

**An epitome of astronomy, with the new discovered planets, and the late comet, as illustrated by the eidouranion; or, transparent orrery / originally invented by A. Walker, and as lectured upon by his son, D.F. Walker.**

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AN  
**EPITOME of ASTRONOMY,**

INCLUDING AN ACCOUNT OF

*THE COMET OF 1811,*

AND AS

ILLUSTRATED ON MR. WALKER, JUNR's.


**Eidouranion ;**

OR,

TRANSPARENT ORRERY.

1818





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Twenty-seventh Edition.

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AN  
**EPITOME OF ASTRONOMY,**  
 WITH  
*THE NEW DISCOVERED PLANETS,*  
 AND THE LATE  
**COMET,**  
 AS ILLUSTRATED BY THE  
**EIDOURANION;**  
 OR,  
 TRANSPARENT ORRERY;  
*ORIGINALLY INVENTED BY* A. WALKER,  
*And as Lectured upon by his Son,*  
**D. F. WALKER.**

STARS TEACH AS WELL AS SHINE!

YOUNG,

OS HOMINI SUBLIME DEDIT; CÆLUMQUE TUERI  
 JUSSIT, ET ERECTOS AD SIDERA TOLLERE VULTUS.

OVID MET. I, 28.

LIVERPOOL :

Printed by T. B. Johnson, 16, Manesty's-lane, for  
 Mr. D. F. WALKER,

And sold at his House, No. 5, Gloucester-street, Portman-square,  
 London.

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1818



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ASTOR LENOX TILDEN FOUNDATION

AN  
EPITOME OF ASTRONOMY,  
AND ITS ILLUSTRATION BY  
**The Eidouranion;**  
OR,  
*TRANSPARENT ORRERY.*

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As the phenomena of the heavenly bodies can be adequately illustrated only by some mechanical contrivances, such as Globes, Orreries, &c. whatever improvement is made in these, must be entitled to regard in proportion as it facilitates the attainment of astronomical knowledge.

The Eidouranion is of a construction new and peculiar, and is designed to give a more natural and comprehensive view of the celestial phenomena than any mode hitherto attempted.

This elaborate Machine is twenty feet diameter: it stands vertically before the spectators; and its globes are so large, that they are distinctly seen in the most distant parts of a Theatre. Every Planet and Satellite seem suspended in space, without any support; performing their annual and diurnal revolutions without any apparent cause.

It certainly approaches nearer to the magnificent simplicity of nature, and to its just proportions of



magnitude and motion, than 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, influences, &c. of the planetary system.

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SCENE I.

THE SUN AND EARTH ;

WITH THE ZODIACAL CONSTELLATIONS.

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As information is the primary object of this lecture, it is thought more useful to exhibit PARTS of the solar system, separately and distinctly, before a grand display is made of the whole. This scene, therefore, opens with only the Sun and the Earth and the new Zodiac. 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 twenty-five days and a quarter : 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 year. Its axis inclines twenty-three degrees and a half



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.

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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 are conspicuous.

This scene is surrounded by an exquisite transparent painting of the twelve signs of the Zodiac, shewing in what manner the Sun, or rather the



Earth, enters and passes through Aries, Taurus, Gemini, Cancer, &c.

N. B. The design of this painting was given by one of the first Royal ACADEMICIANS, and executed by one of the first Artists in London.

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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.

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## SCENE II.

### SUN, EARTH, AND MOON

AND THE STARS THAT FORM THE ZODIAC.

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#### PHASES AND ECLIPSES

THIS SCENE consists of the Sun the Earth, and the Moon. Its object is to display the cause of the waxing and waning of the Moon, and of solar and lunar eclipses: for this purpose, the Earth performs 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 hundredth thousandth part so strong) and performs her rotation, round the Earth, every 29D. 12H. 44M. sometimes exhibiting 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 she appears above the Sun in the West, and exhibiting a small part of her enlightened face, she is the horned, or NEW MOON. As she proceeds on her monthly journey, she soon appears as a half Moon, and is then 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 enlightened side, again disappears.

This scene receives also auxiliary illustration, before the grand scene opens, and by maps of the



Moon during its exhibition, particularly by an unique planisphere, made from a telescope of the largest magnifying power, and laid down with the most minute correctness by the late Mr. Russel, with a map of the appearance of the Earth as seen from the Moon, indicating from their appearance, 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 towards the Earth, and therefore turns on her axis every twenty-nine days and a half; that her surface is mountainous:\* and that she shines without setting, every second fortnight, on the arctic or antarctic parts of our globe, during winter: a

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\* 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. Schroeter indeed apprehends that the mountain *Leibnitz*, is not less than 25,000 feet high, and the Craters of the Moon to be from 4 to 15 miles diameter. He discovers some new spots on the Moon, and calculates her atmosphere to be only about one mile high, an height so inconsiderable, that it might escape our best telescopes or most minute observations.



very sublime and simple provision for the otherwise long continued darkness which at opposite seasons of the year would envelope the polar regions of the Earth.

If the Moon moved in the same plane with the Earth, there would be an eclipse every full and change; but as she travels five degrees and three quarters to the North, 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) move nineteen degrees and three quarters towards the West every year, and therefore pass round the Heaven 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 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; but as she mostly passes above or below the Earth's shadow, we have Eclipses very seldom.

These phænomena are exhibited in the Eidouranion as they appear in nature, and are rendered perfectly intelligible to every capacity.

N. B. Rotulas, exhibiting the Phases, Eclipses, &c. of the Moon, and the rising and setting, &c. of the Stars, and by which



the constellations may be known, may be had of Mr. Shacklock Skinner Street.

In 1847 will be an annular Eclipse of the Sun in England.

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### SCENE III.

## THEORY OF TIDES

ILLUSTRATED.



THIS Scene also consists of the Sun, the Earth, and the Moon. But the intention is to show how the Earth and Moon agitate each other round their common centre of gravity, causing two tides every 25 hours. It is a circumstance 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 such grand impetuosity.

### ADDRESS TO THE OCEAN.

“Hail! thou inexhaustible source of wonder and contemplation! Hail! thou multitudinous ocean! whose waves chase one another down like the generations of men, and after a momentary space, are immersed for ever in oblivion! Thy fluctuating waters wash the varied shores of the world, and while they disjoin nations, whom a nearer connection would involve in eternal war, they circulate their arts and their labours, and give health and plenty to mankind. How glorious! how awful are the scenes thou displayest! whether we view thee when every wind is hushed; when the morning sun silvers the level



“line of the horizon; or when the evening track is marked with  
 “flaming gold, and thy unrippled bosom reflects the radiance of  
 “the over-arching heavens! Or whether we behold thee in thy  
 “terrors! when the black tempest sweeps thy swelling billows,  
 “and the boiling surge mixes with the clouds! when death rides  
 “the storm, and humanity drops a fruitless tear for the toiling  
 “mariner, whose heart is sinking with dismay! And yet, mighty  
 “deep! ’tis thy surface alone we view. Who can penetrate  
 “the secrets of thy wide domain! What eye can visit thy  
 “immense rocks and caverns, that teem with life and vegetation?  
 “or search out the myriads of objects, whose beauties lie scat-  
 “tered over thy dreary abyss? The mind staggers with the  
 “immensity of her own conceptions; and when she contem-  
 “plates the flux and reflux of thy TIDES, which, from the  
 “beginning of the world, were never known to err, how does  
 “she shrink at the idea of that Divine Power which originally  
 “laid thy foundation so sure, and whose omnipotent voice hath  
 “fixed the limits, where thy proud waves shall be stayed!”

KEATE.

This spectacle invites to reflection, and excites  
 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  
 seasons: and that round the centre of gravity  
 with the Moon, to produce spring and neap tides,  
 by their combined and opposite influence. 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 as well as on 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.

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. 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.

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 increased 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 Globe; whilst some apparent exceptions to the Theory are refuted.

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SCENE IV.

THE SOLAR SYSTEM.

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This displays the whole Copernican, Newtonian, or Solar System, with every planet and satellite in their annual and diurnal rotation. The quickness of the motion of some—the slow motion of others—with the apparent changes in their situation and direction, will be here made evident and explained.

This humble transcript of creation is offered with awe and deference as calculated to impress the pious mind with feelings of love and devotion for the Great Giver of all good. Having once raised his eyes to the heavens, and learned to contemplate their motion and appearances, it is



hoped that it may teach him to adore the divine wisdom, which has so adjusted the proportion of days and Seasons in the different parts of the Globes, as to have distributed impartially, though in various ways, an equal share of the Sun's light and influence to every nation under Heaven.

“O thou, that, with surpassing Glory crowned, look'st from  
 “thy sole dominion, like the God of this great world, at whose  
 “sight the Stars hide their diminished heads!

MILTON.

The SUN, ☉, a huge globe, supposed of fire, (957,942 miles diameter, and consequently near a million times as large as the Earth, and intended to give light, heat, and vegetation to 11 primary and 18 secondary worlds) is placed in the centre of the system; and by spots on his disk is discovered to turn on his axis in 25 of our days. These spots cannot be permanently fixed, because they are frequently altering in their shape, situation, number, &c. though 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 or luminous atmosphere surrounded a dark nucleus, which sometimes having transient openings, might occasion the appearance or disappearance of the spots.



MERCURY,  $\zeta$ , is the first planet in the order of the system ; about 3123 miles diameter ; he moves round the Sun with the greatest velocity of any of the planets (as being nearest to him) in 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 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 it is difficult to discover spots on his face ; therefore to this hour we are uncertain of the length of his days and nights ; yet it has been apprehended that he revolves on his axis in 24 hours and 5 minutes. It is rather curious how the ancients saw so much of him as that his period was tolerably guessed, at least so far back as the days of Cicero.—*De. Nat. Deor* 11. 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 Egypt and Syria. We see him partially enlightened like the Moon, sometimes like a small crescent, in other situations half en-



lightened, 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, which in the cooler regions of the planet, is equal to the greatest heat of the earth ; and in their hottest climates, water would continually boil. In magnitude he does not much exceed the Moon. Our earth, viewed from Mercury, must appear much larger and more luminous than any of the planets, (except Venus) appears to us.

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 daylight. She is about 70 millions of miles from the Sun, or about twice the distance of Mercury ; and appears like him, though more conspicuously and for a longer period, under the different phases of the Moon. These, as we have said, are proofs that both planets borrow their light from the Sun, and move round him. The orbits of the 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 nearly as large as the Earth, or 7702 miles diameter; and moves round the Sun in two hundred and twenty-four and a half 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 half of the two hundred and twenty-four days and a half 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 rapidly, 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 suggests 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 summers at her equator ; with such provision, in a planet, over a large part of which, the heat does not exceed that of the Earth, even ourselves, our animals, and vegetation, might subsist. 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 several considerable mountains ; another character of a globe suited for habitation.

The EARTH  $\oplus$ , or ♀ is the third planet in the order of the system, 8,000 miles diameter and 93 millions of miles from the Sun, moves at the rate of 68,856 miles every hour, and hence completes its revolution in its orbit (the Ecliptic) in 365 days and a quarter. The Moon's diameter is 2,160 miles ; she moves with respect to the Earth 2,290 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 phenomena of the Earth, as well as to its satellite, the Moon, we proceed to MARS,  $\delta$ , 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 only half the light from the Sun that we have ; is much smaller than the Earth, being only 4,000 miles diameter. He is about 140 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, 24H. 39M. 22s. and uniform throughout his year : his axis being perpendicular he has no variety of seasons.\* When we pass between the Sun and him he has a fiery and striking 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 distinguished from a fixed star. The warmer regions of this planet, are of nearly the temperature of Russia.



Since the Commencement of this Century,  
 FOUR NEW PLANETS,

(The CERES, PALLAS, JUNO, and VESTA,) have been discovered belonging to the Solar System, all situated at about the same distance from the Sun, and between Mars and Jupiter. They are too small to be seen by the naked eye, and visible only by good telescopes ; being about 150 miles in diameter, and each moves round the Sun in little more than 4 and a half years.

JUPITER, 4, far the largest of our planets, near 1300 times the size of the Earth, or 91,522 miles diameter, is the next in the system, 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 which we do. Though, indeed we are not so certain of the light and heat he may still possess, as of the degree of attraction : *this* being invariably proportioned to the distance, while *those* will be influenced by the density and other circumstances of the atmosphere, and the aptness of the surface of the planet to acquire and retain heat. Next to 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 can be ascertained by the eclipses of Jupiter's satellites, as well as by a transit of Venus; 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, although 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 upwards of 6,000 miles longer in diameter, from one side of his equator to the other, than from pole to pole, or in the proportion of 1 to 14.\* This swiftness of his diurnal

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\* 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.



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 one of his satellites.

SATURN,  $\frac{1}{2}$ , 76,068 miles in diameter, or about 1,000 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 900 millions of miles. He moves in 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 12, 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 to 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 11 hours on an axis perpendicular to its plane, and keeps parallel to itself at all times; hence it disappears twice every thirty 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 interesting and comfortable abode for rational and brute *inhabitants*.

The GEORGIUM SIDUS,  $\text{♃}$  or Georgian Planet (so called by Dr. Herschel, its ingenious and indefatigable discoverer) makes the tenth in the order of the system; most of the other planets we have described have been known as such to the highest antiquity, but from its extreme small-



ness, this had 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 about 84 years 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 36,230 miles diameter; and, on a clear evening, is visible to the naked eye. Six satellites attend 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 distance of the planets from the Sun in the most concise form, and in numbers they will stand thus:—if the distance of Mercury from the Sun be

Mercury...Venus...Earth...Mars...Jupiter...Saturn...Georgium Sidus  
as 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 would reach 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 all the phenomena respecting them are calculated for years before-hand ; and it is almost considered 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.

“ Amid the radiant orbs that animate the sky,  
 “ The life infusing Suns of other worlds,  
 “ Lo ! from the dread immensity of space  
 “ Returning, with accelerated course,  
 “ The rushing Comet to the Sun descends ;  
 “ And gradual sinks below the shading Earth,  
 “ With awful train projected o'er the Heavens.”

THOMSON.

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 ellipse 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 Maupertuis, 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 time and observation may prove that there are Comets of each description. 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. These trains, like electrical and borealian 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 2,000 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 occasional celestial visitants are contemplated by the philosophers with awe and admiration very dif-

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\*The velocity of a cannon ball is about eight miles per minute,  
 Of the Comet in its perihelion..... .. 146,000  
 Of light..... 12,000,000



ferent from that terror with which superstition had long viewed them as portents and prodigies to alarm the world. That they are intended by the great Author of Nature for wise and important purposes no reflecting mind can doubt.

Our great philosopher, Sir Isaac Newton, the glory of Britain and of the world! is of opinion that they rectify and restore the gradual decay of the planets, and preserve in its due order that system of the Universe of which they form a part. They may recruit the atmosphere of the planets in their successive appulse to any of them, as well as supply 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 :

“ All are but parts of one stupendous whole,  
 “ Whose body Nature is, and God the soul.  
 “ And if each system in gradation roll,  
 “ Alike essential to th’ amazing whole,  
 “ The least confusion but in one, not all  
 “ That system only, but the whole, must fall.”

POPE'S ESSAY ON MAN, B. I.



It may not be improper here to record the more peculiar circumstances of the remarkable Comet of 1811, which was so conspicuously visible in this Kingdom, as well as in other parts of the Globe, for ten months, a longer period than has been reported of any other, from the earliest ages of antiquity, to this day.

This Comet, approaching from the Southern Regions, was first observed in the South of France, in March, 1811, since which period it has passed through the Solar System, or from the South side of it, through its Node, and the Ecliptic, to the North side, and was seen in England, early in the morning of August 26.

On the 31st of August, at Hayes, in Middlesex, Mr. William Walker discovered it in the evening, about 8 o'Clock, like a hazy light, of the size of Jupiter, near the middle, and on the back of Leo Minor; it was then approaching its perihelion, or nearest distance from the Sun, to which it arrived on the 12th September, and was then 117 millions of miles from him, after which, the tail had its greatest brilliancy, and was probably near 30 millions of miles in length



and the centre of the Nucleus, or head of the Comet, about 400 miles in diameter.

It never approached quite so near the Sun as the Earth does, and when nearest the Earth, was about 114 millions of miles distant.

The *Nucleus* varied in diameter, from one minute at first, to four minutes, was most bright in the centre, and hazy at the edge; rays appeared frequently to emanate from it, and luminous matter to coruscate at intervals down the whole length of the tail. To the naked eye, and the trial telescope, the Comet was larger, but not equal in brightness to Capella, or the Stars of a Minor first Magnitude, but superior in a very small degree, to all the Stars in the great Bear.

The Coma around the head, was generally about three-quarters of a degree in diameter.

The Tail was of a very singular appearance in the telescope: it seemed quite detached from the Nucleus, and to bend round it like a hood, forming two luminous streams of light behind the Comet, on each side, whilst immediately behind the Nucleus, was dark as the rest of the sky; in this interval and through the rays were



frequently seen small Stars, whose light was totally undisturbed by its passage through them. On the 5th of September, the Tail was only one degree long ; on the 11th, seven degrees : October 6, sixteen degrees ; and on October 17th, twenty degrees. After this it gradually diminished, having been visible in this Country, over nearly half the heavens. On December 9, the Tail was only four degrees long, the division between the head and Coma disappeared, and also the division of the Tail ; and on the 18th of January, 1812, the Comet was barely visible to the naked eye, and received no advantage from the telescope : since that period, Moonlight, its approximation to the light of the Sun, and its great diminution, renders it probable, it will be seen no more by this generation.

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 Lecture on the *Eidouranion*. But the philosophic observer will have this reflection presented to him from the phenomena 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 to 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 ; 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.

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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 narrow 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 powerful telescopes 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 round and perfectly defined. By telescopes we formerly could see three times the number we can by the naked eye ; and now, telescopes having received farther improvement, in the most crowded part of Milky Way, 116000 have passed before the instrument, in a quarter of an hour ; and it is probable, that if every star were catalogued that is visible through the largest telescope, the number would amount to 90 millions. The Nebula of Andromeda, must be composed of the united lustre of many millions of stars. Agreeably to this, Dr. Herschel 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 indiscernable point. Such is the order and greatness of this celestial World, 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 prevades 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 principle of uniformity



runs through the variety of nature, it is reasonable to conclude these Suns to be centres of system like our's ; and destined for the same noble purpose, 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 large 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 the **LAST SCENE**, if not admired, we hope will be forgiven. But were 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 beginning nor end ; it is a circle whose 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 among the fixed stars ; for new stars appear, rise in magnitude, and then diminish and disappear. This would also be accounted for, by supposing that our Sun himself is in progressive motion towards the star Tauri, and carrying his system of worlds along with him. Stars of the *first* magnitude, in Flamsteed'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 axes, with part of their disks 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 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 our's, revolving as regularly round the same Sun, and seeming to have every other convenience for rational and animal Beings. 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 our's, and every world inhabited !—In short, the astonished imagination becomes bewildered, till at length it is entirely lost and sunk in the abyss of nature ! 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

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\* Perhaps the inhabitation 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 the “ Illustrations of Prophecy.” T. H. p. 557, *Anno* 1796.



and omnipresence of the Deity; since all our discoveries serve only to convince us, that a progress of inconceivable extent, continued through ages without number, would find us every where, as here, surrounded with his infinite goodness, and filled with his eternity and immensity.

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