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NEW THEORY

OF THE

ORIGIN OF THE SOLAR SYSTEM

Creation the Result of Law.—Law of Projectiles.—Balancing Orbits.—Original Condition of Solar and Planetary Matter.—A Nebulous World first formed.—How Rotation was impressed upon it.—Momentum.—Consequences of the Expansion and Union of all the Bodies of the System.—No Momentum Lost or Gained.—Union of Complex Motions.—Period increased by Expansion.—Diameter of the Parent World.—Period of Rotation.—How a Nebulous Ring might Originate.—Stable and Unstable Rings.—Projection of Saturn's Rings.—Plural Rings.—Ruptured Rings.—Orbs formed of Ring matter must Rush to Destruction.—The Ring Theory of La Place an Impossibility.—How Planetary Bodies Originated.—How Circular and Elliptic Orbits Originated.—How Balancing Orbits Originated.—How Inclined Orbits Originated.—Table of Inclinations to the Sun's Equator.—Localities of Projections on the Primary World.—Times of Projections within the Reach of Mathematical Computation.—Mathematical Discussion of the Theory in 1861.

THE solar system in every department is governed by law. He who has wisdom to control organized worlds by law, certainly has wisdom to control the materials before they are organized, and to control them during their organization. Some laws are unchangeable in their character, and universal in their operations, being the same in regard to all matter, whether existing as widely diffused chaotic particles, or collected together in the form of worlds. Among these general and universal laws may be named gravitation. Every particle of matter in the universe, whether organized or unorganized, is under the dominion of this Divine law.

Before inquiring into the origin of planetary projections, let us endeavor to understand more fully the law of velocity and direction, in determining the magnitude and eccentricity of the orbit of a projected body. If two bodies of unequal masses be connected by a rigid rod or bar, and balanced on a pivot at their common centre of gravity, the distance of either body from such common centre will be inversely proportional to its weight; that is, twice the weight or mass will be one-half the distance from the common centre that the smaller mass has; three times the weight, one-third the distance; four times the mass, one-fourth the distance; one thousand times the mass, the one-thousandth part of the distance, and so on. Now, if these two bodies, thus connected and balanced, be made to revolve around this balancing point, they will each describe a circle around this common centre, the size of which will be inversely proportional to its mass; that is, twice the mass will describe a circle whose circumference is one-half that of the smaller mass; three times the mass, its orbit will be one-third of that of the smaller; ten times the mass, one-tenth the circumference; one thousand times the mass, the one-thousandth part of the larger orbit; and so on.

Next remove the rigid rod, connecting the two bodies, and in its place substitute the gravitation of the two bodies toward each other. In this case, in order that the two bodies may describe circular orbits around their common centre, they must be projected in opposite directions, and at right angles to the line connecting them; they must also be projected with velocities which will generate centrifugal forces exactly equal to their respective gravitations towards each other, or, which is the same thing, towards their common centre; hence, the balancing velocities will be inversely proportional to the masses; that is, twice the mass will require only one-half the velocity of the smaller mass; three times the mass will require only one-third the velocity; ten times the mass, one-tenth the velocity; one thousand times the mass, the one-thousandth part of the velocity; and so on.

If these proportional projecting velocities are somewhat too great to balance the centripetal force of gravity, and are in opposite directions, and at right angles to the line connecting the bodies, they will each move in curves receding from the common centre, with velocities continually decreasing, until each has described exactly one-half of its curved orbit, at which instant, the two bodies will not only be moving in opposite directions, but at right angles to the line connecting them. But the velocities will now be too small to describe circles; hence, the two curves will be bent inward more than a circle, and will gradually approach nearer, while their velocities will continually increase by the accelerating force of gravity, until they have described the last half of their curved orbit, at which instant their velocities will be precisely the same as at the moment of projection. These two curved orbits are found to be ellipses, and the common centre of gravity is found to occupy that focus of the ellipse nearest to the two perihelia, or, in this case, nearest to the two points of projection. When the two bodies have described one-half of their revolutions, they will both be found on the opposite sides of the common centre in the aphelia points of their orbits. And throughout the entire revolution, the two bodies will move in opposite directions and parallel to each other; and at every instant their velocities will be in one constant proportion to each other, and also inversely proportional to the masses.

If the velocities of projection are not much greater than what are required to generate circular orbits, the two ellipses will be less eccentric, approximating circles. As the projectile velocities increase, the eccentricity of the two ellipses and the major-axis will increase. And when the velocities reach a very high value, or to a definitely high value which can be mathematically computed, the two ellipses will generate into parabolic curves whose branches are infinite and do not return into each other; and if the projectile velocities become still greater, the two balancing curves are still further altered into hyperbolic curves, whose branches are also infinite. Bodies launched forth in either of these last named curves, would never return, unless acted upon by extraneous causes altering their orbits.

If the velocities of projection are less than those required for circular orbits, they will also generate elliptic orbits. In this case if the directions are opposite and parallel to each other, and at right angles to the connecting line, the two points of projection will be the two aphelia, or the most distant points of the orbits from the common centre. The more the velocities decrease below those required for circles, the more eccentric the two ellipses will be, the minor axis decreasing or the flattened sides of the ellipses approaching nearer to each other and to the major axis. And when the velocities of projection diminish to nothing the ellipses generate into a straight line, and the two bodies will fall and meet each other at the common centre of gravity.

If in any given pair of ellipses the two bodies were projected at similar points in opposite directions, and parallel to each other; that is, in the direction of tangents at those points, and with velocities proportioned to the eccentricity, they would describe their respective ellipses in the same time, and in the same path, as if projected with proportional velocities at the perihelia or aphelia.

When the mean distances of the two bodies from the common centre, and their respective masses are known, it is a simple problem in mathematics to determine the distances from the common centre to the perihelia and aphelia, and also the respective velocities of the two bodies at those points.

We will next inquire into the original conditions of the materials of our System.

Let us go back in our imaginations to the time when no worlds in our solar system existed; when the materials, now in the system, were diffused in a nebulous, gaseous form far beyond the limits of the most distant planetary orbit. Indeed, let its boundaries extend half-way to the nearest fixed stars. Such an expansion would not leave the one-two millionth part of an ounce in a cubic mile of space. This excessively rarefied condition would not destroy one particle of matter, nor deprive it of the force of gravitation. There would still be one common centre of gravity towards which all these particles would tend.

In approaching the great common centre, there would be myriads of other centres towards which clusters of particles would move, and around which they would gather, in their onward progress towards the grand centre of the whole. Myriads of these nuclei would in their turn approach myriads of others, uniting and forming still larger nebulous gaseous masses, until eventually they would become united in one vast mass; and by the law of equilibrium each particle would urge its way towards the general centre, and form a surface approximating a regular form. If the grand mass had no rotation, this approximate regular form would be a rarefied gaseous sphere, continually condensing, and becoming smaller, under the influence of the gravitating force.

I shall next proceed to show how rotation may have been first impressed on a group of particles. Two particles gravitating towards each other, if uninfluenced by other particles, would meet in a line joining their centres, at which instant they would come to a state of rest, having no rotation or other motion arising from their mutual gravity. But if a third particle not in the same line and at a greater distance, influences two particles of different masses, these two particles will meet, not in a line connecting their centres, but at an angle; this will generate a rotation in addition to the resultant motion towards the third particle. A fourth particle under similar conditions, and at a still greater distance, will cause the first three, when meeting, to assume a new axis of rotation, with an increased or decreased velocity according to the direction and intensity of the forces in operation. Thus every nucleus will have a resultant rotation, compounded of the elementary rotations of all its particles.

The union of these myriads of nuclei, will also generate a resultant rotation upon a grander scale. Let us suppose that the original nucleus, before it assumes the approximate form of a sphere has been condensed or reduced down to thirty thousand million times less bulk than it originally occupied. This great condensation would bring the surface of the spheroid near the limits of the most distant planetary orbit, which we will suppose is about three thousand million of miles from its centre. Let this immense gaseous body have a rotation, resulting from all the myriads of rotations of its various parts before they came together.

We have thus, by one law, gathered the materials from the vast abyss of space, where they existed "without form and void;" that is, without any regular form, and apparently void or invisible, on account of their excessive rarity. By one law a gaseous world is formed, having a definite rotation from west to east. Thus far, we have assumed no new or unheard of laws, introduced no impossibilities, proposed no absurdities, but have stated certain simple, necessary results, which, under the law of gravitation, *must* take place, provided matter ever existed in the widely diffused state which we have assumed. The complications existing in the first original movements among particles and groups of particles necessarily exclude mathematical computations. But when a rotating spheroid, of definite magnitude and mass, has once taken form, its future phenomena in the formation of worlds are subjects of strict mathematical investigation.

The quantity of motion in a body, or its momentum, is its mass multiplied into its velocity. The quantity and direction of motion in the Solar System, as it now exists, are generally known; that is, it is known that the sun rotates on his axis nearly from west to east, in a period of about twenty-six days; hence, the direction and velocity of every point without his axis are known; the solar mass is also known; the quantity of motion arising from the sun's rotation therefore is a subject of calculation, and can be approximately obtained. The sun's irregular orbit around the centre of gravity of the system, and his velocity therein, are known; hence the quantity of motion arising from this cause can also be calculated. In like manner the quantity of motion, arising from the rotatory and orbitual motions of each planet, satellite, ring, and asteroid throughout the whole system, can be calculated, so far as their rotations and masses are known. And these elements are generally known with some few small exceptions.

Let the sun, planets, satellites, rings, and all known bodies of the solar system be united in one, without any increase or diminution of their respective quantities of motion; that is, let the resultant momentum of the united mass be equal to the sum of the momenta now existing in the separate bodies. Let this united mass be expanded out beyond the orbit of Neptune, its momentum, or quantity of motion, would remain unaltered, being the same as now exists in the system. The quantity of motion now expended in orbitual revolutions would be emerged in the grand rotation of the great nebulous parent orb; and the quantity of motion now existing in the axial rotations of planetary bodies, would also be absorbed in the axial rotation of the combined mass. Thus the complex machinery of orbits within orbits, ellipses intersecting ellipses, eccentric rings revolving within rings, planes inclined to planes, the receding and advancing of nodes, and perihelia, and the whirling of spheroids, would be resolved into one regular rotative motion, simple and uniform in its nature.

The union of so many worlds with the solar mass would necessarily change, in some small degree, the inclination of the solar axis. But as the mass of the sun is several hundred times greater than the aggregate masses of all the other bodies of the system which revolve nearly in the solar equatorial plane, the present position of his axis would be affected, in inclination, but little by the supposed union. We may, therefore, assume, without any appreciable error, the axis of the expanded mass to be parallel to the present solar axis. It is evident that the axis of the expanded globe would pass through the common center of gravity of the system, many tens of thousands of miles distant from the present position of the solar axis. To more fully illustrate the change of the sun's axis by his union with other matter, let us suppose the sun and the planet Mercury to be first expanded. When the surface of the sun had nearly reached Mercury's orbit, it would come in contact with the expanded gaseous volume of Mercury, which would diffuse itself at first in the regions near the contact as a small prominence or gaseous mountain upon the solar surface. But the solar mass, being 4,865,751 times heavier than Mercury's mass, would not be much affected by this comparatively small addition. The centre of gravity of the united mass would be moved 7·4 miles towards the point of contact, through which a new axis of rotation would be formed, parallel to the former one prior to the contact.

It will easily be perceived that Mercury's orbitual and rotative motions will be combined with those of the solar. For it must be remembered, that the sun prior to the contact, had not only a rotation, but a small elliptic orbit, of the same eccentricity and existing in the same plane as Mercury's orbit; that is, the sun revolved around the common centre of gravity of the two bodies in about 88 days, or in one of Mercury's years. While the distance of Mercury was 36,000,000 of miles, the distance of the sun's centre from the common centre was only 7·4 miles. The momentum of the two bodies would be exactly equal; for the greater mass multiplied into the less orbitual velocity is equal to the less mass multiplied into the greater velocity. The orbitual momentum of each body is employed, after contact, in changing and modifying the velocities of all the particles around the new axis of rotation. Those portions of the globe between the old and new axes must be made to rotate in an opposite direction to their former rotation; that is, in the direction of the former solar orbit. Those parts near the new axis which formerly circulated around the old must now have no motion; this too would be the natural result of the former orbit motion, providing that the period of rotation was equal to the orbitual period.

In the expansion of a rotating globe, the period will be increased. If it is uniformly expanded from the centre to the surface, its period will increase as the diameter. If the expansion near the centre is small and increases towards the surface, the period will not increase as the diameter, but much more slowly. If the sun's materials follow a certain law of expansion, maintaining a decreased rate of density from the centre to the surface, he may, when his semi-diameter is expanded to the orbit of Mercury, be made to rotate on his axis in one of Mercury's years. In the union of the two masses the orbit motions would cease, being resolved into rotation, as we have just explained. This may be called the first stage of expansion.

The second stage of expansion would increase the semi-diameter to the orbit of Venus, while the period of rotation would be decreased, until it became of the same length as one year on Venus. This second planet, following the same process as the first, would, in its gaseous form, unite with the solar mass; this would again shift the axis of rotation 169 miles towards the point of contact, the axis still remaining parallel to its former position.

In the third stage of expansion, the combined mass of the sun, Mercury, and Venus, would reach the sphere of the earth's expanded mass, and, uniting with it, would rotate around a new axis 244 miles from its former location.

In like manner Mars would alter the axis 54 miles. If we suppose the united mass of the asteroids to be about two and one-half million times less than that of the sun's, and their mean distance to be about three times that of the earth, they, by their union with the solar mass, would again shift the axis of rotation 111 miles. Jupiter's system would displace the axis over 471,800 miles. Saturn's system would cause another displacement of the axis upwards of 258,000 miles. Uranus would alter the axis over 73,000 miles. Neptune would displace it over 151,000 miles.

Thus it will be seen, that as the system expanded and absorbed successively the gaseous planetary bodies, the axis of rotation would successively shift its location to each new centre of gravity. As long as the bodies were separate, each would have a rotation around its own axis, and an orbitual motion around the common centre of gravity.

Now let us reverse the machinery and see how worlds and orbits may be derived from rotation, combined with condensation.

We have already shown how the materials may be collected into a regular form, and how a rotation of the whole results from the combination of myriads of rotations, existing among the parts before union. Let this immense gaseous body be called the *Primary World* or the *Parent World*.

This primary body must have an increasing density from the surface to the centre, so that its period of rotation shall be nearly equal to Neptune's period of revolution which is over 164 years; the momentum of this primary mass must be exactly equal to the momentum now in the system; that is, whatever changes may occur, the quantity of motion must be invariable. If the sun had been uniformly expanded, its period of rotation at the distance of Neptune would have been nearly three times too great, being over 444 years. It is merely a matter of mathematical calculation to determine what rate of increased density, as you approach the centre, will diminish the period of rotation to nearly 164 years.

With such a rotation, the equatorial gaseous atmosphere would lose all weight, and could no longer follow the interior condensing mass, but would be held suspended above the shrinking surface, sustained in that position by its own centrifugal force acquired by rotation. If at the time of the projection the equatorial surface was smooth and equally distant from the centre, the projected matter would form a ring encircling the spheroid, whose equa-