# CELESTIAL EJECTAMENTA: THE FIRST HALLEY LECTURE DELIVERED BEFORE THE UNIVERSITY ON TUESDAY, MAY 10, 1910

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BY

HENRY WILDE, D.Sc., D.C.L., F.R.S.


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# CELESTIAL EJECTAMENTA

A COMBINATION of interesting circumstances brings me to-day before the members of the University to discourse on an important feature of celestial mechanics which has not hitherto been treated as a generalization drawn from observations on the great scale of nature.

While the principle of dualism is abundantly manifest in every department of knowledge and fully recognized in the attractions and repulsions in molecular mechanics, the phenomena of the repulsive energy of celestial bodies have so far been unduly obscured by the more evident principle of the attraction of gravitation.

The doctrine that the solar system, as at present constituted, was formed by the successive condensations of a nebular substance rotating about a central position, has now so much evidence in its favour that it may be affirmed to equal the best of that obtained from the geological record of the changes which, in past times, have taken place on the terrestrial globe. This doctrine has been more firmly established during recent years through the great advances

made in stellar photography, by which many of the nebulæ are visualized in various stages of evolution as right- and left-handed spirals, and clearly indicate the direction of their revolutions.[1]

That the subsequent condensations of planetary nebulæ into spherical bodies would be attended by the evolution of an amount of heat sufficient to make them vividly incandescent, is an obvious conclusion drawn directly from experimental science. It will be further evident that, after the heat of compression had attained its maximum, the self-luminous planets would ultimately become dark bodies through the radiation of their heat into free space.

It is very generally admitted that the sun, notwithstanding his vast dimensions, would, by continuous loss of heat, ultimately become a dark body like each member of the planetary system. It is also known that the internal parts of the sun are in a gaseous condition and under immense pressure. Some idea of the repulsive force exercised by this pressure may be formed from the ejection of enormous masses of incandescent gas from the surface of the sun to the height of 200,000 miles, with an estimated velocity of 166 miles per second.[2]

[1] *Celestial Photographs*, by Isaac Roberts, F.R.S., vols. i, ii, 1893, 1899.

[2] Young, *American Journal of Science*, 1871, p. 468.

Assuming the secular cooling of the sun to be continuous, the liquefaction and final solidification of his outward parts would follow in natural sequence in accordance with common experience of cooling bodies, while the central parts would remain in their primitive gaseous condition. From strict analogy, it may be justly inferred that all the planetary bodies have gone through the same stages of cooling as those outlined in the instance of the central body.

The notion that the earth and, inferentially, the other planets are solid bodies throughout, finds no support from a reasonable consideration of the constituents of the earth's crust, so far as they are accessible to observation. The late distinguished Professor of Geology in the University (Sir Joseph Prestwich), in his classical work on Chemical, Physical, and Stratigraphical Geology, has clearly demonstrated from the uplift of continental areas and mountain chains, the welling out of basaltic lavas over many thousand square miles of surface and of great thickness, that a comparatively thin crust enveloping a fluid interior is a necessary condition to satisfy the requirements of geologists and physicists. More significant still is the succession of foldings of the earth's crust and stratigraphic contortions of small curvature, both of which features

indicate a thickness of solid crust of less than twenty-five miles. How far the imprisoned gases at the centre of the earth and the aqueous vapours near the surface may have contributed respectively to produce these geological changes it is unnecessary now to discuss, but in the instance of the moon, which has neither water nor an atmosphere, the evidence of intense volcanic action manifested on its surface can only be accounted for by the ejective force of the gaseous substances in its interior, similar to that by which the incandescent gases from the surface of the sun are projected.

The fine series of photographic enlargements of the moon executed by MM. Loewy and Puiseux of the Paris Observatory show the greater part of its surface, from the equator to the poles, covered with extinct volcanoes in every stage of formation similar to those on the terrestrial globe. Some of these volcanoes are twelve thousand feet in height, with their craters upwards of forty miles in diameter, and are striking evidence of the immense repulsive force of the gases which produced them. I will mention here in passing, that Halley himself postulated the earth as a hollow sphere as the basis of his theory of the cause of the secular variation of the mariner's compass, respecting which I shall have more to say in connexion with his important

contributions to terrestrial magnetism. That a high value was set upon this view of the earth's internal constitution, and that it was intended to be handed down to posterity, is evident from his fine portrait, which adorns the apartments of the Royal Society, being embellished with a diagrammatic representation, from the Philosophical Transactions, of the terrestrial globe enclosing an inner sphere rotating with a differential motion about the same axis.

It is generally considered by astronomers that the numerous minor planets between the orbits of Mars and Jupiter are the fragments of a large planet which had formerly revolved in an orbit about the same distance from the sun as Ceres, and had subsequently been shattered by some internal convulsion. Lagrange made this hypothesis the subject of a memoir in which he determined the explosive force necessary to detach a fragment of a planet that would cause it to describe the orbit of a comet. The nebulosities of the dense atmospheres of some of these planetoids, extending to a height above their surfaces of several diameters and concealing their disks, indicate an incipient change of planetary into cometary bodies. It will now be evident without further discussion that had the exploded planet been a solid body as hard as steel it would still be revolving in its orbit, and