An epitome of astronomy, with the new discoveries: including an account of the eidouranion, or transparent orrery / (invented by A. Walker) as lectured upon by his son, W. Walker.

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AN

EPITOME of ASTRONOMY,

WITH

THE NEW DISCOVERIES:

INCLUDING AN ACCOUNT OF THE

Eidouranion,

OR

TRANSPARENT ORRERY;

(INVENTED BY A. WALKER)

AS LECTURED UPON BY HIS SON,

W. WALKER.

STARS TEACH AS WELL AS SHINE! YOUNG.

OS HOMINI SUBLIME DEDIT; CŒLUMQUE TUERI
JUSSIT, ET ERECTOS AD SIDERA TOLLERE VULTUS.
OVID MET. l. 85.

THE FOURTEENTH EDITION.

Ipswich;

PRINTED FOR THE AUTHOR,
BY BURRELL AND BRANSBY;
AND SOLD BY J. ROBSON AND W. CLARKE, BOND-STREET;
AND G. KEARSLEY, FLEET-STREET, LONDON.

1800.

AN

EPITOME of ASTRONOMY;

AS ILLUSTRATED BY THE

Eidouranion,

OR

TRANSPARENT ORRERY.

THIS elaborate Machine is 20 feet diameter: it stands vertical before the spectators; and its globes are so large, that they are distinctly seen in the most distant part of a Theatre. Every Planet and Satellite seems suspended in space, without any support; performing its annual and diurnal revolutions without any apparent cause. It is certainly the nearest approach to the magnificent simplicity of nature, and to its just proportions, as to magnitude and motion, of any Orrery yet made: and besides being a most

brilliant and beautiful spectacle, conveys to the mind the most sublime instruction: rendering astronomical truths so plain and intelligible, that even those who have not so much as thought upon the subject, may acquire clear ideas of the laws, motions, appearances, eclipses, transits, influences, &c. of the planetary system.

Scene 1.

THE SUN AND EARTH:

With the Zodiacal Constellations.

As information is the primary object of this lecture, it is thought more useful to exhibit PARTS of the solar system, separately, before a grand display was made of the whole. This scene therefore, opens with only the Sun and the Earth. The Sun seems suspended in the middle of the system, and by spots on his

face, is seen to turn round on his axis in 25¼ days; light issues from his orb in all directions; in the blaze of which is suspended the Earth, turning on its axis to produce day and night, and revolving round the Sun to produce the seasons: its axis inclines 23½ degrees from a perpendicular to the plane of its orbit; and by that axis keeping parallel to itself during this annual journey, the northern and southern hemispheres are alternately addressed to the Sun; shewing, when it is summer in one, it is winter in the other, and *vice versá*. This scene so naturally exhibits the cause of day, night, twilight, summer and winter, spring and autumn, long and short days, &c. that a bare inspection of the Machine is sufficient to convey the clearest idea of these phænomena.

The Earth in this scene ought to be unshackled with meridians or parallels of latitude:—to be a free and independent ball, with land and water represented as they would appear to a distant spectator looking at the

real Earth. But as globes are seldom seen without these appendages, a globe of two feet in diameter, equipped with meridians and parallels of latitude (being requisite for illustration) will perform a diurnal and annual motion round the Sun, and explain the above phænomena on so large a scale, that their effects on the smallest island may be seen from the most distant part of the theatre.

This scene is surrounded by transparent paintings of the twelve signs of the Zodiac, shewing how the Sun, or rather the Earth, enters and passes thro' Aries, Taurus, Gemini, Cancer, &c.

Auxiliary scenes accompany this, to shew the principles of planetary motion; the formation of the constellations and their allegorical history; the oblate, yet nearly globular figure of the Earth; how ships and mountains appear at sea; with ships moving round a large globe of six feet diameter, &c. proving that the Earth can contain inhabitants on all sides, &c.

Scene 2.

SUN, EARTH, AND MOON:

PHASES AND ECLIPSES.

Consists of the Sun, the Earth, and the Moon. The object of this scene is to display the cause of the waxing and waning of the Moon, and of solar and lunar eclipses: for this purpose the Earth perform its annual and diurnal motions, and projects a conical shadow opposite to the Sun during its journey round him. The Moon borrows her light from the Sun; and which, in reflection to the Earth, is not more than one three hundred thousandth part so strong: and performing her rotation round the Earth, every 29 D. 12 H. 44 M. will sometimes shew us more and sometimes less of the enlightened part of her body. Hence, when she is between the Earth and the Sun, her dark side is towards us, and

we lose sight of her, and call this part of her period the CHANGE; but as she revolves round the Earth from West to East (the same way the Earth turns on its axis) in a few days we see her above the Sun in the West, and seeing a small part of her enlightened face, call the appearance the Horned, or NEW Moon: (for her dark side, receiving no reflection of light from any neighbouring body, cannot be seen except in very clear weather). As she proceeds on her monthly journey, when the Sun sets in the West, we see her near our meridian, and then she appears an HALF Moon, and we say she is at the first quarter; as she approaches the FULL, more of her enlightened side may be seen, and she assumes an OVAL or GIBBOUS appearance. At the FULL she is opposite to the Sun, when the inhabitants of the Earth look at her in the same direction as the rays of that luminary, and of course see the whole of her enlightened face. In performing the other half of her journey, she wanes; and exposing less and less of her enlighted side to us, again disappears.

This scene receives also auxiliary illustration, before the grand scene opens: and in maps of the Moon during its exhibition, particularly one of five feet diameter, made from telescopes of the largest magnifying powers, and laid down with the most minute correctness, with maps of the appearance of the Earth as seen from the Moon, indicating from this similarity, that they are worlds of nearly similar construction.

In the thirteen revolutions she will make while the Earth travels round the Sun, it will evidently appear that the Earth is a Moon to her, but appearing thirteen times as large as the Moon to us; that she does not shine by her own light; that she has no diversity of seasons; that she keeps the same side always turned towards the Earth, and therefore turns on her axis every 29½ days; that her surface is mountainous*; and that she shines without

* Her mountains by some have been calculated nine miles high; but Dr. Herschell's telescopes, which magnify 6500 times, have reduced her highest hills to about *two* miles. Mr. Shroeter apprehends that the mountain *Leibnitz* is not less than 25,000 feet high. The Craters of

setting, every second fortnight, on the arctic or antarctic parts of our globe, during winter: a very sublime and simple provision for the otherwise long continued darkness that at opposite seasons of the year would invelope the polar regions of the Earth.

If the Moon moved in the same plane or level with the Earth, we should have an eclipse every full and change; but as she travels $5\frac{3}{4}$ degrees to the North of it, and the same to the South of it, every lunation, she only crosses the plane of the Earth's orbit in two places, which points of intersection (called the Moon's NODES) though in a trackless path, move $19\frac{3}{4}$ degrees towards the West every year, and therefore pass round the Heavens in 18 years and 225 days; which is the golden number of our calendar. Hence, when one of these nodes is between the Earth and the Sun at the change, the Moon's shadow is

the Moon are from 4 to 15 miles diameter. He discovers some new spots on the Moon, and calculates her atmosphere to be 5376 feet high, an height so inconsiderable that it might escape our best telescopes or most minute observations.

thrown on the Earth, and she eclipses the Sun; and if she comes to the full when either node is opposite to the Sun, she falls into the Earth's shadow, and loses for a short time her borrowed light: hence, as she mostly passes above or below the Earth's shadow, we have Eclipses very seldom. These phænomena are produced in the Eidouranion as they are in nature, and perfectly evident on inspection.

Scene 3.

THEORY OF TIDES,

ILLUSTRATED.

This Scene also consists of the Sun, the Earth, and the Moon. But the intention is to shew how the Earth and Moon agitate each other round their common centre of gravity, causing two tides every 25 hours. It is a cir-

cumstance truly astonishing, to see in calm weather, and under a serene sky, the violent agitation of the great fluid mass of the ocean, whose waves roll against the shore with so grand impetuosity.—This spectacle invites to reflection, and rouses a desire to penetrate into its cause: hence the Earth's THREE-FOLD motion appears in this scene:—that, on its axis, to produce day and night: that, round the Sun, to produce the year and our seasons; and that, round the centre of gravity with the Moon, to produce spring and neap tides, by their combined and opposite influences. The Moon is so near the Earth (240,000 miles at a medium) in comparison of the Sun (near 100 millions of miles) that the Moon's attraction on the waters of the ocean and on the air of our atmosphere (for there are tides in both) is to that of the Sun as ten is to three. So at the change of the Moon, the attraction of the Sun and Moon being in the same direction, a power of thirteen influences the sea, and we have SPRING tides; but at the quarters of the Moon, the two luminaries counteract the attractions of each other, so the

Sun's power of three being taken from the Moon's of ten, leaves only seven operating upon the sea, and NEAP tides take place.

A tumbler filled with water, may be whirled by a string vertically round the head, without any danger of the water falling out of it. Those parts of the Earth that come successively OPPOSITE to the Moon, perform a much larger circle round the centre of gravity, than the parts immediately UNDER the Moon: hence the waters opposite the Moon are THROWN OFF, as it were, by their centrifugal motion, and rise above the common level, as well as the waters exposed to the Moon's immediate attraction; thus two tides are produced in 25 hours, opposite to each other; and by the Earth turning through those protuberances, its waters rise and fall.

The Sun would produce two small, but similar tides, if the Earth had no Moon; therefore at the full of the Moon the Sun's centrifugal tide being reinforced by the Moon's attraction, and the Moon's centrifugal tide being also assisted by the Sun's attraction, spring

tides take place at the full, as well as at the change, of the Moon.

☞ This Scene also receives collateral assistance, exhibiting and explaining the setting of the tides in all the large oceans and the principal seas of the Earth.

Scene 4.

THE SOLAR SYSTEM.

This displays the whole Copernican or Solar System, with every planet and satellite in diurnal and annual motion! With awe and deference I offer this daring but humble transcript of creation! Enough, if one idea can be added, to the ingenuous mind, of the attributes and perfections of the Deity.

The SUN, a huge globe of fire (957,942 miles diameter, and consequently a million times as large as our Earth, and intended to give light, heat, and vegetation, to seven pri-

mary and at least eighteen secondary worlds) is placed in the centre of the system; and by spots on his disk is discovered to turn on his axis in about 25 of our days. These spots cannot be permanently fixed, because they are frequently altering in their shape, situation, number, &c. tho' some have supposed they have seen small indentations on the edge of the Sun, as the spots have passed it, and conjectured that a fluid matter surrounded a dark nucleus, which sometimes becoming bare, might occasion the transient appearance and disappearance of the spots.

MERCURY is the first planet in the order of the system; about 3498 miles diameter: he moves round the Sun with the greatest velocity of any of the Planets familiar to our system (as being nearest the Sun) in about 88 of our days; at the rate of 110,680 English miles every hour, but the angle of his distance from the Sun, as seen by us, is so small, that unless by the telescope, we can seldom discern him*; (and

* It is rather curious how the antients saw so much of him as that his period was tolerably guessed, at least so

even then an equatorial instrument to direct to its place, as indicated by the Ephemeris, will be requisite;) and when we do, it is for so short a time, and in twilight, that we can discover no spots on his face, and therefore to this hour know nothing of the length of his days and nights: we see him partially enlightened like the Moon, sometimes like a small crescent, in other situations half enlightened, and sometimes gibbous or oval, and are therefore certain he derives his light from the Sun, as she does: so that no doubt he is a fellow world, with inhabitants adapted to the heat of his situation: altho' this heat is seven times as great as that of the Earth. He is not much larger than the Moon. Our Earth, viewed from Mercury, must appear much larger and more luminous than any of the Planets, except Venus, appears to us.

far back as the days of Cicero.—*De Nat. Deor. II.* 20. They knew it to be less than the Earth's: which, though far from accurate, was a nearer calculation than could be then expected. And this is the more remarkable if Cicero had it from Plato, and he from Ægypt and Syria.

VENUS is the next planet in the order of the system, and distinguished by her *superior brilliancy*, as the Sun's light is twice as great to this planet as to the Earth; from this cause she is sometimes visible to the naked eye in full day-light. She is about 70 millions of miles from the Sun, or about twice the distance of Mercury; and like him, but much longer and more conspicuously, appears under the different phases of the Moon. These, as we have said, are proofs that both planets borrow their light from the Sun. The orbits of these planets (as well as those of the rest of the system) are inclined to the orbit of the Earth. Hence when Venus and Mercury are found in the nodes of their orbits between the Earth and Sun, they are transferred upon the Sun's face like small round black spots, and which in fact are partial Eclipses of the Sun; these are called the TRANSITS of Mercury, or Venus.

Venus is a little larger than the Earth, or 9360 miles diameter; and moves round the Sun in 224½ of our days, at the rate of 80,955

miles every hour. From faint spots seen upon her surface, Mr. Shroeter apprehends she revolves on her axis in 23 hours, 21 minutes; that her surface is irregular like that of the Moon, and some of her mountains four miles high. The atmosphere of Venus has been calculated to be 50 miles high: and the Sun would appear to the inhabitants of this planet twice as large as to us. When Venus is to the west of the Sun, she is a morning star; when to the east of him, an evening star: her orbit or track is included by the Earth's, and as both move the same way, she appears to be on one side of the Sun longer than the 224½ days she is in going round him. The axis of Venus is said by some astronomers to incline 75 degrees to the axis of her orbit: and therefore her seasons vary very fast, the Sun passing over more of her from pole to pole in one day, than over the Earth in a quarter of a year. Hence the heated places of this planet have time to cool: which suggest to our ideas that provision has been made for inhabitants, that they might not suffer by their vicinity to the Sun; this circumstance also gives her two winters and two sum-

mers at her equator, and indicates her inhabited. The discovery lately made by Mr. Shroeter, of a light faintly extended beyond the bounds of direct solar illumination, when she has her falcated appearance like the Moon near to her change, strengthens this probability: as these are signs of twilight, and of an atmosphere. This astronomer has also observed her to have considerable mountains; another character of a globe suited for habitation.

The EARTH is the third planet in the order of the system: 8244 miles diameter—moves at the rate of 68,856 miles every hour, and hence completes its revolution in its orbit (the Ecliptic) in 365 days and $\frac{1}{4}$. The MOON's diameter is 2183 miles; she moves with respect to the Earth 2290 miles in her orbit every hour; and goes round the Earth from change to change in 29 days and a half. But having devoted so much of this tract to the phænomena of the Earth, as well as its satellite the Moon, we proceed to

MARS, known in the heavens by his peculiarly red appearance, arising from a very thick

and dense atmosphere. This Planet is next above the Earth, and hence has considerable less light from the Sun than we have; is much smaller than the Earth, or about 4470 miles diameter. He is near 150 millions of miles from the Sun, and goes round him in something less than two of our years, moving at the rate of 55,783 miles every hour. His day and night is rather longer than ours, or 24H. 39M. 22s. and uniform throughout his year, so that his axis being perpendicular, he has no variety of seasons. When we pass between the Sun and him he has a most fiery and alarming appearance, and is often mistaken for a Comet; but when we are on the opposite side of our orbit, he appears small, and scarcely to be distinguised from a fixed star.

JUPITER, far the largest of our Planets, near 1300 times the size of the Earth, or 93,333 miles diameter, is the next above Mars, at five times the distance from the Sun that we are; so that he enjoys but a twenty-fifth part of the light, heat, and attraction of that luminary we do.—Though indeed of the

light and heat he may still possess, we are not so certain as of the degree of attraction: that being invariably proportioned to the distance; while these will be relative to the density and other circumstances of the atmosphere, and the aptness of the surface of the Planet to acquire and retain heat: after Venus he appears the most brilliant Planet of the Universe. He is attended with four satellites that revolve very regularly round him. The three first are eclipsed every revolution, and every seventh day come in conjunction with him and one another, as may be seen on the *Eidouranion.* Longitude, at land, can be ascertained by the eclipses of Jupiter's satellites, as well as by a transit of Venus; and these would supercede the necessity of a time-keeper, if they could be observed at sea; hence, in the Nautical Almanack, these eclipses are very exactly calculated for the meridian of Greenwich, and answer very good geographical as well as nautical purposes. Jupiter is near twelve years in making his way round the Sun, altho' he moves at the rate of 30,193 miles every hour; he turns round his axis in about ten of our

hours, so that his days and nights are but five hours each: and he has no variety of seasons; for his axis is perpendicular to the plane of his orbit. Turning so swiftly on his axis, his figure becomes more oblate than that of the Earth, being more than 6000 miles longer in diameter from one side of his equator to the other, than from pole to pole, or in the proportion of 13 to 14.* This swiftness of his diurnal motion also draws his clouds and vapours into streaks or lines over his equatorial parts, forming what are called Jupiter's Belts. An eclipse of the Sun, by this great planet, would be a striking object even to the unassisted sight as viewed from Saturn.

SATURN, 85,782 miles in diameter or about 1000 times as large as the Earth, is still a more remote planet from the Sun, round which he revolves in about 30 of our years, at the distance of 916 millions of miles. He moves in

* If the Earth turned round its axis in 84 minutes and 43 seconds, the centrifugal *force* would be equal to the power of gravity at the equator; and all bodies there would entirely lose their weight. If the Earth revolved quicker, they would all fly off and leave it.

his orbit at the rate of 22,298 miles every hour, and upon his axis in 10H. 16M. by this swift revolution on his axis his figure becomes oblate in the proportion of 11 to 10, and his atmosphere and vapours are drawn like a quintuple belt of 3 darker parts and 2 lighter upon his body. Saturn is attended by seven Satellites, the outermost has been long known to have a period of apparent augmentation and diminution, and hence probably to have a revolution on its axis, and be composed of land and water.

A large, broad, double, and luminous *ring* of 200,157 miles diameter, surrounds Saturn, at a distance from the planet equal to the breadth of the ring.—This ring inclines about 30 degrees to the plane of the ecliptic, and must appear like a great arch of light to the inhabitants of Saturn. It has a revolution every eleven hours on an axis perpendicular to its plane, and keeps parallel to itself at all times; hence it disappears twice every 30 years, when its edge is presented to us; the Sun shines for near 15 of our years together on

the northern plane of the ring; and then leaving it, illumines the southern side for the same period; so there is but one day and one night on each side of the ring, but each will be of 15 years continuance without intermission.

The Sun's direct light being but about a 90th part so strong to Saturn as to the Earth, this ring is no doubt intended to increase it, by reflecting a very considerable portion upon the planet, which added to that from his seven Satellites, must render him a very comfortable abode for rational and brute inhabitants.

The GEORGIUM SIDUS, or Georgian Planet (so called by Dr. Herschell, its ingenious and indefatigable discoverer) makes the seventh in the order of the system; the other planets we have described have been known as such to the highest antiquity, but from its extreme smallness, this has escaped ascertainment till the year 1781, although it had been recognized as a very minute star by several astronomers. It is near twice Saturn's distance from the Sun, and will be near eighty-two years and six months in going round him; is

of a pale colour, and much larger in its telescopic appearance than the fixed stars, being 100 times as large as the Earth, or 37,230 miles diameter, and, on a clear evening, is visible to the naked eye. The Dr. has discovered six satellites to this planet, some of which are said to move retrograde. As familiarity is the principal design of this Treatise and Lecture, it may be useful to exhibit the distances of the planets from the Sun in the most concise form, and in numbers they will stand thus:—if the distance from the Sun of

Mercury	Venus	Earth	Mars	Jupiter	Saturn	Georgium Sidus
is 4	will be 7	10	15	52	95	190

or, if a body projected from the Sun should continue to fly at the rate of 480 miles per hour, (which is about the swiftness of a cannon-ball) it could reach the orbit of Mercury in 9 years, Venus in 16 years, the Earth in 23 years, Mars in 34 years, Jupiter in 118 years, Saturn in 216 years, and the Georgium Sidus in 432 years.

These we consider as the regular bodies of our system; so regular, indeed, that every phænomenon respecting them is calculated for

years before hand, and it is almost considered as a criminal error to be a minute of time wrong in the calculation. But we are sometimes visited by COMETS, which may also be recognized as a part of our system: of these our knowledge is very imperfect. By supposing that the same Comet has appeared at equal intervals of time; by observing that, like the planets, they describe equal areas in equal times; and by having three points in an ellipsis given to make out its eccentricity; from these data it was natural for mathematicians to suppose they could calculate the return of all Comets that had been scientifically observed: but the actual return even of that conspicuous one expected by Dr. Halley, has been thought by some not to be sufficiently ascertained: yet, on examining the balance of probability, as stated by Maupertius, Lalande, Messire and Martin, for its re-appearance, probably this doubt will be greatly lessened, if not removed. As new Comets are almost perpetually appearing, on which calculation hitherto has been silent, there is reason to expect, in a proper period of time, an adequate

number of observations to decide the question, whether in general they revolve at stated times, or traverse our system without probability of return. Perhaps Comets of each description time and observation may confirm to us. We know that Comets accompanied with tails come very near the Sun, and from all quarters of the Heavens! that the tails keep opposite to the Sun; consequently they are only visible to us when seen obliquely to the Sun. Thus the Comet of August, 1797, was observed to have little or no train during any part of its appearance; but a faint hazy light diffused round it; these trains, like electrical and borealean light, do not refract the light of the fixed stars, &c. The appearance of the Comet of 1682, is copied in the *Eidouranion*. It descends from the top of the Machine; its train increasing in length and lustre till it arrives at the Sun, diminishing as it ascends. Its orbit is so eccentric that the small part of it visible is not sensibly to be distinguished from the parabolic curve; and in this representation it finally disappears in the roof of the Theatre; it being impossible, if its return were

ascertained, to represent the extent of such an orbit, and its motion in it, with any degree of suitable proportion. The velocity of such of these as approach nearest to the Sun, particularly of the Comet of 1680, (whose appearance was tremendous) exceeds any swiftness that falls within observation; except that of the rays of light; it being nearly 2000 times greater than the swiftness of a cannon-ball, at the instant of its discharge; yet scarcely a thousandth part of the velocity of light passing from the Sun*. This Comet approached to within 40,000 miles of the Sun's surface, and was calculated to be heated 2000 times hotter than red hot iron; a globe of iron the size of the Earth in this heat, would be 50,000 years in cooling. These amazing visiters, whom philosophy contemplates with awe very different from that terror with which superstition had long viewed them, moving in such amplitude of space, so numerous as they are, and

* The velocity of a cannon-ball is about eight miles per minute.

Of the Comet in its perihelion...14,6000
Of Light.....12,000,000

so great as some of them, must have functions assigned to them proportionally important: either occasionally of terrific revolution; or more generally of recruiting the atmosphere of the planets in their successive appulse to any of them, and supplying the diminution of the solar fires. Perhaps too they are useful in preventing the central tendency of the planets to the Sun, from increasing more than in a certain degree; so that the apparent disturbances, thus produced, will be part of the necessary order and harmony of the system.

It is probable (though their orbits are so much oblique in all directions to those of the planets, that it can rarely happen) that Comets may be instrumental to great shocks; either by direct collision, the effect of which, considering the velocity and mass of some of them cannot be estimated, or by near approach: and of this latter a possible result, and such as seems, in one instance at least, to have already taken place, is noticed in the Remarks annexed to this account of the *Eidouranion*. But the philosophic observer

will have this reflection presented to him from the phænomena of the Universe; that the apparently disturbing and destructive powers are secondary and subservient; while those of the preserving and meliorating kind, are primary, continued, and universal. And those incidental causes of a melancholy and distressing aspect, when resolved into their ultimate tendency and necessary effects, manifest themselves, in so far as we can trace them, to be parts essential to the system of pure and perfect benevolence. Stability and duration are stamped on the Universe, and the imagination is lost in the immensity of the prospects; and whether we turn to the past or to the future, our conception vainly pants to grasp the idea of boundless Eternity.

But when we launch in idea into infinite space, and contemplate the systems without number that fill it; here indeed we have a subject truly worthy of the DEITY! Whoever supposes the fixed stars placed in a concave sphere, as they appear to us, must have a nar-

row and contracted idea of the SUPREME BEING; for one star appears large and another small, because one is immensely distant from us in comparison of another. Through Dr. Herschell's large telescope many fixed stars appear double: the Polar star is double; (but they are only stars at different distances from us appearing nearly in the same line) some appear like a topaz, others azure, others red; all are round, and many as perfectly defined as a shilling is on black cloth. By telescopes we formerly could see three times the number we can by the naked eye; and now, telescopes having received further improvement, in the most crouded part of the milky way, 116,000 have passed before the instrument in a quarter of an hour. The Nebula of Andromeda must be composed of the united lustre of many millions of stars. Agreeably to this, Dr. Herschell has noticed single nebulous stars surrounded with a faint equable whiteness; such as a system of Planets viewed at that distance from us might be supposed to give: others he has seen, which have the appearance of yet unformed systems. And there are, we

may presume, points of view, in the immensity of the Universe, in which all the fixed stars, accessible to the eye or telescope from this station of ours, and all the inconceivable space, through which they extend, vanish into a *nebula*, and almost an indiscernible point. Such is the order and greatness of that Empire, which these Discoveries, the farther they are pursued, must for ever more and more present to our increasing admiration. Such the relation of parts so astonishingly remote! Such the unity of intelligence, power, and preserving goodness which pervades the whole! And why may not stars be so remote, that their light may not have reached the Earth even since the creation! We know that light takes more time in travelling from the nearest stars to us, than we in making a West India voyage, (which is usually performed in six weeks) a sound would not arrive to us from thence in 50,000 years, nor a cannon-ball in a much longer time. The Sun's light could not therefore reach the fixed stars, and be reflected back again with their lustre; of course they shine by their own light—if so, they shine as

our Sun, and consequently are Suns themselves.—Now, as a principal of uniformity runs through the variety of nature, it is reasonable to conclude these Suns to be centres of systems like ours; and destined for the same noble purposes, viz. that of giving light, heat, and vegetation, to various worlds that revolve round them, but which are too remote for discovery, even with our best telescopes! This idea is infinitely too great for the human mind; or indeed for that of any created Being! For how inadequate must the utmost stretch of finite faculties be to represent infinity! The stars, disposed in constellations, and surrounded by concentric circles, may perhaps assist the imagination a little: The attempt in SCENE V. if not admired, we hope will be forgiven. But was it possible we could actually take our flight into infinite space, or be borne on the wings of lightning, to the most distant fixed Star we can now see, even there, perhaps, we should find ourselves on the confines of creation, and see as many stars before us as we left behind! For space has neither top nor bottom in it: it is a circle whos

centre is every where, but whose circumference is no where! Even systems themselves may have revolutions round one another; and account for that difference of distance that we are constantly observing to arise amongst the fixed stars; for new stars appear, rise into magnitude, and then diminish and disappear, which would also be accounted for by supposing that our Sun himself is in progressive motion towards some part of infinite space, and carrying his system of worlds along with him. Stars of the *first* magnitude, in Flamsted's time, dwindle into those of the *third* or *fourth*, in our time. Some of the stars change their magnitude periodically: as Algol, in Medusa's Head, which rises from the third magnitude to the second, in two days and twenty-one hours.—Where such periodical disappearances are short, they have been referred with probability to quick revolutions of such stars on their axis, with part of their disk opaque; or to the regular intervention of some very considerable Planet to intercept them from us. But re-appearances of this kind, after very long intervals, would indicate

rather a revolution in a great orbit. By analogy we conclude, that at a proper distance our Sun would dwindle into a fixed Star among the rest, and his system of worlds disappear. Now as we see that almost every particle of our globe swarms with life and animals, we cannot suppose the other bodies of our system to be only intended as a faint spangle for mortals to gaze at; more especially as they are as well calculated for inhabitants as ours, revolving as regularly round the same Sun, and seeming to have every other convenience for rational and brute inhabitants*. But to carry this idea into infinite space; to recognize Suns and Systems, above us, below us, to the East, the West, the North, the South; to consider each Sun as the centre of a system like ours, and every world inhabited!—In short, the astonished fancy turns round, and is entirely lost and sunk in the abyss of na-

* Perhaps the inhabitants of one system may be destined successively to pass from planet to planet, and from systems to other systems. This would answer, on an immense scale, to the analogy existing on Earth. It is stated as a conjecture with much energy and beauty in a late work. Illustrat. of Proph. T. II. p. 557, *Anno* 1796.

ture! Well might the Psalmist say, that, "The heavens declare the glory of God, and "the firmament sheweth his handy work." Well might he express himself as overwhelmed with the idea of the power and omnipresence of the Deity; since all our discoveries serve only to convince us, that a progress of inexpressible extent, continued through ages without number, would find us every where, as here, surrounded with his infinite energy; eternity, and immensity, filled with his vital presence.

DISSERTATION

ON THE PROBABLE CAUSE OF THE

Deluge.

SO perfect are the laws by which this wonderful system is regulated, and so effectual that Self-physic which the Almighty has instituted through all his works, that if any seeming disorder happens in the system, there requires no immediate interposition to prevent or cure the mischief: each body carrying within itself the principles of preservation and cure; an argument of wisdom and foresight worthy of the Deity!

The Planet Jupiter was attracted out of his orbit by the enormous Comet which appeared in the year 1680. The Comet coming across the plane of his track, had a temporary influ-

ence upon him; and it is observable, he has not travelled by the same fixed stars since that period which he did before it; and no doubt but his usual motion was momentarily retarded, and the shape of his orbit altered. Now if Jupiter consists of land and water (and by the spots seen on his face it is more than probable) it is possible he might experience a revolution something similar to our flood; for that our flood was occasioned by the near approach of a Comet, is a most natural supposition, and in no wise militates against the scriptural doctrine of that event: it being as easy, and as consistent for the Almighty, to render justice by a secondary cause, as by an immediate interposition. Nor is his attribute of mercy arraigned by the promis uous destruction the deluge occasioned; for it is evident, by reasoning from his works, that he governs the universe by "general, not by partial laws."

The vestiges of the Deluge are so remarkable, both on the surface and within the bowels of the Earth, that if examined without

prejudice, they prove, I think, beyond a doubt, that awful revolution to have been the work of a Comet. Not that the moisture of its tail drowned the World, as was unphilosophically suggested by Whiston; but if the attraction of the Moon be capable of raising the water of the sea above its common level, what effects might not be supposed from the near approach of a body perhaps many thousand times larger than the Moon? If a tide by such an attraction was raised three or four miles above the level of the Sea, the Earth, by turning on its axis, would have that protuberance dragged over the land, and its surface would be plowed up into those inequalities we call mountains; for that mountains are not of eternal duration, is evident from their growing less, even in the memory of man. For every thing tends to a level. Rains falling on mountains wash down their asperities; this matter bemuds the rivers, and banks out the sea; rocks themselves yield up their fantastic forms to the effects of air, water, and heat; and land has been growing into the water ever since the Deluge. But why should all assemblages of

mountains be arranged like little ridges of sand on the sea shore? Doubtless by having been produced by a superior tide, and left to dry by an unreturning sea. Almost all great ranges of mountains run North and South; the Andes of the Cordelleras; the mountains of the Moon in Africa; the Dophranes, Caucasus, Allegany, &c.—the Alps and Pyrenees excepted.

As Comets visit our system in all directions, why might not that in question have its motion from North to South, and dragging the sea after it, determine the mountains to those points of the compass? Whence come the shells and fish bones we meet with on the tops of the highest mountains? We have not discovered any power in nature disposed to work such quantities of them thro' the bowels of the Earth; and indeed imagination has not yet been so wild as to carry them thither: they are not a fortuitous assemblage of atoms assuming such forms; not *lusus naturæ*, but *bona fide*, shells and fish bones, such as we meet with on the sea shore! We find them al-

so deep buried in the bowels of the ground, far from the sea; we find them in rocks, and often converted into stone: nay, may not the fat of fish, joined with vegetable substances, form the bitumen of coal? We have experiments that warrant such a suggestion. Now if ever the Sea was dragged over the surface of the Earth by the attraction of a Comet, these effects must naturally follow.

In digging into the bowels of the Earth, we have still stronger evidence that the flood was occasioned by the near approach of a Comet. It is well ascertained, that the united attraction of every atom of the Earth forms that Earth into a dense ball, and not any particular attraction in its centre.—All matter being therefore affected by this power in proportion to its density, one might conclude that the heaviest bodies would lie deepest, and the lightest near the surface, but this is by no means the case: Coal is lighter than stone; various minerals lie upon light earths, &c. evidently proving, that the general order of nature has at some time been disturbed, and the manner

in which matter obeys the laws of gravity disarranged. Hence the philosophic miner finds strata of various density in digging downwards; and in pursuing his vein of ore, finds these strata broken and divided; nay, if he loses the vein, he can easily tell where to find it again, by the manner in which it broke off. In this he never is mistaken: He sees, as it were, through many fathoms of Earth! evidently suggesting, that some revolution on the Earth has broken up its naturally arranged strata, and introduced this "regular confusion."

The various strata of the Earth seldom lie on one another horizontally: they generally dip; and near the shore commonly incline towards the sea. On the South coast of England, the rocks incline Southerly; on the opposite coast of France they incline to the North. Is it not probable, that at the Deluge, the horizontal stratum was broken between these countries: and the ends falling lowest at the breach, formed the channel, into which the sea flowed, when it lost the in-

fluence of the Comet, and again obeyed the power of gravity? Countries separated by narrow channels, universally have their shores inclining towards the sea; shewing that the general geography was at that time altered.

It is true, we have an old doctrine revived, and supported by respectable authority, that mountains were formed originally by those eruptions we call volcanos. The votaries of this theory pronounce the hollows and cavities on the tops and sides of mountains, Craters, or the cups of extinguished volcanos; and if the stone of the mountain be of a bluish colour, then it is declared Lava; and the proof of a volcano having existed there becomes incontrovertible! History, however, affords us very few instances of mountains so formed. Yet this doctrine seems to have received very just authority from the last scientific circumnavigators. The rocks which surround the islands of the Pacific Ocean, generally break off perpendicularly about a mile out at sea, which makes their approach very difficult and dangerous; and as the sratum immediately under

the loam of the surface has an ashy, or lava-like appearance, the voyagers very naturally concluded, that the immense number of small islands which stud that extensive ocean, were the product of subaqueous eruptions. Still if I might be allowed to hazard an opinion against such respectable authority, I should rather apprehend that the Pacific Ocean had been once a continent, and that at the Deluge, when the Earth's surface was disarranged and broken up by the violent motion of the waters, the general body of it sunk beneath the level, or was washed away to other parts, leaving only the more elevated and solid part remaining. For volcanos throw up matter piece-meal; islands, therefore, formed by them, would have a sloping, or gradually sinking shore: whereas the islands of the Great South Sea are surrounded by perpendicular rocks, that sink in that direction to an almost unfathomable depth in the sea. Besides, how can we account for that similarity of manners, customs, colour, and even language, among the inhabitants of islands so distant, that no mode of navigation they prac-

tice could ever make them acquainted, or have any communication with one another? If these islands were thrown up from the bottom of the sea, their inhabitants would not be thrown up with them, and all with the same custom and language. Now if this immense part of the globe was a continent before the Deluge, the inhabitants might be alike; and if the elevated parts were above the subsiding water, (a circumstance more than probable) inhabitants might be saved upon them, with every circumstance of similarity we find among them; for that revolution is not of so remote a date, but remains of antediluvian manners might exist at this time.

Sic undique omni ratione concluditur, mente consilioque divino omnia in hoc mundo ad salutem omnium conservationemque administrari. Quo Spectaculo nihil potest admirabilius esse, nihil pulchrius. Quid tam apertum, tamque perspicuum, cùm cœlum suspeximus, cælestiaque contemplati sumus, quàm aliquod esse Numen præstantissimæ mentis, qua hæc regantur?

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