



I. On the satellitary nature of shooting stars and aërolites

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- I. *On the Satellitary Nature of Shooting Stars and Aërolites.*
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IN the truly philosophic work *Cosmos*, in which the profound Humboldt embodies the results of his life-long studies, he expresses some opinions on the subject of *shooting stars*, which there appears to me considerable difficulty in adopting. If we assume with him that the observations of Benzenberg and Brandes on the parallax of shooting stars are correct, it appears that these bodies have a velocity of from 17 to 36 geographical miles per second, that their elevation above the earth is from 16 to 140 geographical miles, and their diameters from 80 to 2600 feet. It may further be taken for granted, that these bodies revolve in orbits according to the laws of gravitation, that they are ordinarily invisible, but become momentarily luminous whenever they plunge into the earth's atmosphere; and that aërolites are fragments projected or swept from these asteroids (possibly by the resistance of the atmosphere), and hurled to the earth by terrestrial attraction.

Admitting these premises, the next question is to determine the nature of the orbits in which these mysterious bodies revolve, and the influences to which they are subjected in their course. Humboldt here adopts the opinion first propounded by Chladni, that shooting stars and meteors are planetary bodies revolving round the sun in elliptic orbits, and only rendered visible to us at the nodes, where the orbits of the earth and of these asteroids intersect. Their number on this view of the subject must be prodigious, as it is only those whose orbits happen to traverse the earth's orbit, and which

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happen to pass at the moment when the earth is crossing their node, which can ever be visible to us. How then, let me ask, is it brought about that these innumerable planetary bodies, which are so continually entering our atmosphere and passing within a few miles of the earth, never come in contact with it? for be it remembered that *ærolites* are not regarded as being the shooting stars themselves, but only as fragments left behind them in their course. Can we suppose that our earth, a body of nearly 8000 miles diameter, should be incessantly forcing its way through showers of these planetary bodies, hundreds of which daily approach in their circumsolar revolutions within from 16 to 140 miles of the earth, and yet that they should never impinge upon its surface? Should we not in that case continually hear of these fiery masses, with diameters from 80 to 2600 feet, and velocities of 36 miles a second, dashing into the body of our earth like cannon-balls into an earthen rampart? If, in order to meet this objection, it be asserted that the real diameter of the shooting stars has been over-estimated, and that *ærolites* are not fragments of, but are identical with these bodies themselves, which accordingly really do fall upon the earth's surface, still on the doctrine of chances it would follow that the earth's disc, which presents a far larger surface than that portion of its atmosphere which surrounds and projects beyond its limb, must receive a proportionally larger number of these projectiles.

The attraction of the earth would still further increase the amount of those asteroids which would come in contact with it, as compared with those which pass through and escape from the atmospheric stratum; yet, what is the real proportion between the two classes of phenomena? We find in reality that shooting stars, that is, asteroids rendered visible by atmospheric contact, occur to the amount of scores, sometimes of hundreds, every night, while the fall of *ærolites* upon the earth's surface is a phenomenon of very much rarer occurrence. It seems evident therefore that there is some cause which renders the circulation of asteroids in orbits approximately parallel to the earth's surface, the normal condition, to which the fall of *ærolites* to the ground (whether we regard them as being the entire *nuclei*, or merely detached fragments of these meteors) forms only a casual exception.

To what then must we attribute this constant flight of asteroids in lines closely approximating, yet not impinging upon, the earth's surface? It seems evident that we cannot regard them as solar *planets*, pursuing their course through the system regardless of intervening obstacles, as they must inevitably in that case come into very frequent contact with our

earth. Why then may we not suppose them to be *satellites*, revolving rapidly round the earth in orbits more or less eccentric, and occasionally plunging into the upper regions of the atmosphere? It does not follow because these bodies move with "planetary velocity," that they must therefore be planets. The satellites nearest to the bodies of Jupiter and Saturn revolve round those planets with a velocity of about ten miles per second, which is not very greatly inferior to that assigned to some shooting stars; and as the velocities of satellites increase with their proximities, we may well suppose that satellites revolving within 150 miles of their primary would have very high velocities. The alleged velocities of shooting stars accord sufficiently well (allowing for the perturbations to which the proximity of the earth may give rise) with Kepler's law, that the squares of the times are proportionate to the cubes of the distances. By applying this law to the known velocity of the moon, it results that a satellite revolving round our earth at 5000 miles from the centre, or about 1000 miles from the surface, would have a velocity of about 40 miles per second, which is even greater than that hitherto assigned to shooting stars.

We may surely then conceive these bodies to be of the nature of satellites, having all their elements so adjusted as to ensure a perpetual revolution round the earth, into whose atmosphere they occasionally dip and undergo a momentary ignition.

It appears moreover difficult to conceive, that if the motion of meteors is of a planetary nature, such small bodies could pass within a few miles of the earth, and then proceed on their course round the sun, comparatively uninfluenced by the terrestrial attraction. The perturbation produced by the earth's mass on a planet of only a few hundred feet in diameter passing within 100 or 150 miles' distance, would surely be so enormous as wholly to destroy the original orbit of the minor body, and the most probable effect would be to convert it into a satellite and to retain it permanently within the earth's attraction. So that even admitting that these asteroids may have once been in the condition of planets, and that many such bodies may still, unknown to us, be revolving in circum-solar orbits, we must yet regard all the shooting stars which ordinarily make their appearance within our atmosphere, as being at present in the condition of satellites.

The main objection, and it is certainly a very important one, to the satellitary theory of shooting stars, is founded on the fact of the nearly (though not quite regular) periodical recurrence of an increased number of these meteors at certain

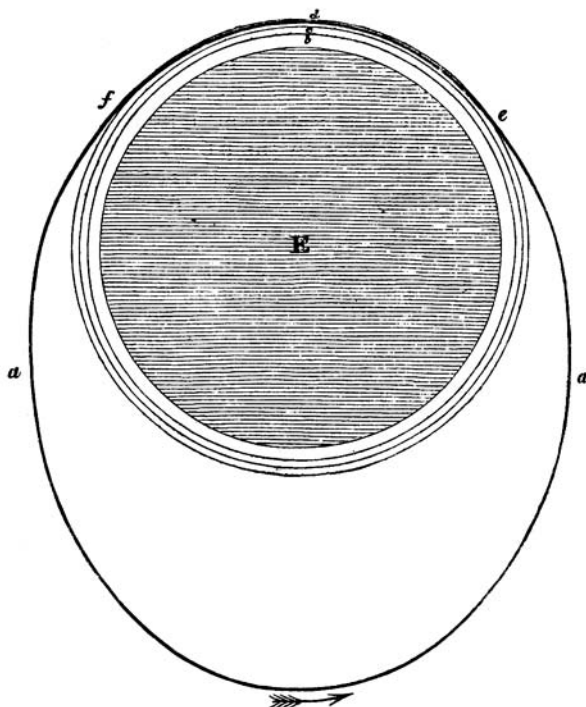
annual epochs. This has been explained by supposing that the earth at these periods intersects certain zones or orbital rings, in which vast numbers of asteroids are constantly revolving round the sun. On the supposition that these bodies are satellitary, and not planetary, it is certainly difficult to account for the fact of their becoming visible in greater numbers at one season of the year than at another. It is however conceivable that the luminosity of shooting stars may be caused by their coming in contact, not with our gaseous atmosphere, but with an electrical atmosphere, which may extend far beyond the limits of the gaseous one; and it may be further conjectured, that from unknown cosmical causes this electric atmosphere may at certain points in the earth's orbit receive quantitative or qualitative modifications, which may enable it at those seasons to illuminate a larger numerical proportion of the meteoric satellites.

At these annual epochs the showers of meteors are said to have apparently proceeded during several hours of observation from the same point in the heavens, viz. the constellation Leo.

But this alleged fact seems irreconcilable with either the planetary or the satellitary theory of shooting stars. Even admitting an approximate constancy in the directions in which these bodies approach our atmosphere, yet as their distance when rendered visible is considered to be not greater than about 150 miles, it is evident that their parallax (whether viewed simultaneously by two distant observers, or at successive intervals of a few hours by the same observer) would be so great as to destroy the appearance of perfect uniformity in the point of the starry heavens, where they make their first appearance. We must therefore suppose that the amount of this uniformity has been overstated; still it is possible that there may be a prevailing direction in which the majority of these bodies enter the atmosphere, and the predominance of this direction may still be in some degree apparent, notwithstanding the influence of parallax. Such a predominance of direction (if it really exist) does not however necessarily prove the shooting stars to be planets, but may be equally explained on the satellitary theory in the following manner:—

Let aa be an elliptical ring composed of great numbers of these satellitary bodies revolving in parallel curves round E , the earth; let b be the limit of the gaseous, and c that of the electric atmosphere in its normal condition. It is evident that while this condition lasts, the meteors in the ring aa will be wholly external to the electric atmosphere c , and will be consequently invisible. The only meteors which would be seen

in these circumstances, would be such stray ones as may revolve in minor orbits occasionally intersected by the circle *c*. But let the electrical atmosphere from some annually recur-



ring cause be temporarily extended to *d*, then while this condition lasts, the meteors revolving in the ring *a a* would be rendered visible during their course from *e* to *f*, and (the ring *a a* remaining always parallel to itself) the meteors would appear (allowing for the effects of parallax) to proceed from nearly the same points of the heavens.

This explanation must however be regarded only as a rude conjecture to remove an apparent difficulty; and as this difficulty, if a real one, may be equally explained on the planetary and satellitary theory of meteors, it need not prevent us from giving the preference to the latter, if the arguments which I have adduced in its favour are of any weight.