Spirit.[6] This is the uncompromising creed of true Brahminism. If, then, this creed can be retained amidst the extravagant Polytheism of later Hindu corruptions, much more easily could it be retained in the early Pantheism of the Vedic hymns.

There is, however, one kind of evidence remaining, which may be said to be still within the domain of history, and that is the evidence derived from language, from the structure and etymology of words. This evidence carries us a long way further back, even to the time when language was in the course of its formation, and long before it had been reduced to writing. From this evidence as we find it in the facts reported respecting the earliest forms of Aryan speech, it seems certain that the most ancient conceptions of the energies of Nature were conceptions of personality. In that dim and far-off time, when our prehistoric ancestors were speaking in a language long anterior to the formation of the oldest Sanskrit, we are told that they called the sun the Illuminator, or the Warmer, or the Nourisher; the moon, the Measurer; the dawn, the Awakener; the thunder, the Roarer; the rain, the Rainer; the fire, the Quick-Runner.[7] We are told further that in these personifications the earliest Aryans did not imagine them as possessing the material or corporeal forms of Humanity, but only that the activities they exhibited were most easily conceived as comparable with our own. Surely this is a fact which is worth volumes of speculation. What was most easy and most natural then must have been most easy and most natural from the beginning. With such a propensity in the earliest men of whom we have any authentic record to see personal agency in everything, and with the general impression of unity and subordination under one system which is suggested by all the phenomena of Nature, it does not seem very difficult to suppose that the fundamental conception of all Religion may have been in the strictest sense primeval.

But the earliest records of Aryan worship and of Aryan speech are not the only evidences we have of the comparative sublimity of the earliest known conceptions of the Divine Nature. The Egyptian records are older still; and some of the oldest are also the most sublime. A hymn to the rising and setting sun, which is contained in the 125th chapter of the "Book of the Dead," is said by Egyptian scholars to be "the most ancient piece of poetry in the literature of the world."[8] In this Hymn the Divine Deity is described as the Maker of Heaven and of Earth, as the Self-existent One; and the elementary forces of Nature, under the curious and profound expression of the "Children of inertness," are described as His instruments in the rule and government of Nature.[9] Nor is it less remarkable that these old Egyptians seem to have grasped the idea of Law and Order as a characteristic method of the Divine Government. He who alone is truly the Living One is adored as living in the Truth, and in Justice considered as the unchanging and unchangeable Rule of Right, in the moral world, and of order in the physical causation.[10] The same grand conception has been traced in the Theology of the Vedas. The result of all this historical evidence may be given in the words M. Renouf: "It is incontestably true that the sublimer portions of the Egyptian Religion are not the comparatively late result of a process of development or elimination from the grosser. The sublimer portions are demonstrably ancient; and the last stage of the Egyptian Religion, that known to the Greek end Latin writers, was by far the grossest and most corrupt."

[6] Professor Monier Williams, "Hinduism," p. 11.

[7] Max Muller, Hibbert Lectures, 1878, p. 193.

[8] Renouf Hibbert, Lectures, 1879, p. 197.

[9] Hibbert Lectures. by Renouf, pp. 198, 199.

[10] *Idem*, 1879, pp, 119, 120.

ANCIENT PLANETARY RINGS, VOLUME, MASS AND DENSITY.

By Edgar L. Larkin.

IV.

In Astronomical literature there is engrafted a venerable doctrine giving details of the processes of evolution of the solar system, trom a mass of incandescent gas. The theory is a hundred years old. It says, all matter now in the sun and planets was once in a state of rare gas, extending beyond the orbit of Neptune. The gas was hot; it cooled, contracted, and rotated. When by condensation it had dwindled to the insignificant limits of the Neptunian orbit, its velocity of rotation was so great that a ring of gas was detached from the equator of the shrinking sphere. This ring in time formed Neptune. In like manner all the planets were formed, the residue of the primordial mass being the sun. This error has been taught to children, and so tenacious are the traditions of youth, that geometers have been known to cling to the illusion in mature years. It has but one rival—perpetual motion—and is known as the Nebular Hypothesis. If it is true it can be handled by arithmetic; if false, computation will detect the fallacy.

How shall it be attacked; and what can be learned of the primeval state of matter? Can we peer into the depths of primordial time when worlds were in development? The geologist penetrates strata, and writes the records of the earth. Can the history of Neptune be written? And can we trace the processes of its evolution? If so, the mass, volume and thence the density, of the ring whence it formed must be determined. We know its mass in terms of terrestrial matter, it was 102 sextillion tons, or 204 septillion pounds; because that is the amount of matter now in Neptune. By what possible means can its volume be learned? The problem seems incapable of solution, mathematics apparently being unable to furnish a method of grappling with the question. We have used diligence to find records showing that the volume and density of the ring have ever been calculated, and failed. But there is one way of learning the magnitude of the mass of gas whence Neptune condensed. It is based on the doctrine of the CENTRE OF GRAVITY, and it is a fact in nature which subverts the Nebular Hypothesis. We know that if the revolving sphere discarded equatorial matter to make Neptune, the planet formed in the line of its centre of gravity. There are formulæ for the determination of the distances of centres of gravity of segments from the centre of the circles whence they were cut. There are only three possible forms of rings that can be cut from the periphery of a sphere—segmental, cylindric and another, whose sections are in shape like sections cut by a perpendicular plane passing through a bi-convex lens. This geometrical figure is formed by the revolution of a segment of a circle about its chord held quiescent; and the solid generated is a circular spindle. This form we overlooked in the previous paper. The volumes of these rings are sought, the data being the distances of their centres of gravity from the centre of the sphere, which is the distance of Neptune from the sun—2,780,000,000 miles. It has been shown in these notes that the radius of the only sphere large enough to afford a segment of sufficient size to have its centre of gravity coincide with Neptune's orbit, was three (3) billion miles. The dimensions of this segmental ring cut off by passing the chord of the segment around the sphere, were: chord, 2,600,000,000; altitude, 300,000,000; and length, 17,500,000,000 miles, the length of the path of Neptune. Therefore its volume was nine (9) octillion cubic miles, and as this number of miles had to contain 204 septillion pounds, one cubic mile held .0224 pounds, or 157 grains, 45 cubic miles being required to contain one pound of gas.

"At 15.5° C, (60° F.), and 30 inches barometric pressure, 100 cubic inches of Hydrogen weigh 2.14 grains."

Fowne's Chemistry, p. 137. Thence one cubic mile of hydrogen weighs over five (5) trillion grains, or 777 million pounds. And as the ring was of such density as to require one cubic mile to contain 157 grains of matter, the Neptunian mass was thirty-four(34) billion times less dense than hydrogen.

The volume of the sphere, radius three (3) billion miles, whence Neptune was detached, the ring being segmental, was $\frac{4}{3}\pi R^3 = 113$ octillion cubic miles. But the ring was in volume nine octillion cubic miles, nearly $\frac{1}{12}$ the entire mass!

What unheard of convulsion took place to disrupt the mass and cause it to part with $\frac{1}{12}$ its bulk! What inconceivable power was displayed if the dogma is true, yet all the force present was gentle centrifugal tendency caused by slow rotations of 3.36 miles per second!

The mass of the first world is $\frac{1}{2000}$ of the solar system, but $\frac{1}{12}$ the volume was required to make it. The volume of a sphere bounded by the orbit of Neptune is $\frac{1}{6}\pi D^3 = 90$* octillion cubic miles, and as it contained 4 nonillion pounds of gas, each cubic mile held 44 pounds, —17,500,000 times less in density than the lightest body on earth, the mass being homogeneous. But it was not since the centre must have been compressed.

The density of the segmental ring was 34 billion times less than hydrogen, therefore, the sphere was old when it cast away its first world, having had time to acquire internal density, greater than peripheral, in the proportion of 17 millions to 34 billions. All along we have been quoting Helmholtz, where he says:—"It required several cubic miles to weigh a single grain,"—not having made calculation, but now we do not see how he arrived at these results, as one cubic mile, by following the principle of centre of gravity, is found to have contained 157 grains.

He probably alluded to the mass when expanded larger; but if extended to half the distance of the stars, a thousand cubic miles might have been required to contain one grain of matter. And we feel that we are traversing solid ground, in basing these deductions on the doctrine of the centre of Gravity. The volume of a cylindric ring to form Neptune must have been the same as the segmental, the density being nearly equal. The diameter of a section of a cylindric ring whose length was equal to that of Neptune's orbit, in order to have the required volume, was 822,000,000 miles. Since the planet coalesced in its centre of gravity, which was its geometrical centre, the material of the ring extended 411,000,000 miles above, and the same distance below the orbit. This added 822,000,000 miles to the equatorial diameter of the mass, retarded its assumed rotation, and prevented detachment of any particle of matter. The disrupting force had to be applied, not where Neptune revolves, but 411,000,000 below, at a point where force was weakest, and resistance strongest. And then such a ring was subjected to lateral pressure, and could not be severed on that account.

The ring made up of an infinite number of solids generated by revolution of circular segments about their chords, to have the same volume as segmental and cylindric, was in radial diameter 380,000,000, and in diameter north and south 2,090,000,000 miles. If this form of ring was discarded the break took place 190,000,000 below the orbit, and along a line more than two billion miles long. Rotation was slower than the orbital velocity of Neptune, and the separation was again required to be made where the force to cause it was in minimum, and its opposing powers, gravity and cohesion, at a maximum. We reassert that in no possible case could the Neptunian matter have been detached from the primeval mass when it was a *sphere*.

Neither could it have been separated when sections of the protuberance were parabolic; thus a chord, or limiting plane, the base of a parabolic segment, in order to cut out a ring in volume sufficient to contain the Neptunian gas, was in length 634,000,000, in altitude 1,250,000,000, the vertex extending 750,000,000 above, and base descending 500,000,000 miles below, the orbit, in order that Neptune might condense in its centre of gravity. This would make the equatorial diameter of the mass 7,060,000,000 miles a physical impossibility, for rotation would have come to a dead rest ages before such elongation. Consider the curvature of sections semi-elliptical and results are still more absurd. Since the mass was unable to part with rings whose sections were hyperbolic, parabolic or semi-elliptic, we dismiss as untenable all varieties of such ring-shaped masses.

Now conceive the mass a sphere again and at rest; let rotary motion be imparted, and should the velocity become sufficient, the equatorial regions will become a swelling tide. But when a protuberance elevated motion waned, and the equator subsided. When at greatest altitude the whole mass was an ablate spheriod. Therefore, we lay down this proposition which must have obtained if the Hypothesis of ring displacement is true. If the equatorially expanding mass parted with a ring, it did so at the first opportunity.

And such fullness of time was when a segment of an ellipse could be cut away large enough to have Neptune in its centre of gravity. When the mass was an ablate spheroid, sections cut by passing planes through the entire mass, at right angles to the equator, bisecting the poles, would all be plain curves—ellipses. And a segment severed from the equator to make Neptune, was a segment of an ellipse, whose centre of gravity coincided with that planet's present track. The dimensions of this ring were, height, 319,000,000, and chord 2,350,000,000 miles, to have volume sufficient, to contain gas enough to solidify into the most remote member of the solar system. The axes of the ellipse whence this segment was cut were transverse, 5,800,000,000, and conjugate, 5,400,000,000, the diameter of the mass when spherical being 5,560,000,000 miles. Therefore, we say that during all mutation in form of the primordial cosmical mass, admitting the hypothesis true, its equatorial diameter was never augmented more than 240,000,000 miles, as is seen in these dimensions.

Mathematical instruments of delicacy are required to measure such small deviation from a sphere. Yet, it was able to discard a ring having a volume of nine octillion cubic miles. Basing conclusions on the sure foundation of the principle of the centre of gravity, we assert that the mass never detached rings whose sections were of any form of curvature known to geometry. Then none were cast off, since every department of celestial mechanics is known to be subject to rigid mathematical laws.

The theory of cosmic evolution, which holds that planets were formed of masses detached from an aeriform sphere belongs in that list of delusions which retarded the early progress of astronomy—the "Geocentric System," the "Firmament," and "Music of the Spheres."

NEW WINDSOR, ILL., *July* 10, 1881.

* Ninety Octillion.

CORRESPONDENCE.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

To the Editor of "SCIENCE":—

Dr. J. J. Mason in his second rejoinder to the criticism made by a reviewer in SCIENCE, leaves his unknown critic to the contemplation of the latter's clause. "Notwithstanding the construction which Dr. J. J. Mason now desires to see placed on his words," and does him "the justice" of supposing that the critic