ANCIENT ASTRONOMY,

MODERN SCIENCE,

AND

SACRED COSMOLOGY.

BY

JOHN WOOD,

AUTHOR OF "BIBLE ANTICIPATIONS OF MODERN SCIENCE."

"I will . . bring to nothing the understanding of the prudent."

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PREFACE.

THE present Essay may perhaps be recognised as an amplification of the argument of an earlier one, "Bible Anticipations of Modern Science."

In treating of Sacred COSMOLOGY, the Author, it will be seen, has made his own application of Physical Electricity, in its more modern development; as especially illustrated in a recent Faraday Lecture, by that pre-eminent master of Natural Science, the learned DR. HELMHOLTZ, of Berlin.

In many of his observations on ASTRONOMY also, particularly on its ancient history, the Author has gladly availed himself of the Astronomical Lectures of Professor Mitchell, of Cincinnati; which had subsequently appeared in this country,

in a volume of rare merit and interest, entitled "The Orbs of Heaven."

In the following inquiry, it may here be proper to apprise the reader, that the Author's main argument commences with the summary of *Modern* Astronomy; and is continued through the subsequent Parts or Chapters of the Treatise.

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Part First.

ANCIENT ASTRONOMY.

THERE is, perhaps, no finer specimen of mental and moral grandeur than that presented by the individual who first resolved to read and comprehend the heavens; with their multitude of stars, in such bright profusion, scattered as far as the eye can reach, over the vault of night.

The name and country of the ancient founder of the science of the stars are, however, both of them, lost to us for ever; but his discoveries survive, and will endure, doubtless, as long as the planets shall continue to roll and irradiate the world.

In imagination standing, then, beside this primitive observer, at the close of his career of nearly a thousand years (for we must pass beyond the epoch of the Deluge, and seek our earliest discoveries amongst those sages who were privileged to count their age by *centuries*), we may learn the

order in which the secrets of the starry world slowly yielded up themselves to long and persevering scrutiny. It is true that history sheds no light, and even tradition fails to unfold the train of reasoning and research which marked this primitive era of astronomical science; but such is the beautiful order in the golden chain of discovery, that the bright links which are known, reveal with certainty those which are buried in the voiceless past. It seems impossible to doubt that the first discovery ever recorded, as the result of human observation, was that afforded by the *Moon.*

The sun, the moon, the stars, had long continued to rise, climb the heavens, and slowly sink again beneath the western horizon. The spectacle of day and night was then, as now, familiar to every eye; but, in gazing, there was no observation, and, in mute wonder, there was no science. When the solitary observer took his post, it was to watch the more striking variations of the moon's phase and position—sometimes a silver crescent, at other times full orbed—walking in majesty amongst the stars, and eclipsing their radiance with her overwhelming splendour.

Scarcely had the second observation been made,

when the observer was struck with the wonderful fact, that the moon had left her place among the fixed stars, which on the preceding night he had accurately marked. The moon then is *moving;* and what is far more wonderful, her motion is precisely *contrary* to the general revolution of the heavens—from east to west; but she marches steadily onward among the stars, until she sweeps the entire circuit of the heavens, and returns again to the point first occupied.

The group of stars in which the new moon was first seen was precisely noted, so as to be recognised at the following new moon; and our primitive observer doubtless hoped that in this same group the silver crescent, when it should next appear, would be found. But the starry group which had ushered her in before, had now disappeared below the horizon, and a new group had taken its place; and thus it was also discovered that each new moon fell further and further backward among the stars. By counting the days, from new moon to new moon, and those which had elapsed while the moon was passing round the heavens from a certain fixed star to this same star again, it was found that these two periods were different; the

revolution from new moon to new moon, occupying $29\frac{1}{2}$ days, while the sidereal revolution from star to star required $27\frac{1}{3}$ days.

The long and accurate vigils of the moon, and the necessity of recognising her place by the clusters of stars among which she was nightly found, had already familiarised the eye with those along her track, and even thus early the heavens began to be divided into *constellations*. The eye was not long in detecting the singular fact, that this stream of constellations lying along the moon's path was constantly flowing to the west, and one group after another becoming invisible in consequence of their nearer proximity to the sun. A closer examination revealed the fact, that the aspect of the whole heavens was changing from month to month. Constellations which had been conspicuous in the west, and whose brighter stars were the first to appear as the twilight faded, were found to sink lower and lower towards the horizon, till they were no longer seen, while new groups were constantly appearing in the east.

These wonderful changes, so strange and inexplicable, must have long perplexed the early student of the heavens. Hitherto the stars along

the moon's route had engaged special attention, but at length certain bright and conspicuous constellations toward the north arrested his eye, and these were watched to see if they would also disappear. Some were found to dip below the western horizon, soon to reappear in the east; while others, revolving with the general heavens, rose high above the horizon, swept steadily round, sunk far down, but never disappeared from sight.

This remarkable discovery soon led to another equally important. In watching the stars in the northern sky through an entire night, they all seemed to describe *circles*, having a common centre; these circles became smaller and smaller as the stars approached nearer to the centre of revolution, until finally one bright star was found, whose position was ever almost fixed; alone unchanged, while all else was slowly moving.

The discovery of this remarkable star must have been hailed with uncommon delight by the primitive observer of the heavens. Here was the first valuable gift of primitive astronomical science to man.

But, to the astronomer, this discovery opened up a new field of investigation, and light began to

dawn on some of the most mysterious questions which had long perplexed him. He had watched the constellations near the moon's track slowly disappear in the effulgence of the sun, and when they were next seen it was in the east in the early dawn, apparently emerging from the solar beams, having actually passed by the sun. Watching and reflecting, steadily pursuing the march of the northern constellations, which never entirely disappeared, and noting the relative position of these, and of those falling into the sun, it was at last discovered that the entire starry heavens were slowly moving forward to meet and pass by the sun; or else the sun itself was actually moving backward among the stars. This apparent motion had already been detected in the moon, and now came the reward of long and diligent perseverance. The grand discovery was made, that both the sun and moon were moving among the fixed stars, not *apparently*, but *absolutely*.

The previously received explanation of the moon's motion could no longer be sustained, for the starry heavens could not at the same time so move as to pass by the moon in one month, and to pass by the sun in a period twelve times as great.

A train of the most important conclusions flowed at once from this discovery. The starry heavens passed beneath and around the earth; the sun and moon were wandering in the same direction, but with different velocities, among the stars; the constellations actually filled the entire heavens, above the earth and beneath the earth; the stars were invisible in the daytime, not because they did not exist, but because their feeble light was lost in the superior brilliancy of the sun. The heavens were therefore *spherical;* and they encompassed, like a shell, the entire earth; and hence it was conceived that the earth itself was also a suspended body, occupying the centre of the starry sphere.

It is impossible for us, familiar as we are at this day with these important truths, to appreciate the rare merit of him who, by the power of natural genius, first rose to their knowledge and revealed them to an astonished world. We delight to honour the names of Kepler, of Galileo, of Newton; but here are discoveries so far back in the dim past, that all trace of their origin is lost, although they vie in interest and importance with the proudest achievements of any age.

With a knowledge of the sphericity of the

heavens, the revolution of the sun and moon, the constellations of the celestial sphere, the axis of its diurnal revolution, astronomy began to be a science. Thus far, however, the only moving bodies known were the sun and moon. To follow the moon as she pursued her journey among the stars was not difficult; but to trace the sun in his slower and more majestic motion, and to mark accurately his track from star to star, was not so easily accomplished. Night after night, as he sank below the horizon, the attentive watcher marked the bright stars near the point of setting which first appeared in the evening twilight. These gradually sunk towards the sun on successive nights; and thus was he traced from constellation to constellation, until the entire circuit of the heavens was performed, and he was once more attended by the same bright stars that had watched, long before, his sinking in the west. Here was revealed the measure of the *Year*. The earth had been verdant with the beauties of spring, glowing with the maturity of summer, rich in the fruits of autumn, and locked in the icy chains of winter, while the sun had circled round the heavens. His entrance into certain constellations marked the coming seasons,

and man was beginning to couple his cycle of pursuits on earth with the revolutions of the celestial orbs.

Some ardent devotee to this infant science at length marked in the early twilight a certain brilliant star closely attendant upon the sun. The relative position of these two objects was noted, when, with a great degree of astonishment, he discovered that this brilliant star was rapidly approaching the sun, and actually changing its place among the stars; night after night he gazes on this unprecedented phenomenon — *a moving star* — observing also its approach nearer and nearer to the sun. At last it disappears, plunged in the beams of the upheaving sun. He observed, too, that when a group of stars, absorbed into the sun's rays, disappeared in the west, they were next seen in the eastern sky, slowly emerging from his morning beams. Just before the sun broke above the horizon, in the rosy east, refulgent with the coming day, he descried the pure white silver ray of his long lost wanderer. It passed the sun; it rose in the east; the first *planet* was now discovered!

For some time the planet pursues his journey from the sun, leaving it farther and farther behind.

But now it slackens its pace, it actually stops in its career, and seems to have again become fixed. Not so; slowly at first, and soon more quickly, the planet again seeks the sun, moving backward in its former path. Again it is lost in the sun's beams, and, contrary to all preceding analogy, when next seen, its silver ray comes out just above the setting sun. It now recedes again from the sun, till it reaches a point never to be passed; here it becomes stationary for a day or two, and then sinks downward again to meet the sun. Where the sun sank to repose, there did the faithful planet sink also; and where the sun rose, there again appeared the planet. The number of days was accurately noted, from the stationary point in the east above the sun to the stationary point in the west above the sun; and thus the period, 584 days, from station to station, became known.

The discovery of one planet led the way to the rapid discovery of several others. If we may judge of their order by their brilliancy, Jupiter was the second; then followed Mars and Saturn, and, after a long interval, Mercury was detected, hovering near the sun, and imitating the curious motions of Venus.

A close examination of the planets revealed many important facts. Three of them—Mars, Jupiter, and Saturn—were found to perform the circuit of the heavens, like the sun and moon, and in the same direction; with this remarkable difference, that while the sun and moon moved steadily and uniformly in the same direction, the planets occasionally slackened their pace, would then stop, move backwards on their track, stop again, and finally resume their onward motion. The periods of revolution were discovered by marking the time which had elapsed after setting out from some brilliant and well-known fixed star, until they should perform the entire circuit of the heavens, and once more return to the same star. The times of revolution were found to differ widely—Mars requiring about 687 days, Jupiter 4332 days, and Saturn 10,759 days, or nearly thirty of our years.

The planets all pursue their journeys in the heavens, among the same constellations which marked the paths of the sun and moon; and hence these groups of stars concentrated, among the early astronomers, the greatest amount of attention.

Whatever light may be shed upon antiquity by deciphering hieroglyphic memorials of the past,

there is no hope of ever going back far enough to reach even the nation to which we are indebted for the first rudiments of astronomical science!

In watching the annual revolution of the sun among the fixed stars, one peculiarity had long been recognised. While the interval of time, from the rising to the setting of the stars, was ever the same at all seasons of the year, the interval from the rising to the setting of the sun was perpetually changing, passing through a cycle which required exactly one year for its completion. It became manifest that the sun did not prosecute its annual journey among the stars, in a circle parallel with those described by the stars in their diurnal revolution. His path was oblique to those circles; and while he participated in their diurnal motion, he was sweeping by his annual revolution round the heavens, and was at the same time, by another most extraordinary movement, carried towards the north to a certain distance, then stopping, commenced a return towards the south, reached his southern limit, again changed his direction, and thus oscillated from one side to the other of his mean position.

These wonderful changes became objects of earnest investigation. In what curve did the sun travel among the stars? All diurnal motion was performed in a circle—the first discovered, the simplest, and the most beautiful of curves. To accomplish more accurately the proposed investigation, an area on the ground was smoothed and levelled, and in its centre a vertical pole was erected, some 10 to 15 feet in length, whose sharp vertex cast a well-defined shadow. And here we have the first astronomical instrument (the gnomon) ever devised by the ingenuity of man. Simple as it is, by its aid the most valuable results were obtained.

The great point was to mark with accuracy the length of the noonday *shadow*, from month to month, throughout the year. Four remarkable points in the sun's annual track were very soon detected and marked. One of these occurred in the summer, and was that point occupied by the sun on the day of the shortest noon shadow. Here the sun had reached his greatest northern point, and for a few days the noon shadow cast by the gnomon appeared to remain the same, and the sun *stood still*. The noon shadows now increased

slowly for six months, as the sun moved south, till a second point was noted, when the noon shadow had reached its greatest length. Again it became stationary, and again the sun paused and *stood still*, before commencing his return towards the north. These points were called the *summer* and *winter solstices*, and occurred at intervals of half a year. At the summer solstice the *longest* day occurred, while at the winter solstice the *shortest* day was always observed. These extreme differences between the length of the day and night occasioned the determination of the other two points. From the winter solstice the noon shadows decreased as the length of the day increased, until finally the day and night were remarked to be of *equal* length, and the distance to which the shadow was thrown on that day was accurately fixed. If, on this day, the diurnal circle described by the sun could have been marked in the heavens by a circle of light sweeping from the east to the west, so that the eye might rest upon and retain it, and if, at the same time, the sun's annual path among the fixed stars could have been equally exhibited in the heavens by a circle of light; these two circles would have been seen to cross each other, and at the point of

their crossing the sun would have been found. The diurnal circle was called the *equator*, the sun's path the *ecliptic*, and the point of intersection was called, appropriately, the *equinox*. As the sun crossed the equator in the spring and autumn, these points received the names of the *vernal* and *autumnal equinoxes*, and were marked with all the precision which the rude means then in use rendered practicable.

The bright circle already imagined in the heavens to represent the sun's annual track among the stars passed obliquely across the equator, and the amount by which these circles were inclined to each other was actually measured, in these early ages, with no mean precision, by the noon shadows of the gnomon. The ray casting the shortest noon shadow was inclined to the ray forming the longest noon shadow, under an angle precisely double of the inclination of the ecliptic or sun's path to the equator, and the inclination of these two rays marked exactly the annual motion of the sun from south to north, or from north to south. A close examination of the order of increase and decrease in the length of the noon shadows cast by the gnomon, demonstrated the important truth already suspected, that the sun's

path was actually a *circle*, but inclined, as has already been shewn, to the diurnal circles of the stars, and to the equator.

By counting the days which elapsed from the summer solstice to the summer solstice again, a knowledge of the length of the year, or period of the sun's revolution, was obtained. But here again a discovery was made, which produced an embarrassment to the early astronomer. In counting the days from the summer to the winter solstice, and from the winter round to the summer solstice, these intervals were found to be unequal. These results could not be doubted, for each observation, from year to year, confirmed them. They were received and recorded, but the problem of their solution had to be handed down to succeeding generations.

A brazen circle had also been devised, and fastened permanently to another brazen circle of equal size, under an angle exactly equal to the inclination of the equator to the ecliptic. Circles perpendicular to the equator, and passing through the solstices and equinoxes, completed the second astronomical instrument, *the sphere*. It was mounted on an axis passing through its centre, and perpendicular to its equator, so as to revolve, as did the

heavens, whose motions it was intended to represent. Having so placed the axis of rotation that its prolongation would pass through the north star, this rude sphere came to play a most important part in future investigations of the heavens. Its brazen equator and ecliptic were each divided into a certain number of equal parts, by reference to which the motion of the heavenly bodies might be followed with far greater precision than ever had been previously attained.

It now became possible to fix with greater certainty the relative positions of the sun and moon. The phases of the moon, the very first point of investigation, had never yet yielded up its hidden cause; and those terrific phenomena, solar and lunar *eclipses*, were still wrapped in mystery.

We cannot doubt that the causes of the solar eclipse were the first detected. It had been observed that such an event had never occurred when the moon was visible. This first excited curiosity, and it was soon discovered that, on the night following the day of eclipse, the moon was seen in her crescent shape very near to the sun, and but a short distance from the sun's path. By remarking the moon's place, next before a solar eclipse, and

that immediately following, it was seen that, at the time of the occurrence of the eclipse, the moon was actually passing from the west to the east side of the sun's place; and finally, a little calculation shewed that a coincidence of the sun and moon in the heavens took place at the precise time at which the sun had been eclipsed. The conclusion was irresistible, that the sun's light *was hidden by the interposition of the dark body of the moon.*

Having reached with certainty this important result, the explanation of the moon's phases followed in rapid succession. It was far more difficult, however, to render a satisfactory account of the lunar eclipse. It was observed that all opaque bodies cast shadows in directions opposite to the source of light; that no lunar eclipse could occur except when the sun, earth, and moon were situated in the same straight line, a position which could never occur except at the *full* or the *new* moon; and that it was only at the *full* that the eclipse occurred.

The questions now naturally arose, Why was not the sun eclipsed in each revolution of the moon; and how it happened that the moon in the full did not always pass through the earth's shadow?

The answer was found to be that the sun and moon did not perform their revolutions in the same plane. The moon's route among the stars crossed the sun's route under a certain angle; and it thus frequently happened that, at the *new* and *full*, the moon occupied some portion of her orbit too remote from that of the sun to render possible either a lunar or solar eclipse. It had been observed also that no eclipse of the sun ever occurs unless the *new moon is in the act of crossing the sun's track.*

To predict the return of an eclipse of the sun and moon was, doubtless, the proudest victory that genius could win; but of the astronomer who first attained to this distinction, the name, age, and country, are all alike swept into *oblivion!* What a lesson of the instability of human fame are we taught in this simple recital!

In pursuing the consequences flowing from the prediction of an eclipse, several remarkable results were reached. It will be recollected that to produce either solar or lunar eclipses, the new or full moon must be in the act of crossing the sun's annual track. This point of crossing, called the *moon's node*, became therefore an object of the deepest interest. The fact was revealed of its

movement round the ecliptic in a period of 18 years and 11 days; during which time there occur 223 new moons, or 223 full moons; and it followed therefrom that from the day on which the eclipse had been observed to fall, on each and every one of these days, during the next period of 223 lunations, eclipses may be expected, and their coming foretold.

This wonderful period of 18 years and 11 days, or 223 lunations, was known to the Chaldeans; and by its use eclipses were predicted more than 3000 years ago. It is likewise found among the Hindoos, the Chinese, and the Egyptians,—nations widely separated on the earth's surface; and this fact suggests the idea that it had its origin among a people even anterior to the Chaldeans. It is now known by the name of the *Zaros*, or the Chaldean period.

It would be a matter of great interest to fix the epoch of this primitive discovery. We find among all the ancient nations—Chaldeans, Persians, Hindoos, Chinese, and Egyptians—that the *seven* days of the *week* were in universal use; and, what was far more remarkable, each of these nations named the days of the week after the seven planets, num-

bering the sun and moon among the planets. The probability of such a coincidence occurring from accident is as millions of chances to one against it.

We are, therefore, forced to the conclusion that the planets were discovered, and the seven days of the week devised and authoritatively named by some primitive nation, from whom the tradition descended to succeeding generations.

A remarkable discovery, made in the stellar world, throws some further light on the era of primitive astronomical research.

It was found that the sun's entrance into the equinox, reducing to equality the length of the day and night, always heralded the coming of Spring. Hence, to mark the equinoctial point among the fixed stars, and to note the place of some brilliant star whose appearance in the early morning dawn would announce the sun's approach to the equator, was early accomplished with all possible accuracy. This star, once selected, it was believed would remain for ever in its place. But the time arrives at last when the bright star, which for more than 500 years had with its morning ray announced the season of flowers, is lost. Each

year the interval, from the first appearance of the star in the early dawn up to the equality of day and night, had become less and less, and now the equinox came, but the star remained invisible, and did not emerge from the sun's beam until the equinox had passed.

These facts were long and deeply pondered. At length the discovery broke upon the unwilling mind, that the sun's *path among the fixed stars was actually changing*, and that his point of crossing the equator was slowly moving backwards towards the west, and leaving the stars behind. The same motion, only greatly more rapid, had been recognised in the shifting of the moon's node. The retrograde motion of the equinoctial points caused the sun to reach these points earlier than it would have done, had they remained fixed, and hence was demonstrated the *precession* of the *equinoxes*.

This discovery justly ranks among the most important achieved by antiquity. Its rate of motion has been determined, and its vast period of nearly 26,000 years has been fixed. Once revealed, the slow movement of the equinox makes it a fitting hour-hand on the dial of the heavens, with which

to measure the revolution of ages. The frequent allusions in the old Hebrew Scriptures, and in the works of all ancient writers, to the constellations of the Zodiac, sufficiently attest the extreme antiquity of these arbitrary groupings of the stars.

Such were the rich fruits of diligence and perseverance which had descended from the remotest antiquity.

The era of discovery from mere *inspection* was, however, rapidly drawing to a close. The problem now presented was to combine together all the facts ascertained, and reduce them to harmony. The Greek philosophers, from Plato down to the extinction of the last school of that philosophy, recognised this as the true problem, and, with an energy and pertinacity worthy of the highest admiration, essayed its solution.

Every effort to *explain* the celestial phenomena started naturally with the then undoubted fact, that the *earth* was the centre of all motion. The centre of motion once determined, the nature of the curve described by the planetary revolutions was so obviously presented to the eye, that it seemed impossible to hesitate for a moment as to

its character. The circle was the only regular curve adopted by the ancients. Its simplicity, its beauty, and perfection, would have induced its selection, even had there been a multitude of curves from which to choose. Its curvature was ever the same. It had neither beginning nor end. It was, in fact, the symbol of eternity. In truth, observation confirmed the idea; and the orbits of all the celestial bodies, when projected on the concave heavens, were circles. It came, therefore, naturally to be a fixed principle, that in all hypotheses devised to explain the phenomena of the heavens, circular motion and circular orbits alone could be employed.

To these great principles of the central position of the earth and the circular orbits must be added that of the earth's *immobility*. This doctrine was undoubtedly sustained by the evidence of all the senses which could give testimony. No one had seen it move, had heard it move, had felt it move.

The early Greek philosophers were accustomed to gather in travel the wisdom which was garnered up in the temples and among the priests of Egypt

and of Judea. Pythagoras had conceived the *sun* to be the centre of the planetary system, simply because it was composed of *fire;* and fire was the more dignified attribute than earth for the central position. We are not surprised that Hipparchus and Ptolemy, the true astronomers among the Greeks, should have rejected a doctrine sustained by so futile a reason. Nicetas, a follower of Pythagoras, is said to have gone further than his master, and to have adopted the idea, that the revolution of the heavens was an appearance produced by an actual rotation of the earth on an axis once in twenty-four hours. Unsustained by any solid argument, this then novel idea was regarded as a vain dream, and was soon lost in oblivion.

From the more minute observations of Hipparchus, however, it became manifest that, in case the motions of the sun and moon were circular and uniform, the earth did not occupy the exact centres of their orbits; for, on this hypothesis, any irregularity of motion would have been impossible. Here, then, was a point gained.

While pursuing these important researches, Hipparchus resolved upon a work of extraordinary difficulty. His catalogue of 1081 of the principal

stars, the richest treasure, perhaps, which the Greek school has transmitted to posterity, has, in consequence, distinguished him with the well-earned title of the *Father* of Astronomy.

After a careful examination of all the facts and discoveries which the world then possessed, adding his own extensive observations, Ptolemy promulgated a system which bears his name; and which endured for more than fourteen hundred years. All the phenomena known to the Greek astronomer were, on this system, so satisfactorily accounted for, that it even became possible to compute tables of planetary motions, from which their places could be predicted with such precision, that the error, if any existed, escaped detection by the rude instruments then in use.

When astronomy was banished from Greece, it found a home among the Arabs; where it had slowly advanced also, until the dawn of learning once more broke on Europe, and the astronomy of the Greeks, improved by the Arabs and the Persians, and preserved in the great work of Ptolemy, was transmitted to posterity.

Part Second.

MODERN ASTRONOMY.

ON the revival of learning in Europe, the literature and science of the Greeks and Romans had rapidly spread, and gained an astonishing ascendency over the human mind. Time-honoured and venerable with age as that ancient literature had ever been, this revival filled, with the philosophy of Aristotle, the geometry of Euclid, and the astronomy of Ptolemy, the colleges and universities, and fastened itself with tenacity upon the age.

Such was the state of science and of the world when Copernicus essayed the investigation of the heavens. By a close examination of Mercury and Venus, he had observed that these planets always accompanied the sun, participated in its movements, and never, except to limited distances, receded from it. The uniformity of their oscillations, from one side to the other of the sun, suggested

their possible revolution about that luminary. The Egyptians, probably because the element of fire was deemed to merit that distinction, had reached this doctrine, and had communicated their idea of it to Pythagoras, nearly 2000 years previously.

If, then, greater apparent simplicity demanded, as Copernicus now conceived, the abandonment of a central earth, a multitude of circumstances, in the search for a new centre, naturally pointed to the sun. The system of Copernicus, based on the sun's central position, though far from perfect, yet seemed to him founded on truth; while the more prominent irregularities in the planetary motions were removed, there yet remained an increase and decrease in the orbitual velocities of all the planets, which were inexplicable. The planets did not revolve, then, in circles whose exact centre was occupied by the sun. The moon's orbit was not a circle whose exact centre was the earth. To explain these irregularities, Copernicus, clinging still to circular motion, was drawn to adopt the same expedients which had characterised the Ptolemaic system; and the eccentric and epicycle were still practically indispensable.

Encompassed with this and other practical ob-

jections, it is not wonderful that Copernicus should, with extreme diffidence, have promulgated his theory, or that it should have been received with distrust, and for a long while absolutely rejected. A few bold minds, however, were struck with its simplicity and novelty.

Copernicus had transferred the centre of motion from the earth to the sun, and rested the truth of his hypothesis on what he deemed to result from that aspect,—a *diminished complexity* in the celestial phenomena. In case the true centre had been found, it now, however, still remained to determine the exact curves in which the planets revolved.

The resolution of this profound question was reserved to Kepler. This eminent astronomer determined, in the first instance, to confine his investigations to one single planet, and Mars was selected for his earliest experiment. For this investigation he had exhausted every combination of circular motion which the fertility of his imagination could suggest. They had all utterly failed. He finally broke away from the fascination of that beautiful curve, and pronounced impossible every hypothesis founded upon it. If he had not found the true curve, he had found, as ancient astro-

nomers had found before, what it could *not* be, namely, a perfect circle.

The next simplest curve is the *ellipse;* an oval figure which nearly resembles the circle in form, but possesses very different properties. All diameters of a circle are equal. The diameters of an ellipse are unequal. The centre of the circle is equally distant from all points on the circumference. No such point exists in the ellipse; but two curious points are found on its longest diameter, possessing the remarkable property of having the sum of the lines joining them with any point of the curve, constantly equal to the longest diameter. Each of these points is called a *focus.* This beautiful curve, with its singular properties, had also been discovered by the Greek mathematicians; but, not remarking its applicability to those uses in nature to which it has since been applied, it had hitherto been regarded only as an object of amusing speculation.

Kepler now found that the orbit of Mars was really an ellipse. The other planets in succession followed, and Kepler proclaimed to the world his first great law:—*Planets revolve in elliptic orbits about the sun, which occupies the common focus of all these orbits.*

By an unlimited faith and perseverance the last of the three great Keplerian laws was finally reached and established.

But in these illustrious and successful pursuits Kepler did not want for able and enthusiastic collaborateurs. While Tycho, the noble Dane, immured within the narrow limits of his little island, was noting with patient and laborious continuity the revolutions of the sun, moon, and planets; and was accumulating the materials which were to furnish amply the keen and inquisitive mind of Kepler; Galileo, with giant hand, was shaking to their foundations the philosophical theories of Aristotle, and startling the world with his grand mechanical discoveries. But for the observations of Tycho, Kepler's laws could not have been revealed; but for the magic tube of Galileo, these laws had been the *ne plus* of astronomical science. Thus do we witness the rare spectacle of three exalted intellects contemporaneously putting forth their diverse talents in the accomplishment of one grand object. Tycho Brahe, however, though the most profound practical astronomer of his age, never accepted the Copernican system.

Enlightened thus by the doctrines of Copernicus,

and uniting to them the great discoveries of Kepler, we proceed now to notice the wonderful sagacity of the pre-eminent Newton; whose mind almost intuitively seemed to grasp the idea of the possible existence of some central force, by whose power all movements of the planetary world were probably controlled.

Kepler, too, had conjectured this, and also that the law of this unknown force was such that it diminished, as the squares of the distances at which it operated, increased. That is, if the intensity of the power which it exerted on a planet, where the distance was 100,000,000 miles from the sun, be counted as unity; removing the planet to double the distance, or to 200,000,000 miles, the sun's influence over it would be reduced to one-fourth of its former value. Descartes, in the interval, had propounded the law of centrifugal force. With these advantages, Newton gave the energies of his mind to the investigation of that principle, which had existed with Kepler as a mere conjecture. The principle admits of this illustration: If any force resided in the sun, which could resist the centrifugal force of the planets; or, in any primary, to resist the centrifugal force of the revolving satellite;

it was conjectured that this force would decrease in proportion as the square of the distance increased. Now, if Newton could have carried a heavy body upward, above the earth, until he should gain a height above its surface of 4000 miles, he would then be twice as far from the centre as when at the surface of the earth. Could he have mounted one unit higher, gaining an altitude of 8000 miles above the earth's surface, or *three* units from the centre; the space passed through from this elevation by a falling body is *one-ninth* of 16 feet, against one-fourth of 16 feet at the former distance of 4000 miles.

Here, then, is precisely what must, if possible, be accomplished to demonstrate the assumed law of gravitation. The loftiest mountain on the earth's surface, even were it 10 miles high, the two elevations at which the experiment might then be performed, would be 4000 and 4010 miles; and the diminished velocity would not be appreciable to demonstrate the truth or falsehood of a great principle. Finding it thus *impossible* to perform any satisfactory experiment on the earth's surface, Newton now conceived the idea of a method of adopting the *moon* as the falling body for his pur-

pose; and, by that means, of hypothetically testing the truth of his theory. The amount by which the moon is deflected in one second of time, from the straight line it would otherwise have pursued, was conceived to be the *amount precisely by which it may be said to fall towards the earth.*

Newton next, *hypothetically*, computed also the space through which a heavy body would fall towards the earth's surface in a second of time, if removed from the earth to a distance equal to that of the moon; and, with the aid of Picard's more accurate measurement of the diameter of the earth, he was now enabled to demonstrate to himself the accuracy of his old computations, and with their aid, as he conceived, the certainty of his great law of gravitation.

There happens to be a remarkable class of curves, which also had been discovered by the Greek mathematicians, called the *conic sections.* The figure of a *cone*, with a circle for its base, and converging to a point, is familiar to all. Cut this cone perpendicularly to its axis, remove the part cut, and the line on the surface round the cone will be found to be a *circle.* Cut it again, obliquely to the axis, then the line of division of the two parts will

be an *ellipse.* Cut again, so that the knife may pass downward parallel to the slope of the cone, and in this case your section will be a *parabola.* Make a last cut parallel to the axis of the cone, and the curve now obtained is the *hyperbola.* Further observation of the heavenly bodies, under the law of gravitation, now confirmed the fact that the planets revolved in ellipses; the satellites of Jupiter in circles; and those strange, anomalous bodies, the *comets*, take their place in the new system, sweeping round the sun in *parabolic* and *hyperbolic* orbits.

The three great laws of Kepler were now deemed to flow as simple consequences of the law of gravitation. The first law, announcing the revolution of the planets in elliptic orbits, was now made general, and recognised the revolution of the heavenly bodies in *conic sections.*

The second law, fixing the equality of the spaces passed in equal times, by the lines joining the planets to the sun, as these were carried round in their elliptic orbits; was, at the same time, deemed applicable to all bodies revolving about a fixed centre, in any curve, or according to any law.

The third law, recognising the proportion be-

tween the squares of the periodic times and the cubes of the mean distances of the planets; was likewise extended to the satellites and the comets.

These renowned achievements of the moderns, but chiefly the promulgation of the theory of *Gravitation*, may be said to characterise and distinguish from the ancient Ptolemaic, the modern Copernico-Newtonian system of astronomy.

Part Third.

THE FUNDAMENTAL PRINCIPLE OF THE MODERN SYSTEM, COMPROMISED BY RECENT SCIENTIFIC DISCOVERY.

THAN the achievements of modern astronomy, there is perhaps no scientific system that has taken firmer hold of the age. It predominates the scientific bodies of Europe and America; and, in the greatest schools of philosophy, is so fully and beyond question established; as well as, in every department of learning, constituted the accepted mark of a polite education: that any person who, till now, should make bold to question whether the Ptolemaic, or the Copernican system of the heavens, with its Newtonian engrafted law of gravitation, be the true one; must be content to be ostracised by both the scientific and the polite world.

The modern aspect of the great Newtonian hypothesis, in fact, is doubtless that which the philosophic poet has characterised as "the guess"

"Which a Newton made immortal."

And yet it would seem that a scientific doctrine, when even thus amongst the learned firmly established, is not now, any more than aforetime, rendered invulnerable, or placed beyond controversy. It has of late years, indeed, become impressively evident, that no philosophic dogma can decorously or successfully repel the inevitable assaults of advancing knowledge; no system, in fact, that is not proof against the strictures of modern investigation and discovery, can hope to survive the rudest of researches amongst even its time-honoured and time-hallowed foundations.

It would now appear, from this later march and progress of scientific investigation, that *Gravitation* is *not*, what till recently it had been assumed to be, the *greatest* force in nature; that the all-pervading force of *electricity* is, by millions of times, more potent and irresistible.

The inference, therefore, which had aforetime been drawn from the opposite view, is no longer tenable; namely, that gravitation, because the greatest of known natural forces, must be the *central* governing law of planetary motions, and of the universe.

In a recent Faraday lecture, Professor Helmholtz

stated, that an insignificant "*Lake*, half an English mile in length and breadth, and a yard and half in depth; contains sufficient positive *electricity* to *balance* the attraction of gravity of the *whole earth!*"

On the same theme, the late Sir John Herschel learnedly expatiates, when observing the fact that Electricity passes all the bounds within which the law of gravitation is supposed to act, and becomes, like Light itself, of universal operation.

Nor would the position appear any longer defensible, that the celestial spaces, as Newton had assumed, are free from a *resisting* medium. The learned astronomer Encke, from a series of cometary observations, conclusive to his own mind as well as to that of others, proclaims the contrary doctrine.

The unqualified reverence with which ourselves till recently, and with which even now perhaps, the majority of the world regard the great mathematical skill evinced by Sir Isaac Newton in the elaboration of the sublime theory of gravitation; would naturally raise in the mind a strong prejudice and reluctance to dissent, even in semblance, from the immensely abler conceptions of so great an intellect.

But, doubtless, on the other hand, we are compelled to allow that the superior deference due to scientific truth, if authoritatively proved to be such; should dispel all prejudice of this natural description; and should command for that truth the preference, and the sincerest devotion of every candid mind.

The circumstances in which the subject under consideration now seems to present itself, are, as a matter of fact, entirely diverse from those prevalent in the Newtonian age; they assume, indeed, a completely new aspect, and a totally unexpected phase.

An extraordinary estimate of the forces of electricity, like that recently propounded by Professor Helmholtz, would alone, we imagine, suffice to create the present contrast of circumstances. That novel estimate (we presume ascertained) of electric energy was, at any rate, by the distinguished scientific world of London, to whom the learned Professor's lecture had been specially addressed, allowed to pass unchallenged.

Without adverse criticism, therefore, on our part, we can but accept, with its necessary results and consequences, on the high authority of so

profound a scientist, this latest philosophic doctrine. And we feel constrained to confess incredulity in regard to the presumption that a prodigious natural force of such almost infinite efficiency, and of such unlimited applicability in nature, can, in any department of the universe, be unproductive of commensurate results; or that science, as now unfortunately would appear to be the case, can much longer consistently ignore and obliviate them.

The only conceivable motive for the ignoring by science of so far-reaching a philosophical law, seems to be the difficulty, or perhaps impossibility, of reconciling its inevitable action with foregone scientific prepossessions and preconceived systems of natural physics.

If the existence in the universe of some central force be a philosophical necessity, then it must, we suppose, be obvious that no such central agent of less potency than electricity can possibly fulfil its proper functions; that gravitation, therefore, because almost infinitely weak in comparison, *cannot* be that central force; and that the palpable disparity between these two forces must necessarily be fatal to the whole gravitation theory, and to every scientific system and doctrine based upon it.

In these certainly novel and unanticipated circumstances, it seemed to us that it might now be even useful, and perhaps not inopportune, to essay some review of the foundations and progress of modern astronomy, as governed by the Copernican idea, and by the Newtonian conception of gravitation thereupon based.

The comparison of the two systems—the ancient Ptolemaic with the Copernico-Newtonian—may be said to disclose chiefly this striking and palpable difference between them: that whereas *all* the essential practical conditions of the science were discoveries exclusively made by the *ancients*, no additions thereto whatever, of like practical utility and importance that are placed beyond dispute, have yet been made by *modern* astronomers; however distinguished in other respects these may have been—nothing, at any rate, which, with the aid of modern instruments, must not equally have been discovered by means of the older system.

It is unquestionable that the following results, at least, were from the remotest antiquity discovered and established by ancient astronomy. The arrangement of the heavens into constellations; the planetary motions and periods; the great lunar

cycle; the mode of predicting eclipses, solar and lunar; the practical immobility of the pole star; the sphericity of the heavens; the obliquity of the ecliptic; the measure of the year; the summer and winter solstices; the vernal and autumnal equinoxes; the precession of the equinoxes, with other less important astronomical phenomena.

Despite their necessary ignorance of modern instruments, such were the grand achievements of the ancient school; and it will be confessed that these great discoveries still remain the fundamental facts of the modern system.

By substituting the sun as the centre of the planetary orbits and motions—the elementary doctrine of the moderns—Copernicus reverses none of these fundamental facts; and Newton, in the certainly more ambitious attempt to assign their physical *causes*, of necessity retains them.

Modern *Navigation*, too, so closely allied to astronomy, is, in its practical and technical language, still ostensibly ruled by the ancient idea of the earth's immobility. It was also in accord with the same system that the great nautical feat was lately performed—the recovery of an electric cable lost in mid-ocean—by observation of the particular

star that happened to be perpendicular to the spot where the cable had sunk, so that by this single mark it became possible to return long afterwards, through the trackless waters, direct to the point so indicated.

Modern astronomy may be said, therefore, to be distinguished from the ancient system principally by Newton's marvellous conception of the law of *gravitation*, as the attempted solution of the problem of the *modus* and physics of planetary motion.

In later years, however, this great law has been singularly and scientifically assailed by the astronomical observations and deductions of the eminent Encke and others; namely, that there incontestably exists in the celestial spaces, contrary to the Newtonian idea, a resisting medium.

This discovery, the English Astronomer-Royal, in 1831, had deemed to be fully established. An important minority of the French Academy of Sciences, from observations of Donati's later magnificent comet, had likewise subsequently been induced to signify adhesion to Encke's doctrine. Sir John Herschel asserts to be indisputable the existence of an electrical force, devoid of *inertia*,

not gravitating, but *levitating;* and, with the diffusion of Light, traversing regions beyond the supposed range of gravitation.

Encke, perceiving, of course, that his discoveries were opposed to all the received modern doctrines of astronomical science, with much hesitation, had been driven reluctantly to announce to the world his practical conclusions. On this interesting subject, the able author to whom our history of ancient astronomy is so largely indebted, further observes, that the hypothesis of Encke,—although so obviously adverse to Newton's fundamental law,—"has long been received with favour by men to whose judgment I am generally disposed with implicit confidence to yield."

Modern astronomy seems, however, to rest, as upon its principal basis, on the single question of the truth of *gravitation;* for, apart from that principle, the Copernican idea had been originally promulged on the ground solely of its presumed greater *simplicity* than the Ptolemaic.

We have not, therefore, now to reconsider whether the Newtonian system of gravitation be grand or sublime, which beyond doubt it is; but are concerned with the single enquiry whether it

be grounded on conclusive facts, and therefore be the *true* philosophy.

By Dr. Paley, it had been shrewdly observed, that the Copernican system was "*one* guess, amongst *many*." It was not a discovery; for he alone *discovers*, who *proves*. And here, we venture to aver, without fear of contradiction, that no man can prove *this* doctrine — this merely *guessed* Newtonian theory—so profoundly *recondite*, and elusive of all human grasp—but he, who, by irrefragable *miracles*, is able to shew that this superhuman philosophy is divine. To this position, of course, none are expected to subscribe, but those who have verified for themselves Scripture truth, on all points embraced within the sacred page. And upon scientists, also, by the latest scientific discovery, our position would seem now to be practically enforced, since Newtonian gravitation, as the law of universal nature, is scientifically annihilated by the Helmholtz development of physical electricity.

On this ground, and on this topic, therefore, we conclude, that Scripture statement stands *alone*, and is unassailable.

It is, we confess, with no little surprise, that we

now only appear to discover how really slight and inadequate have been the data on which the transition, by the scientific world, appears to have been made; from an ancient system, elaborately, and during so many centuries slowly consolidated, while positively still embracing also *all* our actual or practical knowledge of astronomy; to a modern philosophy whose essential characteristic is now found to be that of purely speculative hypothesis; resting on no *conclusive* fact whatever, and destitute consequently of absolute certainty; based, indeed, on perhaps the very slightest only of scientific *presumptions.*

Such, however, appears to be the great gravitation theory—the very essence and foundation of modern astronomy. The Copernican doctrine had regarded the *mode* merely, not the principle, of the system it displaced. And the Keplerian laws themselves supply no additional evidence of the truth of gravitation; or of the inapplicability of the same laws to even the previous, or, indeed, to any other possible system of nature.

Part Fourth.

REVIEW OF CERTAIN SALIENT POINTS OF THIS INVESTIGATION.

A REVIEW and reconsideration of the introductory process by which the magnificent theory of gravitation was originally inaugurated; may serve, perchance, to modify the confidence hitherto accorded to it, and to the consequent modern overthrow and supersession of the great astronomical system of the ancient world which preceded it.

And, first, with regard to the *centre* of the planetary orbits, and of the revolutions of the physical universe.

For such philosophical central body in nature the ancients, although their researches, so transcendently inventive and practical, seem not to have much realised any *necessity* at all; and, to the moderns, the conception appears to have suggested itself only as an after-thought, and because it was the complement of an already foregone conclusion

and theory, which had assumed gravitation to be an universal law.

It was not, however, from such philosophical inception, that ancient astronomers had deduced the idea of the earth's central position in our system; but rather because of the universal *experience* that the sun was really subservient to the earth's behests; supplying thereto its necessary light and heat; was thus the source of its agricultural productiveness, and essential to the life and happiness of its inhabitants.

The idea of necessity for central controlling bodies in nature is one that belongs exclusively to the modern philosophy; one which, on its face, appears destitute of solid or proved foundation; and conclusive evidence of the truth of which must, in the nature of things, be an impossibility.

In the next place, with regard to the theory of gravitation itself, the first idea in the mind of Newton seems to have been suggested by the *falling apple.* It was this simple incident which subsequently, in Newton's mind, expanded itself, until it became assumed therefrom and promulgated, that the cause of an apple's falling revealed a law of nature which is universal.

That so simple a natural phenomenon is governed by the same law—the earth's obvious attraction in some way—the natural force which causes ponderous bodies and huge erections everywhere to retain their perpendicular direction at opposite antipodean points on the earth's surface, is doubtless (if the earth be merely a suspended body, and at rest) beyond dispute. But is *gravitation*, therefore, necessarily its cause? On the contrary, may not such a phenomenon result from the infinitely superior force of *electricity*, or from some other and yet undiscovered force? Can this quasi-centripetal attraction, amidst known and unknown competitors for the honour, be demonstrably that of gravitation only?

The next step in the development of the gravitation theory, to which we are now conducted, is the singular *test*, on the result of which Newton was himself content to rest the truth of the doctrine.

Discarding as impracticable every possible altitude on the earth's surface from which to drop the testing body, Newton conceived that the degree in which the moon's orbit, in a second of time, is deflected from the straight line and towards the earth; and another body falling, in the same time, from a

similar elevation towards the earth; would be an identical and satisfactory test of the law in question; although, of course, no such body has ever been so dropt from the moon's altitude, and although we are still ignorant of—what is essential to such a test—the identity of its component ingredients with those that enter into the moon's substance. The experiment, however, would still be satisfactory to Newton himself, if the *spaces* thus supposed to be passed, in a second, even by such non-analogous body, *agreed* with this ascertained amount of deflection of the moon's orbit; and he would therefrom conclude that gravitation actually constituted the law of the universe!

The *scientific* element elicited by this hypothetical experiment would seem to have been the very slightest of possible data, on which to rest so prodigious a practical conclusion. Yet, we know, the observation of this test constituted the very highest degree of even *probability*, contemplated by Newton himself, of the universality of the law of gravitation.

Newton had deduced from this hypothetical lunar test his great law of universal gravitation, as being the "first of all second causes, an incorporeal and spiritual substance."

Helmholtz discovers that the earth's entire gravity may be counterpoised by means of a more spiritual or ethereal force of electricity, contained within a superficial *half mile* only of that earth's surface.

If a central power in nature be still a philosophical exigency, and if Newton's hypothetical test of this force has been plausibly made the basis of so many scientific systems; it now devolves upon the scientific world, with equal skill, to adapt to this certainly more universal and incomparably paramount law of electricity, all subject scientific facts and projects.

Thus the phenomena of the *tides* are referred to gravitation, simply because their variations coincide with those of the sun and moon; that is, because these are coincident. No *necessary* connection appears between them, other than that founded on Newton's hypothetical lunar experiment. The discovery of Helmholtz—that of a *new*, more central force—now elevates electricity to the throne, till now occupied by gravitation; and forces the conclusion, that all the above coincidences may flow only from electricity, acting simultaneously alike upon sun, moon, and tides.

Under the law of gravitation, this rule of coin-

cidence is, in like manner, applied to planetary motion; but here again this presumed rule of coincidence must likewise yield to that of electricity. The same also with regard to every other system to which the law of gravitation has, in the same inconclusive manner, been supposed to apply; but which, of course, have no real foundation besides that of Newton's lunar test. The observed coincidences in all these systems are not to be compared in conclusiveness with those which equally countenance the exploded science of Astrology.

We seem, therefore, authorised by this new physical doctrine, to return an *affirmative* answer even to the hazardous challenge of Pope, conveyed in the couplet—

> "When the loose mountain trembles from on high,
> Shall gravitation cease, if you go by?"

The electric hand of Helmholtz, it seems, is equal even to this feat.

Another and more recent instance of the application to practical astronomy of this sort of circumstantial evidence, is the incident of Adams's discovery of the latest planet.

Following the lead of an adopted theory, Adams

had inferred, from perturbations of a previously known planet, the existence in its vicinity of a yet undiscovered one. An actual discovery rewarded the search for such a celestial body.

Here again the result, though in the smallest degree presumptive, is of course anything but *conclusive* of the truth of the theory. Herschel had before, without search for it, detected the presence of an earlier planet; and this, as well as that of Adams, might, by astronomical analogy alone, have been equally discovered by simply noting the regular distances at which all the planets are found to be arranged in relation to each other; and by instituting, in such indicated locality, the proposed search for a new planet.

It is entirely, however, from conclusions on such observations as these—in their nature less or more *presumptive* only, but in no instance *conclusive* or demonstrably certain—that gravitation was assumed to be the philosophical modus of celestial motions; and had professedly subverted and superseded the ancient astronomy, which, ages before, had accurately ascertained all the present fundamental facts and doctrines of the science.

Forensically, the deceptive character of circum-

stantial evidence is almost proverbial; and doubtless many innocent lives have from time to time been sacrificed to its hazardous conclusions. But more analogous to our present subject, probably, is the remarkable illustration, authenticated in the life of the poet Dryden, of the misleading character of circumstantial evidence.

Dryden having, on scientific conviction, become an adept in *astrology;* had calculated the nativity of his son. He thereupon owned to his wife, with grief, that this had occurred under an evil planetary conjunction; for, should the child live until his seventh year, his life must be then endangered; and should he even survive, and reach his twenty-third birthday, he must again be beset by disaster; but if he still escaped death, his thirty-third year would be fatal.

The child was consequently, with extraordinary foresight and precaution, watched on his seventh birthday; but notwithstanding, by a most remarkable fatality, he was accidentally buried beneath a falling wall, and only survived with difficulty and with emaciated frame. On his twenty-third birthday, through a swimming in the head, he suffered a severe fall from an old tower; but surviving also

this casualty, he was, in his thirty-third year, finally drowned while swimming the Thames.

It would seem impossible to cite, in support of modern astronomy, or, indeed, of any problem dependent on such evidence, circumstances *more* presumptive than were these singular episodes, of the truth of a now discarded scientific system.

But there remain other important practical inferences, deduced from the gravitation theory, which seem to demand some reconsideration.

Had the developments of subsequent centuries of observation elicited a single *conclusive* fact in support of hypothetical astronomy, the case might have been otherwise. But, instead of any such developments, we have now to accept the discovery of an entirely new, natural, and overwhelming force of electricity; compared with which, in its almost omnipotent range throughout the universe, gravitation, although in the interval regarded as *solely* predominant, now sinks into comparative insignificance.

As bearing, too, upon this now problematic principle, there may be importance also in the observed motions of telescopic *binary* stars, now brought under inspection. It may, at any rate, be

here remarked, that these celestial bodies, revolving positively about *each other;* and although apparently of equal bulk, may not be, as they certainly cannot be demonstrated to be, really of equal magnitude or density. If not, their motions, about each other, clearly demonstrate the possibility that a larger body *can* revolve about a smaller one. And, if this be the fact, as a necessary consequence, the sun (not as a *gravitating* centre, of course) *may*, after all, by possibility and analogy, actually revolve about the earth—an aspect from analogy, which seems impossible of contradiction; and which also must necessarily go far to invalidate the entire system of gravitation.

If, too, as alleged, the celestial field of stars in their aggregate be revolving about some single star of a given constellation, why is that single star, if so employed, not more adequately *conspicuous:* since its bulk must, of necessity, bear some *visible* proportion to the enormous mass, when so combined, of the whole starry world? And, farther, who is to confute or demonstrate the equality of such a variable incalculable mass, to be the precise centrifugal *balance* of the centripetal attraction of such single star?

It is a law of gravitation, we presume, that when a celestial body revolves about its centre, the centrifugal and centripetal forces exactly balance each other; *exactly*, because an excess, in the smallest degree, of either force, involves an inevitable catastrophe.

Such balance of these conflicting forces we have, at any rate, always conceived to be an exigency of the doctrine in question. To suppose the contrary, it appears to us, must only be the occasion of the most chaotic consequences. It would then, of course, be immaterial, as a question of gravitation, whether the gravity of the planetary mass were *double* or *half;* or whether the sun were half or double of what either mass is now supposed to be; and, consequently, would matter little, whether either the sun or the earth, as matter of fact, be taken to be the true centre of planetary motions and orbits.

This balance of two opposite destructive forces in nature, is obviously essential to the harmonious working with other known laws, of any system dependent on gravitation; while the utter impossibility, in any instance to which the theory is supposed practically to apply, of demonstrating

the exact precision of such balance, seems necessarily fatal, in every way, to the possibility of its truth.

The revolution of our planetary system about the sun falls under the same law; the centrifugal force of all the planets, taken together, is therefore supposed to be neither greater nor less than that of the attraction of the central sun.

Yet, since the Newtonian age, two large new planets have been added to this planetary mass, and no catastrophe therefrom has resulted. The aggregate weight of the planets in our system, therefore, had not, in Newton's time, been exactly ascertained, and found equal to that of the sun; but had simply been inferred to be so, because the theory of gravitation had rendered necessary such a result. Whether necessary or not, however, it is abundantly clear that such a fact had not been, and could not have been, by Newton then ascertained.

Thus, therefore, an assumed planetary weight seems made, as if it were a matter of fact, to prove the theory of gravitation; and an assumed theory is reciprocally applied to prove a precise planetary weight. Assumption and gravitation, in this

instance at least, thus become synonymous and convertible terms.

If the supposed balance of the centripetal and centrifugal forces be a necessity of gravitation doctrine; and if the planetary orbit be an *ellipse*, how can an ellipse conform to this fundamental law, unless the whole circumference of an ellipse be always equidistant from the focal or attracting body? which we know cannot be the case. A focus is necessarily never equidistant, like the centre of a circle, from every point of the circumference. And if the focus be at one time nearer to its circumference by, say one-fourth, than it is at another, the revolving body must at such times be, of necessity, by one-fourth more powerfully under the attraction of the focus force; and thus all the supposed equality between the force of the attracting and that of the revolving body must, in the same degree, be constantly broken, and the system thereby deranged. How, then, is the necessary balance of these two forces throughout an elliptical orbit, while the squares of distance from the focus are thus alternately augmenting and diminishing, constantly maintained? and, if it be not maintained, what becomes of the essential law in question—the law

that an attracting focus, whose force *cannot* vary with the varying distances of its satellite, requires, to exert its proper power over it, that the latter be always equidistant?

The ancients, we know, believed in circular planetary orbits, but were ignorant of gravitation. We reject circular orbits, in which alone, it seems, gravitation could efficiently act; and we adopt the ellipse, in which, apparently, it is impossible for gravitation, in conformity with its proper law, perfectly to act at all. No doubt, the planetary orbits *are* ellipses; but, from the above reasoning, and possibly from our inability to fathom these mysterious points; it would seem a natural impossibility that gravitation can act *equally* from any focus upon a body perpetually moving round an entire orbitual circumference, which, at all times, is not equidistant from such focus at every point.

The progressive advance of science having disclosed, as we have seen, the operation in nature of the master physical law of electricity, we seem to be now landed, as it were, on the very threshold of an incalculably wide dominion—that, indeed, of a potency which, if it do not absolutely regulate the movements of the sidereal world, is innately

capable, as its prime mover, of controlling both that world and the universe itself.

The greater simplicity, therefore, which solely had determined the selection by Copernicus of the sun as the centre of the planetary orbits; and the peculiar evidence which had determined Newton in assigning gravitation as the controlling force of the universe; may perhaps thus present themselves as additional examples of the proverbial unwisdom of reckoning without the host; since both of these great men must necessarily have done so, if the doctrine of electricity, as developed by Helmholtz or by Herschel, had still remained (as we know to have been the case) unknown, in their day, equally to Newton and to Copernicus.

The alleged superior simplicity of the Copernican, as compared with the Ptolemaic system, even had such a consideration ever constituted a sufficient *scientific* reason for the abandonment of the latter; can hardly, therefore, in these now altered circumstances, be adopted as a proper scientific ground for the substitution of the Copernican.

The first creative ordinance of Deity, we learn from Scripture, was, "Let there be light;" and, according to Sir John Herschel, light (or elec-

tricity) involves a law of nature not limited by any region of the binary stars, as that of gravitation apparently is, but one that is co-extensive with the universe. According to Helmholtz, compared with this immense natural force, gravitation is weakness itself. It would thus seem as irrational, as it is impossible, still to concede to the latter principle the supremacy hitherto accorded to it; and, therefore, that science must now be driven to regard electricity as the foremost and master force in nature; and, in this aspect, as directly assailing the previous "fundamental conception of the physical universe."

This discovery of a new element of natural force, is calculated to revolutionise the previously ruling idea of universal physics; and much to enhance our views of omnipotent power, by enabling us almost to realise the very force by means of which possibly the material acts of Deity may *apparently* be controlled at pleasure by a simple divine *volition* merely; just as our own corporeal and *material* frame is irresistibly moved and controlled by an *immaterial* mental faculty—the *will.*

That *mind* does so act upon *matter*, and does so act directly, as to ourselves it appears to do, is

a fact beyond dispute. This fact mystifies completely, of course, all our preconceived ideas of the power of mind over the material world. The fact itself is however indisputable. By a simple exercise of this mental faculty, I will to raise my arm, and do so; the material body being immediately obedient to a physical force initiated entirely by the immaterial will.

It is possible, confessedly, that this mental power over matter, may be exercised through some yet undefined medium, and that its action may therefore *not* be direct; but no such intermediate agency is at the same time perceptible. To ourselves, because the bodily action succeeds so instantaneously to the mental act, it is as if it were really not so.

Enormous masses of brute matter also, as in the bodies of the elephant and the whale, are in the same manner moved at pleasure, by the simple exercise of an immaterial faculty, analogous, in many respects, to mind in man. And the power which this faculty, both in man and brute, is able to exercise over so much material substance; evidences to that extent that matter is really thus metaphysically and mysteriously *subject* to mind.

Some aid to the comprehension of this aspect of metaphysics is now afforded by the presumption that, while mind thus operates on subject-matter, it does not so act directly, but mediately, since it is possible it may do so through the almost immaterial medium of electricity.

As the revelations of the *microscope* have disclosed to us the existence of (what we previously could have had no conception of) an almost infinitely minute and invisible world; so this new doctrine of electricity, perchance, may eventually serve to bring within our mental grasp an intelligent idea of something approaching *infinite* velocity; and of the means whereby even the diurnal revolution of the heavens, though now to us beyond conception, may, in the hands of Omnipotence, be not a semblance only, but, as anciently believed, a reality.

It is remarkable, perhaps, how little we yet really seem to know of the purposes for which the stellar world exists. That the stars may be inhabited (although certainly not impossible) is yet simply a speculative doctrine assumed only, and devoid of everything of the nature of certainty. The highest Biblical authority affirms that the heavens declare

the glory of their Creator; and, besides this manifest object, we seem yet to have discovered no other end or purpose of their existence.

The same Record informs us, with regard to the sun and moon, that both were created to give light on the earth. We have experience of the truth of this information; but, by science, are still, with any degree of certainty, left unacquainted with every diverse or imagined purpose subserved by these great luminaries. Even the very sources from which the sun's heat is supplied and sustained; why it burns, and is yet unconsumed; to the scientific world of our own day seems just as great a mystery as the bush of Moses anciently was to its amazed beholder.

Can the astronomical motion of the earth, as deduced from gravitation, be discerned by the natural senses? The ancients disclaimed this doctrine, on the ground simply that such motion is imperceptible; and this fact is indisputable: we neither see, nor hear, nor feel it.

With regard to the other planets, the question is quite another affair, and purely speculative. But with regard to the *earth's* motion, the inquiry is intensely practical, and appeals to our senses.

Men accept, on authority, the doctrine of the earth's motion, and in scientific faith that it constitutes an essential part of a scientific theory; and to this view they deferentially assent, but, at the same time, distinctly contemning the testimony of the senses.

Watching the sunset on the horizon, motion *somewhere* is, to the very senses, a palpable *fact;* and, ostensibly, it is that of the *sun:* not of ourselves and of the earth.

Can this visible and apparent motion really be that of the earth and of ourselves? Jupiter's motion involves a question that to mankind is less practical: we could with composure accept such motion, as the dictum of scientific theory. But the other concerns us more practically and thoroughly.

And much more so must this be the case, if we attempt to realise the sort of motion which theoretic science assigns to our earth: it is not *motion* simply, but incredible *velocity:* a rotary, rolling, topsy-turvy velocity, of not less than 1000 miles an *hour!*

Conceive, if you can, of a railroad speed of the same degree; and of the earth in motion, with a

velocity far greater than that of the cannon ball's flight—17 miles each *minute*, day and night. The earth's *orbitual* motion, as deduced in the same manner, is, however, in addition to this rolling one—each *minute*—more than 1000 miles, or incessantly 17 miles every *second* of time!

Is it possible for the mind ever to realise what such a rate of progress really means; and although clearly, perhaps, theoretically deducible; to conceive that it is yet a motion of which ourselves, the subjects of it, are, notwithstanding, all the while unconscious? *Could* this kind of insensitiveness to such inconceivable velocity of our own persons with the earth itself, be a naturally possible fact, without, indeed, the aid and operation of a permanent *miracle?*

But, further, would even the computed centripetal force of *gravitating* attraction be capable of overcoming such a degree of centrifugal projective force from the earth's surface as that, on the other hand, also theoretically computed? According to Helmholtz, the amount of *electricity* contained in only a half-mile of water, would balance the attraction of gravity of the *whole earth!* But that the earth's inhabitants, although exquisitely sensitive

to the slightest shock of earthquake, should yet be insensible to this tremendous, though computed, motion of the earth,—these doctrines seem to be, if both are facts, naturally incompatible with each other; as well as incompatible with the obvious fact that, amidst all this disturbing double commotion, diurnal and orbitual, of the entire earth; no earthquake shock, from that cause, has ever yet transpired, although apparently it should be an inevitable occurrence. To guard against such earthquake disasters, necessarily incident to so violent a motion of the earth, one would suppose only a perpetual miracle, in this case also, could be effective.

The crews of ships passing each other at sea are apt to imagine their own proper motion to be that of the opposite vessel. But inspection of the *log* at once dissipates the illusion. How much more may the inspection of the not only *unwrecked*, but positively *unaltered* condition of everything mundane, all through the topsy-turvy roll and rush of such an imaginary tumult, within the bowels and on the surface of the earth, dispel all belief in its reality! Notions of probability are the very pest of science, which thus admits of an appeal to *fact*.

A former age boasted of an Archimedean lever to *move* the world: ours, it seems, more nobly boasts an electric hand to *steady* it, and arrest Newtonian motion.

The question whether the heavens revolve, or the earth does so, involves difficulty on either supposition; but the nature of the difficulty differs in the two cases. The revolution of the heavens presents a simple intellectual query; as if the magnitude of the idea alone were too great for mental conception, and as if nothing mentally of equal magnitude had ever before been witnessed; which, of course, is not the fact.

But the question of the earth's motion is of quite another kind—a difficulty, of which the natural senses are the proper judges. These pronounce it to be an *impossibility* that so violent and extraordinary a movement of the earth should occur *unconsciously* to the senses of its inhabitants.

It is a consequence of the earth's suspension in space, that erections at all antipodean points on its circumference do not, as imagined, simply *rest* upon, but are actually *suspended*, and are therefore held to, or attracted to, its surface.

That this kind of centripetal attraction can re-

sult from so comparatively weak a force as gravitation is now proved to be, is inconceivable: probably the illimitable force of *electricity* alone could fulfil this necessary function; but even this, we may conclude, could only be the case, if the earth were a body always at *rest*.

A force almost *omnipotent*—according to Helmholtz—is certainly indispensable to the earth's *steadying* process, and is adequate thereto; as necessarily it also is to the earth's centripetal attracting function. If, however, besides this latter function, there has to be provided against the supposed centrifugal action of the earth, on a motion of 1000 miles a *minute;* such provision can only be regarded, perhaps, as both impossible and supererogatory — especially if we are to believe that mankind could really be insensible to it.

To us, indeed, it seems fairly questionable whether any scientist exists who, reflecting on the impossibility of such an unnatural degree of unconsciousness, could, in spite of all theoretic conclusions, for a moment hesitate to reject such a conceit, and any scientific theory that exacted so great a stretch of credulity.

On the surely monstrous idea of this stable

earth's being moved with such terrible velocity, the sooner, perhaps (and it really seems neither possible nor rational to suppress such a confession), the sooner, one would imagine, the world returns again to its senses on this point the better.

To astronomers, it is well known, that there does not exist a particle of *certain* evidence that the earth moves at all; and that Galileo, when he affirmed such motion, did so after the manner of modern astronomers, merely as a simple deduction from scientific theory.

The only alternative, however, to the earth's diurnal motion is, that we must accept in its place that of the *heavens*. But should we, by the palpable impossibility, in the nature of things, of the earth's computed motion, be driven to that only alternative; would the opposite diurnal movement of the heavens be at all a *more* possible conception?

This celestial motion certainly would then, of course, concern us as *spectators* only. And, even in this case, the electricity of Helmholtz would supply every mechanical force instrumentally auxiliary to omnipotence to accomplish the result.

Another consequence of this alternative idea would be, that celestial and stellar motion would

be what, to the observer, it really appears, and, by astronomers themselves, has still to be reported to be. The astronomer, then, would no longer, as now, be compelled, by common sense, to speak of the rising or setting of the sun or the stars, when he at the same time scientifically believes the contrary. The similar phraseology of Scripture would, in like manner, then also be descriptive of actual natural facts.

Our allusion above to electricity, as an auxiliary to omnipotence, is made in consideration of that peculiar mental infirmity which seems to afflict certain scientists, incapacitating them to comprehend, and disposing them to question how it is possible, even for Omnipotence, to perform a miracle, unless, at the same time, its physical means of accomplishment are also made palpable to the senses.

This prodigious force, as described by Helmholtz, seems, for the first time, now to furnish the very physics of nature, by which, through an almost omnipotent ethereal law, any and every miraculous event of Scripture history commends itself to the mind as at least *physically* practicable; and, to the most scientific, even palpably so.

Electricity, however, is not *sentient;* and though of the most varied applicability, and probably the most erratic of forces, its harmonious co-operation with all other natural laws, we may conclude, could result only from its perfect control by a *supremely* intelligent power.

In electricity, as now proclaimed by an authority of the highest scientific eminence, there exists, it seems, at all points, an ethereal element, by means of which a *half-mile* of water is made to counterbalance the total weight of the globe!

If this be really so, then, by parity of reason, the electric contents of two or three hundred miles must counterpoise the whole Solar system; and, taking all the waters of the earth together, must probably counterbalance even the aggregate gravity of the sidereal heavens. As a central force of the universe, how striking, then, the contrast between this ethereal agent and gravitation!

In nature, therefore, there is always, it appears, latent and available force enough for any and every physical result, regarded as miraculous by minds only whose ideas of Divine power are limited by the *previously* known physics of science.

This is the astronomic aspect of electricity:

the illustration of Dr. Helmholtz applied in its *mechanical* power being competent to control a globe of 24,000 miles circumference.

To practically annihilate *distance*, this amazing force already is now seen daily in operation: an impulse on the electric current is instantaneously felt 12,000 miles off; and, were the electric current of the globe complete, must, at the same instant, be also repeated at the point from which it was first given. Were it possible, besides, to extend the electric current to the most distant star, the response, even at a point so remote, must still be equally instantaneous!

To the effective lighting up of *Night*, also, has this strange power been already successfully applied. It is incipiently in process of mechanical adaptation to the varied uses of *steam*-power; but, in this field of practical utility, it possibly may not be either efficient or economically successful, until the method mentioned by Dr. Helmholtz shall be perfectly understood—of generating electricity from *water:* in which element steam-power, like that of electricity, until accidentally observed, had also for so many ages lain hidden and dormant.

Such are the actual achievements and projects

of electricity. Contrasted with gravitation, what beyond the merest theoretic plausibilities have yet resulted from the latter?

Another result of adopting the alternative astronomy in question would be, that, accepting as sufficiently correct, the existing computation of sidereal distances from the earth; we should really possess, in the diurnal revolution of the heavens, a more impressive demonstration than we can now realise, of a force of *velocity* approaching the *infinite*: just as we are compelled to receive the not more repugnant revelation (intellectually considered) of the existence everywhere around us of an almost infinitely minute and invisible microscopic world of animal life. How greatly, too, must this alternative doctrine of a revolving heavens, enhance our conceptions of an omnipotence, which can thus manipulate and hurl through space the whole starry host, with the same facility even as that with which a playful kitten tosses about cotton reels!

Besides these more scientific considerations, however, there is another aspect under which our subject must also be viewed, and that is, the light which Sacred Scripture seems incidentally to cast upon the enquiry.

Scripture is not professedly a revelation of scientific knowledge; but if it be a record of divine information, its suggestions may not be wisely disregarded; and there are points interesting even to science, of which Scripture certainly takes incidental cognisance. The question of the earth's stability, and the place which our globe holds in the estimate of Deity, in comparison with the whole universe besides, are points of this kind.

As to the first point, every Scripture allusion to the earth's stability, is conclusive of the light in which divine revelation regards that question. That its very precise language in this respect is an accommodation to the imperfect science of a previous age; is an explanation that is more indispensable to the philosophy of the present day, than consistent with a divine revelation from the Author of Nature.

With regard to the second point—the Scripture estimate of the earth's comparative insignificance in relation to the rest of the universe—this estimate appears to differ *toto cælo* from that of Science. While philosophy is wont to expatiate upon the possible or speculative uses served by the world of *stars*, Scripture is altogether silent on that aspect

of nature. Not an allusion is ever made to the possibility of other worlds than ours being inhabited, or to events and exigencies which concern them; but, as if really no other inhabited sphere than our own existed, the references and bearing of all Scripture notices, are exclusively engrossed by events and affairs appertaining to this world alone.

It is, indeed, impossible to exaggerate the Scripture estimate of this earth's concerns; or the magnitude and interest they assume in the eyes of Deity. Events are related respecting this world of ours, which evidently are such as could not possibly be repeated in another sphere: such, for instance, as the voluntary vicarious sacrifice for human offences, offered by an infinite Creator, in a human body. Nor could Divinity declare, in regard to another sphere, as is alleged to have been the case with reference to this earth, in anticipation of its future perfect renovation, "*This is My rest* FOR EVER: HERE will I *dwell;* for I have desired it" (Ps. cxxxii. 14).

Such events, and this emphatic declaration of Divine interest in human concerns, seem utterly to confute the philosophical idea, that our earth is

altogether too mean a thing, and that its Creator cannot regard it as worthy of so magnificent a satellite as even the entire starry world would be; while that world's Creator condescends to confer upon the same earth so much higher marks of personal honour and dignity as God's identification of Himself with its interests clearly implies.

It would follow, consequently, from this Scripture aspect of the subject, that since philosophy knows with certainty no other uses for which the stars exist in the universe, it may be possible, after all, that those resplendent orbs have a future destiny beyond the conceptions of science; and that, like the profuse creation of delicate and gorgeous flowers, they exist for glory and beauty only; and possibly may be designed to decorate, even though with such lavish astronomical magnificence, the celestial canopy of an earthly pavilion of the future great King of Zion—the throne, which Deity itself avows, as in the Scripture just cited, so intense a desire hereafter to occupy!

The very natural objection, therefore, that the immense starry host *cannot* have been constituted the mere satellite of the comparatively insignificant earth; seems, in this manner, conclusively to be

met and solved, in so far as Scripture declarations are concerned.

On the assumed doctrine of the necessity for an operative central force in nature, it is curious to observe also how completely this sacred oracular authority ignores the scientific *gravitation* idea of its character; and substitutes for that idea the more rational conception of a natural power, directly controlled by the Author of Nature Himself.

The first creative edict had been, "Let there be Light." Science now discovers this primitive ordinance to have involved the diffusion through the universe of an ethereal *electricity*.

We are again told that, on Creation's fourth day, a further creative edict had given birth to the *Sun*, in order to give light upon the earth. By this origin and order of existence of the sun, we can only understand probably that some concentrated portion of the just created universal electricity, had now, for this specific object, and after some natural modification of its lightning fire, been detached from the original electric mass.

If such be the origin and nature of *sunlight*, a scientific and intelligible solution seems here to be furnished of the moot problem—*how* the sun's light

and heat are perpetuated without exhaustion of their natural fuel. We have now, it seems, to conclude *that* fuel to be simply an ethereal and comparatively inexhaustible material; or such as, by means of reinforcement, a continued natural supply is maintained, by the constant absorption into the sun's substance of an incessant stream of electricity.

The fixed stars, those radiant "light-bearers" of heaven, shining, like the sun, by their own light, may possibly have had a similar origin. As to their composition, since science has nothing positive to advance on that point, beyond what we perceive by visual inspection; those brilliant luminaries may possibly be formed of similar unsubstantial materials to those of comets, and, like them, may even be transparent also.

That the mental faculty, whether divine or human, as already suggested, may, in the first instance, possibly act on matter, through some intermediate agency; is now rendered more intelligible to us; by the knowledge that there actually exists in nature an ethereal, almost immaterial, and irresistibly potent energy, like electricity; an agent so powerful in operation that, even admitting gravita-

tion to be of the force estimated, electricity still exceeds that agency, and is, by incalculable millions of times, more potent.

There seems, however, to be yet known to us no other natural agent that is of equal, or even proximate potency. But this force alone may assist our comprehension of a means whereby, as Sacred Scripture affirms, the simple *Word* of God alone had, in the beginning, originated and created *all* things; and, by which immaterial Word, the fabric of universal Nature is still upheld in being.

In fact, by this simple discovery of the existence in nature of an illimitable force of electricity, all our previous ideas of the necessary dominion, throughout the universe, of the physics of science, are subverted; and, for the first time, we seem enabled to realise intelligently the possibility of the great works of creation being only the *necessary* effects of a simple divine *volition* and *mandate;* how, also, through the same efficient cause, it became possible for the after destruction of the same world to have resulted from a divinely decreed supernatural deluge; and how, by a long revealed admonitory decree, may inevitably yet be witnessed by the world, its own final overthrow by fire,

through a sudden ignition of the atmospheric elements.

This ascendency, in the higher realms of nature, over the ordinary laws of material physics, may also assist our comprehension of the possibility that, at Deity's command, even the *sun*, for a space of twelve or twenty-four hours, may have actually stood still in the heavens; how, also, by a similar supernatural interposition, the noon sun may have been made to retrograde by ten degrees on the dial of Ahaz; and how, at the Crucifixion, while no natural eclipse of that luminary was possible, the sun, for the space of three hours, should have been supernaturally veiled as in sackcloth.

It may, perhaps, be impossible to estimate the degree in which this hypothesis of Gravitation, undesignedly, of course, but not less certainly, may have gone, as their great precursor and authorisation; to originate, foster, and countenance the novel brood of ambitious scientific theories, already verging upon, or immersed in, downright atheism; which to-day so rudely assume the place of *real* scientific knowledge, founded, as it ought to be, upon its only possible basis,—ascertained *fact*.

The great Bacon, we know, never accepted, but

rather ridiculed, the Copernican idea of the earth's motion; and amongst others, in later times, the celebrated Oxonian, John Wesley—no mean judge of scientific questions of this type—expressly demurred to the astronomical dogma of gravitation.

Pictures of the imagination are apt, at all times, to interest and charm. But its conceptions, of course, may be either grand or absurd, sublime or ridiculous. With Akenside, we often confess that—

> "Not content
> With every food of life to nourish man;
> By kind illusions of the wond'ring sense,
> THOU mak'st all Nature, or beauty to the eye,
> Or music to the ear."

When imagination runs wild, we have only to give it wings, and be carried, we know not whither, into dismal regions of fatal error. Fancy, therefore, has to be sternly bridled, and held within the domain of facts; otherwise, fiction becomes fact, and, arrayed in scientific dress, captivates as though it were truth. This reckless mental latitude and skilled play of science upon plausible elements, mainly, perhaps, characterise the philosophy of the present day.

At present, the theory of gravitation is, with few exceptions, universally accepted as an essential branch of education; not on any appropriate evidence, but chiefly, perhaps, on *authority*—the authority and prescription of its eminent professors.

It is, at the same time, a doctrine that seems to have so little relation to the affairs of common life, that it can clash with nothing practical; restricted, as it exclusively is, to an ideal world of its own creation; and, whether true or false, therefore, can really make no difference whatever to any individual living. The case, confessedly, would be different, had the doctrine been one, like that of practical geology or chemistry, of grave practical import.

Started on mere hypothesis, and in an age when the great Cartesian and kindred dreamy hypotheses were in the ascendant; gravitation has, to its scientific votaries, been the source of innumerable mathematical and abstract calculations; interesting to those who pursue them, because to themselves mathematically true—if only their basis were so: otherwise this learned trifling merits only the more apt designation of mathematical folly. But, revelling in this unlimited world of its own creation,

the mathematical mind is furnished with endless fascinating occupation.

Such purely mental exercitations, however, undertaken, like the game of chess, to shew mainly the player's skill, can have no appreciable result, except possibly to engender such irrational conclusions as that of the immortalised astronomer, who, contemplating the starry world, could only declare his opinion, that "the heavens do not declare the glory of God, but that of the astronomer —Arago, Laplace, or Newton!"

In this puerile vain-glorious conceit, the allusion, of course, is to an ideal *mechanique celeste*, and to the more select range of astronomical mathematics; by means of which the modern astronomer is supposed at pleasure to manipulate the heavenly spheres, and exactly to compute their motions, bulk, gravities, &c., &c.; himself all the while at ease in this purely hypothetical world of gravitation theory. This scientific system, we know, can of necessity possess only just so much truth as may be supposed to be evolved from Sir Isaac Newton's imaginary test—that of an anomalous substance hypothetically dropt from the moon's altitude. Such an experiment, bold as its inception appears,

we may be sure has never yet been, nor ever can be, so dropt towards the earth, for the verification of any theory whatever; from the moon's intangible elevation, or that of any other planet.

The astronomer whose telescopic eye (without, however, discerning *why* such celestial spheres exist) is enabled to explore the outskirts merely of nature's boundless realm. Yet, we must confess, how utterly inconceivable it is to ourselves that so grand a survey of creation, should not, from every logical mind, rather extort the more natural reflection, How infinitely great, then, must be the Divine Author of all existence!

We have before had occasion to remark upon the circumstance that not only the age and country, but even the names, are lost in the remotest antiquity of the distinguished authors of many of the most important ancient astronomical discoveries.

It is not, therefore, we conclude, impossible that some of these extraordinarily gifted persons may have flourished so early as the date of the erection of the Great Egyptian Pyramid. The interesting recent researches of Mr. Piazzi Smith, Astronomer-Royal of Scotland, within the long-concealed

interior of this remarkable building, seem conclusively to point in the same direction.

This mysterious fabric has been thus described: The original vertical height was 485 feet, each of its four sides 762 feet. It was cased, when originally completed, with blocks of smooth white limestone, almost like marble, in a sloping plane, exhibiting matchless workmanship, marvellously correct and true, the blocks having each a height of nearly 5 feet, a breadth of 8 feet, and a length perhaps of 12 feet, joined together with a film of cement no thicker than a sheet of silver paper, the whole rising at an angle of 51° 51′ 14.3″.

The purpose of this erection baffles all conception, except that it certainly was not built for a *mausoleum* of any sort, as the other and later Egyptian pyramids evidently were.

Sir John Herschel has pointed out that the angle of the northern entrance passage had a special *astronomical* meaning; and was evidently intended to indicate the date of the pyramid's erection to be the year 2170 B.C.; when, at midnight of the autumnal equinox, this passage pointed directly to the then polar star Draconis. This opinion has

since been confirmed on the spot by the Astronomer-Royal of Scotland.

Another and most marvellous fact disclosed by the examination is, that the vertical *height* of the building, in its original condition, was to *twice* the *breadth* of its square base, as the diameter is to the circumference of a circle; that is,

as 5813 : 9131 × 2 :: 1 : 3.14159, &c.;

or, that the sum of the measured four sides of its base bore the same relation to its vertical height that the circumference of a circle bears to its radius.

This is, therefore, of course, neither more nor less than the solution of the celebrated practical problem of the mediæval and modern ages, commonly known as the *squaring of the circle.*

If, then, this quantity be really found, with exactness and magnitude, built into the plan and architecture of the Great Pyramid; the erection distinguishes its designer and architect, whoever he may have been, as raised by the work of this surpassing structure, not less than 3000 years above and in advance of the most learned or most scientific person of even our own boasted age!

From the only existing traditional data, the

architect of this remarkable fabric is reasonably conjectured to have been no other than the antediluvian patriarch Shem, the son of Noah; who, we know from Scripture, survived the epoch of the Deluge so long as 500 years; was, therefore, long the contemporary of the patriarch Abraham; residing in Palestine, after the completion of this colossal building, and presumed to have there been the true Melchisedec of Scripture.

On this interesting structure, a writer has further observed: "This unique and gigantic erection is of the greatest interest, from whichever point of view it may be looked at; and there is such an evident and peculiar connection of all parts of the Pyramid with each other, and with the heavens and the earth, as to leave no doubt upon any unprejudiced mind, that its architect had a deep design and settled purpose in its construction;" a purpose which, no doubt, if not immediately, may yet hereafter be more perfectly revealed to the world.

Like the lately exhumed tablets and monuments from ancient Chaldea, Nineveh, and Babylon, it is thus, from such wholly unanticipated quarters, that new and deeply interesting light is constantly being

thrown upon the wonderfully perfect architectural skill, the science, and the astronomy of the ancient world.

It would seem an impossible conclusion, that men possessing the genius which could design, and the art which could exquisitely execute, an unparalleled work of this remarkable character; the men who had anciently discovered, systematised, and consolidated *every* fundamental fact and doctrine known to us of astronomical science,—excepting, perhaps, the now problematical hypothesis of gravitation,—should have been the intellectual pigmies which the present self-sufficient age has been but too apt to account them.

On the contrary, these gigantic minds, through their own native dignity, rise to the rank of the foremost scientists and philosophers of any age; while their immortal achievements will descend, with the inimitable verse and sculpture of ancient Greece, to following generations, so long as the world shall endure.

From this careful review of the *pros* and *cons* of so important an astronomical question, we confess we should be not greatly surprised, were we yet to

witness,—impossible as such a spectacle fifty years ago must have been,—the return, one after the other, of our learned scientific bodies—freed from the bewitching thraldom of a comparatively new-born chimera of misdirected science—to the apparently heaven-taught system of the ancients—the astronomy of Nature, of the Senses, and of the Bible: that is to say, the possibility forces itself on the mind, that even so complete a revolution of sentiment on this great subject, must result, as we conceive, from the simple, unbiassed reconsideration, by these various schools, of the inconclusive steps by which the final conclusion, as to the truth of gravitation, had been reached; and of the already ascertained forces by which that conclusion is presently assailed.

The consequence, of course, of so great a scientific revulsion, must necessarily be, the proportionate renunciation, as a simple fiction, of the now popular theory of gravitation.

Contemplating the beauty and grandeur of the heavens, the exclamation, "Lord, what is man!" was naturally extorted from the lips of the devout Psalmist. "Lord, how great is man!" is, perhaps, more frequently now the sentiment involuntarily

escaping the lips of the enrapt astronomer, absorbed in the congenial investigation of some gravitation problem.

The natural tendency towards either exclamation and state of mind, seems sometimes to depend mainly on whether the one or the other system is predominant in the thoughts of the student. What we know with certainty is, that it was *not* the modern astronomical conception of the heavens, which, in the breast of the Royal Psalmist, had inspired the natural and appropriate sentiment just cited from Sacred Scripture.

In conclusion. It will probably have been perceived that the central argument, upon which our main conclusions have been based, is the novel scientific doctrine of Dr. Helmholtz.

We have here, beyond dispute, a great rudimentary philosophic fact, apparently without essayed application of it. It has been proclaimed by, without exception, we suppose, the greatest living master of Natural Science. Its practical application, too, is inevitable. We think this must be patent alike to the most, as to the least, scientific mind, that is simply capable of appreciating its direct bearing;

explosively, upon much physical science till now deemed established; and, indirectly, by the flood of confirmatory light which it throws on several scientifically obscure facts of sacred cosmology.

And yet this astounding scientific revelation would seem already to have passed out of mind, as if it had been an ordinary communication, and possibly of no permanent import.

The singular inconsistency with their professed reverence for scientific facts, thus evinced by philosophers, is to us unaccountable; and merits from them, as we conceive, and most humbly submit, either justification or apology.

The extraordinary scientific doctrine thus authoritatively announced to the world, is obviously calculated to revolutionise all our preconceptions of natural physics; to undermine and explode the previous "fundamental conception of the physical universe;" and to be especially fatal to every gravitation hypothesis.

The last-named system had received the spontaneous homage of the great scientific world, as it would now appear, rather from the grandeur and sublimity of its inception, than from any propor-

tionate *evidence*, on which even its accomplished author had been able to ground it.

When Sir Isaac Newton adopted his extraordinary lunar demonstration of the law of gravitation, he did so because, on the earth's surface, every adequate theatre was by him pronounced impossible for that exceptional experiment. By this admission, he necessarily proclaimed the futility, in his judgment, of all those collateral indecisive illustrations of the doctrine, in which its inferior advocates, by various modes, have essayed their peculiar demonstrations. By this general Newtonian confession, therefore, the whole argument would seem to be narrowed down to the single merits of the selected test of the greatest of its exponents—the hypothetical lunar experiment.

In an earlier essay,* we had recently occasion to shew that, in every instance in which an ancient philosophic hypothesis had been broached, even in an erudite and classical age; just in the degree in which such learned thesis had conflicted with the merely incidental Scripture notices of the same topic; it had in every case, by the better established verifications of modern science, been ultimately

* "Bible Anticipations of Modern Science."

rejected as false. That, on the other hand, these Scripture condonations and incidental references had uniformly (without, however, observing this coincidence) been affirmed by the same authority of modern science. And, further, that the simple reason or cause of this discrepancy between Scripture and these ancient learned hypotheses was, that the latter had been professedly advanced upon a purely *speculative* basis.

Judged by the same scientific standard of *fact* and actual discovery, this hypothetical doctrine of gravitation, which also seems to go so directly in the face of the plainest Scripture language, and against evidently its real meaning; if for no other reason than that just specified (although we have besides offered other arguments which to us appear conclusive); it would appear at least presumptive, that this purely speculative scheme of gravitation, also, must ultimately prove itself just as false as every other kindred doctrine has been found to be, which is not legitimately founded on true science; that is, on *facts* which have been ascertained, and can therefore be verified to be such.

And now, like a very noble pile, erected upon an inadequate foundation, this stately fabric itself

seems already to topple towards collapse, and doomed eventually to fall.

In this aspect, it would seem difficult perhaps to repel the natural surmise that, contrasting so magnificent a superstructure with the feebleness of its base, even this too much idolised theory of gravitation, may possibly have formed the very *prototype* hypothesis, the master model and inspiration, in fact, of the many baseless scientific crudities, which, in this characteristically projecting age, and under the sacred name of Science, degrade and disfigure its so-called philosophy.

The very flattering idea of having found the law of the universe, may, by possibility, have blinded the great Newton to the palpable weakness of his fundamental test. To every scientific mind it will now, we suppose, be clear—if such a law be still the desideratum of science, and if *two* paramount forces in nature be an impossibility—that the only adequate agent to fulfil such a function must be electricity; and that gravitation must consequently fall from its usurped high pedestal.

That gravitation rests upon presumptions of *probability* pure and simple; and that still the system is accepted, as though it had been

grounded upon *fact*, we suppose, will be conceded.

We humbly submit that this is not a state of things at all creditable to science; whose laws, we conceive, bind her to ignore probability altogether until confirmed by facts—fact *alone* being the basis of true science. By contrast, electricity is found to be one great fact, universal as the light of heaven.

It is true that, in regard to gravitation, the grandeur of its original conception had acted like dust thrown in the eyes of the scientific mind, so as to conceal its fundamental defect. But, surely, science herself may be presumed able to appreciate this distinction. Until she practically do so, however, both with regard to this great ideal system, and to every other equally devoid of solid basis; and shall learn to sever idealism from realism, fiction from fact, falsehood (properly speaking) from truth, her decisions, we much fear, must be fatal to her high judicial prerogative, viewed as the proper guardian of all philosophic truth.

Not that science should discourage all scientific theory based on probability, but, on the contrary, should even patronise it; as being possibly science in embryo, though disentitled in that stage to so

high a designation, until the corroborative facts, necessary to sustain that designation, have been discovered, and can be produced in evidence.

Like a very stately building, without foundations, had gravitation till now found place only in this probationary class—at least until a single *decisive* fact in her favour had appeared—the dignity of science had not been compromised by this premature advancement of a baseless theory.

But it now so happens that gravitation, having finally lost all possibility of thus establishing herself, electricity suddenly starts to the front, monopolises the field, and definitively ejects her from the throne, on which, by the scientific world, she had till now been worshipped, as the sole central power of Nature.

Let us not here, however, be misunderstood; we do not dispute the *fact*, that bodies on or about the earth *do* tend towards it as to a centre. It is not *this* palpable fact that we question. What we dispute respects the philosophic *cause* of this fact; and we make bold to deny that a single *decisive* proof exists, that this tendency of bodies towards the earth is necessarily—what Newton assumes gravitation to be—the natural attraction of each

particle towards every other particle of matter. This has never yet been demonstrated; and we submit that the cause of the tendency mentioned is more probably the now discovered greater force of electricity, or may be any similar natural cause yet unknown.

That, in the estimation of science, electricity must permanently displace gravitation, seems inevitable. The circumstance is evidence also that even science is not infallible; and, at the same time, it administers a salutary rebuke to certain philosophic critics and scientific commentators of Sacred Scripture, who seem but too ready to yield implicit credit to a dictum of science, while disputing, on the same point, the infallible authority of a divine oracle.

Science had affirmed Scripture to be contrary to Nature, simply because science herself, it appears, had not fully understood Nature; but had invented her own laws of nature,—one of which was gravitation. To science, nature has now greatly expanded her field of vision, by disclosing the law of electricity. Besides which, we know not what additional discoveries are still (as electricity long had been) hidden from view.

The present age is prolific of marvels in the history of science. We may yet have revealed to us the *medium* (if it be *not* electricity) by which *mind* acts on *matter;* and as we know such to be the fact in ourselves, with regard to the mental faculty of *will;* we may yet learn the solution of the scientific problem, and be enabled to comprehend the *medium* by which an *infinite* Will, after the same manner, acts infinitely (though in a mode which science deems counter to nature) upon a subject material world.

With this advancing knowledge on such important new points, it may be hoped that science herself may yet have so much added to any former stores she had possessed of practical wisdom; as to be enabled to speak with becoming diffidence on some matters entirely beyond her unaided reach.

By the recent discovery in electricity, scientific society seems simply *stunned*—deprived of speech; embarrassed alike to reconcile with this overwhelming physical force present established scientific theories, or future scientific reconstructions. This new aspect of electricity, in fact, subverts the whole philosophic basis of the material universe!

Physical Science, as applied to *universal* Nature, has now, it seems, to be begun *de novo*, and *ab initio*. The downfall of the great *quasi* philosophical system of gravitation, would necessitate this. It must apparently also upon the advancement and the moral atmosphere of real knowledge, in all its departments, have this salutary effect generally; if such hereafter is to be based on *certainties* alone: for it would seem impossible that the admonitory effect, amongst the learned, of so singular a catastrophe, should not henceforth pervade the whole tone of science; and inevitably enforce therein the rule or law that, in future, the distinction be strictly drawn between philosophy that is *sound*, and that which is *unsound*; or, what is *certainly* ascertained, and what is merely *conjectural*.

In this aspect, the catastrophe, even to the scientific world, will not have been without advantage. And, all the better, should it even lead to the recognition, by our pre-eminent ROYAL SOCIETY, of this vital distinction between pure and vitiated philosophy; and to the possible endowment, by that great Society, of a CHAIR, for adjudication, in so far as its own authoritative influence shall extend, upon their intrinsic merits, in this respect,

of all present or future philosophic theories: so as to debar from the high designation of *science*, and to restrict such theses, however promising of future development, to some elementary or *probationary* class; until found to be adequately grounded on decisive fact or facts.

From this disquisition, we may also perhaps discern, with how much possible facility, human science may ignorantly, and to itself even *suicidally*, anticipate the effect of advancing knowledge of nature; and how, in this way, "the wisdom of the world," is sometimes made "foolishness with God;" how progressive discoveries in natural science, too, in their varied consequences, may frequently serve chiefly to vindicate, on the part of Christian men, that confidence in *divine* truth, which, even though its scientific *modus* be concealed; in the event, is certain to be literally verified, as the simple faith of *God's* word—that infallible testimony, which, founded on the impregnable rock of God's veracity, "cannot be broken."

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