingathering, *(after they had gleaned up their Olive and Vineyards)* to be kept in Remembrance of that great Event.—This Feaſt was to be kept on the 15th Day of the Moon (as it is in the Hebrew) or Month, in the *End* or *Revolution* of the *(Solar)* Year.(7) As every Month was begun on the Evening of the Viſibility of the Moon, ſo this 15th Day muſt be juſt after ſhe was paſt the full. The Jews keep their Feaſts of Tabernacles and Ingathering in this Manner, to this Day; and, according to their Tradition, it is in Commemoration of the Creation of the World, which happened at this Seaſon; viz. at the autumnal Equinox, the Sun in *Libra*, at the full of the Moon. To be ſhort. (8)

I ſhall now aſſume the following *Data*, and prove,

(7) Exodus, XXIII, 16—Deut. XV, 13. —— (8) Indroduction, Page 6.

prove, by Mathematical Demonſtration, that they are true. Viz. 1ſt, that the Sun was formed on the fourth Day of the Week, at the Creation, at twelve o'Clock, in the firſt Meridian, at the Autumnal Equinox, or the Sun in Libra, the Moon 15 Days paſt the Conjunction, the Day after the Oppoſition.

Secondly.—That according to the Moſaic Account, A. D. 1753, is in Connection with A. M. 5760, and Time is meaſured, poſitively and abſolutely, by the Rotation of the Earth round its Axis, or a natural Day; and its annual Revolution thro' the Ecliptic. If, therefore, I prove that A. D. 1753, is the ſame identical Year with A. M. 5760, it muſt be mathematical Demonſtration that the above Aſſumitions are true. Now, (9)

A. D 1753, we know to be the ſame Year as 6466, according to the Julian Period. I ſubſtract Moſes's Account of the Age of the World, 5760, from 6466 of the Julian Period, there remains 706, in Coincidence with the

(9) Introduction, Page 25.

the Year of the Creation. — The Julian Year is 11 Minutes longer than the Solar tropical Year, by which Means the Equinox fell back 44 Days, and, according to the Julian Kalendar, from Oct. 25, to Sep. 22, N. S.

Multiply 5760 the Number of annual Revolutions, or Solar Years.
By 1461 the Number of Rotations of the Earth round its Axis, or natural Days in a Quadirennium.

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   5760
  34560
 23040
 5760
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Divide by the Years in a Quadriennium. } 4)8415360 (2103840 Days in 5760 Julian Years.
Days of Retroceſſion in 5760 Julian Years, 44 to be ſubſtract.

Sun in Libra, A.D. 1753, A.M. 5760, 2103796 A.I.P. 6466, *true Solar Days.*

To know the Day of the Week, add the extra Days before the Sun and Moon meaſured Time. 4

Divide by 7) 2103800 (300542 Weeks ſince the Creation, or in 5760 Solar Years. (6) Saturday.

T A B L E.

A. I. P. 706. Sun in Libra. Firſt Meridian	Interval.	A. I. P. 6466. Sun in Libra. Firſt Meridian.
D. H. M. Oct. 25. 00. 00.	5760 Years. 2103796 Days.	D. H. M. Sep. 22. 00. 00.

By

By a very accurate Obſervation, Dr. Bradley obſerved that the Sun entered Libra A.D. 1753, September 22, on *a Saturday*. This had not happened before, ſince the Creation, neither can it happen again, on the ſame Hour and Minute, and Day of the Week, for many Thouſand Years to come; therefore 1753 muſt be in Connection with A. M. 5760; this proves it to be as mathematically certain, that the Year, Day, Hour, and Minute, and Day of the Week, happened at the the Time when Moſes tells us it did, as it is to meaſure the Diſtance from Hatfield to London, by a Wheel: For Here are two Points, viz. Hatfield and London; by running a Wheel from Hatfield to London, you will know how many Rotations the Wheel makes, between Hatfield and London: So here you have two Points, viz. the Autumnal Equinox, A. I. P. 706, or the Year of the Creation, and the Autumnal Equinox, A. I. P. 6466, in which Time the Earth performed 5760 annual Revolutions, and 2103796 Rotations round its Axis, which meaſured the Interval, and united the two

Points

Points together.—Hence we have mathematical Demonſtration that Moſes's Chronology is true; and alſo, we have an *Epoch* whereon to begin our aſtronomical Enquiries.—The above is trifling Evidence, to what may be brought by the Aſtronomy of the Sun and Moon, by all the *Eclipſes, Equinoxes, Solſtices, new, and full Moons*, which have happened ſince the Creation.

I am not very fearful to be convicted of Error, in what I have ſaid above, therefore (as perhaps you may meet with *Adepts* in Aſtronomy) I ſhall have no Objection to your ſhewing them what I have ſaid; and, as Truth is the Object ſought, I ſhould be glad to hear their Criticiſms on it.

I am,

DEAR SIR,

Your obliged Friend,

And Servant,

F. PENROSE.

STONEHOUSE,
Wedneſday, Feb. 9, 1785.

To F. PENROSE, Esq.

Mr. Heaviſide having ſhewed Mr. Penroſe's Letter to ſome eminent Aſtronomers, Members of the Royal Society; they " all agreed " *that his Calculations were* perfectly right, " *and* proved *what He intended they ſhould*; " and that they would *have deſired Leave to* " *have read the Paper at the Meeting of the* " *Royal Society; but that it was deemed to* " *be connected with religious Subjects, which* " *they never meddle with there.*" Queries *to Mr. Penroſe, occaſioned by the aforeſaid Letter.*

DEAR SIR,

I AM highly obliged to you for your kind Letter, and for being ſo good as to ſtate to me the Proofs of the Truth of the Moſaical Hiſtory of the Creation: They are certainly very learned and ingenious; I have read them with great Pleaſure, and have only to lament my own Ignorance, in not being able (for

want of more Science in Aſtronomical Matters) to fully comprehend their Force. As you have always been ſo good as to make Allowance for my Ignorance on any Philoſophical Subjects, and hear, without Offence, my Objections to ſome of your Opinions; ſo, I hope, you will pardon me for aſking you a few Queſtions, not in the Way of *Objections*, but merely for Explanations, that I may the better comprehend the Whole of your Theory; which, I preſume, is this, viz. that according to Moſes's Account of the Creation, and the Number of Years he makes it from thence to the Flood; added to the Years from the Flood to the coming of our Saviour; and from thence to the Year 1753 of our Æra, making up the Number 5760, the true and real Age of the World, is thereby fully aſcertained, and Moſes's Hiſtory proved to be a true one of the Creation *at that Time*.

You have proved, from Dr. Bradley's Obſervation, that the Whole Planetary Syſtem was in the exact Poſition, in the Year of our Lord 1753, that they were, and muſt neceſ-

ſarily

ſarily have been at the Creation; and that they had not, nor could have been in the like Situation for 5760 Years before; nor will, probably, be ſo again, for as many to come. I ſhall therefore call this 5760th Year, the Year of the great *Cycle* of the Univerſe: But whether I call it properly ſo, or not, I do not know; nor does it much ſignify, if you will give me Leave to uſe it as a Term, by which you may underſtand my Meaning. Now I would aſk what Proofs can be adduced, that the ſame Cycle, or Number of Revolutions, may not have happened over and over again, before Moſes's Date of the Creation.

I muſt alſo beg you to explain the Uſe of your Table, and why in the one is Oct. 25, and in the other Sept. 22. I ſubjoin the Table as I copy it from yours.

TABLE.

A. I. P. 706. Sun in Libra. First Meridian	Interval.	A. I. P. 6466. Sun in Libra. First Meridian.
D. H. M. Oct. 25. 00. 00.	5760 Years. 2103796 Days.	D. H. M. Sep. 22. 00. 00.

I know that I expoſe my Ignorance in aſking this, but I am not aſhamed of doing that to you, who already know it ſo well.

The above I wrote (as what occurred to me on the firſt attentive Peruſal of your Scheme) as ſoon as I had read it; and, having your Permiſſion, I afterwards copied it, and ſhewed it to two or three of my Friends, whom I thought better acquainted with Aſtronomy than myſelf.

One of theſe I knew to be intimate with an eminent Aſtronomer, of the Royal Society; and, as I wiſhed, he aſked my Leave to ſhew it to him, which I readily gave him. He called on me a few Days ago, and told me that that Gentleman was much pleaſed with it, and had kept it till now, that he might ſhew it to his Aſtronomical Friends of the Society; and that they *all* agreed that your Calculation was *perfectly right*, and *proved* what you intended it ſhould do: But, at the ſame Time, they made the ſame Obſervation upon it that I had done, viz. that it did not

not prove that there had not been previous Revolutions (or Cycles, as *I* call it) to that mentioned above. You will not wonder that I was both ſurprized and pleaſed, to find that *I*, who am *un*-learned in ſuch Subjects, ſhould thus have *blundered* upon what had ſtruck all theſe *learned Men*.

I muſt add, that the Aſtronomical Gentleman would have deſired Leave to read the Paper at the Meeting of the Royal Society; but that it was deemed to be connected with *religious* Subjects, which they never meddle with there.

I find you will, in Time, give me an Itch for Philoſophizing likewiſe, which hitherto I have only amuſed myſelf with now and then, as it has fallen in my Way. As a Proof of this, I have lately often thought of our Converſation at Hatfield, wherein you explained Sir Iſaac Newton's Aſſumption of the inexplicable Terms of Gravitation and Attraction, and in their Place, affirmed that Fire, or Heat, anſwered all the Purpoſes equally, and

was

was a Subſtance, or Quality, known and allowed by all. As we had not then Leiſure to develop the Whole of your Ideas on that Subject, I ſhould eſteem it a great Favour if you would be ſo kind as to give me a general View of your Opinions upon it, whenever you have Leiſure, and find Inclination to gratify me with it.

I am,

DEAR SIR,

Your very obedient,

And obliged Servant,

J. HEAVISIDE.

PRINCE'S-STREET,
March 20, 1785.

To JOHN HEAVISIDE. Esq.

Moſes's Hiſtory of the Creation ought to be examined by Chronology and Aſtronomy, which is the true Teſt *of all Hiſtory. — The Cycle of Years explained; — Anſwer to Mr. Heaviſide's laſt Queries;* — Ether *the Cauſe of Gravitation; — Gravity and Levity relative Terms. — The Agency of the* Ethers explained; — they *are the Cauſe of Winds, Hurricanes, Earthquakes, &c. — they alter or deſtroy* Attraction, Gravitation, Coheſion, &c. *Is the Cauſe of the different Motions of the Earth, and its ſpheroidal Shape; the Cauſe of Tides, &c.*

Dear Sir,

I Thank you for your laſt Letter, which (by informing me, that what I had written to you had received the Approbation of ſome eminent Aſtronomers, Members of the Royal Society) gave me great Pleaſure, as their Approbation does me a greater Honour than

than ever I expected to receive.—So learned a Body of Men (by the Diſcouragement they have given to Gueſs, Speculation, and Hypotheſis) have been the Means of thoſe diſtinguiſhed Improvements, which the Sciences have received: It being one of their Conſtitutions to admit Nothing *but what muſt terminate in Mathematical Demonſtration, or what is founded on Facts, and Reaſonings and Calculations which neceſſarily flow from them.* — I think we ſhould pay the *ſame* Regard to Moſes's Account of the Creation, as we would do to any other Hiſtorian. — For, as I obſerved in my laſt Letter, Hiſtory, if not proved by Chronology, is no more than a Romance; and there can be no Certainty in Chronology, unleſs proved by Aſtronomy.— On the Contrary, Hiſtory and Chronology, which is proved by the Situation of the Sun and Moon, at the Time theſe Events happened, and confirmed by Eclipſes, when the Moon interſects the Earth's Orbit; together with her Oppoſitions and Conjunctions, &c. muſt be as true as that there is a Sun and Moon; for their Conjunctions and Oppoſi-

tions

tions will occur, at their appointed Seaſons, as long as Time ſhall laſt. — Thus we know, by Calculation, that *Ptolemy*'s Account of the moſt ancient Eclipſe of the Moon to be true; as we find, by Calculation, it muſt have happened, at the Time He mentions, either at Alexândria or Babylon: — I would try Moſes's Account of the Creation in the ſame Manner.

The Gentlemen you ſhewed my Scheme to, as well as you, very juſtly obſerve, that the Exactneſs of it depended upon a *Cycle* of Years, and tho' my Calculations were perfectly right, *yet they did not prove but that there might have been many Cycles before the Time mentioned by Moſes.* — In Regard to the Time of the Creation; it muſt have been known, (if known at all,) either, 1ſt from Obſervation, or, 2ndly, it muſt be proved by Calculation; or, 3dly, it muſt be revealed. — It could not be obſerved, as there was *then* no Human Perſon to obſerve it; neither could it be found out by Calculation: But Moſes informs us it was revealed, and to confirm his

Account, has given us the Situation of the Sun and Moon, and Day of the Week, at that Minute of Time.—*Theſe are Facts!* and I think it cannot be imagined that Moſes (who wrote at a Time when Aſtronomy was little known) ſhould be able to calculate the exact Place of the Sun and Moon, at the particular Inſtant of Time of that Event, which he tells us happened more than Two Thouſand Years before he was born.—I therefore, think that if, on Calculation, we find that his Aſtronomical Account be true, we ought to allow his Fidelity, as an Hiſtorian, to be confirmed.

In order to find the Cycle of Years,

Multiply 525949 the Minutary Meaſure of a Solar tropical Year,
Into 5760 the given Number of Solar tropical Years.

Divide the Product
By 2103796) 3029466240 (1440 equatarial Minutes ſought.
The Number of the Earth's Rotations about its Axis. 4 Cycles.
A. M. 5760 in Connection with A. D. 1753, when Dr. Bradley made his Obſervation at Greenwich.

In Regard to your other Queſtion, *Why I made*

made Time to begin Oct. 25, and the *Cycle of Years* to end Sept. 22?

To explain myſelf as well as I can, why theſe *Cycles* began Oct. 25, and ended Sept. 22. I obſerve, that the *Julian* Year conſiſts of 365¼ Days, (or Rotations of the Earth,) but this Quadrant, or Quarter of a Day, or ſix Hours, is not compleated on the ſame Meridian where the Rotation began, but 11 Minutes more Eaſtward on the Equator. — This Preceſſion of 11 Minutes *of Rotation Eaſtward*, makes 11 Minutes *in Time Weſtward*, (as in the Calendar); ſo that the preciſe Length of the Year is 365D. 5H. 49M. Thus, if the Solar Year began in any Meridian, exactly at Noon, the ſecond Year it would begin 11 Minutes before ſix in the Evening; the third 22 Minutes before Midnight; the fourth 33 Minutes before ſix in the Evening, and end 44 Minutes before Noon.— Hence a Day is added to every four Years, and that Year is what we call *Biſſextile or Leap Year*: And in a Cycle of 1440 Years, having paſſed every Minute on the *Equator*, the

the Year and Day will begin again together, in the ſame Meridian, but not on the ſame Day of the Week. — Hence the Day of the Week, and not the Day of the Month, muſt be the *Characteriſtick* to diſtinguiſh the Cycle.

The Julian Year (as obſerved) being 11 Minutes longer than the ſolar tropical, the Day of the Month, (according to the Julian Calendar,) from the Year of the Creation, or the Year of the Julian Period 706, had receded 44 Days, which brought the Day of the autumnal Equinox from Oct 25, which it was in the Julian Year 706, to Sept. 11, O. S.; but 11 of theſe Days being thrown off, in the Year 1752, in Order to bring the Equinox *nearly* on the ſame Day of the *Julian Month* which it was at the Nicene Council, which was held 1439 Years before; it brought the Day of the Month, (when the Sun entered Libra,) from Oct. 25, at the Creation, to Sept. 22, N. S. 1753.

In Regard to what paſſed between you and me, about Sir Iſaac Newton's Aſſumption of Gra-

Gravitation and Attraction, I think you miſunderſtood me: I did not oppoſe them, as *Effects*; but I would not have it underſtood that we ought not to be ſatisfied in going thus far, and no farther; — I contended that we ought to have Liberty to enquire what Agent, or Agents, were the Cauſe of theſe Effects; and not to make Uſe of Words which ſeemed to point out ſome occult Quality, and that it was the *ne plus ultra*, and improper to enquire any farther. — No! We ought to uſe theſe Words, as *Sir Iſaac Newton* has directed, only to expreſs *Phenomena* in Nature, to which he was going to apply his mathematical Demonſtrations: Thus in his *Opticks*, (which was one of his laſt Works,) ſays he, "I would have Gravitation and Attrac-
" tion to be underſtood as an *Effect only*,
" *which might be occaſioned by the Preſſure of*
" *a moſt ſubtle Ether*, (with which the Space,
" from the Sun to the Extremity of the Syſ-
" tem *might be filled*,) *or to ſomething which*
" *he did not know*."

Daily Experience ſhews us, that Gravitation

tion and Attraction are *relative* Terms only, as Gravity and Levity, and are always in Proportion to the *Specific Gravity* of the Body, and the Denſity of the Medium that ſurrounds it. As, for Inſtance, drop a piece of Cork out of your Hand, in the Air, it will be forced to the Ground, by being of a greater ſpecific Gravity than the Atmoſphere; put this Piece of Cork at the Bottom of a Baſon, cover it with Water, and the Cork will be forced upwards, and lie in the *Medium* between Air and Water, higher or lower in Proportion to its ſpecific Gravity. The Experiments on Balloons greatly confirm and explain the above Theory.

The following Axioms (I think) are allowed by all Phyloſophers: 1ſt, that Matter connot act but when acted upon; 2dly, that it occupies Space, and cannot act in two Places at once, but only in the identical Space it occupies; therefore it cannot act at a Diſtance from itſelf, or in any Place it does not occupy. Hence it muſt be the *ſurrounding Medium* which cauſes the Gravitation of Bodies.

dies.—Thus, as was obſerved by the Cork; — a Body, placed in any fluid Medium, will riſe or fall, in that Medium, in Proportion to the ſpecific Gravity of that Body, and the Denſity of the ſurrounding Medium.

My Aſſumption is, that the *firſt Agent* in Nature muſt be the moſt *ſubtile* (or *active*) and *univerſally expanded*, and capable of entering all Pores, and Interſtices, of the moſt denſe Subſtances in Nature, even *Adamant!*— And I ſuppoſe that the *Ether*, which Sir Iſaac Newton imagined, (9) might, by its Pulſion, be the Cauſe of Gravitation and Attraction, & be compoſed of two Qualities; which, for the Purpoſe of being underſtood, (not being able to find more proper Names,) I will call Heat and Cold.—I ſuppoſe this *Ether* to occupy all Space, from the Sun, at the Centre, to the utmoſt Extremity of the Syſtem; which *two* Qualities are in continual Conflict, in the Manner we have obſerved (10) the cold and hot Air, or Atmoſphere to be.— Theſe Ethers, mixed with the Atmoſphere, being

(9) P. Def. V, VIII——Lib. I, Sec. II.

(10) See Letter IV. Page 164.

being the Cauſe of the Conflict, we always obſerve, between hot and cold Air; each endeavouring to poſſeſs the Place occupied by the other; — the Heat expanding, and the Cold compreſſing. If they are the firſt Agents, their Power will be indefinite, and capable of deſtroying all material Subſtances, as we have numberleſs Inſtances and Experiments every Day, which confirm it. Does not the Experiments in Electricity prove that it is univerſally expanded and enters all Subſtances, and that it is in all Matter, Ice not excepted?

Boerhaave, and a great many Philoſophers, have thought that Motion and Fire were ſynonimous Terms, as has been obſerved.(11) Viz. where Fire abounds, there will be the greateſt Motion, and Cold the oppoſite. — Hence we ſee the Cauſe of all Winds, Hurricanes, Earthquakes, &c. which deſtroy every Thing, and force all before it: *in thoſe, the Phenomina* of Attraction, Gravitation, and Coheſion, are all loſt. — Hence may be obſerved, that all Matter, by having Fire added to it, is

(11) Letter V, 169.

is expanded, and occupies more Space. Thus the Sun Beams, ſtriking againſt the Earth, a great Part of them are reflected, and of Conſequence there muſt be a greater Quantity of theſe Sun Beams, or Heat, at the Surface, than at an Inch from it, and a greater there than at two Inches, and ſo on.—When the Rarefaction is made on the Surface of the Earth, the Cold, or more denſe *Ether*, ruſhes towards the Earth, together with the Atmoſphere, and forces this *light*, Heat, or rarefied Air, upwards from the Earth; and with it every thing that is of leſs ſpecific Gravity than the Atmoſphere. — The Earth, being placed and ſurrounded with theſe Ethers, it has no more Reſiſtance than a Body, of the ſame ſpecific Gravity, placed in the middle Part of a Tub of Water;—it would neither riſe to the Top, nor gravitate to the Bottom, but would remain in the Middle, and move as the Body of Water moved; unleſs by Means of Heat, or ſome other Cauſe, the watery Medium, on one Side, ſhould be expanded, & made to occupy more Space, and to be of leſs ſpecific Gravity than it was on the other:

If this was the Caſe, then the Medium, or Water, on the other Side of the Body, having greater Gravity or Preſſure, would force itſelf into that Place of leſſer Gravity, and of leſs Reſiſtance; and, by that Preſſure, would force the Body to turn round together with it. — Thus the Earth, being placed in and ſurrounded with Ethers, can have no Reſiſtance: The ſide of the Earth next or oppoſite the Sun, having the Atmoſphere heated and rarefied, and the other Side covered with cold and denſe Ether;—this cold and denſe Air, by forcing itſelf into the Place occupied by the hot and rarefied, carries the terraqueous Globe round with it. Thus, the Heat from the Sun, and the Cold from the Extremities, continually acting, cauſe the perpetual Motion of the Earth. Hence, whilſt theſe two Motions remain a Ballance to each other, ſo long would the Earth go round the Sun; going round its Axis alſo at the ſame Time.— Does not all Experiments in Electricity, Gunpowder, and the late Experiments on Balloons confirm it?

Hence

Hence, the greateſt Heat, or Rarefaction, being on the Earth, every Body of greater ſpecific Gravity than the Atmoſphere, is forced towards it; and contrary, all Bodies of leſs ſpecific Gravity, are forced from it. hence the ſpheroidical Shape of the terraqueous Globe; for if the Water, or fluid Parts, are preſſed by the cold at the Poles, more than they are at the Equator, they muſt form a Spheroid, as Experiments on the Shape of the Earth have proved it to be.—Hence alſo, we are informed of the Cauſe of the Tide, or Sea, always flowing from the Poles to the Equator; (as Cook, in his Voyage to the South Pole, found they always did); and *this is alſo obſerved at Nova Scotia*, Newfoundland, that the Tide always flows from the North Pole towards the Line; which is contrary to the Doctrine of Attraction; for the Earth being a Spheroid, longeſt at the Equator, the Tide flows uphill, or from the Centre of Attraction. — The fall of Bodies is alſo proved not to be in an exact Perpendicular to the Place they fall from, but more towards the Equator, or where the Rarefaction

is

is the greateſt, and Reſiſtance the leaſt.— Another Experiment, which alſo ſeems to prove the above is, that when they drop a Weight, or Lead, into the Sea, to try its Depth, the Preſſure, or Weight, on the Finger, cannot be felt at more than Two Hundred Fathoms, let the Weight be as great as may be; and the Preſſure of the Line, on your Finger, becomes leſs and leſs every Fathom it deſcends.—Was the Attraction the greater, the nearer it comes to the Centre of the Earth, the contrary of this would be the Caſe.—I ſhould imagine, that was a Barometer to be carried down Two Hundred Fathoms, into ſome of our deepeſt Coal Pits, the Quickſilver would ſink in Proportion as you deſcended, in the ſame Manner it does when you aſcend into the Atmoſphere: But this is a mere Hypotheſis, which I believe has never yet been tried; but I much wonder at it, as we are ſo curious in Experiments.—If you have any inquiſitive Acquaintance amongſt the Coal Miners, who may be willing to make this Experiment, I think it would be a uſeful one.

Thus,

Thus, you ſee, I do not oppoſe any of Sir Iſaac Newton's mathematical Demonſtrations, (who, perhaps, was the greateſt Mathematician that ever lived,) nor his Calculations of the *Effects* the Sun, Earth, and Moon, &c. have on each other; — I only lay a Claim for Liberty to explain the *Cauſes* of theſe *Effects*. — The whole Difference lies in This; whether the firſt *Agents* in Nature be Solids or Fluids: — Moſt of Sir Iſaac Newton's Followers believe that they are in *Solids*. I, on the contrary, think they are in Fluids; the moſt ſubtile, the moſt active; therefore, as from Experiments, Fire ſeems to be the moſt ſubtile and active; of Conſequence the *firſt material Agent*. —— Indeed there was one Thing elſe, which was contended for a great While; but, I believe, is *now* given up: Viz. that the Space between the Sun, Moon, and Earth, was *void* of Matter, a *Vacuum*; otherwiſe, ſay they, if it contained Matter, it muſt have Reſiſtance, which, on theſe Principles, would have overcame all Motion before now.—For, ſay they, a Body once put in Motion, will allways continue

continue in Motion, if it meets with no Reſiſtance, but if it meets with Reſiſtance, it would be continually loſing Part of its Motion, every Minute, and in Time ſtand ſtill; which muſt have been the Caſe with the Planets, before now, if they met with any Reſiſtance.

I am,

DEAR SIR,

Your obliged and

Faithful Friend,

F. PENROSE.

STONEHOUSE,
Monday, April 11, 1785.

To F. PENROSE, Esq.

Doubts proposed concerning some Parts of Mr. Penrose's Philosophy, in Order that Truth *may be ascertained. Queries concerning* cold Ether; *and the Pressure of that cold Ether into the* Hot, *or where it is more rare.— What is the Cause of the Motion of the Earth?— What is the Cause that the Earth does not fall into the Sun? — Do you impute it to a Current of Ether? — Answer to the last Queries conclusive, if it be allowed that Moses was so far ignorant of Astronomy, as to be incapable of calculating the Eclipses which preceded his Time. — He is said to have been learned in all the Learning of the Egyptians; — State of the Sciences in Chaldea and Egypt.*

DEAR SIR,

I SHOULD have thanked you for your obliging Letter sooner, but that I have been a good Deal out of Town; and I have had

had a lurking Sort of rheumatic Fever hanging upon me for more than a Month paſt, which broke my Reſt and Spirits very much, and thereby made me reluctant either to write, or to ſet about any Thing elſe. Thank God, I have almoſt got rid of it within the laſt Fortnight, ſince the Weather has been warm. I am greatly obliged to you for the Trouble you have been ſo good as to take, to inform me of your philoſophical Principles, and ſhall make no Apology for offering ſome of my Doubts to your Conſideration; becauſe without a fair and candid Diſcuſſion, of any Subject, *Truth* cannot be aſcertained. In ſtrict Propriety indeed, I ought rather to ſay, I muſt beg ſome farther Illuſtration, on ſome Points which I do not underſtand, nor ſee the Conſequences which you draw from the Premiſes.

I have lived a Life of ſuch Hurry lately, that the above has been wrote at *twice*, and each Time a Week from the other, tho' I have taken every probable Opportunity of having Half an Hour to myſelf; and 'tis odds whether

whether I ſhall not be interrupted now, in five Minutes.

To begin—Heat and Cold are certainly relative Terms, as up and down are; and ſome Philoſophers deny them totally: But I do not mean to quibble about Terms; for no Doubt there are ſuch Effects produced as we call by thoſe Names.—Nor have I any Objection to your *Ether*; for I think there probably may be ſuch a ſubtile Matter, which pervades every ſenſible Subſtance that we are acquainted with.—But when you talk of the *cold* Ether driving out the *hot*, do not you recur to that *Gravity* which you want to explode? For by ſaying that the *Denſity* of the former cauſes it to ruſh into the Place of the latter, becauſe it is there more rarefied, &c. is allowing of a Principle, little if at all different from our Ideas of Gravity.—The Inſtances of a Cork, or Piece of Wood put into Water; the Air Balloons, &c. &c. all go to the ſame Principle; for they will all of them *reſt* when they come into a Medium of equal *Denſity* with themſelves; and *in this Caſe*,

Denſity and Gravity ſeem to me ſynonimous Terms.

I will alſo readily grant you, that the Sun Beams acting ſtrongly upon that Surface of the Earth, which is oppoſite the Sun, will rarefy the Atmoſphere there, and that the denſe cold Air on the oppoſite Side the Earth, will then puſh it forward into that rarefied and lighter Atmoſphere: Nay, I will grant you that it will cauſe the Motion round the Axis of the Earth, (though I by no Means think that a *rotary* Motion muſt *neceſſarily* follow from it,) yet I would aſk why the Earth did not proceed in a ſtraight Line directly to the Sun? —— We will ſuppoſe the Earth this Inſtant formed, and at reſt: The Sun Beams play upon it, and rarefy the Air on that Side which is oppoſed to them; (I ſhall take the Liberty of uſing the Word *Air*, as a ſhorter Word, inſtead of *Atmoſphere)* the denſe Air on the other Side will puſh it forward into that lighter Air moſt certainly; but I do not ſee why it ſhould cauſe a rotary Motion round the Axis of the Earth; much

leſs

leſs can I ſee any Reaſon for its elliptick, annual Motion from *this* Cauſe; Recourſe muſt therefore ſtill be had to an original Impulſe, or trajectile Force, *for its annual Motion;* and then what is the Power that brings it back from that immenſe Diſtance at which it is, in the Summer Solſtice? or prevent its flying off in a Tangent? If the mere Rarefaction of the Air was ſufficient for this, would it not cauſe the Earth to fall plump into the Sun, and not take that circuitous Courſe which we ſee it does? Would you impute it to ſome Current of the ſubtile Ether? We know and allow that there is ſuch a Current from North to South, which is the Cauſe of Magnetiſm; but that will not ſerve to carry the Earth round its annual Orbit.—Or would you aſſign various Currents for that Purpoſe? If ſo, there muſt likewiſe be a Cauſe aſſigned for them, which I fear will be ſtill more incomprehenſible than Sir Iſaac's Doctrine of Gravitation and Propulſion.—In ſhort, this is the great *Deſideratum* in your Theory, which puzzles me, and to which you have not ſpoke at all in your Letter.—I readily

readily aſſent to the Idea that Motion and Fire are the ſame Thing; *I have always thought it ſo:* For Fire or Heat has no Exiſtence till Motion is excited.—The Principles of Fire, I preſume, lye in Steel and Flint; but it muſt be drawn out, and put into Action by Colliſion, and then there is evident Motion. I will not diſpute the Cauſe you aſſign for the ſpheroidical Shape of the Earth; though I think that Shape is ſufficiently well accounted for by the centrifugal Force, (which cannot be denied to exiſt) acting upon the Globe while yet moiſt, during its rotary Motion round its Axis.—I dare ſay that your Hypotheſis, that Quickſilver would fall in Proportion to the Depth it was carried into a Coal-pit, would prove true; and I will endeavour to get a Trial made of it; for I think it would be curious to know whether it falls *in the ſame Ratio* beneath, as above the Surface of the Earth, and I have a Friend in the North of England, whom I can truſt, and hope he will get the Experiment made for me.

I give you many Thanks for the Explanations you favoured me with, respecting the Queries in my last; they are very conclusive, provided that it be allowed that Moses was so far ignorant of Astronomy as to be incapable of calculating the Eclipses which had preceded his Time.—For though he is said to have been learned in all the Learning of the Egyptians, who were at that Time the most learned People in the World; And though the Israelites were originally from Chaldea, (if I mistake not) who were the first People who studied Astronomy; yet I am willing to allow that neither of those Nations were capable of calculating a Series of Eclipses for two thousand Years backwards.—The Consequence is, that Moses must have wrote from Inspiration, and that his Account is a true one.—Yet if I had Leisure, I should like to state some Difficulties which arise from the State which the Arts were certainly in, some hundred Years ago in China; the long Duration of that Empire, (I do not mean their fabulous one) and the numerous Strata of Lava which are found one under another, to great Depths

Depths under the Earth, and which muſt have been vomited out many Ages before hiſtorical Times; (perhaps before the Invention of Letters) and which would ſeem to carry us back to Times long before Moſes's Account of the Deluge.—But this I muſt leave to ſome other Opportunity, having no *preſent* Proſpect of more Leiſure than I have now; and I have had ſo little lately, that 'tis above a Fortnight ſince I began this Letter, and have hardly been able to write five Lines at a Time; ſo that I fear you will find it a very confuſed and unconnected one; which I truſt you will excuſe, as it ariſes from a Wiſh to ſhew the Senſe of your Favour, the firſt Moment it has been in my Power, rather then defer it longer in order to write a more correct one.

I am,

DEAR SIR,

Your very obedient,

And obliged Servant,

J. HEAVISIDE.

PRINCE'S-STREET,
May 16, 1785.

To JOHN HEAVISIDE. Esq.

*Mr. Heaviſide's Quere anſwered.—Calculations of the Motions of the Heavenly Bodies demonſtrably true; but the Principles of natural Philoſophy cannot be demonſtrated with that Clearneſs and Preciſion as thoſe in Aſtronomy.—Three Principles of Matter.—*Gravity *explained.—*Cold *and* Hot Ether *deſcribed according to* Sir Iſaac Newton.—Centre *of* Gravity *ſuppoſed formerly to be placed in the* Centre *of the Earth, but late Experiments prove that* Gravity *does not tend to the Centre of the Earth, but to the Superficies, and to the Place where there is the greateſt expanſive Heat.—*Gravity *proved to be increaſed or leſſened in Proportion as* Heat *and* Cold *prevail.—The* Preſſure *of the* Cold Ether *or* Gravity *acts exactly in the ſame Proportion on the Poles and the Equator, as the ſpheroidical Shape of the terraqueous Globe ſhews it does.—The Centre of* Gravity *proved to be near the Surface of the Earth, where every Thing tends.*

DEAR

DEAR SIR,

BY your laſt Letter, we were ſorry to be informed that your Conſtitution had been ſo much diſordered both in Health and Spirits; but as you found Benefit from the Change of the Weather from Cold to Warm, we hope that the late fine Weather has made a perfect Cure.—I am afraid my long and tedious Letters diſturb you, and put you to great Inconveniencies, both by reading and writing Anſwers to them.—Notwithſtanding I imagine this to be the Caſe, I will trouble you with *One* more; as, what I am going to obſerve may, perhaps, appear ſatisfactory *to ſome*, that the World was created at the Time Moſes informs us it was.—There may be others who imagine, or *pretend to imagine*, that the World is *eternal*; ſuch Perſons, I apprehend, neither mathematical Demonſtration, nor any Thing elſe will convince.

In your former Letter you ſay, that notwithſtanding the Sun and Moon were in the Places Moſes records them to have been at the

the Time he mentions the Creation to have happened; yet, ſay you, "may there not have been many Cycles before that Time?" And you obſerve, that the Chineſe Hiſtory makes that Empire to have been in Being ſome hundreds of Years before.—In Anſwer to this I ſhall again remark, that Hiſtory, without Chronology, is little better than a Romance; and there can be no Certainty that Chronology is true, unleſs proved by Aſtronomy; but when the Sun and Moon give their Teſtimony to it, there cannot remain a Doubt, they are two faithful Witneſſes.

Now, Sir, as to this Queſtion, I obſerve, that I never undertook to prove, by Mathematical Demonſtration, that there might not have been a Series of Years before the Time in which Moſes places the Creation.

To prove a Negative is always attended with great Difficulty, and often impoſſible! What I attempted was to try Moſes's Hiſtory and Chronology, by the Evidence of Aſtro-

nomy, and to examine whether the Sun and Moon were in the ſame Places in the Heavens, as Moſes tells us they were, at the Time when the Creation happened; which your aſtronomical Friends allow I have done.—This appears to me to be Evidence ſufficient to eſtabliſh any other Hiſtory: If ſo, why ſhould it not Moſes's Hiſtory?—And it is not credible that he would have calculated thoſe Places of the Sun and Moon, two thouſand Years before he was born.—If he could not, and we find it in his Hiſtory, it muſt be revealed from God, as he tells us it was!

As I obſerved to you before, I aſſume, (from Moſes's Hiſtory, and Dr. Bradley's Obſervations) that the Moon was Full, and in her Node, A. I. P. 706, Oct. 24th Day, 10th Hour, 24th Minute, at Night, in the Meridian of Greenwich Obſervatory; between that Time, and the Year 6490, which is in Connection with A. D. 1783, when, on a Wedneſday Night, the third Year after Biſſextile, there happened an Eclipſe of the Moon,

Moon, Sept. 10th Day, 12th Hour, 40th Minute.—Between theſe two Points of Time the Earth made 5789 Revolutions through the Ecliptick, and was interſected in her 5790 Revolution, by the Moon, 12th Day, 16th Hour, 14th Minute, before ſhe entered Libra; during this Time ſhe made 2114741 Rotations round her Axis.—While the Earth was performing theſe Rotations, the Moon performed 71,612 ſynodical Revolutions, and interſected the Earth as above.— Here we have two Points of Solar Time, Oct, 25th, 706, Julian Period, the Sun in Libra, and Sept. 22d Day, 16th Hour, 54th Minute, 6490, I. P. the Sun in Libra, meaſured by the Number of Rotations the Earth made between them.—We have alſo Oct. 24th Day, 10th Hour, 24th Minute—706, when the Moon was in Oppoſition to the Sun; and Sept. 10th Day, 16th Hour, 40th Minute, 6490, when the Moon was obſerved to be in her Node, and exactly oppoſite to the Sun, (by the Eclipſe which then happened.)—Between theſe two Points, the Time is meaſured by the Number of Rotations the Earth

has

has made, *with as much Eaſe, and as great an Exactneſs*, as the Diſtance between any two Places are by a Surveyor's Wheel.

Hence alſo by knowing the Quantity of the Motion of 71,612 Lunations, we ſhall have the preciſe Length of Time of one Lunation.—Here you have *mathematical Preciſion!* As the Interval which lyes evenly between thoſe two Points, is meaſured by the Number of Rotations the Earth has performed during that Time; and alſo the Point of Interſection where the Moon ends her 71612th ſynodical Revolution, meaſured with the ſame Exactneſs, and alſo the Diſtance between that Point of Interſection, and that other, when the Sun entered Libra.—Hence I remark, that the Revolutions of the Moon, when compared to thoſe of the Earth, are ſo complicated, ſo curious, various, and exact, that it requires 7,948,800 ſynodical Revolutions, which are more than 600,000 Years for Her to go through all her Variations, and to cauſe the Moment of her mean Oppoſition to fall again on the ſame Point of the Equator,

tor, in the ſame Meridian, on the ſame Day of the Week, and the ſame Year of Biſſextile. [a] —This appears to me to be ſufficient Evidence, that the World was created at the Time when Moſes informs us it was, and that the Hiſtory of the Duration of the Empire of China is fabulous.

I have teaſed you thus far on a Subject that muſt appear *dry* to any one who does not take a particular Pleaſure therein; with a Deſire, (if it is not too troubleſome,) that you would ſhew it to thoſe Gentlemen who joined with you in Quering whether there might not have been *Solar* Cycles before the Time when Moſes places the Creation to have happened.

In Order to give you ſome Satisfaction for this Trouble, I will promiſe that I will aſk no more ſuch Favours; for I am ſatisfied, the Trouble of peruſing and making Remarks thereon, muſt be very vexatious to one who has ſo little Time to ſpare.—If you ſhould

(a) Kennedy's Chron. P. 196.

ſhould have an Opportunity of ſhewing the above to the Gentlemen who ſaw the other, be pleaſed to inform them, that the above Calculations were made without *Tables*, *Equations*, or *Anamolies*, after a moſt eaſy and ſimple Manner; by the firſt four Rules of Arithmetic only. [b]

I obſerved to you in one of my Letters ſome Time ago, that as the firſt Principles of natural Philoſophy could not be demonſtrated with that Clearneſs and Preciſion as thoſe of Aſtronomy, I deferred entering upon them.—In Aſtronomy we only calculate and demonſtrate the Phenomena of the Motions, which the Heavenly Bodies are known, and *obſerved*, to have.—Sir Iſaac Newton, in his Philoſophical Calculations, went no farther than this, and therefore they are *certainly true:* But if we Philoſophize, or draw Inferences from them, we muſt always take Care that they flow eaſily from, and are not in the leaſt contradictory to the known Principles of Matter.—Now, Sir, the following are

(b) Introduction, P. 80.

are Principles of Matter, which I believe are allowed by all Philosophers.—1st, that Matter occupies Space, and has Resistance.—2d, that no two Particles of Matter can occupy the same identical Space, at one and the same Time.—3d, that it can only act where it is present, *not the least Distance from the Place it occupies.*

Now, I believe, you and I, and all Philosophers, have seen and observed the EFFECTS which the Heavenly Bodies have on each other, known by the Name of *Gravity.* I endeavour to account for these Effects by the Ethers, *or the Matter* which fills the Heavenly Space, in the same Manner as Sir Isaac Newton supposed, and consequently is in *Contact* with them. [c] This is my Theory and my Ideas of it.—Without this *Ether* occupying the Space between them, I shall be glad to be informed how they act on each other, in a *Mechanical Way*, and not by saying *that Gravity is the Cause of it*; which is no more than saying that a Ship sailed from London

(c) See Let. IV. P. 162.

London to Plymouth, without telling us that the Air was a continued Medium between the two Places, and that a Current of that Air or Wind carried her there.— Do you ſuppoſe that Gravity is (as it is often explained) *ſomething ſuperadded* to Matter? If ſo, is it ſpiritual or material? If material, it muſt act according to the known Laws of Matter.—If you ſay it is ſpiritual, there muſt be an End of the Controverſy, for it is what I don't underſtand, and muſt not pretend to explain.—I ſhould alſo be glad to be informed, that if the Motions of the Earth or Planets are occaſioned from an *original Impulſe or trajectile Force, how this Force is continued and ſupported?* For if you allow Matter to reach from the Planets to the Sun, and to the End of this Syſtem, it muſt *reſiſt*, and if it reſiſts, it muſt have taken off ſuch a Quantity of the trajectile Force, that they muſt have ſtood ſtill Ages ago; when, in Fact, we know their Motions are the ſame they were ſome thouſand Years ago.—Theſe are Difficulties which I think will not be ſurmounted, till we allow the *firſt Agency in Matter to be*

in

in Fluids, and not in Solids, and the more *Subtile* the Fluid, the *greater* the Agency.

In my laſt Letter, when I mentioned the different Modifications of Ether, I told you that I uſed *Heat* and *Cold*, (if poſſible,) to explain my Ideas of them, though I did not think them proper ones, but I could find no better; but then I did not join the Ideas of the Senſations which Heat and Cold have on our Bodies, but pure elementary Heat and Cold, ſuch as may be obſerved from the Effects of Lightning, and electrical Experiments.

Theſe Ethers I endeavoured to explain by a Quotation from Sir Iſaac Newton, who calls them *Spirit* and *Light*; I there deſired to be underſtood in the ſame Manner whenever I made Uſe of them. (d)

In this Year's Philoſophical Tranſactions, there is the Hiſtory of Experiments made on the Difference of Cold on the Earth, and, at

(d) Letter IV. P. 162.

the ſame Time, at different Heights from it; which are curious and worthy to be read: The Gentleman that made them, (whoſe Name, if I remember right, is Cavendiſh,) obſerves, that Cold is reflected, riſes or flies off from the Earth, as well as Heat.—According to my Theory, both *Heat* and *Cold* muſt be intercepted by the Earth, and be reflected from it, by interrupting their Paſſage, whereby they are made to rebound from it.

As you ſeemed to be puzzled by the Uſe I made of *Heat* and *Cold*, and that you underſtood thereby, that I wanted to explode *Gravity*; I ſhall therefore endeavour to explain my Ideas of that *Phenomenon* of Nature, which is certainly a juſt and true one, and not to be diſputed; therefore, I hope, you will not imagine I wanted to explode it.—My Deſign is to clear it from ſome Difficulties attributed to it, and to elucidate its Power.—In Order to do this, I ſhall take the immortal *Newton* for my Guide, who tells us,

us, (e) "That the *Ether* which fills the "heavenly Spaces, is a *Medium* which per- "vades all Bodies, and that there is *no* Va- "cuum but what it fills; that it readily per- "vades all *Bodies*, and by its elastic Force, "is expanded through the whole Heavens, "and that it may suffice *to impel* Bodies from "the denser Parts of the Medium to the "Rarer, with all that Force or *Impulse* which "we call GRAVITY." (f) He also describes this Medium to act with a *two-fold Quality*, which he calls *Light* and *Spirit*.—The one expanding itself from the Sun, and the other condensing and pressing this expanded *Ether* towards the Sun. — That these opposite Forces are carried on in a *vibrating* Manner, being alternately in Fits of easy Reflection, and easy Transmission.—In Order to shew the Place where the Centre of Gravity is supposed to be, and how it acts, I shall give you the Description of it by Mr. Ferguson. "Bodies, says he, are heavier near the Poles, "than those towards the Equator, *because* "*they are nearer the Earth's Centre, where* "*the*

(e) Opuck, P. 323, 325.— (f) Letter IV. P. 135.

" *the* whole Force *of the Earth's Attraction* " *is accumulated.*—*Bodies* carried from the " Poles towards the Equator, gradually loſe " their Weight.—Experiments prove that a " Pendulum, which vibrates Seconds near " the Poles, vibrates ſlower near the Equa- " tor, which ſhews us that it is lighter or " leſs attracted there.—To make it oſcillate " in the ſame Time, it is found neceſſary to " diminiſh its Length.—By comparing the " different Lengths of Pendulums ſwinging " Seconds at the Equator, and at *London*, " it is found that a Pendulum muſt be $2\frac{160}{1000}$ " Lines ſhorter at the Equator than at the " Poles." (g) It is alſo obſerved that the *cold Ether* at the Poles, gives a *gravitating* Power to Bodies removed there from the Equator, nearly as $\frac{1}{222}$ ——Does not this Fact ſhew us that the *cold Ether*, or, as Sir *Iſaac Newton* calls it, *Spirit*, makes Bodies to gravitate, and is the Cauſe of Gravity as he ſuppoſed it did? Thus we find that the *cold Ether* preſſes at each Pole, juſt in the ſame Proportion, more

(g) Ferguſon. P. 50, S. 117.

more than the *hot Ether* at the Equator. As the equatorial Diameter of the Earth exceeds the polar Diameter in Measure.—By the Experiments of *Messrs. Maupertuis*, &c. in the Years 1736 and 1737, the equatorial Diameter of the Earth was found to be $36\frac{948}{1000}$ Miles more than the Polar, which is $\frac{1}{292}$ nearly.

Hence it may be observed, that the spheroidal Shape of the Earth is exactly according to *Gravity* or the *ethereal Pressure*.—For the cold Ether is found to press or make *all* Bodies to increase in Gravity there, just by the same Proportion as the Equatorial Diameter of the Earth is longer than the Polar.

Now, Sir, if the cold Ether gravitates in that Proportion, more at the Poles than it does at the Equator, the terraqueous Globe must be in the Shape it is found to be.—For it is the Property of Fluids to *move easily* in every Direction, and *to acquire* a uniform Surface in Proportion to the Pressure on it.

Thus

Thus the Air is a fine elaſtick Fluid, ſurrounding this terraqueous Globe, and is found by Experience, to be compreſſed or condenſed by *Cold*, and expanded or rarefied by *Heat*. The Seas are a watery Fluid, giving Way to Preſſure, and ſurround this Globe; therefore if they are preſſed more at each Pole, occaſioned by the *Cold*, than at the Equator, where they are expanded by *Heat*, they muſt be in the ſpheroidal Shape as $\frac{1}{222}$ nearly.

Having ſhewn that the *cold Ether*, *preſſing more* at the Poles than at the Equator, is the Cauſe of the ſpheroidal Form of the Earth, I ſhall endeavour to find, from Experiments and the *Phenomena* of Nature, where the Centre of Gravity is, or the Place where it tends.

It was obſerved in my laſt Letter, that Dr. *Halley*, many Years ago, found that a Weight dropped from above, does not deſcend according to the Perpendicular of that Place, but a little to the Eaſtward of the South, tending to the Place on the Globe where the Rarefaction

faction is the greateſt, and the Heat the ſtrongeſt.—The Tides at Newfoundland are found to tend in the ſame Manner a little towards the Eaſtward of the South.—In like Manner later Experiments have proved, that a Plumb Line placed on each Side of a Mountain, will not deſcend Perpendicular to the Centre of the Earth, but, *on both Sides*, tends towards the Mountain; the Place where the greateſt Number of the Sun Beams are reflected, and where the Heat is the greateſt.

It has long been an Obſervation amongſt Sailors, that Gravity was loſt about Two Hundred Fathoms under the Surface of the Sea: That when they ſounded with a Line longer than that, they could feel no Effect from the Weight, let it be ever ſo great; and by a late Experiment it has been found, that if you ſuſpend a Pound Weight at one End of the Scale Beam, and at the other End hang another Pound Weight, by a fine String, over a Shaft or Mine, and let it deſcend gently below the Surface of the Earth; it loſes Part of its Gravity as it deſcends, till

till it comes to Nothing; and the Weight muſt be leſſened in that Scale above Ground continualy, to make an *Equipoize.*— From the ſame Cauſe it is found by Experience, that Candles will not burn but about Two Hundred Fathoms under the Earth's Surface.

The above Experiments ſhew us, that the Force of Gravity does not tend to the Centre of the Earth, as has been imagined, but to the Place where the *expanſive Force and Rarefaction from Heat, are the greateſt.*—Thus, where the Sun Beams are moſt reflected, and their expanſive Force the greateſt, there the Preſſure of the *cold Ether* or Gravity will tend.—They alſo ſhew us the Reaſon of the ſpheroidal Form of this terraqueous Globe, and why the Waters or Tides are always flowing from each Pole, towards the Equator.— Hence it may be obſerved, that *Heat* and *Cold* are the Cauſes of *Gravity* and *Levity*; Heat enters, projects, and expands the Parts of Bodies, and makes them ſpecifically lighter. On the contrary, *Cold* preſſes them cloſer together, and increaſes their *Attraction of Coheſion,*

hesion, and adds to them *Gravity*.—Do not the above Experiments shew us the Cause of *Gravity*, and how it acts?—Thus, Sir, you may observe it is not my Design to deprive Gravity of any of its Powers, I only mean to endeavour to point out the Cause of that *Phenomenon*.

From what has been observed, it appears, that as *Heat* is the Cause of Projection and Expansion, so *Cold* is the Cause of Compression and Gravity: That these two Ethers are in a continual Conflict or Vibration; each endeavouring to jostle the other out of its Place.

You also imagine that *Density* and *Gravity* were synonimous Terms. The Ideas I used them for is quite opposite: I suppose Gravity an *Agency*, forcing every Thing towards the Body or Place to which it gravitates: On the contrary, I suppose the *Density of the Medium between* two Bodies, the Resisting Quality.—I never did or ever will make Objections to Author's Terms, so he does but

explain what he means by them.—The Earth cannot fly off in a Tangent, no more than a Balloon can fly into the Sun. The Earth is placed in a *Medium*, (ſurrounding the Sun,) of *the ſame Specifick Gravity* with it, therefore it cannot depart from, or approach nearer to the Sun, than that Medium reaches, in the ſame Manner as a Balloon or a Cloud; it muſt continue at the ſame Diſtance from the Earth, unleſs its ſpecific Gravity is altered, by throwing out Ballaſt, or letting out ſome of the light inflammable Air. — By theſe Actions the Balloon will either riſe or fall, as its ſpecific Gravity is leſſened (in Proportion to the Atmoſphere) by throwing out Ballaſt; or its gravitating Quality is increaſed, by letting out inflammable Air. — Hence, as you juſtly obſerve, *Heat and Cold* are relative Terms, as all Parts of Matter are to each other.

I return you many Thanks for the Trouble you have taken, in Order to get the Experiments on the Barometer tried, in ſome of our deep Coal Pits; I wiſh you had joined the

the Thermometer with it.—I am much ſurpriſed they have never yet been tried, as we live in an experimental Age.

I am,

DEAR SIR,

With great Reſpect,

Your obliged humble Servant,

F. PENROSE.

STONEHOUSE,
June 18, 1785.

To

To F. PENROSE, Esq.

State of the Sciences about two thousand Years ago.—The former Query repeated: "If the Earth, &c. were first put in Motion by the Heat of the Sun, rarefying the Atmosphere between these Bodies, why did not the Earth immediately gravitate into the Sun?—Must not a trajectile Force have been at first necessary to cause its annual Orbit?"

Dear Sir,

'TIS now above ten Weeks since I was favoured with your last; a shameful Time I confess! And yet I wish that I had not so good Reasons to give for my seeming Negligence. — The Illness of a particular Friend confined me here in Town, during all the hot Weather, till near the Middle of August; by which I was reduced to such Weakness and Langour, that I could neither write, or do any Thing else; and if my Confinement here had continued much longer, I could not have supported it; for never having got

got rid of the Illneſs I had laſt Autumn, the cloſe warm Air of this Town, for ſo long a Time, quite overſet me; ſo that when I was at Liberty to get out of Town for a few Days, I was not able to ride on Horſe-back more than ſix or eight Miles at a Time; nor have yet been able to ride from hence to Potterels, without taking a Poſt-Chaiſe at Barnet. About three Weeks ago I ſet out, (but in a ſingle Horſe Chaiſe,) on a little Ramble thro' Norfolk and Suffolk, which has done me a great deal of good, and enabled me to venture on a little Sea-Bathing, ſo that I ſhall ſet out for Margate to-morrow Morning, where I hope to recover ſome Part, at leaſt, of the Strength I have loſt.—However, my own Illneſs has not been the ſole Cauſe of my having ſo long deferred to thank you for your laſt obliging Letter.

Since I was favoured with your laſt, I have had no Opportunity to ſee any of my Mathematical Friends, they having left Town long ago; I muſt therefore wait for their Opinion till Winter brings them back again; conſequently

quently I can only give you a few of my own trivial Remarks upon it.

First then, I entirely assent to what you say, as to the Time of our Saviour's Birth. 2dly, I think there is *very great Probability* that you have also fixed the Creation of the World rightly, and proved that the Mosaic History is true.—I say, *very great Probability*, because it is still *possible*, that the World *may* have existed 600,000 Years, which you say it would require to compleat all those various Revolutions among the Heavenly Bodies, which are necessary to bring them again into the identical Situation they must have been in at the Time of the Creation.—What strongly induces me to believe the World cannot have existed so long, is, the very low State that all the Arts and Sciences, (particularly the former) are well known to have been in 2000 Years ago: Astronomy being almost the only Science that seems to have been cultivated prior to that Period.—Indeed, about that Time the Mathematicks and Mechanicks seem to have made a prodigious Progress

greſs under Archimedes; but I think it appears that they were not generally underſtood, for tis plain the Romans were totally ignorant of them.

Another Proof, I think, is the total Want of Civilization among Mankind, at that Period; a very few Nations (if any) perhaps excepted.—So that you ſee I am far from objecting to your Opinions, though I am forced to draw my Reaſons for approving them, from other Fountains than you do, and by no Means ſo good ones.—I am not ſo *perfectly* well ſatisfied with your Natural Philoſophy, though I acknowledge that you Support your Ideas well; but being now upon the Wing, I have not Time to ſtate and explain my Objections ſo thoroughly as I wiſh to do.

In the firſt Place give me Leave to obſerve, that you have given me no Anſwer to the Query I put in my laſt, viz. That if the Earth, &c. were firſt put in Motion by the Heat of the Sun rarefying the Atmoſphere between

between theſe Bodies, why did the Earth not immediately gravitate and fall into the Sun, as the Medium between them muſt have been much more rarefied then it could be any where elſe, or in the Courſe they took? And if ſo, muſt not a trajectile Force have been at firſt neceſſary to cauſe its annual Orbit? For I will allow that the Sun's Heat might cauſe the diurnal Motion, as you explain it in your former Letter, provided *that* Heat did not cauſe the Earth to fall directly into the Sun, as I ſaid above.

You did not rightly apprehend my Meaning, I ſee, when I ſaid that Gravity and Denſity were ſynonimous Terms; I only meant that Bodies gravitated through any Medium, in Proportion to the Denſity or Cloſeneſs of the Matter of which they are compoſed; as that a Pound of Lead will gravitate ſooner than a Pound of Feathers, and ſo forth; but did not apply it to the Medium through which they were to fall, for *that* will certainly obſtruct the fall of both, in Proportion to its Denſity, and the *Bulk* of the falling Bodies. After

After all, I fancy that I do not fully comprehend your Ideas of Heat and Cold, as to the Degrees and Situations of them.—I know that you ſuppoſe that the greateſt Degree of the former is on the Surface of the Earth; in which you, no Doubt, are perfectly right: And it juſt now occurs to me that you dropped a Hint one Day at Hatfield, (which you did not purſue, or farther explain;) that you did not know but all the ſuperior Regions of the Air were perfect Ice.—If I am right in this, perhaps ſome Concluſions may be drawn from this Coldneſs in the Upper Regions, in Anſwer to my Query; but I have not now Time to conſider them properly, as the Time of ſending to the Poſt is now at Hand, for Letters muſt, by the laſt Regulations, be ſent to the receiving Houſes by *Five* o'Clock, which is very inconvenient.— However, I cannot at preſent ſee how this Coldneſs above can prevent the Deſcent of the Earth to the Sun; becauſe the Air being rarefied near its Surface, would move that Way; and as it advanced further and further, would carry the ſame Degree of Heat before it, till

it arrived at the Source of Heat, the Sun.— I write this, (especially the latter Part,) in great Hurry, and therefore hope you will allow for the Imperfections of all Kinds; but I would not go again from Town without telling you how much I think myself obliged to you for the Trouble you take in answering my idle Queries; and assuring you, that your Letters give me infinite Pleasure; I therefore hope you will never entertain an Idea that they can be too long.

I am,

DEAR SIR,

Your much obliged,

And very humble Servant,

J. HEAVISIDE.

PRINCE'S-STREET,

Sept. 12, 1785.

To JOHN HEAVISIDE. Esq.

Heat and Cold Ether first Agents, according to Sir Isaac Newton, Boerhaave, *&c.— Internal Make of this terraqueous Globe described. — The Thickness of the Shell of Earth.—The confused Appearances on this terraqueous* Globe, *prove that it has undergone some tremendous Convulsions from within, and that the earthly Shell has been burst into Millions of Pieces.—Earthquakes examined, and their Effects described.— These Effects occasioned by Fire.—The Causes of Earthquakes explained,—which prove that there is an immense Quantity of Fire within the Earth.—The above Account agreeable with what is given in the Scriptures.*

Dear Sir,

I WAS sorry to be informed by your last Letter, that you had been so ill, but was glad to find you had nearly got the better of it; I hope the Sea Bathing will perfectly restore you to your former State of Health.

As

As you obſerve, I did not perfectly explain myſelf, with Regard to all the Motions of the Earth.—It will require a long Letter or two to do it; but as you deſire it, you muſt thank yourſelf for the Trouble they will give you.—You want in particular to be informed, "why, according to my Expla-"nation, the Earth does not proceed in a "ſtrait Line to the Sun, &c."—And you ſay that *Heat* and *Cold* are relative Terms.—They certainly are, with Regard to that Effect on our Senſes; but when we mean by them Sir Iſaac Newton's Ethereal Medium, *Light and Spirit.* (h) We mean firſt Agents, which, according to his Definition of them, "fill all the Space between the Sun and Sa-"turn, and beyond; that it is rarer at the "Sun, than in the celeſtial Spaces, and "rarer there than at Saturn, and beyond; "and may *impel* Bodies from the denſer "Parts of the Medium, towards the rarer, "with that Force we call *Gravity.*"—This compreſſing Agent he calls "*Spirit* or *Weight*; "which, ſays he, may condenſe thoſe Va-"pours

(h) See Letter IV. P. 163.

"pours and Exhalations aſcending from the "Sun, and make them fall back into him "again, and by that Action increaſe his "Heat, after the ſame Manner as it increaſes "a culinary Fire."—Hence it may be obſerved, that Sir Iſaac Newton ſuppoſes a Circulation from the Sun, to the Extremities of the Syſtem, by *two* vibrating Agents.—*The Ethers*;—the one, going out, iſſuing from the Sun, in Form of *Light*, and the other returning in Form of *Spirit*.—And, as was before obſerved, *Boerhaave* has proved by the heating and cooling of an Iron Bar, &c. that Heat is the firſt *Agent* or *Mover*, and *Cold* the Compreſſor, Contractor, or *Gravitator*.—But before I explain myſelf any farther, it will be neceſſary to get the beſt Information we can, concerning the internal Make and Contents of this terraqueous Globe: This appears to be a difficult Taſk! and if you remember, when we firſt entered on theſe Diſquiſitions, I entered the following *Caveat*, "viz. [i] "That there may be ſome *Arcana* in the Mechaniſm of Nature, that may be beyond

(i) Letter IX. P. 224.

yond our Power to explain;" for it cannot be thought that we can give a mechanical Solution of all its Operations.—However, I ſhall not *now* take any Advantage from it, but endeavour to anſwer your Queſtions in the cleareſt Manner I can.

It is related in the Hiſtory of the Deluge, that the Waters were fifteen Cubits above the higheſt Hills; and that there was an Expanſion in the *Midſt* of the terraqueous Globe; and that the Flood was occaſioned by the Waters proceeding through the Fountains and Openings from the great Deep.—After the Waters had prevailed the Time God appointed them, he cauſed a *Wind* or *Spirit* to force them back again from whence they proceeded, whereby the Earth became Dry. And Job tells us, (k) that God had made the Spirit the Inſtrument of Gravity.

Now in Order to conjecture the Thickneſs of the earthy Shell, we will allow, three Miles above the Earth (which, is generally reckoned)

(k) Job XXVIII. 25.

reckoned) to be the Meaſure of the higheſt Mountains; four Miles for the Thickneſs of the earthy Shell, and other three Miles for the Waters within the Shell; all this will be but ten Miles.—But what will ten Miles be to nearly 4000, the ſuppoſed Number of Miles from the Surface to the Centre.—This is but as one to 400, which will be as thin a Shell or Covering, in Proportion, as what is made uſe of to cover a Balloon.

It ſeems reaſonable to conjecture, (as an ingenious Author has obſerved,) from the natural Appearances of this terraqueous Globe, that it has been burſt to Pieces by an expanſive Steam from within; for we obſerve on it Mountains, broken Clifts, craggy Rocks, angular and impending Shores, ſubterraneous Caverns; together with a vaſt Variety of Fiſſures, Cracks, &c.—All theſe are particularly to be obſerved in the Marble or Lime Stone about Plymouth!—And, ſays this Author, that "without farther Inquiry, "theſe romantic Appearances are not the "Effect of a regular, uniform Law, but of "ſome

" ſome tremendous Convulſions, which have
" burſt its *Strata*, and thrown their Frag-
" ments into all this Confuſion and Diſorder:
" Nay, ſays he, the very Repreſentation of
" Sea and Land, upon a Geographical Chart,
" ſeems alone ſufficient to eſtabliſh the Truth
" of ſuch a Conjecture.—The Mountains in
" Derbyſhire, and the Moorlands in Staf-
" fordſhire, appear to be ſo many Heaps of
" Ruins:— The *Strata* lye in the utmoſt
" Confuſion and Diſorder; broken, diſlo-
" cated, and thrown into all Directions;
" and their interior Parts are no leſs rude
" and romantic, *full of ſubterraneous Caverns*,
" with every poſſible Mark of univerſal Vio-
" lence.—Alſo Blocks of Stone ſcattered over
" the Surface of mountaneous Countries,
" and blended with Soils to very conſiderable
" Depths, as if they had been originally
" ejected from their native Beds, by *ſubter-*
" *raneous Blaſts*, as Stones from Veſuvious
" and Ætna. (1)

" The Fragments near the native Beds are
" too

(1) Whitburſt, P. 21.

" too numerous and maſſy for the Hand of
" Man to have placed them there, and are in
" as much Diſorder as Stones caſually thrown
" together.—The Banks on the Eaſt Side of
" the River Derwent, from Crick Clift, for
" twenty Miles up the River, are thus co-
" vered; and the ſame may be ſaid of many
" other Mountains in Derbyſhire and Staf-
" fordſhire.

" Theſe Stones lying ſo near their original
" *Stratum*, we may eaſily ſatisfy ourſelves
" that they are detached Parts thereof; and
" by Analogy, the more diſtant Fragments
" may be aſcertained with equal Certainty,
" though at the Diſtance of ten or twelve
" Miles.

" In the Neighbourhood of Utoxeter, in
" Staffordſhire, Blocks of Lime Stone are
" frequently dug up, of four or five Hundred
" Weight each; and yet there are no Quar-
" ries of the ſame Kind nearer than four or
" five Miles.

"Fragments of Stone, perfectly analogous "to the former, were dug up at *Etwall*, in "Derbyſhire.—A Well being ſunk to the "Depth of eleven Yards, many of theſe "Stones were found, intermixed *with other* "*adventitious Bodies*, from the Surface of "the Earth, to that Depth; ſome of them "were ſix or eight Pounds Weight, and "ſome ſmaller.—Now although *Etwall* can-"not be leſs than fifteen or twenty Miles "from any known Quarry of the ſame Kind; "we cannot help concluding, that they were "originally ejected to that Diſtance; ſince "ſuch Effects are frequently produced on "ſubterraneous Exploſions." (m)

The above accurate Deſcription of the natural *Phenomena* of this terraqueous Globe, (as the Author obſerves,) appears to be Evidence, that the Shell of the Earth was burſt and broken into Millions of Pieces, by an expanſive Exploſion from within; and theſe Pieces could not poſſibly fall together again into their primitive Order and Regularity, but muſt leave an infinite Number of Caverns,

(m) Whitehurſt, P. 53.

verns, many Miles, probably many Hundreds of Miles in Length, below the Surface; and I think we may juſtly conclude, that this happened at the Reformation after Noah's Flood.—Now in Order to ſhew that there ſtill remains a violent expanſive Force, occaſioned from the internal Fire, I ſhall give an Account of the moſt remarkable Phenomena of late Earthquakes, from the above Author.

At the Earthquake at Liſbon, which happened Nov. 1, 1755, "The Mountains of "Arrabida, Eſtretta, Julio, Marvan, and "Cintra, being ſome of the largeſt in Por-"tugal, were impetuouſly ſhaken to their "very Foundations, and ſome of them open-"ed their Summits, ſplit and rent in a wond-"erful Manner, and huge Maſſes of them "were thrown down into the adjacent Val-"lies. [m] This Earthquake was more dread-"ful in Barbary than at Portugal; at Me-"quinez, that Part of the City where the "Jews reſided, was entirely ſwallowed up.—"The

(n) Hiſt. and Phil. Earth. P. 317.

"The Mountains were ſo ſtrangely torn, "that they ſeemed to be different Shapes "now from what they were.—A large Moun- "tain near Portmorant, near a Day's Jour- "ney over, is ſaid to be quite ſwallowed up; "and in the Place where it ſtood, there is "now a great Lake, of four or five Leagues "over. [n] In this memorable Earthquake at "Liſbon, not only the Sea, but Lakes and "Ponds were violently agitated all over "Europe.—Now, as Mr. *Whitehurſt* obſerves, "as one of the Properties of the Steam is "Condenſation by a ſmall Degree of *Cold*, "the ſame Degree of expanſive Force, can "only exiſt during the ſame Degree of Heat, "therefore the incumbent Weight cannot "become elevated to any greater Diſtance "than the ſubterranean Fire is continued.— "But on Nov. 1, 1755, the Waters were "agitated through an extenſive Country, not "leſs than 3000 Miles; ſo that the Steam "muſt be in one continued Body thus far." [p]

Mr. Hook, in his Poſthumous Works, P. 302,

(o) Philoſ. Tranſact. Low. Abrid. Vol. II. P. 417. (p) Whitehurſt, P. 94.

302, informs us, " That from Sept. 24, to " Oct. 9, 1650, the Island of Santitirum " was dreadfully shaken with Earthquakes, " but the People were more amazed to see a " horrid Eruption of Fire break out at the " Bottom of the Sea;—previous to the Ap- " pearance of Fire, the Water was consider- " ably elevated in that Place, and the Wave " spread itself round every Way; overturn- " ing every Thing it met, destroying Ships " and Gallies, in the Harbour of Candia, " which was eight Miles distant. [n]

" The Earthquake filled the Air with " Ashes, and horrible sulphurous Vapours, " and dreadful Lightnings and Thunder suc- " ceeded.—All Things in the Island were " covered with a yellow, sulphurous Crust; " Multitudes of Pumice and other Stones, " were thrown up, and carried as far as Con- " stantinople, and to Places at a great Distance.

" Nov. 20, 1720, a subterraneous Fire " burst out of the Sea, near Tarcara, one of " the

[n] Whitehurst, P. 64.

" the Azores, which threw up ſuch a vaſt
" Quantity of Stones in the Space of thirty
" Days, as formed an Iſland about two
" Leagues Diameter, and nearly round.

" In the Year 1767, a ſolid Stone, meaſur-
" ing *twelve Feet* in Height, and *forty-five*
" in *Circumference*, was thrown a Quarter of
" a Mile from Veſuvius."

Now, Sir, in Order to confirm my Theory, I have extracted ſome Obſervations from Mr. *Whiteburſt*'s State and Formation of the Earth, (the Book which you were ſo kind as to ſend me lately, as a Preſent,) he appears to me to be a diligent Inquirer into the component Parts of this terraqueous Globe, and a faithful Relater of the Obſervations he made himſelf, or received from others.—I ſhall therefore take his Advice, and follow his Example, viz. " *Not to find Faults with other Syſtems; but to avail myſelf of ſuch Parts of them as are applicable to my own Deſign*," but muſt beg Leave to differ from him *in Deſign*; for he tells us, " That his *Inquiry* was after
" the

" the *Laws* by which the *Creator chose* to " form the World, and that the *only* natural " *Datum* required, was the oblate, spheroidal " Form of the Earth."—My Design is to enquire after, and point out, the physical *Causes*, how one Part of Matter, acts by *mechanical Laws*, on another.

From the above Observations we may naturally conclude, that all the apparent Confusion and Disorder of the *Strata*, are undoubtedly Convulsions and Effects occasioned by FIRE, and fiery Vapours continued within this terraqueous Globe.—But when we compare these tremendous Operations of Earthquakes, with those which the Earth underwent at the Deluge, when the Alps, the Andes, &c. were formed, it will hardly bear a Comparison.

Hence, as Mr. *Whitehurst* observes, (o) " their " Effects leave no Room to doubt the *Existence*, *Force*, and *Immensity* of *subterraneous* " *Fires*; not only under the Bottom of the " Ocean,

(r) P. 84.

" Ocean, but likewiſe *under Mountains, Con-*
" *tinents, &c. in all Parts of the World.*"

Thus, if the expanſive Power, (within this terraqueous Globe, which is occaſioned by Fire acting in the ſame Manner as has been obſerved,) is continually increaſing, it will gradually become equal to the incumbent Weight or Bond which ſurrounds it; theſe ſame Cauſes ſtill continuing, they will become ſuperior to the Preſſure of Gravity from without:—It will then, by Degrees, expand and diſtend the incumbent *Strata*, and cauſe an Earthquake, and find a Vent to mix itſelf with the ſurrounding Airs without. After this, the Fire and Steam from within the Globe, having expanded themſelves, and being mixed with the Atmoſphere, (which they will ſoon do;) the Gravity and Preſſure from without, will again take Place, and *compreſs* and force the Parts of the terraqueous Globe towards the Centre, with the *ſame Power* it did before this *Phenomenon* happened. But ſince the aſtoniſhing Cataſtrophe at the Deluge, which made ſuch Alterations in the terreſtrial

terreſtrial Globe, it cannot now be affected to ſo great a Degree as it was then :—For by the confuſed Manner the Fragments were forced back again into the great Deep, Mountains were formed, which we may conjecture to be nearly equal in Height to the whole Thickneſs of the earthy Shell; and, it is probable, that ſome of theſe huge Fragments may reach as much below the Deep, or Waters within the earthy Shell, as the Hills and Mountains do on the Outſide; and as is obſerved, have left innumerable and large Caverns and Fiſſures, which reach from the fiery Expanſion within, to the Tops of our higheſt Mountains without; where many of them, in different Parts of the World, have Volcanos on their Tops, and therefrom diſcharge their *ſuperfluous Fire*, as Occaſion may require.—By theſe Vents, whenever the internal Expanſion is arrived to a Strength ſufficient to overcome the outward Preſſure, it forces itſelf up through theſe Vents, and expands itſelf into the common Atmoſphere without; but if it happens to make its Way into any of thoſe Caverns, that have not the

aforesaid Vent, it there distends the incumbent *Strata*, and forms Earthquakes; and after it has found a Passage into the Atmosphere without, these Fragments are again forced together as before, but in a confused Order.—Hence it may be observed, that as soon as it arrives at a certain Force, it then spreads itself, and the *Equilibrium* is again restored.

Thus, as has been remarked, there will be left an internal *Void* of Space nearly 8000 Miles Diameter; which, from the above Observations, may be supposed to contain Fire and inflammable Air, and Steam.—Hence, this terraqueous Globe will be of no greater *Specifick Gravity* than the *Ethers* wherein it is placed; and that this is so, is confirmed by the Alterations made on the Flux and Reflux of the Sea into the Abyss; and this *only* by the Moon's intercepting the Pressure from the Extremities; so that this terraqueous Globe will be carried round the Sun, (and not fall into it) in the same Manner as Clouds, or in particular a Balloon, which is kept

kept ſuſpended at ſuch a particular Diſtance from the Earth, viz. till its *Specifick Gravity* is altered, either by throwing out Ballaſt, to leſſen that Gravity, and make it aſcend higher, or by letting out ſome of the inflammable Air, and thereby increaſing its Gravity.—If neither of theſe are done, or happens, by Accident or otherwiſe, the Balloon will continue at the ſame Height from the Earth, and be carried by the Current of Air wherein it ſwims, either North, South, Eaſt, or Weſt; as that Current goes.—Heat and Cold are now allowed by all to be the Cauſe of the Current of Air we call Wind!—And what is very remarkable, the Perſon therein, let him be carried ever ſo faſt, feels very little Effect from it.

Now it may be aſked how is this Fire ſupported? If it does not receive ſome *Pabulum*, it muſt loſe its Strength!—Certainly!—But it receives this Support by *Circulation* from without; as the Sun does by the *cold Ether* preſſing into it from the Extremities of the Syſtem. — For the expanſive Power from within

within the Shell of the Earth, may be obſerved to be in an exact *Equilibrium* with the compreſſive Power without.—For it has been often obſerved by Navigators, that at particular Places in the Ocean, there are certain *Gulfs* by which the Sea communicates with the *great Deep* below the Earth, particularly that Whirpool called *Maelſtroom*, or *Navel of the Sea*, upon the Coaſt of Norway, where, ſays *Gordon*, in his *Geographical Grammar*, "The Sea, for upwards of two Leagues round, "makes ſuch a terrible *Vortix*, that the Force "and Indraught of the Water, together *with* "*the Noiſe* and Tumbling of the Waves upon "one another, is rather to be admired than "expreſſed.—But, as in the Time of Flood, "the Water is drawn in with a mighty "Force, ſo during the Time of Ebb, does "it throw out the Sea with ſuch Violence, "that the heavieſt Bodies then caſt into it, "cannot ſink, but are toſſed back again by "the impetuous Stream which ruſheth out "with incredible Force."—Hence may be obſerved, that there is a continual Circulation, or alternate *Flux* and *Reflux*, between the Seas,

Seas, without the earthy Shell, and the *Abyss* within; and that the *expansive* Force within is in so exact an *Equilibrium* with the *Compression* without, that no greater Force is required to cause this Flux and Reflux, than the Difference the Moon makes by her intercepting some of the Pressure from the Extremities, when she is either over, or at a great Distance from the Part.—Now the Waters, in running into the Abyss, carry with them Air enough for the *Pabulum*, or Support of the internal Fire.—On the Return of the Waters to the Expansion within the earthy Shell, they are again, by the Fire there, expanded into Vapour, which Vapour is forced up through the Caverns and Fissures from below, to the Tops of the highest Mountains, where by the Cold it there meets with, is again condensed into Water, falls into the different Cavities of the Earth, and is forced out in Springs, from thence into Rivers, and thence into the Sea.—Thus, as the Preacher tells us, "*All the Rivers run into the Sea,* "*yet the Sea is not full: Unto the Place from whence*

whence the Rivers come, thither they return again." (f)

It gives me Satisfaction to find that the Scriptures confirm the above natural Obſervations, and that they ſpeak phyſically true concerning them.—Thus Job tells us (t) "*That the Earth is ſuſpended on the conſtrict-*"*ing Mixture of Ethers*; the Place in the Heavens where theſe two ethereal Agents are in a juſt Proportion to each other, and of the ſame ſpecifick Gravity with the Body of the Earth;

(f) Eccleſ. I. 6.—(t) Job, XXVI. 7.

(t) What I have tranſlated the *conſtricting Mixture* of the Ethers, in the Engliſh Bible is tranſlated *Nothing*, but that cannot be the Signification of this Word: It is BaLIMaH, from BaLaM, which according to all Lexicons, ſignifies *to conſtrict, to bind, to reſtrain*, as the Violence of an Horſe or Aſs is by a Bridle; and is to be found but once more in the Bible, which is Pſalm XXXII. 9, where it is made uſe of as a participle paſſive, for the reſtraining an Horſe or Aſs with a Bridle;—without the final *Mem*, it is often made uſe of as a *Mixture* of different Things, as dry and wet, &c.—It is probable that the Engliſh Tranſlators were led into this Error, by following the Latin Tranſlation too cloſely; which at that Time, was by many of the Church of Rome believed to be more infallibly true than the original Hebrew.

Earth; in which the terraqueous Globe is carried on in them, with as much Eaſe as a Cork is on the Water, or as if the whole Body was compoſed of Ethers; having neither *Projection* nor *Gravity*.—Hence, notwithſtanding the terraqueous Globe is carried on by theſe Ethers, at the incredible Rate of more than one thouſand Miles every Hour; yet the Inhabitants on it meet neither with Reſiſtance or Preſſure from theſe Ethers, and therefore find Nothing of this almoſt *inconceivable* quick Motion. — Much the ſame Thing has been obſerved by thoſe who have been carried with the greateſt Celerity in a Balloon; not finding any Thing of the Quickneſs of the Motion, or how it went.—*Theſe* Ethers *compoſe the Swadling Band that ſurround it:* [u] *Theſe are the* Pillars *which ſupport it;* [v] *when he gave his Decree that the Sea ſhould not paſs his Command.* [w]

Having now been forced to write a long Letter, in order to explain my Conjectures about the internal Make of this terraqueous Globe,

(u) Job. XXXVIII, 9.—(v) Job, IX. 6.—(w) Prov. VIII. 27, 28, 29.

Globe, I ſhall defer pointing out the Agents Nature makes Uſe of, and the Method they act by, in order to carry on the diurnal Rotation, and the annual Revolution, to my next Letter, which you will receive ſoon.

Adieu,

F. PENROSE.

STONEHOUSE,
Oct. 18, 1785.

To JOHN HEAVISIDE, Esq.

Mr. *Heavifide's Queftion, "Why does not the "Earth gravitate into the Sun, &c." anfwered.—All Space filled with* ETHERS, *which reach from the Sun, to the Extremities of this Syftem, and are in continual Conflict, and caufe a* vibrating *Motion, by their Endeavour of getting the better of each other. Thefe* Ethers *the Caufe of* Projection *and* Gravity.—*The Earth and Planets of different fpecifick Gravities, according to their Diftance from the Sun.—The diurnal and annual* Motion of the Earth *accounted for. The Phenomena of Nature, and the Scriptures, confirm the Teftimony of each other.*

DEAR SIR,

IN the laft Letter, I fent you my Conjectures on the Make and Form of this terraqueous Globe; by which you may obferve, that I fuppofe the Thicknefs of the earthy Shell to be [illegible] fmall, in Comparifon with the inter-

nal *Void* or *Hollow* in the *Midſt* of it.—By the *Phenomena* of Earthquakes, &c. it appears that this Hollow is filled with Fire, inflammable Air, and Steam. --Thus the whole Body of the terraqueous Globe will be of no greater ſpecifick Gravity, than the Ethers which ſurround it.—If this was not the Caſe, and it was ſolid to the Centre, it ſeems probable that it would be forced into the Sun: But, as it is of the ſame ſpecifick Gravity with the ſurrounding Ethers, they keep it at the ſame Diſtance from the Sun, and it ſwims therein with as much Eaſe as a Balloon does in the Air, above the Earth.

Having mentioned thus much, I ſhall now endeavour to anſwer the two Queſtions you were ſo anxious about, which you propoſed in your Letter dated May 16; and again repeated in your laſt.—Firſt, "If the Earth, "&c. were put in Motion by the Heat of "the Sun, rarefying the Atmoſphere between "theſe Bodies, why did the Earth not im-"mediately gravitate into the Sun, as the "Medium muſt be there more rarefied than

"any

" any where elſe?"—Secondly, " What is " the Impulſe or trajectile Force for its an- " nual Motion; and then, what is the Power " that brings it back again from the immenſe " Diſtance at which it is at the Summer " Solſtice; or prevent it from flying off in a " Tangent?"

In ſome of my former Letters [x] I obſerved it was the Opinion of the ancient Philoſophers, that the Heavens were filled with Fire or Light and Air, and that theſe were the Agents which governed all other Things: Sir Iſaac Newton ſeems to think ſo too, [y] for he ſuppoſed " that Light and Ether lay hid " in *all* Bodies; that the *Light proceeded from* " *the Sun*, and the *Spirit from the Extremities!* " That if their elaſtic Force were expanded " through the whole Heavens; and that if " this Medium be rarer at the Body of the " Sun, than at its Surface, and rarer at the " Surface, than at the hundredth Part of an " Inch from the Body of the Sun; and rarer " there than at the fiftieth Part of an Inch " from

(x) Letter IV. Introduction, P. 60.—(y) Opt. P. 323, 325.

" from its Body; and rarer at this Place,
" than at the Orb of Saturn; I ſee no Rea-
" ſon, (ſays he) why the Increaſe of its Den-
" ſity ſhould ſtop any where, and not rather
" be continued through all the Diſtances, from
" the Sun to Saturn, and beyond.—Then, if
" we ſuppoſe two vibrating Mediums, the
" one rarer at the denſe Bodies of the Sun,
" Stars, Planets, and Comets, than in the
" celeſtial Spaces between them; ſo that if
" the elaſtic Force of this Medium may be
" exceeding great, it may ſuffice to *impel*
" Bodies *from the denſer Parts of the Medium,*
" *towards the rarer, with all that Force or*
" *Impulſe which we call Gravity.*

Hence we find, that it was the Opinion of Sir Iſaac Newton, and the ancient Philoſophers, that there was an ethereal Fluid, which filled *all Space*, from the Sun to the Extremities of this Syſtem.—That what iſſued from the Sun, in Form of Light, was more rare than that which was returned from the Extremities to the Sun, which he calls Spirit.— By theſe Agents, (the ETHERS) all

all Motion was performed, and by the Spirit, every Thing was forced to the Sun, with that Power we call *Gravity*.—That the *Mixture* of these two Ethers was of a different specifick Gravity, in Proportion as one or other abounded.—Hence, that the Bodies of the Earth, Planets, &c. circulating round the Sun, must be of different specifick Gravities, agreeing exactly with the specifick Gravity of the Medium *(Mixture,)* wherein they were placed.

Thus the Earth must be of less specifick Gravity than *Venus*; *Venus* than *Jupiter*, *&c.* This may be explained so far, as to understand my Meaning, by placing a Glass or Metal Bubble, of the exact specifick Gravity, between Water and Spirit of Wine —If we place this Bubble at the Bottom of a Glass Tube, and pour on it an Inch of Spirit of Wine, it will be forced and kept at Bottom by its own Gravity; if we add an Inch of Water, it will then remain at Rest, in any Part of the Fluid:—If we again add another Inch of Water by Degrees, we shall perceive,

perceive, that the Fluid, by this Means, will acquire a greater ſpecifick Gravity than the Bubble, and will then, (according to the Laws of Hydroſtaticks,)be forced, *by Gravity*, down to the Bottom, and will then force the Bubble of leſs ſpecifick Gravity, to aſcend to the Top.—This Motion of the Bubble in the Fluid, may be made to move or change its Place, in the ſame Manner by Heat and Cold. Thus by applying Heat to the Top, or any Side of the Fluid, it will expand its Parts, and thereby make it to occupy more Space: Hence its Pores being filled with Heat or Fire, it will reſiſt leſs, and the cold and denſe Parts of the Fluid will preſs it towards, and into that Part which is more rare, and of leſs ſpecifick Gravity, and reſiſts leſs.—Hence we may obſerve, that Gravity and Levity are relative Effects.

Thus, the Earth being of the ſame ſpecifick Gravity, with the *Mixture* of the ſurrounding Ethers; theſe Ethers keep it at the ſame Diſtance it is from the Sun, and prevent it being projected farther from the Sun, or forced nearer to it. Having

Having obſerved thus much, that the Aſcent from the Sun, and the Deſcent to it, are occaſioned by the Rarity and Denſity of the different Mediums, as the different Mixtures of the Ethers, between the Sun and the Extremities, according as the Quantity of either one prevails; I ſhall now endeavour to point out the Cauſes of the *diurnal* and *annual* Motions of the Earth; but before I do this, let it be remembered, that Bodies of different Denſities, are a longer or a ſhorter Time heating, and alſo that they retain their Heat a longer or a ſhorter Time, according to their Denſities. (z)—Thus, Water will acquire a greater Heat than Air, and Earth than Water, &c.—This is obſerved to be the Cauſe of different Winds; for it is a known and invariable Quality of the Air, for the Cold to endeavour to force out the Hot, and the Hot to open and expand the Cold.—Thus the Earth being denſer than Water, it will acquire a greater Heat than the Sea.—"It is obſerved, that the Sea Breezes blow "towards the Land, in the Middle Part of "the

(z) See Let. V P. 181, 189.

" the Day, in *every Direction*; and in the
" Middle or coldeſt Part of the Night, the
" Land Breezes blow towards the Sea, and
" thus alternately they ſucceed each other.—
" Hence the Equilibrium of the Preſſure of
" the two Atmoſpheres being deſtroyed, and
" the Land Atmoſphere, by the Heat being
" rendered ſpecifically lighter than the Air at
" Sea, the former aſcends by the ſuperior
" Preſſure or Weight of the latter; therefore
" the Sea Breezes *blow towards the Land, in*
" *every poſſible Direction*.—When Night comes
" on, the Sun's Heat abates, until the Land
" Atmoſphere becomes equally denſe with
" that at Sea.—The Equilibrium of Preſſure
" being thus reſtored, the Sea Breezes totally
" ceaſe.—Thus, Cold increaſing by the Ab-
" ſence of the Sun, and its ſudden Departure
" below the Horizon, accumulates on the
" Surface of the Iſlands, and condenſes their
" incumbent Atmoſphere more than that at
" Sea."

I ſhall now apply Deductions from the Phenomena obſerved, and by them I ſhall endeavour

deavour to explain the Motions of this terraqueous Globe.—First then, I suppose, there is a *hot Ether* or Light continually issuing from the Sun at the Centre, which is the Cause of *Projection*, Rarefaction, Expansion, and what we call a *centrifugal Force*, *&c.* and a *cold Ether* or Spirit continually descending from the Extremities of this System, to the Sun at the Centre, which is the Cause of Attraction, Cohesion, Pressure, *Gravity*, and what is called a *centripetal Force*.

Thus, Light or one Moiety of the celestial Ethers, (which is the rarer or finer Part,) is in continual Motion, from the Sun to the Circumference; and the other Moiety or *Spirit*, (which is the grosser Part,) is in continual Motion from the Circumference or Extremities of this System, to the Sun in the Centre;—that these two Forces, by Mixture, exactly balance each other at the Morning and Evening Edge of the Earth, and parallel with the Ecliptic.—The Motion of these adverse Forces causes an Expansion, and lays a Stress or Pressure on every Body, and every

Particle of the ethereal Fluid, (and is the Cauſe of Coheſion,) and forces the Bodies contained therein, either nearer or farther from the Sun, according as the different Mixture of theſe two Particles prevail, and the ſpecific Gravity of the Body.—Thus, when an Equilibrium is formed round that Body, it remains at Reſt, and continues ſo, till by Light or Heat an Expanſion is made on one Side, or Part of it; when Motion enſues, and continues ſo long as the Preſſure behind is of greater Force than the Projection or Expanſion before.

The Mixture of theſe two Qualities of Ethers, being rarer or denſer in Proportion to the Diſtance between the Sun, and the Extremities of the Syſtem.—Thus the Bodies of the Earth, and all the Planets, are formed of different ſpecifick Gravities, according as they are placed either nearer or farther off from the Sun, and are placed in a *Mixture* of Ethers, of the ſame ſpecifick Gravity with the Planets placed therein; and are thereby prevented from approaching nearer, or receding

ceding farther from him.—Thus the Light projecting on one Side of the terraqueous Globe, and Spirit preſſing in at the oppoſite, cauſes the Earth's Motion round its Axis, in the ſame Manner as a Cork or Piece of Wood may be obſerved to circulate round, when a River is obſtructed by a Bank, and the Water made to circulate round.

We will now ſuppoſe the Sun to be placed in the Firmament or Expanſion, and the Earth in the ſame Place it now occupies; I will then ſuppoſe, (as Moſes informs us) that it was firſt made to turn on its Axis by the immediate Power of God; after that, having finiſhed his Work, it was an *Automaton*, and he ſaw that it was good, and every Part of it capable to perform the Office he deſigned it for.—Thus he left *Nature*, or the *material* Agents, to perform their own Work; *unleſs, by a Miracle*, he ſtopped or altered them, to ſhew his Power over them.—Thus, as has been obſerved, the *projectile Force* of the Light from the Sun, on that Side of the Earth oppoſite to it, was exactly

counterbalanced

counterbalanced by the *gravitating Force* of the Spirit on the Backſide of the Earth, oppoſite to the Extremities.—Now, it is well known, and has already been obſerved, that Bodies receive and retain their Heat, in Proportion to their Denſities, and that this has been proved to be the Cauſe of Winds, Hurricanes, &c.—Thus, that Side of the terraqueous Globe, oppoſite the Sun, having its Parts greatly heated, and being more than one thouſand Times more denſe than the Atmoſphere, it retains it a great While longer;—Thus, the Atmoſphere at the Evening Edge of the Earth, is more rarefied and expanded by this Heat, and the denſe Air or Spirit preſſing in from behind, (and alſo from that Side oppoſite the Extremities) to form an Equilibrium, forces it round its Centre, towards the Morning Edge, or from Weſt to Eaſt.—Hence the diurnal Motion;—the lateral Rarefaction being greater on this Quarter from Noon to Evening, or between South and Weſt, than on its oppoſite, receives a different Impulſe, in *a Diagonal* of theſe two Forces, viz. that of the projectile, on that Side the

Earth

Earth next the Sun, and the gravitating, on that Side oppoſite the Extremities.—Hence, the annual Impulſe through the Ecliptick, which makes an Angle of 23 D. 30 M. with the diurnal; and as theſe Forces are continually acting, ſo the Earth will continue her Motion round her Axis, from Weſt to Eaſt, together with that through the Ecliptick;—As theſe Ethers are of different Qualities, both nearer or farther from the Sun; and as the terraqueous Globe is exactly of the ſame ſpecifick Gravity with this Mixture of the Ethers, wherein ſhe is placed, (which is in a continual Current or Circulation round the Sun,) ſo muſt the Earth be carried round the Sun with it.

We may form ſome Conception how theſe two oppoſite Forces act by the Motions of a Pendulum, or a Weight ſuſpended by an inflexible Rod on a Pin, as its Centre of Motion.—" Its Weight or Gravity will hinder " its approaching any nearer to the Centre, " and the Rod or Projection will prevent its " Weight or Gravity from carrying it farther " from the Centre; but, nevertheleſs, it is " capable

" capable of being put in Motion by a *ſmall* " *lateral* Impulſe, and will deſcribe not a " ſtrait Line, but *Arcs* of a Circle, whoſe " Centre is the Pin from whence it is ſuſ- " pended.—And as the two Forces are ſup- " poſed equal, the Caſe of the Earth will be " exactly analogous to that of the Pendulum!"

Thus the progreſſive or lateral Impulſe being always exerted in the Direction of the Plane of the Earth's enlightened Hemiſphere, where the mixt Force of theſe conflicting Ethers is equal, and Reſiſtence nothing.—Which Plane is always perpendicular to the Rays drawn from the Sun to that Place.—If in any Part of the Earth's Orbit, the *Preſſure or Gravity* be greater than ordinary, or *the Projection of the Light* leſs; the Earth, in either Caſe, will be made to approach in that Part of its Orbit, nearer to the Sun: Or, if the *lateral* Impulſe be ſtronger or weaker than ordinary, the Earth will be forced farther off, or nearer to the Sun: And as the Moon and Planets are ſometimes ſo ſituated, that if, by the Intervention of their Bodies, they

they interrupt the Action of *Spirit* or *Light*; this Interruption may leſſen or increaſe their Force, either to bring the Earth nearer to, or farther from the Sun. — Witneſs the Moon's Influence on the Tides!

The foregoing Account of the Phenomena of Nature, ſeems to confirm and explain to us the ſhort Hints thereof given in the Scriptures.

I ſhall therefore ſubmit to your Judgement and Candour, whether what I have ſaid may not illuſtrate the Moſaic Account of the Formation of the Earth, and Reformation of it, at the Deluge; and then conclude, that as the Phenomena of Nature, Reaſon, and Revelation ſo perfectly agree, whether that Coincidence may not be conſidered as a Teſtimony of the Truth of each.

Thus we are informed, that the all-wiſe Creator has obſerved the moſt exact Proportions, and has made ALL Things in *Number*, *Weight*, and *Meaſure*:—Who made *Weight* for

for the *Winds* or, (which is more literal) *who made the Spirit the gravitating Instrument*, and *weighed the Waters by Measure.* [a] Who hath measured the Waters in the Hollow of his Hand; and meted (or spread) out the Heavens with a Span, and comprehended the Dust of the Earth in a *Measure*;—who *weighed* the Mountains in Scales, and the Hills in a Balance. [b] "Who hath *bound the Waters* in a *Garment*; who hath established all the Ends of the Earth: [c] Who shut up the Sea with Doors, and made the Cloud the Garment thereof, and thick Darkness a Swadling-Band for it; and said hitherto shalt thou come, but no farther; and here shall thy proud Waves be stayed. [d] The North declines, (or *gravitates)* to the empty Place, (or South) and hangeth the Earth upon Nothing, (in Hebrew) (the *Mixture of Ethers,)* [e] These, as we are informed, [f] are the *Pillars* of the Earth, and the Lord has set the *World* upon them.

Adieu,

F. PENROSE.

STONEHOUSE,
Oct. 20, 1785.

(a) Job, XXVIII. 25.—(b) Isaiah, XL. 12.—(c) Proverbs. XXX. 4.—(d) Job, XXXVIII. 8, 9, 10, 11.—(e) Job, XXVI. 7.—(f) I. Sam. II. 8.

To JOHN HEAVISIDE, Esq.

DEAR SIR,

IN your laſt Letter, you were ſo complaiſant as to aſſure me, that my long Letters gave you infinite Pleaſure, and that I had not anſwered your former Queſtions.—In my two laſt, I endeavoured to do it in as clear a Manner as I could; I hope they will find your Health quite reſtored, by your Journey into Norfolk and Suffolk, together with your Sea Bathing.

I herewith ſend you a New Year's Gift, for A. D. 1786, in Hopes to profit by the Remarks of yourſelf and Friends.

It is two Diagrams, (an original Deſign of my own) conſtructed to ſhew the Places of the Sun and Moon, for every Day next Year, according to the Julian Calendar.—You will find ſome Part of it to differ from what is generally taught in Aſtronomical Lectures, and received as true, viz. the Diviſion of the

Ecliptick, and the Preceſſion of the Equinoxes, but theſe appear to me contrary to the Operations or Laws of Nature; I therefore wiſh to have them examined by Perſons well verſed in theſe Sciences; and as the Improvement of Knowledge is the ſole End of my Deſign, ſo if you will ſend me the critical Remarks of your Mathematical Friends thereon, I doubt not but all theſe Difficulties will be cleared up.

I am,

DEAR SIR,

Your faithful

And obliged Friend,

F. PENROSE.

STONEHOUSE,

Dec. 26, 1788.

To F. PENROSE, Esq.

The Obſervations of Mr. Heaviſide's aſtronomical Friend, on Mr. Penroſe's Diagrams, not concluſive.

DEAR SIR,

YOUR laſt Favour found me very early in the new Year at Potterels, where I had been for two Months, ſo far from well, as not to have ſtired out of Doors hardly in all that Time. My little Excurſion into Norfolk and Suffolk, was of ſome Service to me for a While, but I ſoon grew worſe again, and was unable to ſtir; indeed I have not been able to ride ten Miles on Horſeback, in any one Day, for near a Year and Half paſt; however, I have been recovering full as faſt as I can expect, for the laſt five or ſix Weeks, and have got up my Fleſh and Strength again amazingly, if I can but keep free from Colds, to oppreſs my Lungs, which are ſtill in a Situation too ſuſceptible of Injury.—This State of Health has detered me from

from ſtaying in London more than a Day or two at a Time, when Buſineſs obliged me to it, till very lately; when, upon Trial, I found myſelf, thank God, equal to ſtaying here without Prejudice.—For theſe Reaſons I had no Opportunity till very lately of ſhewing your Diagrams, (with which you favoured me, and for which I think myſelf very highly obliged to you) to any of my learned Friends; but I do aſſure you, that I did not neglect the very firſt I had; and this very Day the Gentleman called, when I was out, and left it for me, with a Note, of which you will find a Copy in the Margin; I would have ſent the Note itſelf, but that it would have made it a double Letter.

As I do not think he has entered ſo deeply into this Buſineſs as he ſhould have done, I am by no Means ſatisfied with the little he has ſaid, and therefore ſhall endeavour to find out ſome other Aſtronomer, who will give it more Conſideration than I fear he has done; I ſhould therefore have defered writing till then, but that as I think it probable you may wiſh

wiſh to have the Plate engraved ſoon; I trouble you now, to beg you will give me your immediate Directions for having it done, if you wiſh to have it done *now*, and I will uſe my beſt Endeavours to find out a good Engraver.— Pray what think you of this Gentleman's Idea on that Subject?

On the other Side you will likewiſe find what my Friend Dr. Alexander, (to whom I wrote ſome Time ago, to get ſome Experiments made relative to the Weight of Bodies at different Depths in Mines,) ſays on that Head: His Account ſeems in ſome Meaſure to contradict your Opinion as well as my own.—If you are not ſatisfied with this Anſwer, and would put any more particular Queſtions to him, pray ſend them to me, and I will endeavour to procure an Anſwer to them; for it will give me great Pleaſure to procure you any Information or Satisfaction in your laudable Purſuits after Knowledge and Philoſophy.— Nor would I have you think, that becauſe I am too idle a Fellow myſelf, to apply cloſely to the Study of Philoſophy

losophy as you do, that therefore I take no Pleasure in such Enquiries; far otherwise; I really have great Pleasure in it, and should follow the Pursuit closely had I Leisure, and any Friend near me to assist or join me in it.

The astronomical Gentleman who had the Examination of your Diagrams, presents his Compliments, and has returned it, and observes, that "He fears some of the Positions "it contains will not be found to have been "corrected up to the latest Discoveries, or "*rather newest Opinions.*"

I am,

DEAR SIR,

Your very obedient,

And obliged Servant,

J. HEAVISIDE.

PRINCE'S-STREET,

Feb. 22, 1786.

To JOHN HEAVISIDE, Esq.

DEAR SIR,

YOUR laſt very kind and obliging Letter came to Stonehouſe when I was in Cornwall, where I had been a great Part of the Months of February and March:—For this laſt Month I have been confined with the Gout:—I thank God, I am now able to walk again.—It gave us very ſincere Pleaſure to be informed, that you were recovered from your late Indiſpoſition.

I am greatly obliged to you for the Trouble you have taken, in conſulting your Aſtronomical Friends, about my Diagrams.—As I differ therein from what is generally taught by Aſtronomers, about the Diviſion of the Ecliptick, the Preceſſion of the Equinoxes, which appear to me to be Things of great Importance, I did hope that they would have thought it a Matter worthy their Examination, and that I ſhould be confirmed either that I was right, or that my Errors, if any, would

would be pointed out and corrected.—I therefore join entirely in your Opinion concerning it, viz. that they have not entered ſo deeply into the Buſineſs as I could have wiſhed they had done.—For, as they obſerve, "*the Poſitions therein differ from the lateſt* "*Diſcoveries, or rather the neweſt Opinions.*" For that Reaſon I wiſhed to have them thoroughly examined, as Truth is my Object.

If you have not yet met with an Aſtronomer, whoſe Opinion may be depended on, I hope, from your great Acquaintance, you ſoon will have an Opportunity of doing it.—I have ſent one of theſe Diagrams to Oxford, with a Deſire that it might be examined by the Geometricians and Aſtronomers there, but I have not yet received any Intelligence concerning it.—I am afraid that many Teachers of Science go on by Rote, with the ſame String of Experiments and Arguments that they have been taught, without giving themſelves Freedom and Trouble to examine the Truth of them.

I give you and Dr. Alexander many Thanks for the Intelligence he ſent you, concerning the Riſe and Fall of the Mercury in the Barometer, when under the Earth.—I am afraid that Dr. Alexander, by conſulting Miners, who *had the Rudiments of Philoſophy*, has anſwered the Inquiry from Theory and not from Experiment.—All Experience tell us, that the deeper we dig under the Surface of the Earth, the Heat is the greater, and of Conſequence the Air is the rarer;—therefore, for that Reaſon, I am fearful that thoſe Perſons, whom Dr. Alexander applied to, have impoſed on him, and anſwered his Queries from the Ideas they had of the Matter, and *not* from Experiment.—If they had made Uſe of a Thermometer, inſtead of a Barometer, I believe their Theory would prove true.—I could only wiſh for an Experiment without Theory.—Let a Barometer be carried down into a Mine, mark the Height of the Quickſilver on the Surface of the Ground, and alſo every thirty or forty Fathom you deſcend.—If they had alſo a Quickſilver Thermometer, and likewiſe mark the different Heights of

the Mercury, it would be more ſatisfactory. I am ſorry that you and Dr. Alexander ſhould have had ſo much Trouble, and that he ſhould have met with ſo many Difficulties about it.—All this I can moſt readily believe, as I have met with the ſame.—It might be imagined that I could get a Thing of this Kind eaſily done in Cornwall.—I have applied to many of my Acquaintance for that Purpoſe, and told them that I ſhould be glad to pay a Man for his Trouble in doing it.—I have been often promiſed it, but have never yet been able to get it performed.—If I could go down in a Mine myſelf, I could eaſily get it done! A Gentleman, when I was laſt in Cornwall, promiſed me to get it done, but I am fearful it will be ſome Time before it will be brought about.

I am,

DEAR SIR,

Your obliged and faithful Servant,

F. PENROSE.

STONEHOUSE,
April 10, 1786.

To F. PENROSE, Esq.

DEAR SIR,

I AM aſhamed to ſee that it is now ſix Weeks ſince I was favoured with your very kind Letter, and that I cannot even now anſwer it ſatisfactorily, either to myſelf or to you; for having been ſo much out of Town, (in which I dare not ſtay long at a Time, on Account of my Cough,) and having had ſo very much to do when I am here, and now finding that *real* deep Philoſophers and Aſtronomers are much more thinly ſown than I apprehended, I have not been able to get at any one who has ventured to give me any *decided* Opinion upon your Diagrams. — I want much to get them ſhewn to Dr. Maſkelyne, but have not yet been ſo luckly as to meet with one Acquaintance of mine that knows him enough to do it; however, I do not yet deſpair of finding ſuch a one, if your Friends at Oxford fail you.

I have wrote again to my Friend, Dr. Alexander,

exander, to try if he can procure a more exact Experiment to be made with a Barometer, in a Coal-Pit; which I dare ſay he will do if he can; but I need not tell you how difficult it is to put thoſe Miners, (or indeed any Body elſe) out of the Way in which they have been uſed to tread, unleſs it were poſſible to impreſs them with a Deſire of real Knowledge, unadulterated with Prejudice, *or make it* their Intereſt.

I am,

DEAR SIR,

Very truly,

Your Friend, and obedient Servant,

J. HEAVISIDE.

PRINCE'S-STREET,

June 29, 1786.

On the MOON and LUNAR MOTIONS.

To JOHN HEAVISIDE, Esq.

The Moon not a Planet, but a Satellite attending the Earth.—The recorded Obſervations of Aſtronomers, concerning Her, collected.—Her Make and Motions deſcribed. — The Chaldean Cycle, with the Methods they made uſe of for calculating their Eclipſes.—The phyſical Cauſes of theſe Motions explained, and confirmed by the Obſervations of Mr. Herſchel, and the French Aſtronomers.

DEAR SIR,

I GIVE you many Thanks for the Trouble you have taken to get a decided Opinion on my Diagrams, &c.— As you expreſs a Hope, in your laſt Letter, to get Dr. Maſkelyne's Opinion on them, I have herewith ſent you my Theory on the Moon, and the lunar Motions, in Hopes that you may, at the ſame Time, get his Sentiments on the lunar

lunar Motions alſo, and perhaps he will let you know what Objections he has to any of them.

The lunar Motions are called irregular; but, on Examination, we ſhall find no Irregularity belonging to the Moon or her Motions, but all of them performed according to the moſt exact and perfect Harmony and Mechaniſm; and that their apparent Intricacy proceeds from our Incapacity to comprehend their almoſt innumerable Variety of Motions. If we ſtudy them with a proper Attention, we ſhall find, that, inſtead of being irregular, they are performed with the greateſt Harmony and Regularity, according to the moſt ſtrict Laws of Geometry, Number, Weight, and Meaſure; and though their Number and Variety exceed the Power of comprehending them, or even of believing their Regularity, unleſs by thoſe who make them their particular Study; for though the Moon requires 7,948,800 ſynodical Revolutions, (which are more than 600,000 Years) for to go through all

all her Variations, and finish her Period or Cycle; [g] yet all these various Motions are carried on in the most curious, exact, and mechanical Manner, according to Number, Weight, and Measure, and cannot be calculated or understood by no other Method; therefore if any Theory concerning them will not bear the Test of Geometry and Numbers, it must be discarded.—Having premised thus much, I shall, in the first Place, collect the recorded Facts and Observations of Astronomers concerning them; from which I shall endeavour to draw the most natural Inferences, to explain these various Motions, and to point out their physical Causes.

The Moon is not a Planet but a Satellite, attending the Earth; which, together with the Sun, are allowed to be the principal Cause of her Motions.—These Motions are generally divided in a three-fold Manner; which are not only connected with each other, but are also connected with those of the Earth's, in

(g) Kennedy, P. 196, 210.

in a moſt wonderful Manner.—In the firſt Place, ſhe has a Motion round the Earth from Change to Change; or, from Sun to Sun, which ſhe performs in 29 D. 12 H. 44 M. 1 S. 45 T. which is called a *Lunation*.—2dly, She has a forward Motion, compounded with this Lunation, from Weſt to Eaſt, attending the Earth through the Ecliptick, round the Sun;—this ſhe performs in twelve Lunations, 10 Days, 21 Hours, and 39 Seconds.— Theſe twelve Lunations are called a *lunar Year*, and the 10 Days, 21 Hours, and 39 Seconds, are the Time required for her to get up with the Sun again. Theſe 10 Days, 21 Hours, and 39 Seconds, are not dropt or loſt, but go on as Part of the next Lunation, and is called *the Epact*, and is the Difference between the lunar and ſolar Year.—She does not keep the Earth's Path round the Sun, through the Ecliptick, but goes round the Earth in a progreſſive Circle, like a Screw, and forward, through the Ecliptick, at the ſame Time, together with the

the Earth; always, (throughout her whole Orbit,) keeping nearly at the ſame Diſtance from Her;—that is, Half the Diameter of her Orbit; which is ſuppoſed to be about 240,000 Miles. — Theſe Motions of the Moon in her Orbit, round the Earth, and through the Ecliptick, is ſo well deſcribed by Mr. *Ferguſon*, in his Aſtronomy, (h) that I ſhall take the Liberty to ſend it you, in his own Words.—" The Moon's abſolute Mo-
" tion *(ſays he)* from her Change, to her firſt
" Quarter, is ſo much *ſlower* than the Earth's,
" that ſhe falls 240 thouſand Miles, (equal
" to the Semidiameter of her Orbit) behind
" the Earth, at her firſt Quarter; that is,
" ſhe *falls back* a Space equal to her Diſtance
" from the Earth:—From that Time, her
" Motion is *gradually accelerated* to her Op-
" poſition or Full, and then ſhe is come up
" as far as the Earth; having *regained* what
" ſhe *loſt* in her firſt Quarter.—From the
" Full to the laſt Quarter, her Motion *con-*

(h) Ferguſon, P. 194, S. 267.

" *tinues accelerated*, ſo as to be juſt as far *be-*
" *fore the Earth*, (at her third Quarter) as
" ſhe was *behind* it at her *firſt*; but from
" thence to her Change, her Motion is *re-*
" *tarded*, ſo that ſhe loſes as much, with
" Reſpect to *the* Earth, as is equal to her
" Diſtance from it, or *to the* Semidiameter
" of her Orbit; and by that *Means ſhe comes*
" in Conjunction (at the Change) as *ſeen*
" from the Earth."

Theſe Motions of the Moon, both round the Earth and round the Sun, are performed from Weſt to Eaſt, *and from* Left to Right, in the ſame Manner as the Earth goes round the Sun:—But, beſides theſe two *joint* Motions of the Moon, there is a Motion or an *ecliptick Current* of Ethers, *abſolutely* belonging to the Moon.—This *Current of Ethers* goes alſo from Weſt to Eaſt, as do the Earth and Moon, but with this Difference, that as the Earth and Moon proceed Eaſtward, from Left to Right; ſo this proceeds juſt in the oppoſite

oppoſite Manner, from Right to Left, and may moſt properly be denominated *the Path of the Nodes or Eclipſes.*—This alſo creeps round the Ecliptick in a progreſſive Circle, in 18 Years, 10 Days, 19 Hours, 46 Minutes, and 15 Seconds; when it again meets the Sun in the ſame Point of the Ecliptick, and then begins a new Cycle.—This was in Uſe in *Chaldea*, and is called the *Chaldean Cycle of Eclipſes:*—For, in this Period, there will be a regular Return of the *ſame Eclipſe* for many Ages; only the Eclipſe get 28 I 12 II forward at every Return; and, by theſe ſlow Degrees, comes in at one Pole of the Earth, and after having paſſed quite over it, goes out at the other:—Thus thoſe which come in at the North Pole, go out at the South; and thoſe which come in at the South, go out at the North; after which they are again loſt in the Expanſe, but require more than one thouſand Years to do it.—Hence it may be remarked, that the *Chaldeans*, (from amongſt whom Abraham was called) had a Method

Method of calculating Eclipſes; for they had only to keep an Account of Number of Days and Years; the Method the Patriarchs and Iſraelites were taught to calculate the Returns of the Weeks, Months, and Years, and to keep their Chronology. (i) Thus by *only numbering* and keeping an Account of the Days and Years of this *Chaldean Cycle*, which was finiſhed every eighteen Years, and the ſame Eclipſe was ſure to make its Appearance again; for at the End of every eighteen Years, the Sun, Moon, and Nodes meet the Earth on the ſame Point of the Ecliptick, and they then begin a new Cycle.—To illuſtrate this, I ſhall here add the Calculations of the fourth and fifth Return of that remarkable Eclipſe which happened at London, May 3, N. S. 1715—at 9 H. 51 M. or 2 H. 9 M. before twelve o'Clock, when the aſtronomical Day is compleated, ſo that it was May 2 D. 21 H.

(i) Introduction, P. 27, 28.

On the MOON and LUNAR MOTIONS.

H. 51 M. ſubſtract this from the three Days of May, and it leaves D.H.M.

					28	2	9—	1715		
To which add June					15	4	56—	1787	the Eclipſe	
It makes in the Whole					43	7	5—	72	Years, 43 D. 7 H. 5 M.	
		Years	D.	H.	M.		D.	H.	M.	
4th—4 Cycles———		72	43	7	5—	June	15	4	56 P. M.—	1787
5th—1 Cycle ———		18	10	19	46	15 June	26	0	42 15 P.M.	18
It makes in the Whole		90	54	2	51	15				1805

From the above Example we may obſerve with what Eaſe and Certainty the Chaldeans might calculate the Return of the Eclipſes, viz. by knowing exactly the Length or Quantity of Time which the Sun, Moon, and Nodes require to perform their Circle, or to meet again in the ſame Point of the Ecliptick at which they parted; for though they do not meet preciſely at the ſame Point, yet it wants only 28 I 12 II. —— Theſe Calculations make it appear, that the Nodes move forward to the Eaſtward as well as the Earth and Moon, and alſo that they move a contrary Way

Way from them, and by that Means the Moon croſſes them twice every Lunation.

In this Cycle there are 223 Lunations
229 Nodes
And 18 Julian Years, 10 Days, 19 Hours, 46 Minutes, 15 T.

Hence the Regularity and the Harmony of the Sun, Moon, and Earth, may be remarked, and the Method of the Ancients in calculating their Eclipſes, which they did in ſo *mechanical* a Manner, that they had no Occaſion to know which of them moved, or whether any one of them did; yet were able to calculate, to prognoſticate, or foretel theſe ſuppoſed portentous Events.

Thus, as has been obſerved, the ecliptick Path of the Eclipſes, goes forward from Weſt to Eaſt, but a contrary Way to the Earth and Moon, and makes an Angle of 5 Degrees 20 Minutes, with the ecliptick Path of the Earth.

The

On the MOON and LUNAR MOTIONS.

The Moon makes her Orbit round the Earth, by an Angle of 45 Degrees, with the Ecliptick;—but as this Angle is not the ſame throughout her whole Orbit, as the Moon, in one Part of her Orbit, is Half the Diameter of it *before* the Earth, and in another Part, ſo much behind her, ſo ſhe does not make the ſame Angle with the Ecliptick quite through her Revolution. — Thus, at the Entrance into her *third* Quarter, ſhe cuts the Ecliptick *diagonally*, and *ſlackens* her Motion two-thirds, (when ſhe enters the South, or Summer Part of her Lunation,) and, (as was obſerved by Mr. Ferguſon,) *falls back*, and proceeds to the Weſtward, by an Angle of 45 Degrees.—Thus ſhe keeps on with this Angle, till ſhe comes to the Change; when it is altered to the Complement of that Angle, which is alſo 45 Degrees; which Angle is continued from the Change to her *firſt Quarter*;—at which Point ſhe croſſes the Ecliptick, and enters the North or Winter Part of her Orbit.—Here this Angle is

is altered from 45 Degrees, to 19 Degrees, 50 Minutes, and her Motion is *increaſed* two-thirds, and ſhe now recovers the Motion *ſhe loſt at her third* Quarter; and, by this Means, ſhe gets ſo forward to the Eaſtward, in the Ecliptick, as to be exactly in a Line with the Earth and Sun at her Oppoſition.—From this Place ſhe returns round the Earth, and continues her *accelerated* Motion, till ſhe arrives again at her third Quarter, where ſhe is again a Semi-diameter of her Orbit, *before the Earth*; and from this Place ſhe goes on as above deſcribed.

The Moon's Orbit, round the Earth, is marked by Aſtronomers with four Diviſions: The firſt is from Star to Star; which ſhe performs in 27 Days, 7 Hours, 43 Minutes, 4 Seconds.—This would compleat her Orbit, did ſhe not go forward in the Ecliptick at the ſame Time.—The ſecond is from Apogee to Apogee, which requires 5 Hours, 35 Minutes, 39 Seconds more.—Theſe 5 H. 35 M. 39 S.

39 S. ſhew us how much her progreſſive Motion, forward, in the Ecliptick is, during the Time of her going from Apogee to Apogee.—The Earth's progreſſive Motion forward, through the Ecliptick, during one Rotation round her Axis, or twenty-four Hours, is four Minutes; hence, 1 H. 50 M. 12 S. belong to the Earth, and the remaining 3 H. 45 M. 27 S. is the Quantity of the Ecliptick *forward* Motion which belongs *abſolutely* to the Moon during that Time.—Thus we may obſerve, that the Moon's abſolute Motion *forward, through the Ecliptick,* is more than double to that of the Earth's.—This cauſes her to compleat her Orbit round the Sun, in leſs Time than the Earth does. This is alſo confirmed by the Motion of the Moon's Shadow over the Earth, during the Time of an Eclipſe, which Mr. Ferguſon tells us, (k) moves at the mean Rate of 30½ Minutes of a Degree every Hour.—The third Diviſion is from Node to Node.—This is not generally

 diſtinguiſhed

(k) Ferguſon, P. 126. S. 338.

diſtinguiſhed in this Manner by Aſtronomers, as they have ſuppoſed that the Motion of the Nodes receded from Eaſt to Weſt, and did not proceed forward, (as I do) from Weſt to Eaſt, which requires 1 D. 4 H. 51 M. 8 S. 44 T. Time to compleat it, than from Apogee to Apogee.—The fourth Diviſion wants 18 H. 34 M. 10 S. 1 T. to be added to the laſt, to bring the Moon to the Sun, or compleat the Lunation; which, as was before obſerved, is 29 D. 12 H. 44 M. 1 S. 45 T.

When the Moon comes to her Apogee, ſhe has compleated her Orbit round the Earth, in the Ecliptick; but as the *ecliptick Current of Ethers*, (as they move forward in a progreſſive Circle) has got 1 D. 3 H. 51 M. 8 S. 44 T. before the Moon, during that Time, ſo it requires for the Moon to go juſt ſo much beyond her Orbit, to meet and croſs it.—At the very Point, where the Moon, in her Orbit round the Earth, *croſſes the ecliptick Current of Ethers*, is her Node, and a Line

Line from Node to Node, croſſing the Centre of the Ecliptick, is called the *Line of Nodes.*—Thus the Line of Nodes croſſes the Ecliptick every ſixth Lunation, when the Node that was laſt in Conjunction with the Moon, *now* croſſes the Ecliptick 4 D. 15 H. 25 M. before the Moon meets the Sun; and as the Nodes are diametrically oppoſite to each other, ſo this other Node wants the ſame Time to meet the Sun; but as the ecliptick Current of Ethers goes forward every Half a Node but 9 H. 17 M. 5 S. ſo the Moon comes in Conjunction only 9 H. 14 M. 5 S. after the Node.

The Nodes then croſs each other, and change Places; the aſcending one to the deſcending, and the deſcending to the aſcending: Hence, whenever either Node at the End of the ſixth Lunation, is 4 D. 15 H. 25 M. before the Moon, the other Node (being the ſame,) will meet the Moon in the Ecliptick, and cauſe a total and central

Eclipſe

Eclipſe.—But, as all theſe Points are of ſuch different Lengths, and vary ſo much, it is not to be wondered at, that we have ſo few Eclipſes; more eſpecially, as the Orbit of the Moon is divided into 360 Degrees, and the Moon muſt paſs the Node within 17 Degrees of it, at the Change, and within 12° at the Oppoſition, to cauſe an Eclipſe; otherwiſe the Moon's Shadow will not touch the Earth, nor the Earth's Shadow the Moon.—In Order to make more clear what has been obſerved, I ſhall deſcribe the Nodes and Eclipſes for this Year, A. D. 1786.

The Nodes move forward ſo much faſter, through the Ecliptick, than the Moon, that at the End of every twelfth Lunation, that Node, which was in Conjunction with her, when ſhe began her firſt, is got 9 D. 6 H. 50 M. 0 S. 12 T. before her; and juſt Half that Quantity, or 4 D. 15 H. 25 M. 0 S. 6 T. at the End of every ſixth Lunation.—The Nodes change Places every ſixth Lunation,

tion, when the aſcending Node becomes the deſcending, and the deſcending the aſcending one.

Now to explain their Motion this Year.—We will ſuppoſe the two Nodes to be marked A and B.—The Nodes croſſed the Ecliptick Jan. 14 D. 12 H. 0 M. when A became the deſcending Node, and B the aſcending one.—The Moon comes in Oppoſition to the Sun, 44 Minutes after, and cauſes a total Eclipſe.—14 Days, 9 H. 5 M. after that, the other Node was in Conjunction with the Sun, and cauſed an Eclipſe of that Luminary; after this, the Moon in her Orbit round the Earth, never croſſed the ecliptick Path of the Nodes, *near enough* the Sun, to cauſe an Eclipſe, till July 6, at 16 Minutes paſt twelve at Night, when the Node A will croſs the Ecliptick 3 D. 15 H. 9 M. before the Moon was in Oppoſition; and, the other Node B will alſo want juſt as much to be in the Ecliptick, by that Means the Node B will

will be in the Ecliptick, 54 Minutes only after the Moon is in Conjunction, and cause a total Eclipse of the Moon, July 11.—On the next Change, fourteen Days after, viz. July 25, the other Node A will meet the Moon in the Ecliptick, and cause an Eclipse of the Sun, and then will become the descending Node again.

The above are the collected Observations of Astronomers on the Moon, and the lunar Motions, from whence we may infer, that they are all caused and governed (as immortal Sir Isaac *Newton* has supposed) by the subtile *Ethers* with which the heavenly Space is filled, and by which they are surrounded.—For, according to him, " these ETHERS " are expanded through the whole Heavens, " and *impel* Bodies from the denser Parts of " of the Medium, towards the rarer, *with all* " *that Force* and *Impulse* which we call " GRAVITY. (1) That these *Ethers* act in a " double Capacity, the one as *Light*, pro- " ceeding

(1) Let. IV. P. 163.

"ceeding from the Sun, and the other as "*Spirit*, deſcending towards the Sun;—and "thus a *Circulation* is carried on between "*theſe two vibrating Mediums.*"—Thus *they act by a continual Conflict, in a vibrating Manner, with a Force in Proportion as the one or the other prevail:—When the Light prevails*, it opens, expands, and projects *every Thing:*—On the contrary, *when the Spirit prevails*, every Thing is *compreſſed*, and their Parts *are forced in cloſer Contact.*—Thus all Bodies, by being compreſſed into leſs Space, are increaſed in their ſpecifick Gravity, and they are alſo made to adhere with all that Power or Force called *Gravity*, *Attraction* of *Cobeſion*, &c.

I think it muſt add to the Veneration we have for the Scriptures, to find that they ſpeak juſtly in phyſical Matters, about the Mechaniſm of Nature.—Thus *Job* tells us [m] that God *made a Weight for the Winds*; this

[m] Job. XXVIII, 25.

this is according to our Engliſh Tranſlation, but the Hebrew is more clear and expreſſive, it is there ſaid that God made the *Wind* or *Spirit*, the *Inſtrument* of Gravity.

In the firſt Place, the Earth is carried through the Ecliptick, round the Sun, by *a Current of Ethers*, and the Moon, as a Satellite of the Earth, is carried round the Sun, throught the Ecliptick with it.—The Moon has alſo a circular Motion of her own, round the Earth, which Motion interſects the ecliptick Motion by an Angle of 45 Degrees.

In Order to explain myſelf the better on theſe two Motions of the Moon, I ſhall inſtance the Sailing of a Ship, which is alſo affected, *(at the ſame Time,)* by two Forces, the Wind and the Tide, and her going forward is occaſioned as either one or other prevail.—Thus, as the Sailors always obſerve the Ship is accelerated or retarded in her Sailing, according as ſhe goes either with or a-

gainſt

gainſt the Tide, and that which ever of the two prevails, either the Wind or the Tide, ſo is the Ship carried on, either North or South; or, if both meet in an Angle, her Courſe is in a Diagonal between them; but if they meet exactly oppoſite to each other, both Forces are deſtroyed, and the Ship ſtands ſtill in the ſame Place.—Hence, if a Ship receives a Force from the Wind, to ſail two Miles an Hour, and the Current or Tide runs one Mile an Hour; this one Mile an Hour of the Current, ballances one Mile an Hour of the Force ſhe receives from the Wind; ſo the Ship will looſe the Force of one Mile an Hour in her ſailing, and in Fact, will be found to proceed forward one Mile only.—On the contrary, let her turn back with the ſame Wind and Current, ſhe will then go forward with the joint Forces of both; and will then proceed forward three Miles an Hour.—Much in the ſame Manner the Moon is carried round the Sun, through the Ecliptick, as a Satellite of the Earth together

gether with her; but as her *absolute* Force round the Earth is double to what carries the Earth round the Sun, and this Force or Current of Ethers which belongs to the Moon *only*, makes an Angle of forty-five Degrees, in crossing the Ecliptick: By this Means she is in one Part of her Orbit, round the Earth, Half of a Diameter of that Orbit, before the Earth, in the Ecliptick; and at another Part of her Orbit as much behind the Earth, and at her Conjunction and Opposition, exactly in a Line with it; always keeping nearly the same Distance from the Earth.—Thus being acted on *jointly* by both these Forces, when she comes to her third Quarter, she is then carried with an Angle of 45 Degrees, against the Current of Ethers which forces the Earth round the Sun, through the Ecliptick, and carries on the Earth four Minutes every twenty-four Hours, or a natural Day; which, as has been observed, is but Half the Force with which the Moon is carried round the Earth, so this ecliptick Current of Ethers resists

resists one Minute of that Force, and the Moon's absolute Motion forward, being resisted by one Minute out of two, so she proceeds but one Minute every six Hours, or ninety Degrees.—Hence it may be observed she loses a Moiety of her Force, and goes forward one only.—As soon as she comes in Conjunction with the Sun, she is then forced towards her first Quarter, by the Complement of the Angle she makes from her third Quarter to her Change.—This is also 45 Degrees; and, as she still continues to go *against* the ecliptick Current, she keeps that slow Pace, till she comes to the End of her first Quarter; at which Point she changes, and instead of going against, and being obstructed by the ecliptick Current, she receives its additional Force to carry her on.—Thus, as has been observed, her own Force carries her forward *two*, and the ecliptick Current *one*;—and instead of going with that slow Motion of one, which she did from her third Quarter to her first, she now goes three;

and

and being a Semi-diameter of her Orbit, behind the Earth, occaſioned by her *ſlow* Motion from her Change to this Place; ſo now, by her accelerated Motion, ſhe recovers this ſecond Quarter what ſhe had loſt in the firſt, and by that Means comes oppoſite to the Sun at her Full.—She, now by the ſame Means, continues the like *accelerated Motion*, till ſhe arrives at her third Quarter, at the Entrance of which ſhe goes on with her ſlow Motion as before.

The above Deſcription of the Phenomena of the Moon's Motions, and the Conjectures how they are cauſed, ſeem to make it appear, that the Body of the Moon, and probably the Bodies of all the Planets, are formed much in the ſame Manner as this terraqueous Globe is deſcribed to be, [n] viz. of a thin Shell on the Outſide, with a large Hollow or Void in the Midſt, filled with Fire, Steam, or inflammable Air; and conſequently of the ſame

(n) Let. XVI. XVII.

ſame ſpecifick Gravity with the Ethers that ſurround them.—Thus the Moon is carried round the Earth by theſe Ethers, in the ſame Manner as the Earth is round the Sun; and by being exactly of the ſame ſpecifick Gravity with theſe Ethers, *at the ſame Diſtance* ſhe is placed from the Earth; ſhe meets with no Reſiſtance from them, but is carried on by and with them, with as much Eaſe as we ſee a Glaſs Bubble, of the ſame ſpecifick Gravity with Water, will be carried on by it, never altering its Place, but goes with it in the ſame eaſy Manner as if it was a Part only of the Water; neither can ſhe be moved nearer to the Earth:—As the expanſive or projectile Power or Force of the Light, reflected from the Earth, prevents it; nor can ſhe be carried farther from the Earth, as the compreſſing Power of the Spirit, from the Extremities, prevents it: — Which two Powers, by a joint Mixture, being of the ſame ſpecifick Gravity with the Moon, ſhe conſtantly moves in the ſame Direction that

theſe

theſe do, and with as much Eaſe as a Balloon does.

Since this Letter was written, Mr. *Herſchel*'s Diſcoveries of the *Volcanos* in the Moon, confirm the above Conjectures to be true, and that the Body of the Moon is formed much in the ſame Manner as we have deſcribed the Earth to be; indeed it ſeems difficult to conceive how any large Body of Matter can be ſupported and conſtrained in the heavenly Spaces, by the ſurrounding Ethers, unleſs it is of the ſame ſpecifick Gravity with them; and the only Method found or obſerved to do it, has been by filling their internal Void with Fire; by this Means a Body of Gold, or the heavieſt Metal, may be made to be of ſo ſmall ſpecifick Gravity as to be forced to the greateſt Diſtance from the Earth, by the ſurrounding Air.—Thus we find that all Nature is formed in a *mechanical* Manner, and relative to each other *in Number, Weight, and Meaſure.*—Hence, as has been already obſerved,

obſerved, theſe Volcanos, both in the Earth and Moon, appear to be the moſt proper Method to regulate the Gravity of theſe Bodies, to the ſpecifick Gravity of the ſurrounding Ethers.—Theſe Vents being a Means, whenever the internal Expanſion, *from the internal Fire*, becomes too great to throw off and diſcharge the ſuperfluous Fire, and the remaining is condenſed, much in the ſame Manner as may be obſerved in the Fire Engine; ſo that it never can arrive to ſuch an Height as to deſtroy the Body, unleſs theſe Vents were effectually ſtopped. (o)

Mr *Baudy*, a Citizen of Geneva, a great and able Aſtronomer, has publiſhed a Letter againſt Mr. *Herſchel*'s Diſcoveries, wherein he has treated them as imaginary Viſions, for ſays he, " If within the Compaſs of his Te-
" leſcope alone, he can count from 60 to 110
" Stars, (Mr. *Picter*'s Aſſertion) that may
" prove the Perfection of his Inſtrument, but
" in

(o) P. 312.

" in a Zone of 15 Degrees in Length, and 2
" in Breadth, could he have ſeen paſſing in
" an Hour, 50,000? *ſo prodigious a Number*
" could not be ſo eaſily nor ſo readily told!"
He then criticiſes theſe Diſcoveries in the following Manner.— " Mr. *Herſchel*, (ſays
" he,) a learned Aſtronomer, gives Scope to
" his Imagination, but pays no Regard to the
" Reality of his Experiments; for, (conti-
" nues he,) by the exact Obſervations I have
" taken the Pains to make and repeat, in dif-
" ferent Climates of Europe, with excellent
" Teleſcopes, I am ſure that the moſt crowded
" Parts of the *Heavens* cannot contain ſo
" great a Number of Stars, united in the
" Focus of the beſt Inſtrument whatever.—
" Whenever the Sky is clear of all Kind of
" Vapours, Stars are, or ſeem to be in Mo-
" tion; ſo that their *continual Vibration* oc-
" cupies the Eye in ſuch a Manner, that the
" Objects *multiply* in Proportion as you
" count them.—*This is what generally de-*
" *ceives thoſe who truſt too much to Appear-*
" *ances!*

" *ances!*—From thoſe Illuſions ſprung the " Idea of Volcanos in the Moon, *which would* " *deſtroy the very Idea* of the Planet being in- " habited as ours."—Hence I obſerve, that notwithſtanding the above judicious Remarks of ſo able an Aſtronomer as Mr. *Baudy* appears to be, yet, I think, with Regard to the *Volcanos* in the Moon, he ſhould have tried his pre-conceived Idea *of the Moon being inhabited by the Matter of Fact only*;—whether theſe were Volcanos or not?

Since the above Publication of Mr. Baudy, the French Aſtronomers appear to have aſcertained the Certainty of the Fact; for in a Letter *M. De la Laude* has written in the Paris Journal, dated March 8, 1788, he obſerves, that " on the 13th Inſtant, from Se- " ven to Nine in the Evening, *Dom. Novet*, " one of the Aſtronomers of the Royal Ob- " ſervatory, perceived in the unlightened Part " of the Moon, what Mr. *Herſchel* has called " a Volcano, like a Star of the ſixth Magni-

" tude, or one of the cloudy ones, the Bright-
" neſs of which increaſed, from Time to
" Time, as by Flaſhes.—Other Aſtronomers
" have perceived it, and Mr. *de Villeneuve*
" had ſeen it before, on the 22d of May,
" 1787.— We *cannot*, (ſays he) *therefore*
" *doubt* of the Exiſtance of this Volcano in
" the Moon, Mr. *Herſchel* ſaw it the 4th of
" May, 1783, and particularly the 19th of
" April, 1787.—In the Eclipſe of the 24th
" of June, 1778, *M. d'Ulloa*, a well-known
" Spaniſh Aſtronomer, had ſeen on the dark
" Diſk of the Moon, a bright Point; and in
" the total Eclipſe of 1715, certain curious
" Obſervers ſaw ſome Flaſhes of Lightning.
" There is no ſenſible Atmoſphere in the
" Moon, it is true, and Chymiſts may diſ-
" pute about the Name of Volcanos being
" given to *ſuch apparent Eruption*; but the
" Name after all is of no Conſequence, and
" we muſt certainly ſubſcribe to Mr. *Herſchel*'s
" Opinion.—This Volcano is ſituated in the
" North-eſt Part of the Moon, about three
" Minutes

" Minutes from the Moon's Border, towards
" the Spot called Helicon, marked N°. 12,
" in the Figure of the Moon, in my Aſtro-
" nomy."

As I was deſirous of ſending you my Theory of the lunar Motions, it has occaſioned my Letter to be of a greater Length than I propoſed.—I had alſo a Deſign of ſending you my Calculation of the Eclipſe which is to happen on the 25th of this Month; but ſhall now ſend it you in a ſeparate Letter next Week.

I am,

DEAR SIR,

Your Friend and Servant,

F. PENROSE.

STONEHOUSE,
July 5, 1786.

To JOHN HEAVISIDE, Esq.

To confirm what Mr. Penrose has observed in his last and former Letters.—He has sent Mr. Heaviside a Calculation of the Eclipse which is to happen July the 25th.—It is calculated by the Method made use of by the Ancients, *to measure and record Time:—But to shew how certain their Method was, it is also calculated according to the* present, *by Equations and Anomilies.—It may be remarked, that both these Methods differ from each other only* 8 *M.* 11 *S.—That the Patriarchs and Chaldeans had more Knowledge in Astronomy than is generally allowed them. This is proved by the* 18 *Years Cycle of Eclipses, and also the* 19 *Years Cycle of the Moon, both which, it is certain, we received from them, and without these Cycles, Astronomers would be at a great Loss.—* Data *on which the Calculations are made, and Conclusions infered from them.*

DEAR SIR,

ACCORDING to Promise, I herewith send you a Calculation of the Eclipse which

which will happen July 25; with a Recapitulation of ſome former Obſervations, to confirm what has been obſerved in my laſt and former Letters.—The ancient Patriarchs and the Chaldeans, meaſured their Time, and recorded Events, by the ſimple, eaſy, and natural Method of keeping an Account of the Days and Years.—That this Account might be remembered with the greateſt Exactneſs, Moſes tells us, God ordered the Sabbath Day, (or Cycle of ſeven Days) to be kept as a Feſtival, in Commemoration of the Creation, and to tranſmit to Poſterity, an Account, that the Powers and Operations of the heavenly Bodies, were not eternal, nor inherent in them, but was given to them by Him.—And in Order to commemorate their Months, they were ordered to keep the *new*, or *firſt* Appearance of the Moon, as a Feſtival alſo; that, by this Means, it might not be forgot.—And that they ſhould not miſtake or forget when one Year or annual Revolution ended and another began, they were to keep the Feaſt of Ingathering, at the *End or Revolution* of the Year, *after* the Fruits of the

the Earth were ripe and gathered in. [p] —— That this was the Method in Use about six hundred Years after the Flood, is most certain; for when Jacob was brought before Pharoah, Pharoah said unto him, "*how old* "*art thou.*"—In the Margin of the Bible, there is a literal Translation of the Hebrew, "How many are *the Days of the Years* of "thy Life. [q] Jacob answered in the same Style, "An hundred and thirty Years; few "and evil have *the Days of the Years* of my "Life been."—This shews us that it was the Method of Computation *then* in Use, both by the Patriarchs, and also by the Egyptians, who were supposed to be possessed of the greatest Learning.—After this, by some Means or other, Astronomers either dropt or lost this Method of measuring and keeping an Account by *Days and Years*; and since that Time, have made their Calculations, by dividing the annual Orbit of the Earth into 360 Degrees, and measured it accordingly; and not by the Number of Days as *Nature* performs it, and as the ancient Patriarchs did

[p] Introduction to Prophecy. P. 23, Let. X. P. 235.

did it.—By this Means, in Order to make the 365½ Rotations of the Earth, in her annual Orbit, to tally and agree with the 360 Degrees of the Equator, they were obliged to contrive and uſe artificial Numbers.—In my Calculations, I have adopted the ancient Method, as the moſt eaſy and certain, and the Method Nature directs.

It appears to me that the Patriarchs and Chaldeans had more Knowledge in Aſtronomy than is generally attributed to them.—Nay, it appears by what I obſerved in my laſt Letter, on the lunar Motions, that they knew very well how to calculate the Return of an Eclipſe.—It is allowed by all, that we received the Cycle of 18 Years, for the Calculation of the Return of Eclipſes, from them; which is called the *Chaldean Cycle* to this Time.—We alſo received the lunar Cycle of 19 Years from them; for we are certain, that *Meto*, the *Athenian* Aſtronomer, made uſe of it more than 430 Years before Chriſt. [r]—Now, Sir, take away theſe two Cycles from Aſtronomers,

[r] Diodorus Siculus, LIB. 12, P. 305.

Aſtronomers, and they will find themſelves at a great Loſs, notwithſtanding the aſtoniſhing Improvements in Arts and Sciences, particularly in Opticks.— For my Part, I do freely acknowledge, (notwithſtanding it is ſo unpopular to do it, in an Age when all Speculations which aggrandize the Dignity of Reaſon, are ſo eagerly received,) that I cannot conceive how Adam, juſt after he was created, could have Knowledge and Underſtanding ſufficient to give *ideal* Names to *all* Animals, &c. unleſs that Power was given from God.—If God gave him a Power to ſpeak and underſtand Language; is it unreaſonable to ſuppoſe that he had Inſtructions from the ſame Original, how to calculate and know when the appointed Seaſons were, which God commanded him to keep holy? It belongs *only* to a Tyrant to make Laws which cannot be obſerved!—Moſes taught the Iſraelites when to *begin* their Days, their Weeks, Months, and Years.—This has much the Appearance of Chronology and Aſtronomy!

It

It is allowed by *All*, that Aſtronomers calculate Eclipſes, (which are not of long ſtanding) with great Preciſion; therefore, in Order to confirm what has been obſerved, I herewith ſend you Calculations of the ſucceeding Eclipſe, (which will happen on July 25,) by both Methods, viz. the ancient one, by Days, Years, and Lunations, and the preſent one by Equations and Anomalies, from which you may obſerve, that the Difference of Time is 8 Minutes and 11 Seconds only: But the Calculations of all Eclipſes, by both Methods, will not always agree with the ſame Exactneſs; for the Motions of the Moon with the Earth, are ſo various and complicated and eccentrick, that the Angle of her viſible Appearance often deceives us, ſo that equal, true, calculated Time will not agree with that of Obſervation, occaſioned by the Eccentricity of the Moon's Motions, and the Angle of Viſion.—This Difference is occaſioned much in the ſame Manner as the variable Angle the Shadow of the Sun makes on a Dial, and the equable and true Diviſion of it by a well regulated Clock.—

Hence, when we truſt too much to Appearances and Obſervations alone, (as Mr. Baudy obſerves) they often deceive us, as all Aſtronomers allow.—But, as theſe Calculations of Time, and the Places of the Sun, Moon, and Earth, by Days, Years, and Lunations, cannot deceive us, they are therefore the moſt proper and certain to try Chronology by, and to meaſure the Diſtance between any two Points of Time.

In my former Letters, I have endeavoured to prove, that the Year of the Creation, according to the Moſaic Chronology, happened at the autumnal Equinox, in the Year anſwering to 706, of the Julian Period; and that at this very Point or Inſtant of Time, the Duration of this terraqueous Globe is to be dated from. (f) — In that Point, I have made all Calculation to *begin*, and to *end* at ſome certain Inſtant of Time, in which we cannot be miſtaken or deceived; as at an Equinox or Eclipſe.

Now,

(f) Introduction, P. 7, Let. X.

Now, if we know the Number of the Rotations the Equator has made between theſe two Points, we muſt be mathematically certain of its Length and Duration. (t) And to ſhew you that it will do ſo, I have collected the following Data, and prove, by Calculation, that theſe Data are true.

1ſt That at the Creation, the Sun was placed in Libra, at Noon, in the firſt Meridian, on a Thurſday, the fourth Day of the Week; when, according to the Moſaic Hiſtory, Chronology began.

2dly, That the Moſaic Chronology places the Year of the Creation, in the Year 706, according to the Julian Period.

3d, That if the Moon had been in Being, ſhe would have been Full the Day before, at Noon.

4th, That there were four Days, or four Rotations of the Earth, before the Sun was placed in the Haevens.

5th.

(t) Introduction, P. 16, 78 113.

5th, That Moſes begins his Chronology on the fourth Day of the Week, at ſix o' Clock in the Evening, at the going off of the Sun, when the Moon made her Appearance, and they *then jointly* began to perform the Office God deſigned them for; to *point out Times, Seaſons, Days, and Years*;— and that they then enlightened the *whole Earth* from Pole to Pole. (u)

This Year, (1786) is the 6499th of the Julian Period; therefore in Order to know the Number of annual Revolutions, ſince the Creation, I ſubſtract 706 from 6499, which leave 5793; the Number of annual Revolutions ſince that Time; the laſt of which will be compleated at this next autumnal Equinox, at the next Full Moon after the Sun enters Libra.— Hence we can meaſure the Diſtance between theſe two Points with a *mathematical Exactneſs, ſuperior* to a Surveyor meaſuring a Garden Walk with his Wheel; and that as Nature performs it, by Days, Months, and Years.

(u) Let. X, XIV.

The CALCULATION.

A. D. 1786

Multiply by the Number of Minutes a Julian Year is longer than a Solar Trop.

Julian Years
5793
11

5793
5793

Divide by Numb. of Years which compleat the Sun's Cycle

1440)63723(44 Days
5760

6123
5760

363
Hours in a Day — 24

1452
726

Divide 1440)8712(6 Hours
8640

72
Minutes in an Hour 60 Minutes

1440)4320(3
4320

0000

Julian

```
                    Julian Years.
          A. M. 5793                A. I. P. 6499
                1461 Num. of Quadrants in
                ---- a Quadriennium.
                5793
               34758
              23172
              5793
              ------ Days.   H. M. (J. Y.
Years in Quadriennium 4)8463573(2115893 6 0 in 5793
                        1(      44 6 3 Retroc.
                        ---------------------
                Sun in Libra  2115848 23 57 1ſt M.
add to bring Meridian of Greenwich        10 24
                        ---------------------
                Sun in Libra  2115849 10 21 Lond.
Days from Kalends of Jan. to Oct. 25     298
                        ---------------------
                              2116147 10 21
Julian Bissext. 11 D. deduct for N.S. 2115882
                        ---------------------
Days from January 1ſt inclusive          265 10 21
              Sun in Libra, Sept.        22 10 21
```

According to those Calculations, the Sun will enter Libra this Year, at Greenwich Observatory, Sept. 22d Day, 10th Hour, 21ſt Minute, and that it was placed in Libra, at the Creation, (or in the 706 of the Julian Period,) at Noon, in the firſt Meridian, Oct. 25.—But as Moſes begins his Chronology at Six o'Clock in the Evening, when the Moon

was

was placed nearly in Oppofition to the Sun, being a little paft its Full, the two Luminaries together enlightened the whole Earth. Thefe fix Hours being added, brings it to fix in the Evening, Oct. 25th Day, 6th Hour, 0 Minute, P. M.

Another Method.

	D.	H.	M.
Retrocefſion	44	6	3
Deduct for N. S.	11		
	33	6	3
Deduct for Meridian of Greenwich		10	24
	32	19	39

	D.	H.	M.	
Oct.	25	6	0	
Sept.	30			added to make a Subftraction
	55	6	0	
	32	19	39	true Retrocefſion
Sept.	22	10	21	

Mofes informs us that his Chronology began at Six o'Clock in the Evening, which was fix Hours after the Sun was placed in *Libra*; hence it may be obferved, that it was the firft Year of the *Quadriennium*; therefore if we add One to the Year of the World,

World, it will always give us the Year of the *Quadriennium*, by dividing that Sum by four, the Remainder the Year ſought.

Thus 5793
1

Divide 4)5794(1448
2 Second

This Hiſtory alſo lets us know, that the Sun was placed in the Heavens, and the Earth began her annual Orbit on a Thurſday, the fourth Day of the Week; therefore if we add thoſe four *extra. Days*, to the Number of Rotations the Earth has ſince made, and divide the whole Number by Seven, it will give us the Number of Weeks ſince the Creation, and the Remainder will be the Day of the Week.

Thus we find, that from the Sun's entering *Libra*, in the Year 706, A. I. P. to Sept, 22, this Year, when the Sun enters *Libra*, the Earth will have performed 5793 annual Revolutions, and

2115849 Rotations round its Axis
4 extra. Days
Divide 7)2115853/302264 Weeks
5 Friday——According to this Calculation, we find that Sept. 22, 1786, being the ſecond Year of the Quadriennium, will be on a Friday, the fifth Day of the Week.

Having now proved, by Calculation, that the Sun will enter *Libra* this Year, Sept. 22d Day, 10th Hour, 21ſt Minute, on a Friday, as it will be found to do from Obſervation :—I ſhall now try if the lunar Motions, meaſured by the Rotations of the Equator, as they are performed by Nature, will alſo confirm the ſame.

A. M. 5793 ending at the autumnal Equinox.

	Julian Years.
Years in a Cycle, divide by 19	5793/304
	57
	93
	76
	17
Lunations in a Year	12
	204
Intercatory Lunations	5
	209

```
                304
                235 Lunations
              ------
               1520
               912
              608
             -------
              71440
Lunations       209 Lunar Years
             -------
          12) 71649(5970
              60
             -------
               116
               108
             -------
                 84
                 84
             -------
                   09 Lunations
```

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                    Lunar Years.
Years in a Period  30)5970(199 Periods
                      30
                    -------
                     297
                     270
                    -------
                      270
                      270
                    -------
                      000
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The Moon's Lunations being a ſmall Fraction leſs than 29 D. 12 H. 44 M. 1 S. 45 T, cauſe one Day, (as may be obſerved) to be thrown off in 138 Periods, or 49,680 Lunations.

Rotations

	Rotations or Days	H.	M.	S.
In 138 Periods are———	1467078 (24)	9	00	
In 60 Ditto ———	637860	10	30	00
In 1 Ditto ———	10631	0	10	30
In 9 Lunations ———	265	18	36	15
Full Moon, 4ſt Meridian	2115835	5	25	45
add to bring to Greenwich Obſervatory		10	24	
Full Moon, London	2115835	15	49	45
add Days from Kalends of Jan. to Oct. 24	297			
	2116132	15	49	45
Julian Biſſex. 11 D. deduct for N. S.	2115882			
Days from Jan. 1 incluſive	250	15	49	45
Full Moon, Sept.	7	15	49	45
to bring to New Moon add Half-Lunation	14	18	22	
New Moon, Sept.	22	10	11	45

This is Sept. 22d D. 10th H. 11th M. 45 S. Morning, according to the Julian Reckoning.

Full Moon 2115835
4 extra. Days

7) 2115839 (302262
5 Friday.

According to the preceding Calculations, the Sun will enter Libra, at the Greenwich Obſervatory, Friday, Sept. 22d Day, 10th Hour, 21ſt Minute, (1786,) being the ſecond Year after the Quadriennium, or after Leap

Leap Year.—The Earth will then have performed, ſince ſhe entered Libra, A. I. P.

	Rotations or Days	H.	M.
706	2115849	10	21

In which Time the Moon will have made 71,649 Revolutions round the Earth, from Sun to Sun, which ſhe has performed in

	Days.	H.	M.	
	2115835	15	49	
Full Moon	14	18	32	EPACT
Half Lunation	14	18	22	
New Moon			10	EPACT

	D.	H.	M.	
New Moon, Sept.	22	10	11	
Half Lunation	14	18	22	
Full Moon	7	15	49	
according the Julian Reck.	8	3	49	Morning.

The aforeſaid Motions of the two Luminaries, or more properly, of the Earth and the Moon, as they are performed by Nature, and meaſured by the equable Rotation of the Equator, (the juſt and true Root of all Meaſure,) prove that the Sun and Moon are now in the ſame Place, in the Heavens, which they were 5793 Years ago.

As

As there will be an Eclipſe of the Sun, July 25, this Year, (1786) though inviſible to us; I ſhall firſt calculate this Eclipſe, according to the foregoing Method, and then make a Calculation of it from *Fergusſon's Tables*, in Order to try whether it will confirm or diſprove it.

```
                    A. M.
                19)5793(304
                   57
                   ---
                     93
                     76
                   ---
                     17
                     12
                   ---
                    204
Intercatory Lunations 3
                   ---
                    207

                304
                235
               ----
               1520
               912
              608
             -----
             71440
               207
             -----
          12)71647(5970
             60
             ---
             116
             108
             ---
              84
              84
             ---
              07
```

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30)5970(199
   30
   ---
   297
   270
   ---
    270
    270
    ---
    000
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	Rotations or Days.		M.	S.
In 138 Periods are	1467078	(24)	9	00
In 60 Ditto———	637860	10	30	00
In 1 Ditto———	10631	0	10	30
In 7 Lunations	206	17	8	12
	2115776	3	57	4
		10	24	
	2115776	14	21	42
		10	24	
	2115776	14	21	42
	297			
	2116073	14	21	42
	2115882			
Full Moon	191	14	21	42
Half Lunation	14	18	22	
	206	8	43	42
New Moon, July	25	8	4	24

Days ſince the Creation.

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   2115790
         4 Extra. Days
   -------
7)2115794(302256 Weeks
        2 Tueſday
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According to theſe Calculations, this Eclipſe of

of the Sun will happen on a Tuesday, July 25th D. 8th H. 43d M. 42d S. We will now try what is the Time according to *Ferguson's Tables.*

1786	New Moon. D.	H.	M.	S.	Sun's Anomaly. S.	D.	M.	S.	Moon's Anomaly. S.	D.	M.	S.	Sun from Node S.	D.	M.	S.
March	18	5	21	30	8	28	6	7	5	11	34	19	2	7	58	12
4 Lunations	118	2	56	12	3	26	25	17	3	13	16	02	4	2	40	56
New Moon, July	14	8	17	42	0	24	31	24	8	24	50	21	6	10	39	8
1st Equation		1	42	6	8	24	11	33			38	48				
Once Equated	14	6	35	36	4	0	19	51	8	24	11	33				
2d. Equation		9	40	3												
Twice Equated	13	20	55	33												
3d. Equation			4	12												
Thrice Equated	13	20	51	21												
4th Equation				32												
Old Stile, July	13	20	51	53												
add for N. S.	11															
July	24	20	51	53												

New Moon and Eclipse of the Sun,

	D.	H.	M.	S.	
July	25	8	51	53	according to Ferguson's Tables.
July	25	8	43	42	Tuesday—according to Mosaic History of the Creation.
			8	11	Difference.

	H.	M.	S.	
New Moon	20	51	53	after Twelve at Noon, July 24

	D.	H.	M.	S.
that is, July	25	8	51	53

By comparing both these Calculations together, viz. that from the Time and Place of the Sun and Moon at the Creation, according to Moses's History of them, measured by the Rotations of the Equator, as Nature performs them; the other from *Ferguson's Tables*, which being some of the newest, we take it for granted that they are most correct. By comparing both those Calculations together, we find a Difference of 8 Minutes and 11 Seconds only.—Supposing *Ferguson's Tables* to be precisely true, this small Quantity of Difference in Time, can be of no Consequence in 5793 Years or annual Revolutions.

Let it be observed, that there were here two Points given, viz. the autumnal Equinox, 706, of the Julian Period, and the autumnal Equinox, 6499, of the same Period.—Between these two Points the Earth has performed 5793 Revolutions round the Sun, and 2,115,790 Rotations round its Axis. During this Time the Moon has made 71,647 Revolutions round the Earth, and Half of another, when she intersected the Earth's Orbit,

Orbit, and caufed an Eclipfe of the Sun.—Both thefe are meafured by the equable Rotations of the Equator.

From the Facts and Obfervations in my former Letters, confirmed by the above Calculations, I fhall infer the following Conclufions.

1ft. That the equable Rotation of the Equator, round its Axis, is the Root or Standard by which Diftance, Duration, and Progreffion of Time are meafured.—By dividing the Equator into twenty-four Parts or Hours, the Duration and Progreffion of Time is known; by its being divided into 360 Degrees, that of Meafure or Diftance.—Thus a Revolution of 15 Degrees in Meafure, anfwers exactly to an Hour, or the twenty-fourth Part of the Revolution of the Equator.—In a Minute of Time there will be a Revolution of 15 Minutes of the Equator.—In a Second, a Revolution of 15 Seconds.—Hence, by knowing the Diftance or Number of Rotations and Degrees moved forward, or

the Length of Time paſt, the other may be as eaſily known, by converting Rotations and Degrees into Time, or ℣ *contra*. Time into Meaſure.

Thus the Diſtance between any two Points of Time, *(it being a Strait Line)* may be meaſured with the greateſt Exactneſs and Preciſion; for the Number of Rotations the Equator makes, is a ſtrait Line, the exact Length between theſe two Points;—and it is the Property of a ſtrait Line to meaſure the Diſtance between two Points, with a Mathematical Exactneſs.—By the equable Rotation of the Equator, the annual Orbit is meaſured. By the ſame Means, the Moon's Lunations, and her other Motions are meaſured; and by this Method the foregoing Eclipſe, and all the others, have been meaſured and calculated; which Method will always prove mathematically true, if we know the Number of Rotations, and the Remainder, between any two Points, let their Diſtance be ever ſo great, as may be obſerved in the foregoing Calculations.—The mathematical Exactneſs

of

of this Measure may be observed, as you may begin at either Point, or at any intervening Eclipse, and they will all come out the same, which no Tables already formed have been able to do.—This Calculation begins at the Point when the Moon came first in Opposition to the Sun, after the Sun entered Libra, 706, of the Julian Period; and ends at the Point of Intersection, when the Moon will be in Conjunction with the Sun, the 25th of this Month.—In this you have not only the Measure between these two Points, by the Earth's Orbit, but you have also the Point where the Moon, in her Orbit round the Earth, intersects the Earth in her annual Revolution round the Sun.—The Moon does not measure her own Orbit or Motions! but by her Intersections of the Earth's Orbit, with the Assistance of the twelve Signs or Stars, Chronology is ascertained, and Times and Seasons pointed out with a mathematical Precision.

2dly, That as Calculations may be made equally true between any one, two, ten, or ten thousand Years, (each beginning and end-

ing

ing when the Sun enters Libra, making theſe Calculations according to 365 Days, 5 Hours, 49 Minutes, being the exact Length of the ſolar tropical Year;) ſo it muſt prove that the Length of the ſolar Year is 365 Days, 5 Hours, 45 Minutes exactly.—And alſo that the Length of the Year is preciſely the ſame it was 5793 Years ago.

3dly. That as all or any one of the Moon's Interſection of the Earth, in her annual Orbit, may be calculated with equal Exactneſs; ſo I conclude, that the Length of her Lunation is properly aſcertained; and that in 706, (the Year of the Julian Period, when the Creation happened, according to the Moſaic Chronology,) ſhe was preciſely in the Place in the Heavens aſſigned to her;—that her Orbit is exactly of the ſame Length it was 5793 Years ago; and that ſhe is now no nearer the Earth than ſhe was then.

4thly. I conclude, (as theſe Calculations prove) that the Moon was Full, or in exact Oppoſition to the Sun, Oct. 24, at Noon, in

in the 706th Year of the Julian Period.—That the Sun entered Libra that Year, Oct. 25, at Noon, one whole Rotation of the Earth, after the Moon was in Oppoſition to the Sun.—That this happened on a Thurſday, the fourth Day of the Week.—That the Moon roſe and began to enlighten the Earth at ſix o'Clock in the Evening, ſix Hours after the Sun was placed in the Heavens, when the Chronology of Time began. That the Moon was then thirty Hours paſt her Oppoſition, but that her Declination was ſo ſmall, as not to prevent the Sun and Moon to enlighten the WHOLE Earth.—That the Moon, by being departed one Quadrant, or ſix Hours, from the Sun, ſhews us that 706, A. I. P. muſt be the Beginning of the ſecond Year of the Quadriennium.

5thly, That theſe Places of the Sun and Moon, in the Heavens, the Year of the Quadriennium, the Day of the Week, and the Minute of the Day, have not happened again ſince that Time, viz. in 5793 Years; nor can it happen again for many Thouſand Years to come.

I now conclude with assuring you, that I am, with great Truth,

DEAR SIR,

Your real and affectionate Friend,

F. PENROSE.

STONEHOUSE,
July 12, 1786.

FINIS.

E R R A T A.

Page 4	Line	4, *for* Equatereal, *read* Equatoreal.
Bottom 8		*for* LET. XVII. *read* LET. XXIII.
Bottom 10		*for* LET. VII. *read* LET. XI.
12		14, *for* Elipſe, *read* Ellipſe.
		18, *dele* That
13		16, *for* is, *read* are.
Laſt Line,		*for* Anomilies, *read* Anomalies.
15		4, *dele* by.
16		15, *for* Elipſe, *read* Ellipſe.
20		19,
Note at Bottom		*for* Horns, *read* Focus, *and* is *for* are.
25		2, *for* 3420, *read* 4320.
		10, *for* 1783, *read* 1753.
Bottom 26		*for* LET. VIII. *read* LET. X.
33		3, *for* this, *read* their.
		4, *for* their, *read* this.
37		17, *for* rectify, *read* rectifies.
51		11, *for* Equinox, *read* Equinoxes.
52		24, *for* Strauchas, *read* Strauchius.
61		13, *for* Portes, *read* Partes.
74		10, *for* Sceptic, *read* Skeptick.
78		4, *for* 2116214, *read* 2116219.
		6, *for* 30216, *read* 302317.
		7, *for* two Days, *read* Nothing.
		11, *for* ſixth, *read* four.
		12, *for* Saturday, *read* Thurſday.
96		*for* 11 H. *read* 1 Hour.
102		21, *for* 5th Hour, *read* 10th Hour.
139		1, *for* America, *read* Africa.
175		18, *for* eliptical, *read* elliptical.
207		2, *for* Placentia, *read* Placentæ.
237		17, *for* Aſſumitions, *read* Aſſumtions.
274		9, *for* would, *read* could.
277		13, *for* Quering, *read* Querying.
279		7, *after* not, *insert* at.
316		12, *for* Vortix, *read* Vortex.
362		6, *after* 44 F. *read* more.
363		9, *for* this, *read* the.
386		9, *for* Anomilies, *read* Anomalies.