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Comets and Meteors

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COMETS AND METEORS.

Comets and meteors are so intimately connected that they must necessarily be taken together for the description of either to be approximatemy complete. And the relation is one that excites the greatest interest.

Most of us have seen a comet; and we have felt something of that awe which is inseparable from the thought of its immensity and its rush through space like a runaway star. Its head is commonly a small luminous point surrounded by a hazy cloud, from which usually streams out a relatively enormous tail of pale light, sometimes seen to stretch across the whole sky from zenith to horizon.

The orbits of these, "hairy stars", may be,- as determined by Newton,- either species of conic sections, many of them, however, describe an elliptical course. These are erratic members of the solar family returning after their excursions; all at regular and some at enormous intervals. But those of parabolic or hyperbolic orbits are thrown into the system by a power beyond the sun's control, to hasten away again, never to return, unless retarded by some of the planets.

Observation of comets by the spectroscope has wonderfully increased our knowledge of them. The first successful application of this instrument was made by Donati in 1864. He admitted the light of a comet through his train of prisms, and found it, thus analysed, to consist of three bright bands - yellow, green, and blue -separated by wide, dark intervals, This implied that comets did not shine wholly by reflected sunlight as previously considered, but that they were partly self-luminous, a condition due to glowing gas. This gas was determined by Huggins in 1868. On comparing the spectrum of a comet in that year with that of an olefiant-gas vacuum tube rendered luminous by electricity, he found tha agreement exact. And it has since been abundantly confirmed. All the eighteen comets between 1868 and 1880 showed the typical hydrecarbon spectrum common to the whole group of these compounds, but probably due to the presence of acetylene.

Vogee and Hasselberg, on experimenting with tubes containing a mixture of carbonic oxide with olefiant gas found that their illumination by disruptive electric discharge was, however, an indispensable condition for the exhibition of the cometary type of spectrum; for when a continuous current was employed, the carbonic oxide bands asserted themselves to the exclusion of the hydrocarbons. This distinction has great significance as regards the nature of comets. For it indicates, first, that combinations of carbon with oxygen as well as with hydrogen, are present; while it affords, secondly, a criterion as to the quality of the electrical processes by which their constituent vapors are rendered luminous. Of particular interest in this connection is the fact that carbonic-oxide is one of the gases envolved by meteoric stones and irons under stress of heat. It must, then, apparently, have formed part of an aeriform mass in which they were immersed at an earlier stage of their history.

The gaseous surroundings of comets are thus largely made up of a compound of hydrogen with carbon. Other materials are also present; but the hydro-carbon element is probably always present and predominant. Its luminosity, there is little doubt, is due partly to electrical excitement, and partly to reflected sunlight.

Thus far, astronomers have on their lists about six hundred and fifty comets. And about four hundred of these were recorded previous to 1600, before the invention of the telescope and therefore must have been bright enough to attract the attention of the naked eye. Since that time, the number annually observed has very greatly increased; for only a few ~~of these bodies~~, perhaps one in five are visible without telescopic aid. The total number must be enormous.

Some of the most wonderful comets are: Halley's, of 1835, which returns again in 1911; Encke's, of 1819, which has the shortest known time of revolution, only three and one-half years; Donati's, of 1858, which is perhaps the finest of the present century; and the great comet of 1882, which will always be remembered, not only for its beauty, but for the great variety of unusual phenomena it presented.

Towards the end of August 1862, a comet became visible to the naked eye high up in the northern hemisphere, with a nucleus equaling in brightness the lesser stars of the Big Dipper and a feeble tail of 20° in length. It thus occupied quite a secondary position among the members of its class. But it was, nevertheless, a splendid object in comparison with telescopic nebulosity discovered by Tempel in December 1865. This, the sole comet of 1866, slipped past perihelion, January 11, without pomp of train or other appendages, and might have seemed hardly worth the trouble of pursuing. Fortunately, however, this was not the view entertained by observers and computers; since upon the knowledge acquired of the movements of these two bodies, has been founded one of the most significant discoveries of modern times. The first of them is now styled the comet of the August meteors; the second, that of the November meteors. The steps by which this curious connection came to be ascertained were many, and were taken in succession by a number of individuals.

Meteors, or shooting stars, as we call them- and there is no great difference except in size-are much more common than comets. But how little one is likely to <u>think</u> of their marvelous history, when one sees their fiery streaks. Many perhaps consider them stars traveling through space at an enormous rate. The idea prevalent in the lat century was that they were mere aerial ignes fatui, inflammable vapors accidentally kindled in the atmosphere. Neither of these theories however is the real truth.

Halley had already entertained the opinion of their cosmical origin. And Chladni in 1794 formally broached the theory that space is filled with minute circulating atoms, which drawn by the earth's attraction, and ignited by friction of its gaseous envelope, produce the luminous effect so frequently witnessed. Adting on these suggestions, Brandes and Benzenberg began to determine the heights of falling stars by simultaneous observations at different places. They soon found that these stars move with velocities comparabe with that of the earth, in the most elevated regions of our atmosphere.

Many high authorities declared the origin of meteorites to be in matter erupted from the volcanoes of the moonbut thought on the subject was turbid, and inquiry seemed to stir up the mud of ignorance. It needed one of these amazing spectacles, at which man assists- not now as formerly in abject terror for his own frail fortunes, but with keen curiosity, and vivid expectation of new knowledge to bring about a clarification.

On the night of November 12-13, 1833, a tempest of falling stars broke over the earth. North America bore the brunt of its pelting. From the Gulf of Mexico to Halifax, until daylight with some difficultu put an end to the display, the sky was scored in every direction with shining tracks and illuminated with majestic fireballs. Their numbers, while the first fury of their coming lasted were quite beyond counting; and at Boston, their frequency was estimated to be about half that of flakes of snow in an average snow storm.

Now there was one very remarkable feature common to them, and that was, that they all seemed to come from the same part of the sky. Traced backward their paths were invariably found to converge to a point in the constellation Leo. Moreover, that point travelled with the stars in their nightly round. In other words, it was entirely independent of the earth in the latter's rotation. It was a point in interplanetary space.

The effected perception of this fact amounted to a discovery by Olmsted. He showed that the emanation from a fixed "radiant" proved the approach of meteors to the earth along nearly parallel lines, appearing to diverge by an effect of perspective, and that those parallel lines must be sections of orbits described by them round the sun and intersecting the orbit of the arth. For the November phenomenon was now seen to be a periodical one.

The falling stars of November did not alone attract the attention of the learned. Similar appearances were associated with August 10th. A second meteoric revolving system was shown to exist. Adolf Erman of Berlin maintained that these no longer revolved in a cloud but in a closed ring, and thus the mere circumstance of intersection by a meteoric, of the terrestrial orbit, without any coincidence of period, would account for the earth's meeting some members of the system at each annual passage through the node. This was an important step in advance; yet it decided nothing as to the forms of the orbits of such ring like asemblages, nor was it followed up in any direction for a quarter of a century.

Professor Herbert A. Newton, of Yale College, took up the dropped thread of inquiry. A search through old records carried the November phenomenon back to the year 902 A.D. long distinguished as "the year of the stars". From that time recurrences were traced down through subsequent centuries, always with a day's delay in about seventy years, which was afterwards proved to be due to perturbation. It was easy to derive from these dates a cycle of thirty-three and one fourth years, so that Newton did not hesitate to predict the exhibition of an unusually striking meteoric spectacle on November 13-14, 1866, and 1899. He also found that conspicuous recurrences every thirty-three or thirty-four years could be explained on the supposition of five widely different periods of revolution around the sun. And Professor Adams's great mathematical resources determined the true one to be that of thirty-three and twenty-seven hundredths years, and an ellipse spanning the vast gulf between the orbits of the earth and Uranus; the group being so extended as to occupy six or eight years in defiling past the scene of terrestrial encounters. But before it was completed in March, 1867, the subject had assumed a new aspect and importance.

Professor Newton's prediction of a remarkable star shower in November 1866 was punctually fulfilled. This brought the study of shooting stars once more vividly to the notice of astronomers.

Schiaparelli had, indeed, been already attracted by it. The results of his studies were, in the first place, the conclusion that meteors possess a real velocity considerably greater than that of the earth, and travel, accordingly, to enormous distances from the sun along tracks resembling those of comets. He next inferred that comets and meteors alike have an origin foreign to the solar system, but are drwn into it temporarily by the sun's attraction, and occasionally fixed in it by the backward pull of some planet. But the crowning and the most astonishing fact was that the August meteors move in the same orbit with the bright comet of 1862.

This discovery was quickly capped by others of the same kind. Leverrier published January 21st, 1867, elements for the November swarm, at once identified by Dr Peters with Oppolzer's elements of Temple's comet of 1866. Professor Weiss pointed to the agreement between the orbits of a comet which had appeared in 1861 and of a star shower found to recur on April 20th, as well as between those of Biela's comet and certain conspicuous meteors of November 28th. The view that meteorites are the dust of decaying comets was put to a definite proof by this ~~last comet.~~ discovery of Biela's. On its visit in 1846, something unprecedented happened. When first seen on November 28th, it presented its normal appearance; but on December 19th, it had become rather pear-shaped, and ten days later, had divided. These twin comets traveled along side by side for more than four months at an almost unvarying distance; but on their return this distance had greatly increased. Neither of them has ever been seen since, although they ought to have returned five times. But on the night of November 27th, 1872, just as the earth was passing the old track of the lost comets, she encountered a wonderful meteoric shower; and it became evident that Biela's comet was shedding over us the pulverized products of its disintegration.

But these instances do not seem to be exceptional. The number of known or suspected accordances of cometary tracks with meteor streams, amounts to seventy-six; although the four first detected still remain, perhaps, the only absolutely sure examples.

The tenuous matter composing comets'tails is, therefore'no doubt permanently lost to the body from which it emanated. And Olbers originated the idea that this matter was subject to electrical repulsion both by the nucleus of the comet and the sun, as well as to the gravitatiobal attraction of the sun. This accounts for the position and magnitude of the tail on different dates; and with the addition of the solar tidal influence, also accounts for the fragments revolving independently in parallel orbits, at first as a swarm; finally, when time has been given for the full effect of the lagging of the slower moving particles to develop, as a closed ring, from which are derived the granules whose swift passage seam our skies with periodic fires.

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