A COMPENDIUM OF ASTRONOMY;

BEING A CONCISE

DESCRIPTION OF THE MOST INTERESTING PHENOMENA OF THE HEAVENS.

INTENDED TO ACCOMPANY

A SERIES OF THIRTY DIAGRAMS,

CONTAINED IN SINGLE SLIDERS,

THE PAINTINGS THREE INCHES IN DIAMETER,

(No. 3 SET).

EXHIBITED BY THE

IMPROVED PHANTASMAGORIA LANTERN.

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LIST OF DIAGRAMS.

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2. ——— Copernicus and Newton.
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GENERAL VIEW OF THE SOLAR SYSTEM.

	SATEL.	DIAMETER.	ROTATION.	DISTANCE.	REVOLUTION.	INCLINATION OF ORBIT.
Sun		882,000	25 days, 8 h.			
Mercury ...		3,140	24 hours, 5 m.	37 Millions	88 Days	7° 0′
Venus... ...		7,800	23 h. 21 m.	68 do.	225 do.	3° 23′
Earth	1	7,926	24 h. 0 m.	95 do.	365¼ do.	
Mars		4,100	24 h. 37 m.	142 do.	687 do.	1° 51′
Flora		Uncertain	Uncertain	209 do.	1193 do.	5° 53′
Vesta		250 ?	ditto	224 do.	1325 do.	7° 8′
Iris		Uncertain	ditto	226 do.	1341 do.	5° 28′
Metis		ditto	ditto	226 do.	1345 do.	5° 34′
Hebe		ditto	ditto	230 do.	1379 do.	14° 47′
Astræa ...		ditto	ditto	245 do.	1511 do.	5° 19′
Juno		79 ?	ditto	254 do.	1594 do.	13° 3′
Ceres		163 ?	ditto	263 do.	1682 do.	10° 37′
Pallas		Uncertain	ditto	263 do.	1686 do.	34° 37′
Jupiter ...	4	87,000	9 h. 56 m.	490 do.	4333 do.	1° 18′
Saturn ...	8	79,160	10 h. 29 m.	900 do.	10,759 do.	2° 29′
Uranus ...	6	34,500	9 h. 30 m. ?	1800 do.	30,687 do.	0° 46′
Neptune ...	2	41,500	Uncertain	2850 do.	60,127 do.	1° 46′
Moon		2,180	27 d. 8 h.	240,000	27⅓ do.	5° 9′

A

COMPENDIUM OF ASTRONOMY.

THE science of Astronomy teaches the laws which regulate the motions of the heavenly bodies, explains their appearances, and ascertains their magnitudes, distances, and relative situations.

When we look at the heavens, we seem to be in the centre of a vast dome or hemisphere, in which the Sun, Moon, and other heavenly bodies, are fixed. This dome appears to us to revolve from east to west in twenty-four hours, round a point, which in our latitude is nearly half way between the zenith (which is directly above our heads) and the horizon. This point is called the North Pole of the heavens; and it would appear to an observer at the North Pole of the Earth to be directly above his head; to one at the Equator, it appears in the horizon: it is never seen by those below the equator; and it is always as many degrees above the horizon, as the place from which it is seen is to the north of the Equator. In consequence of the oblique situation of this point in our latitude, every other part of the celestial hemisphere appears to us considerably more elevated at some times than at others, in proportion to its distance from the pole; and some parts daily disappear below the horizon. For instance, if we observe the course of the Sun, we shall see that he rises in the east, sometime between four and eight o'clock in the morning; that he attains his greatest elevation in the sky at twelve; and that he sinks below the western horizon between four and eight in the evening. We observe the same also with respect to the Moon; but the times of her rising and setting vary much more, according to her situation with respect to the Earth. If we watch the Stars, we shall see some of them rising and setting in the same manner; but those which are near the pole never set; and one star may be observed which nearly occupies the place of the pole, and scarcely changes its position at all. This is called the Pole Star. If we watch the stars still further, we shall see a few of them which change their places with regard to the others; these are called *Planets*, whilst the others are denominated *Fixed Stars*.

The earliest, and what at first sight appears the simplest, method of accounting for these appearances, was that afterwards defended by *Ptolemy* (who flourished about A. D. 100), and called after him the Ptolemaic system.

DIAGRAM I.

Ptolemy considered the Earth to be in the centre of the system, and that the whole starry sphere revolved around it in 24 hours; but that the Sun, Moon, and Planets revolved around it in periods varying more or less from that time; the Moon being the nearest, then Mercury, Venus, the Sun, Mars, Jupiter, and Saturn.

This system, notwithstanding many palpable errors, maintained its ground for 1500 years; until *Copernicus*, a Polish Astronomer, revived the system believed to have been taught by *Pythagoras* about B. C. 500, but which had been relinquished on account of its apparent difficulties. Copernicus taught that the Sun is fixed in the centre of the system, and that the Earth and other planets revolve around him at different distances, in different periods of time, and with different velocities; that the Moon revolving round the Earth accompanies it in its annual course round the Sun; and that the apparent motion of the heavenly bodies from east to west is caused by the Earth's motion on its axis from west to east. (When we speak of the Earth's axis, we mean that the Earth revolves or turns round, as if it were upon an axis or spindle, the extremities of which imaginary line are called the North and South Poles of the Earth.) The truth of this system has been completely established by the discoveries of Galileo, Kepler, and Newton, who established the great laws which regulate planetary motion. Since the time of Copernicus, several additional planets have been discovered, as well as satellites or moons revolving round the four more distant. The system as at present known is represented by

DIAGRAM II.

Here we see the Sun in the centre, nearest him Mercury, then Venus, the Earth and Moon, Mars, then several small newly-discovered planets or Asteroids, Jupiter with his 4 moons, Saturn with his ring and 8 moons, Uranus with 6 moons, and Neptune with his ring and 2 moons. Besides these, two Comets are represented in the diagram.

All these bodies move round the Sun in regular orbits, those nearest him revolving most quickly, and those at a distance moving at a much slower rate. Thus Mercury performs his circuit in 88 days, whilst Neptune occupies 164 years. The daily rotation of the Earth upon its axis causes all the heavenly bodies to *appear* to move round us in twenty-four hours. The annual revolution of the Earth around the Sun causes the apparent place of the Sun and Planets among the fixed stars to change from day to day (see p. 20); but, in addition, the places of the planets as seen in the heavens among the fixed stars are changed by their own revolution round the Sun.

The movements of the planets round the Sun are not, however, perfectly uniform. The orbits in which they revolve are not circular, but oval or elliptical, so that they are nearer to the sun in some parts of their course than they are in others; and when they are nearest the Sun, they revolve more rapidly than when they are more distant from him. The orbits of Comets are very long ellipses (Diag. XIII.) so that the distance of these bodies from the Sun, and their rate of motion in different parts of their orbits, vary extremely; but the orbits of the Planets generally approach the circular form much more closely (some of them departing from it very little), and there is, consequently, much less inequality in their rate of motion in different parts of their orbits. It is to Kepler that we owe the discovery of the elliptical orbits of the planets; and also of the very simple law which governs their rate of movement. This law is explained by

DIAGRAM III.

which represents an ellipse, of which the points F and S are the *foci;* the line P to P 6 drawn through these foci to the two extremes of the ellipse is called its *long diameter;* whilst a line A B passing through its *centre* C at right angles, is called its ***short diameter***. The more nearly the foci of an ellipse approach each other, the less will be the difference between the long and the short diameters, and the more closely will the ellipse approach the circular form. On the other hand, the more distant the foci are from each other, the greater will be the difference between the long and the short diameters, and the more long and narrow will be the ellipse. The more widely the orbit departs from the circular form, the greater is said to be its ***eccentricity***. The position of the Sun is not in the centre C, but in one of the foci S. When the planet or comet is in the part of the orbit nearest to it, as at P, it is said to be in *perihelion;* but when it is in the most distant part of its orbit, P 6, it is said to be in *aphelion*. Now, a planet revolving in such an ellipse will pass through the distance from P to P 1 in the same time that it occupies to pass from P 5 to P 6; its rate of movement being much greater when near its perihelion, than when near its aphelion. The law which governs this variation, applying equally to the planets whose orbits are nearly circular, and to comets whose orbits are most eccentric, is very simply expressed in mathematical language, being as follows: *The radius vector moves over equal areas in equal times.* The radius vector is a line drawn from one of the foci of an ellipse to any point in the curve; thus, each of the lines S P, S P 1, S P 2, S P 3, S P 4, S P 5, and S P 6, is a radius vector. Now, if we conceive the line S P to be travelling towards S P 1, it will move over the area or space included between these two lines and the curve that joins them; and whatever be the time which is occupied in this movement, exactly the same time will be required for the radius vector to pass over the same area in any other part of the orbit. Thus the space included between S P 1 and S P 2, and bounded on the outside by the curve, being equal to that between S P and S P 1, the part of the orbit between P 1 and P 2 will be traversed in the same time as that between P and P 1. In like manner, the portions between P 2 and P 3, between P 3 and P 4, between P 4 and P 5, and between P 5 and P 6, will all be traversed in equal times; the areas, or spaces included between the lines drawn from the focus to these points respectively, and bounded on the outside by the curve, being all equal. Thus, for example, the area included between the lines S P 5 and S P 6, and bounded by the curve P 5, P 6, being equal to the area between S P and S P 1, and bounded by the curve P, P 1, the time occupied by the planet in passing through the distance P 5, P 6, will be as great as that required for its passage through the much longer distance P, P 1. If a *circle* were similarly divided into equal areas, as the *radius vector* is everywhere of the same length, these areas would be enclosed by equal portions of the curve; and the motion of the planet would consequently be uniform. On the other hand, in the very eccentric orbits of some comets, the aphelion distance, S P 6, is many hundred times the perihelion distance, S P; and the rate of movement in the part of the orbit most distant from the Sun is proportionally slower.

There is another cause which disturbs the movements of the planets, and which prevents them from being exactly conformable to the law just explained. Being attracted not merely by the Sun, but by each other, they are liable to be drawn out of their paths by each others' influence; and Jupiter, being the largest of all the planets, thus produces a considerable disturbance in the motions of those that are nearest to him. These *perturbations*, as they are called, are shown much more conspicuously by comets, which, in consequence of the very small quantity of solid matter they contain, are liable to be completely drawn out of their course by the attraction of any planet near which they may happen to pass.

The planets do not all move round the Sun on the same plane or level. We are accustomed to compare the position of their orbits with that of the Earth, which is called the Plane of the Ecliptic; and they are all more or less inclined to it. This is shown in

DIAGRAM IV,

which represents the orbit of the Earth, AC, and that of another planet (shown by the blue line) crossing it at the points B and D; these points are called *Nodes*. The inclination of the orbit of Pallas is greater than that of any of the other planets, being $34\frac{1}{2}°$; whilst that of the orbit of Uranus is the least, being less than one degree. It results from this inclination of the planets' orbits to each other, that no planet can pass between the Sun and any other planet whose orbit is much inclined to its own, unless they happen to be near one of the Nodes, or crossing points of their orbits; in which case they will be, so to speak, upon the same level. Thus we very seldom see either Mercury or Venus pass across the Sun's disk; because the inclination of their orbits to that of the Earth generally causes them to pass either above or below the Sun. In order that a *transit*, as it is termed, of Mercury or Venus should take place, it is necessary that the planets should be very near one of the points B or D of its orbit, and that the Earth should be in the same line, which very rarely happens.

What has been stated of the elliptical form of the orbits of the planets, of their inclination to each other, and of the inequalities in their rate of motion, is equally true of those of the moons or satellites by which several of the planets are attended.

The Sun is the centre of light, heat, and attraction to the whole system, and round him the planets and comets revolve. His diameter is 882,000 miles, and his bulk is more than 1,300,000 times greater than that of the Earth. When viewed with a telescope, various dark spots are seen on his surface, by the motion of which it is ascertained that he rotates on his axis in $25\frac{1}{3}$ days. The appearance which one of these spots successively presents is shown in

DIAGRAM V.

The spots are by no means constant; their size and form undergoing great changes from day to day. The diameter of some which have been observed has been as great as 45,000 miles. There can be little doubt that the solid body of the Sun itself is dark, its brightness arising from the luminous atmosphere with which it is surrounded; and that the spots are openings occasionally formed in this atmosphere, through which the dark mass below is seen.

Mercury, the first planet in the system, is 3140 miles in diameter, and 37 millions of miles distant from the Sun. His revolution round the Sun is performed in about 88 days, and his velocity is about 109,000 miles per hour. He can never be seen except at a small distance from the Sun (never more than 28°); and as in the day time he is overpowered by its light, he is only visible a short time before sunrise and after sunset. His appearance is that of a small star, emitting a bright white light. It is calculated that he receives from the Sun about 7 times as much light and heat as we do.

Venus is the most beautiful of all the planets. She is a bright star of a greyish colour; but never appears more than 48° distant from the Sun, so that she is never seen more than $3\frac{1}{2}$ hours before or after him. When she is west of the Sun she rises before him, and is a morning star; and when east of him, an evening star, as she is then seen after he sets. When viewed with a telescope, she presents, in common with Mercury, the same appearances as the Moon; being crescent-shaped, gibbous, or round, according to her situation. These appearances are shown in

DIAGRAM VI.

Venus is distant from the Sun about 68 million miles; her time of revolution around him is about 225 days, and she moves at the rate of 80,000 miles an hour. Her diameter is 7800 miles, rather less than that of the Earth; and she is believed to revolve on her axis in about $23\frac{1}{2}$ hours.

When either Venus or Mercury passes between the Earth and the Sun, the enlightened side is turned from us, and the planet is seen as a black spot passing across the Sun's disk. This, however, happens very seldom, owing to the inclination of their orbits to the Ecliptic, as already explained.

The Earth is the next planet in the system. Its mean distance from the Sun is 95 million miles, and it moves at the rate of 68,000 miles an hour. It revolves on its axis in 24 hours; so that each point on its surface is alternately presented to the Sun's influence, and turned from it. By this movement day and night are produced.

Mars has a fiery red appearance, as shown in

DIAGRAM VII.

This is supposed to be owing to the density of his atmosphere. His distance from the Sun is 142 million miles, and he revolves about it in 687 days. His diameter is 4100 miles, and he revolves on his axis in $24\frac{1}{2}$ hours. The white appearance at his poles is supposed to be caused by perpetual snow.

Beyond the orbit of Mars are nine small planets, four of which were discovered at the commencement of the present century, and the other five within the years 1846-8. The first four are called Vesta, Juno, Ceres, and Pallas; the five others, Flora, Iris, Hebe, Metis, and Astræa. The distance of Vesta from the Sun is 224 million miles, and she revolves round him in $3\frac{2}{3}$ years. The orbit of Juno is very eccentric; that is, she is much nearer the Sun at some times than at others; her greatest distance from him being 320 million miles, her least 190 millions. Her revolution is performed in less than $4\frac{1}{2}$ years. Ceres and Pallas are about 263 millions of miles distant from the Sun, and they revolve about him in a little more than $4\frac{1}{2}$ years. These two planets are very near together. The diameters of these planets have been very differently stated by various astronomers; they are at any rate exceedingly small, it being only possible to see them with a telescope. Their similarity in size, in distance from the Sun, and in period of revolution, have caused many to believe that they all originally formed one planet, broken into several pieces by some vast eruptive force. They are not unfrequently termed *Asteroids.*

DIAGRAM VIII.

The next of the planets is Jupiter, the largest in the system, and the brightest of all the planets except Venus. His diameter is 87,000 miles, and his bulk is about 1,300 times that of the Earth. He is distant from the Sun 490 million miles, and takes nearly 12 years to perform his revolution. He revolves on his axis in less then 10 hours; and owing to this very rapid motion, he is much flattened at the poles, from the tendency which it gives him to bulge out at the equator. When viewed with a telescope, his surface is seen to be crossed by several irregular cloudy belts which are parallel to each other. Sometimes eight or nine of these are seen; sometimes not more than one. He is attended by 4 moons, which revolve around him nearly in the plane of his equator with great velocity, the nearest being only $42\frac{1}{2}$ hours, and the farthest $16\frac{1}{2}$ days, in performing its revolution. The eclipses of the moons behind Jupiter himself, which very frequently occur, afford valuable data for astronomical calculations.

DIAGRAM IX.

Saturn is distant 900 millions of miles from the Sun, and revolves around him in $29\frac{1}{2}$ years. His diameter is 79,160 miles, and he revolves on his axis in about $10\frac{1}{2}$ hours. He presents the same phenomena as Jupiter with respect to his shape, and the belts which cross his surface. He is accompanied by 8 moons, which revolve around him in periods varying from 22 hours to 79 days. The most remarkable feature in the appearance of Saturn is his being surrounded by what appears to be one broad ring; by which, by a very good telescope, may be perceived to be double. The edge of the inner ring is about 19,000 milesfrom Saturn, and the whole breadth of the two is about 30,000 miles. The space between them is about 1,790 miles. These rings revolve on the axis of the planet, but are about 13 minutes longer in performing the circuit. They present very different appearances by their change of position with respect to the Earth; at one time appearing as a broad oval, and at another merely as a white line.

The next planet in the system was called the HERSCHEL, after its discoverer; but it is now more generally termed URANUS. It was first perceived to be a planet in the year 1781. His distance from the Sun is 1,800 millions of miles, and he takes $83\frac{1}{2}$ years to perform his revolution round it. His diameter is about 34,500 miles. He is attended by 6 moons, whose periods vary from 4 days to 107. There are two very remarkable circumstances to be observed respecting them; 1st, that they revolve in a plane nearly at right angles to that of his orbit; and 2nd, that they revolve in a retrograde direction from east to west, whilst the moons of the other planets, and the planets themselves, revolve from west to east.

The last planet at present known, is termed NEPTUNE. The history of its discovery is very remarkable. Certain irregularities had been observed in the movements of Uranus, which could not be accounted for, except on the supposition that it was drawn out of its path by the attraction of another planet beyond. From calculations founded upon these irregularities or *perturbations*, Mr. Adams, in this country, and M. Le Verrier, in Paris, came to the conclusion in the year 1846, that such a planet *must* exist; they further specified the part of the heavens in which it would be found, and stated its probable distance from the sun, its bulk, and time of revolution. Their prediction was realised by the discovery of the planet Neptune, on the 23rd of December, 1846, by Dr. Galle, of Berlin. The distance of Neptune from the Sun is 2,850 millions of miles, and he takes 164 years to perform his revolution round it. His diameter is about 41,500 miles. Like Saturn, he is surrounded by a ring, whose diameter is 64,500 miles;

and he is also attended by satellites, two having been already discovered, and more not improbably existing.

An idea of the relative *diameters* of the Sun and Planets may be formed from

DIAGRAM X,

in which the whole coloured circle represents the Sun, the Planets being arranged on it in their proper order, and of their proportionate sizes.

A more exact idea of their relative *distances* from the Sun, than could be conveyed in Diagram 2, is afforded by

DIAGRAM XI.

If the distance of the Earth from the Sun be taken as 10, then that of Mercury will be 4, Venus 7, Mars 16, Jupiter 52, Saturn 100, Uranus 196, and Neptune 300.*

A good idea may be formed of the relative magnitudes and distances of the parts of our system, by the following illustration :—Choose a level field, and on it place a globe two feet in diameter ; this will represent the Sun. Mercury will be represented by a grain of mustard seed, on the circumference of a circle 164 feet in diameter, for its orbit. Venus by a pea, on a circle 284 feet in diameter. The Earth also by a pea, on a circle of 430 feet. Mars by a rather large pin's head, on a circle of 654 feet. The nine Asteriods, by grains of sand, in orbits of from 1000 to 1200 feet. Jupiter by a moderate sized orange, in a circle nearly half a mile across. Saturn by a small orange, on a circle 4-5ths of a mile. Uranus by a full-sized cherry, upon the circumference of a circle more than a mile and a half in diameter. And Neptune by a large plum, on a circle

* It has not been thought desirable to introduce the orbit of Neptune into the diagram, in its proper proportion; as all the other orbits must have been reduced to little more than half their present size, which would have rendered some of them undistinguishable.

of more than two miles and a half in diameter. To imitate the motions of the planets, in these orbits, Mercury must pass through a space equal to his own diameter in 41″; Venus in 4′ 14″; the Earth in 7′; Mars in 4′ 48″; Jupiter in 2h. 56′; Saturn in 3h. 13′; Uranus in 2h. 16′; and Neptune in 3h. 30′

The proportional size of the Sun's disk, as seen from the different planets, will vary with their respective distances. A comparative view of this kind is given in

DIAGRAM XII,

in which the largest disk represents the size of the Sun as seen from Mercury; the next, his dimensions as seen from Venus; the next, as seen from the Earth; and so on, the apparent size and brightness of the Sun as seen from Neptune being probably not much greater than that of some of the brightest of the fixed stars as seen by us.

Besides the planetary bodies, there are a number of bodies moving round the Sun in very eccentric orbits, called Comets. Few objects have excited more speculations among the learned, and more wonder and dread amongst the ignorant. Several hundred comets are on record as having appeared at different times; and the size, appearance, and distances of all of them vary considerably. Their usual aspect is that of a brilliant but ill-defined mass of light, which is usually much brighter towards the centre; this appears like a star or planet, and is called the head. From the head diverge two or more streams of light, which sometimes unite again at a little distance from it, and sometimes continue distinct; this is termed the tail. Comets are bodies of very little density, as is evident from the fact that the Comet of 1770 became entangled among the satellites of Jupiter, and was completely thrown out of its orbit by the attraction of that Planet, although the motions of its satellites suffered not the least perceptible derangement. The motions of Comets are regulated by the same laws as those of Planets; but there is no limit to the inclination of their planes to the ecliptic; nor is there any uniformity in the direction of their revolution. The orbit of one of these bodies, which is remarkable as lying entirely within the solar system, and as being traversed in the short period of about $6\frac{3}{4}$ years, is shown in

DIAGRAM XIII.

This comet, which is known as Biela's, from the name of its discoverer, is small and insignificant; but has excited much interest from various circumstances. It was one of the first whose return was accurately predicted; and it has on various occasions passed very near to the Earth. The *aphelion* point of its orbit, marked A, is seen to be a little beyond the orbit of Jupiter; while its *perihelion* point, marked P, is within that of the Earth. It crosses that of the Earth very near one of the Nodes; and consequently if the times of these two bodies should ever exactly coincide, they would come into collision at that point. Little, however, is to be feared from such a contingency, as far as the Earth is concerned, owing to the extremely small quantity of solid matter which this Comet contains. It is computed that in 1805 it must have passed within 5 millions of miles of the Earth. Its appearance is by no means comet-like, as it possesses scarcely any tail, and is more like a faint nebulous star. At its last return in 1846, a most remarkable change took place in its structure; being actually seen to separate itself into two distinct comets, which yet continued to journey onwards together in their orbits, until their increasing distance from the Earth rendered them no longer distinguishable.

The orbits of Comets, however, are usually much more eccentric than this one; frequently approaching nearer to the Sun, whilst their aphelion distance must be far beyond the bounds of the solar system. Thus the great Comet of 1843 approached within 64,000 miles of the luminous surface of the Sun; but, in common with the greater number of Comets, the form of the part of its orbit traversed in the short time during which it could be observed, was rather that of a *parabola* than an ellipse; and consequently no estimate can be formed of its aphelion distance.

A small number of comets have been found to have elliptical orbits, and their period of return can be consequently predicted; but in general, the orbits seem to be parabolic, so that whether they are really ellipses of very great eccentricity (in which case the return of the comet may be expected), or are really parabolas carrying off the comet towards some other system, remains uncertain.

Many comets are bodies of extraordinary size and brilliance, especially when they are passing their perihelion. The appearance of six of the most remarkable, *viz.*, 1680, 1682, 1744, 1811, 1835 and 1844, is shown in

DIAGRAM XIV.

COMETS generally consist of a large and bright but ill-defined mass of light, called the head, which is usually much brighter towards the centre, and offers the appearance of a vivid nucleus, like a star or planet. From the head, and in a direction opposite to that in which the Sun is situated, two streams of light appear to diverge from the comet. These grow broader and more diffused at a distance from the head, and commonly close in and unite at a little distance behind it; but sometimes continue distinct for a great part of their course, in either case constituting the tail. Sometimes the tail is subdivided into several streams of luminous matter. The tail is generally somewhat curved, bending towards the region which the comet has left. It is by no means an invariable appendage to comets; many of the smaller ones appearing only as round or somewhat oval vaporous masses, increasing in density towards the centre.

The planets when seen from the Earth, do not appear to revolve continuously around it. They are seen to move forwards for some time, then to become nearly stationary, and then to move backwards; they are then again nearly stationary, and again begin to move forwards. This phenomenon is called the *direct and retrograde motion* of the planets, and is explained by

DIAGRAM XV.

Suppose A to be the Earth remaining stationary, and *b* to be one of the inferior planets, Mercury or Venus; it will be seen among the fixed stars at B. As it moves on to *c*, it will gradually change its place in the heavens to C, and when it arrives at *d* it will be seen at D, where it will appear to remain stationary for a short time. As the planet moves towards *e*, it will appear to return to C, and will be seen in the same situation as when at *c*. As it moves along *e*, *f*, *g*, *h*, it will appear to take the direction C, B, G, H. When at *h* it will again appear stationary; and as it moves along towards *i* and *b*, it will again appear to move in the direction H, G, B. The motion of the Earth will occasion a slight difference in these appearances, but the diagram sufficiently explains the cause of them. This diagram also shows why Mercury and Venus are never seen at a great distance from the Sun. For the Sun's place among the fixed stars will be at B, and the planet will never appear to move farther on either side than H, or D, which two periods are called the times of its greatest elongation. The two situations *b* and *f*, are termed the *conjunction* and the *opposition*.

The apparent diurnal revolution of the Sun, Moon, and Stars around the Earth, is caused by the Earth's rotation on its axis; and the change of place of the Sun among the stars, is caused by the Earth's revolution around him.

The path in which the Earth moves, as seen from the Sun, and in which the Sun appears to us to move, is called the Ecliptic. The stars which are seen at a little distance on each side of this path are divided into twelve Constellations; and among these the Sun appears to move, changing his place from west to east nearly one degree daily; that is, supposing we could see the stars by day, the star which the Sun covers one day would be nearly a degree to the westward of him the next; so that those stars which are at present on the meridian at noon, six months hence will be on the meridian at midnight. Hence arises the difference between the *solar* and the *sidereal* day. The sidereal day is the time which elapses between two passages of a star across the meridian, and is in fact a complete revolution of the Earth; this takes place in 23 hours, 56 minutes. Whilst the Earth has made one revolution, the Sun has changed his place in the ecliptic nearly a degree; and the Earth therefore must turn a degree more on its axis for the Sun to arrive a second time at a meridian of any place. This occupies 4 min. longer; and the period of 24 hours is called a *solar* day. After the lapse of 365 days, or one year, the Sun returns to the same place among the stars, as that in which he was a year previously.

DIAGRAM XVI.

Represents the figures given to the different Constellations, which are called the signs of the Zodiac. Their names are Aries (the Ram), Taurus (the Bull), Gemini (the Twins), Cancer (the Crab), Leo (the Lion), Virgo (the Virgin), Libra (the Scales), Scorpio (the Scorpion), Sagittarius (the Archer), Capricornus (the Goat), Aquarius (the Water-bearer), Pisces (the Fishes): the Earth is shewn in its path, with its moon.

We now come to what is to us the most important part of the science, the astronomy of our own planet and its satellite.—That the Earth is a globular body, there are many ways of proving. Though the different irregularities in the Earth's surface appear great to us, they are very small when compared with the size of the globe; not being greater in proportion to the Earth's diameter, than grains of sand on a globe of a foot diameter. The Earth, however, independently of this irregularity of surface, is not a perfect sphere; the equatorial diameter being greater than the polar by 34 miles. This is caused by the tendency of the matter composing the globe to fly out at the point most distant from its axis, owing to the velocity of its diurnal revolution.

If the Earth's axis (or line joining the poles) were perpendicular to the ecliptic (or plane of its orbit), the Sun would shine directly upon the equator in all parts of the Earth's revolution round it; and there would consequently be no change of seasons, or of the length of the days and nights throughout the year. But this is not the case, for the axis of the Earth is inclined $23\frac{1}{2}°$ from the perpendicular, and is always in the same direction; so that, the poles being alternately directed towards the Sun, he shines in succession opposite all the parts between the tropics of Cancer and Capricon.

DIAGRAM XVII.

Represents the Earth in four different positions. On the 21st of June, the north pole inclines towards the Sun, and it is summer in the northern hemisphere; the Sun then shines vertically upon the tropic of Cancer: whilst on the 21st of December, it is winter in the northern hemisphere, and summer in the southern, the south pole being then turned towards the Sun, and the Sun shining vertically upon the tropic of Capricorn. On March 21st and September 21st, both poles are equally turned towards the Sun, which then shines vertically on the equator, so that each hemisphere receives an equal portion of light and heat, and the days and nights are equal all over the globe. The latter periods are called the vernal and autumnal equinoxes; June 21st, is called the summer solstice, and Dec. 21st the winter solstice. Now, it will be seen that from March 21st to Sept. 21st, the greatest part of the upper hemisphere is enlightened by the Sun, so that the days will be long and the nights short; and the more so as we approach the pole, where the Sun constantly shines for six months. From Sept. 21st, to March 21st, on the contrary, the greater part of the northern hemisphere is unenlightened; and the nights will be long, and the days short, and at the pole the Sun will not be seen for six months. The difference in the length of the days and nights diminishes as we approach the equator, where they are constantly equal, as that circle is always equally divided into the enlightened and unenlightened parts. In consequence of the Sun not shining so directly upon us in winter as in summer, a smaller part of his rays will reach us, and the temperature will be colder; although, owing to the form of the Earth's orbit, the Earth is nearer to the Sun in winter than in summer, by nearly three millions of miles.

DIAGRAM XVIII.

Represents the telescopic appearance of the MOON, which is distant from the Earth 240,000 miles, and revolves around it in 27 days, 8 hours, nearly. Her diameter is 2180 miles. A portion of the Moon's surface more highly magnified (the southern cusp or point when the Moon is in her first quarter), is shown in

DIAGRAM XIX.

The physical constitution of the Moon is better known to us than that of any other heavenly body. By the aid of telescopes we discern inequalities in its surface, which can be no other than mountains and valleys. The convex outline of the limb turned towards the Sun is always circular, and very nearly smooth; but the opposite border of the enlightened part is always observed to be extremely ragged, and indented with deep recesses and prominent points. The mountains near this edge cast long black shadows, as they should evidently do when we consider that the Sun is in the act of rising or setting to the parts of the Moon so circumstanced. But as the enlightened edge advances beyond them, their shadows shorten; and at the full moon, no shadows are seen on any part of her surface. The existence of such mountains is corroborated by their appearing as small points or islands of light beyond the extreme edge of the enlightened part, which are their tops, catching the sunbeams, before the intermediate plain, and which, as the light advances, connect themselves with it, and appear as prominences from the general edge. The lunar mountains generally exhibit a volcanic character; the highest has an altitude of about $1\frac{3}{4}$ mile.

The Moon completes her revolution round the Earth, that is, she returns to the same place among the stars, in 27 days, 8 hours: but the period which elapses between one new Moon, or conjunction, and another, is 29 days 13 hours; because whilst the Moon is making a revolution round the Earth, the Earth itself will have moved on in its course round the Sun; so that for the Moon again to arrive at the conjunction, will require two days more. During her revolution she presents to us a constant change in her appearance, which is familliar to all.

DIAGRAM XX.

Explains the cause of the different *phases* of the Moon, as they are called. The planets and their moons do not shine by their own light, but by a light reflected from the Sun; therefore, when the Moon is between the Earth and the Sun, or at her conjunction, her illuminated side is wholly turned away from the Earth, and she is not visible; in about two days she begins to appear, a small part of her enlightened face being seen from the Earth. This is what is termed the new moon. As she proceeds in her revolution, more and more of her is seen; and when she has passed through a quarter of her orbit, half of her illuminated side is visible from the Earth. When she arrives on the other side of the Earth, or at the opposition, it is plain that the whole of her enlightened side is seen; she is then said to be full. She then again begins to diminish until she arrives at the conjunction, when she is totally obscured. The Moon always keeps the same side turned towards the Earth; and in consequence, all parts of her globe are successively opposite the Sun, during one revolution round the Earth.

DIAGRAM XXI.

is an imaginary view of the Earth as seen from the surface of the Moon. It is nearly certain from observations upon the Moon's disk, that she has neither atmosphere nor water on her surface; but that it has been broken up by violent volcanic action. An attempt is here made to represent the probable character of that surface, as seen by an observer situated upon it. The Moon not only receives direct light from the Sun, but reflected light from the Earth, which will serve as a magnificent *moon to the Moon;* its apparent size to an observer on the Moon being thirteen times as great as that of the Moon is to us. It will present the same succession of phases as the Moon does to us; but will be *full* at our *new* Moon, and *vice versâ.*

As the planets and their moons derive their light entirely from the Sun, they throw a dark shadow behind them, where they intercept the Sun's light. From the immense proportional magnitude of the Sun, however, this shadow is of a conical form, and converges so soon to a point, that in no case does the dark shadow of one planet reach the orbit of the next. That of the Moon, however, sometimes falls upon the Earth, and that of the Earth upon the Moon, as shown in

DIAGRAM XXII.

When the Moon passes between the Sun and the Earth, the Sun is eclipsed to the inhabitants of those parts of the Earth on which the point of the conical shadow falls. Besides the dark shadow called the *umbra*, there is a lighter one called the *penumbra*, which diverges, becoming lighter the farther it spreads from the umbra. In those parts where it falls, the Sun is partially eclipsed; more or less of it being hidden, in proportion as the observer is nearer to or farther from the umbra, where it is totally obscured.

The shadow caused by the Earth is much larger, and is about 840,000 miles in length. When the Moon enters this shadow, she suffers a deprivation of light; more or less of her disk being eclipsed according to the degree in which she enters the shadow.

An eclipse of the Sun can only happen at new moon, when she is said to be in *conjunction*, the Moon being then between the Sun and the Earth; and an eclipse of the Moon at full moon or when in *opposition*, as the Earth is then between the Sun and Moon.

DIAGRAM XXIII.

Explains the cause why an eclipse of the Sun does not happen every new moon, and an eclipse of the Moon at every full. The small blue circles represent the orbit of the Moon on the plane of the ecliptic; in which case there is evidently nothing to prevent an eclipse always happening at those times. But the Moon's orbit being inclined to that of the Earth, as represented by the light circles, she generally passes either above or below the Sun, and no eclipse takes place; and it is only when the situation of one of the nodes nearly corresponds with the Moon's conjunction, that an eclipse of the Sun can take place; or, when it corresponds with the opposition or full moon, that an eclipse of the Moon can take place.

The nodes of the Moon's orbit do not remain stationary, but revolve in a retrograde direction once in 18 years and 10 days; and as that period corresponds very nearly with 223 revolutions of the Moon, she returns to the same part of the ecliptic at the end of each period, and a recurrence of all eclipses within that interval must take place with little variation. This period is sometimes called the *Moon's cycle.*

The degree in which the Sun or Moon is eclipsed depends upon the Moon's proximity to one of her nodes at the time of conjunction or opposition. If the Moon be *upon* the node at her change, or, in other words, if the centres of the Sun, Moon, and Earth be in the same line, and at the same time the Moon be in that part of her orbit nearest to the Earth, or in *perigee*, the eclipse will be total in that part of the Earth where the *umbra* falls, and partial in those parts covered by the *penumbra*. But if the Moon be in that part of her orbit most distant from the Earth, or in *apogee*, the umbra will not reach the Earth, and the eclipse will be *annular*, that is, the Moon will not totally obscure the Sun, but a ring of light will be left around her. Total and annular eclipses of the Sun are of very rare occurrence. It more often happens that the Moon at the time of conjunction is a few degrees on either side of her node, so that she is above or below the plane of the Earth's orbit. In this case, the *umbra* will fall above or below the Earth, and the eclipse will be partial.—The same cause influences eclipses of the Moon; but owing to the large size of the Earth's shadow, total eclipses of the Moon are more frequent than those of the Sun. The number of eclipses in any year cannot be more than seven, or fewer than two; the most usual number is four, two of each luminary. It must be remembered, however, that as an eclipse of the Moon is seen from any part of the Earth, whilst an eclipse of the Sun is only visible where the shadow falls, the former are much more frequently seen by a spectator at any one place than the latter.

Besides occasioning the striking phenomena of eclipses, the Moon is the chief agent in producing a more ordinary but not less wonderful effect, which we observe in the alternate flux and reflux of the ocean.

The Moon, having an attraction for the Earth similar to that which the Earth has for the Moon, though much less on account of the difference in size, has a constant tendency to draw up the more moveable parts of it to the point nearest itself; so that the depth of water in any part of the Earth, when the Moon is exactly opposite to it, or on its meridian, is much greater than it is at other times. As the Earth turns on its axis once in 24 hours, each part of it would be opposite the Moon once during that time, and there would consequently be a rise of the water in each part of the Earth once in 24 hours; but as the Moon during that time has travelled forwards about 1-30th part of her orbit, it will not be on the meridian of any place, till about $24\frac{3}{4}$ hours from the time it was there before; and therefore that would be the interval which would elapse between one tide and another. But we find that only half that interval elapses, and that there is a tide on the side of the Earth directly opposite to that, on the meridian of which the Moon is. This may be explained in the following manner. It is the law of attraction, that the attraction diminishes as the square of the distance of the attracting body increases. The part of the Earth nearest the Moon will therefore be attracted more strongly than the centre of the Earth; and the centre more strongly than the opposite extremity. The water, therefore, in that part, will have less attraction towards the centre of the Earth; and being as it were left behind, will rise in that part to a height nearly equal to that of the water which is under the Moon; whilst the water being drawn away from the parts of the Earth midway between these two points, ebb tide will be produced there.

The attraction of the Sun also has an influence upon the water; but not in so great a degree as that of the

Moon. It is calculated that the Moon can raise the waters of the ocean 6 feet above their mean level, and the Sun 2 feet.

At new Moon, the Sun and Moon will be both acting in the same direction; and the water will rise 8 feet instead of 6, being what is termed a *spring* tide. The same thing happens at full Moon, because each of these bodies acts on the same parts of the Earth at once; and they thus raise the tide nearly to the height it would be at new moon. But when the Moon is at the quarter, the Sun acts on those parts where, by the Moon's influence, there would be low water. Their attractions are therefore opposed to each other; and the water neither rises so high nor falls so low, as at other times. This is called *neap* tide.* The rise and fall of tide in various places is very much modified, both in time and quantity, by various local circumstances; it is therefore impossible to ascertain by mere calculation the state of the tide at any place, except in the open sea.

Having now considered the principal phenomena of the Solar System, we shall explain some of their causes. It has been already stated that the planets move round the Sun, and the satellites round the planets, in eliptical orbits; and it will now be shown how these motions are produced by the joint action of two forces, —the tendency to continuous motion in a straight line, —and attraction towards a central body.

DIAGRAM XXIV.

In this figure, E represents the Earth, which we may conceive to have been projected through space in the direction E A. Now, if no other force operated upon it, this body would continue to move onwards in the same straight line towards 1 and 2. On the other hand, suppose the Earth to be situated at A, and to

* These different effects are well shown by the moveable slide, No. 3, in the other set.

have no motion of its own, it would be drawn in a straight line towards the Sun, along the line A K. Now, by the combined action of these two tendencies, according to the laws of *composition of forces*, the Earth or other body will be impelled in a curved path. This curve *may be* a circle, of which A B is a part; but in order that it should be so, there must be an exact and constant balance between the two forces. If this proportion does not exist, or any cause alter it after it has once existed, a different curve will be the result. For suppose the attraction towards the centre to be such as would cause the body at A to fall towards the Sun as far as A 1′, in the same time that it would have been carried by the projectile force to A 1, then it will be bent out of its straight course into the elliptical curve A *b*, the curvature being here *greater* than that of the circular orbit A B. In like manner, if the Sun's attraction would draw the Earth to 4′, whilst its projectile force would carry it to 2, it will be carried by the joint action of the two forces along the elliptical curve *b c*. Having arrived at *c*, it would proceed in the straight line *c h*, if uninfluenced by the force of gravitation which tends to draw it towards the Sun; just as a stone whirled round in a sling, flies off in a tangent from the joint of the circle at which it is let go. Under the influence of these two forces, it is carried onwards to *d*; and in like manner, by the joint influence of its tendency to proceed in the straight line *d i*, and of the attractive force of the Sun, it is carried onwards through *e* and *f*,—its rate of movement continually increasing, as distance from the Sun diminishes, so that it performs in equal times (as formerly explained) the distances A *b*, *b c*, *c d*, *d e*, *e f*, *f g*. The increased velocity thus acquired, however, now more than balances the increased attraction which is caused by the Earth's nearer approach to the Sun; and consequently the distance tends to increase again, and the rate of motion to diminish. For whilst the projectile force would carry it on to l, the attractive force of the Sun will only draw it out of the straight line by the amount $g\,j$, or $l\,m$; instead of the amount $g\,o$, or $l\,n$, which would be required to keep it at the same distance from the Sun; so that instead of moving in a circular path to n, its distance will increase again, and it will traverse the elliptical path m, a continuation of which, produced by the same joint action of the two forces, will carry it on to A, with a constantly diminishing rate of movement. By the time it reaches A, the projectile force is reduced so far as to be again overpowered by the attractive; so that the distance begins to diminish, and the motion to be accelerated as before.

DIAGRAM XXV.

This figure explains what is meant by the *parallax* of the heavenly bodies, on which is founded our estimate of their distances from us and from each other. This term is used to designate the difference in their *apparent places*, consequent upon the different positions of the observer. Every one must have noticed that, when walking or riding through a country, there is a continual change in the aspect of the scene, arising from the change in the direction under which we view it; the apparent position of the nearer objects being much more altered than that of the distant ones. The same is true of the heavenly bodies; the apparent places of the Sun, Moon, and Planets, among the fixed stars, being different according to the position of the observer on the Earth's surface. Thus to an obsever at A, the bodies B and D will seem to be in the same line, and their apparent place among the fixed stars will be at G. But to an observer situated at the centre of the Earth, or on the point A′ of its surface, the apparent place of the body B will be at E, and that of the body D at F; this angular movement, which is termed *parallax*, being greater for the nearer than for the more distant body. In like manner, the bodies H and P, which are seen from A in the same line, their place among the stars being at W, will be seen from the centre of the Earth, the former at S, and the latter at V. So, again, the bodies N and O, which appear to an observer at A to be both situated at T among the stars, will be seen by an observer at the centre of the Earth to be the former at Q, the latter at R. It will be perceived that the parallax or angular movement diminishes as we approach the Zenith; and the bodies M and K, which appear to an observer at A to be in the same line, and to be situated at J among the stars, will be seen by an observer at the Earth's centre to be in the same position. It is by the measurement of the parallax of the Moon, Planets, and Sun, as seen from different points of the Earth's surface, and by calculations founded on these, that our knowledge of their distances is obtained. The immense distance of the fixed stars, however, prevents any difference in their relative position from being perceptible to observers who survey them from different parts of the Earth's surface at the same time. Some slight difference is seen, however, in the relative places of a few of them, during the revolution of the Earth round the Sun; the extreme distance between the two points of observation being the diameter of the Earth's orbit, or about 190 millions of miles. This, which is called the *annual parallax*, affords our only means for even guessing at the distances of the nearest fixed stars.

DIAGRAM XXVI.

The purpose of this figure is to explain the fact that we do not see the Sun and other heavenly bodies precisely in their real places in the sky, in consequence to the refractive power of the atmosphere. According of the laws of Optics, a ray of light passing through a void space is in some degree bent from its course as soon as it enters the atmosphere; and it is bent more and more as it passes from the rarer through the denser layers of the atmosphere, in its approach towards the

Earth's surface. Thus the ray of light passing from the star *f* is turned from its course as soon as it leaves the void space represented by the blue tint; so that, instead of passing on towards the Earth in the continuous dotted line, it is refracted in such a manner as to fall upon its surface at the point *d*. Now by an observer at this point, it will be seen in the direction in which its rays last come to him; and this being in the line *d g*, the apparent place of the star will be at *g*, or above its real place. This is the case with all the heavenly bodies, except when in the zenith; at that point there is no change induced by refraction, since the rays fall perpendicularly upon the strata of the atmosphere; and any luminous body in that spot of the heavens is seen in its right place.—From the same cause it happens that we see the Sun and Moon before they really rise above the horizon, and after they set. For the horizon of an observer at *d* being represented by the line H O, when the Sun is at *a*, so as to be really *below* it, the rays passing off in the direction *a b* are prevented by the atmospheric refraction from going on to *c*, but are bent to *d*; and as they reach the eye of an observer in the line *d e*, the apparent place of the Sun will be at *e*, that is, *above* the horizon. The amount of refraction is greatest at the horizon, and gradually diminishes towards the zenith.

The atmosphere contributes in another way to prolong the duration of day-light; namely, by *reflecting* downwards some of those solar rays which penetrate its higher regions after they have ceased to fall directly upon the earth's surface. Thus in Diagram XXVI., the rays *h* and *i* are reflected downwards in the direction *j, j, j*, as they pass through different strata of the atmosphere, and thus indirectly illuminate a part of the earth to which the sun has set. It is in this manner that *twilight* is produced; the length of which is of course greater in temperate and arctic regions, where the sun sinks obliquely and gradually below the horizon, than in the tropical zone, where the sun sinks almost perpendicularly downwards, and the twilight is very short.

The most numerous bodies which we see in the heavens are called Fixed Stars. They are at an immense and almost inconceivable distance from us; and very little is known with certainty respecting them. They are generally supposed to be Suns like our own, each the centre of another system. Their number is almost incalculable. Those which can be seen on a clear night with the naked eye amount to about 3500. With a powerful telescope, this number is increased to an inconceivable extent. These stars are distributed into Constellations, which are named from some fancied resemblance to various objects. Of these, two of the most brilliant are Orion (in whose belt is found a remarkable and beautiful nebula),

DIAGRAM XXVII.

and Ursa Major, or Great Bear,

DIAGRAM XXVIII.

Recent observations have discovered many curious facts relating to the fixed stars which are worth notice. Many of the stars, when examined with powerful telescopes, are found to consist of two, and in some cases three, placed very near together. More than 3000 of these double stars have been discovered, some of which are very conspicuous. Many of these are found to revolve round each other; and their periods have been ascertained with considerable accuracy. These are called *binary* stars. The two stars forming η *Coronæ* revolve round each other in $43\frac{1}{3}$ years; whilst those in γ *Virginis* (one of the principal binary stars) have a period of 629 years. It is not impossible that these stars may be suns revolving around each other, each having its own train of planets, satellites, and comets.

Many of the double stars exhibit a curious and beautiful contrast of colours. In such instances, the larger star is usually of a ruddy or orange hue, while the smaller one appears blue or green. "It may be more easily suggested in words than conceived in imagination, what variety of illumination *two suns*—a red and a green, or a yellow and a blue one—must afford a planet circulating about either; and what charming constrasts and grateful vicissitudes,—a red and a green day, for instance, alternating with a white one, and with darkness, —might arise from the presence of one or another, or both, above the horizon."—*Sir J. F. W. Herschel.*

With a good telescope, several small cloudy appearances may be discoverd in different parts of the heavens, having a faint, dusky light. These are clusters of stars too distant to be distinguished. Some of these Nebulæ, as they are termed, are shown in

DIAGRAM XXIX.

The appearance termed the Milky Way, is occasioned by an immense number of stars situated at too great a distance from us to be seen distinctly without the aid of very powerful telescopes. Dr. Herschel counted 7200 stars in the field of view of his telescope, which comprehended about 1-500,000th of the whole celestial hemisphere. The Milky Way is a nebula, which appears to us large and more distinct, on account of our proximity to it; and with the whole of our starry firmament it will form a cluster, the form of which may be in some degree judged of by the arrangement which they exhibit to us. An imaginary view of this cluster, as it would be seen from the remoter nebulæ, is shown in

DIAGRAM XXX.

of which the round figure shows a side view, and the other figure an end view. It is remarkable that among the most distant nebulæ visible to us, there is actually one which seems like a copy of our own; presenting very much the aspect of the round figure, with the same division on one side into two layers, which we see when we trace the Milky Way through the firmament.

In conclusion, it may be observed that it seems impossible for any person to enter so far into the study of Astronomy, as to arrive at a knowledge of the various disturbing causes which affect different parts of our system, and the wonderful powers of compensation which everywhere counteract them, without arriving at the conclusion "that all this is the work of intelligence and design, directing the original constitution of our system, and impressing such motions on the parts, as are calculated to give stability to the whole."

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LIST OF CONSTELLATIONS,

IN SIX SLIDERS.

Their situation with regard to the North Pole is denoted by an arrow.

No. I.

1. Aries.
2. Tanrus.
3. Gemini.
4. Cancer.

No. II.

5. Leo.
6. Virgo.
7. Libra.
8. Scorpio.

No. III.

9. Sagittarius.
10. Capricornus.
11. Aquarins.
12. Pisces.

No. IV.

13. Draco and Ursa Minor.
14. Cepheus and Cassiopeia.
15. Andromeda and Triangula.
16. Auriga.

No. V.

17. Perseus and Caput Medusæ.
18. Bootes and Canes Venatici.
19. Hercules and Cerberus.
20. Cygnus and Lyra.

No. VI.

21. Antinous and Aquila.
22. Ophiuchus and Serpens.
23. Canis Major and Minor.
24. Cetus.

N. B. C. and W., have also in Stock the Northern and Sonthern Hemispheres, Egyptian and Hindu Zodiacs, the Zodiac of Dendera, &c., &c.

LIST OF

MOVEABLE ASTRONOMICAL SLIDERS

(THE MOTION PRODUCED BY RACK-WORK),

PACKED IN A BOX WITH A LOCK.

No. I.

The Solar System, shewing the Revolution of all the Planets with their Satellites round the Sun.

No. II.

The Earth's Annual Motion round the Snn, shewing the Parallelism of its Axis, thereby prodncing the Seasons.

No III.

This Diagram illustrates the cause of Spring and Neap Tides, and shows the Moon's Phases during its revolntion.

No. IV.

This Diagram illnstratos the apparent Direct and Retrograde Motion of Venus or Mercury ; and also its Stationary Appearance.

No. V.

A Diagram to prove the Earth's Rotnndity.

No. VI.

This Diagram illustrates the Eccentric Revolntion of a Comet ronnd the Sun, and shews the appearance of its Tail at different points of its Orbit.

No. VII.

The Diurnal Motion of the Earth, shewing the Rising and Setting of the Sun, illustrating the canse of Day and Night by the Earth's rotation npon its own Axis.

No. VIII.

This Diagram illnstrates the Annnal Motion of the Earth round the Snn, with the Monthly Lunations of the Moon.

No. IX.

This Diagram shows the various Eclipses of the Sun, with the Transit of Venus.

N. B. There is sometimes added to this set a Slider to shew the different Eclipses of the Moon ; also one to shew the Eclipses of Jupiter's Moons ; they are numbered X, XI.

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