ASTRONOMY

The Leonids of 1833

"A Classic of Science"

A Scientific Eye-Witness Describes the Famous Shower Of Falling Stars Which Occurred Ninety-Nine Years Ago

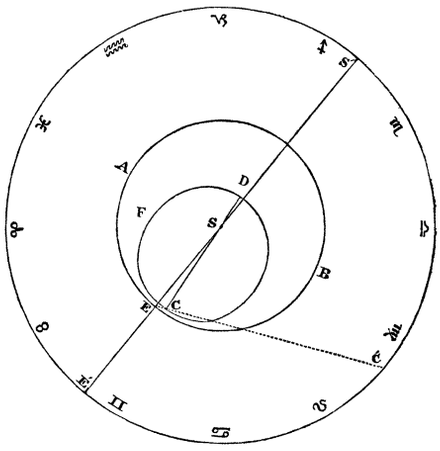
OBSERVATIONS ON THE METEORS OF NOVEMBER 13th, 1833; by Denison Olmsted, Professor of Mathematics and Natural Philosophy in Yale College. Published in The American Journal of Science and Arts (Silliman). Vols. XXV and XXVI. New Haven: 1834. This is an exact reprint of extracts from the original publication.

ABOUT DAY BREAK this morning, our sky presented a remarkable exhibition of Fire Balls, commonly called *Shooting Stars*. The attention of the writer was first called to the phenomenon about half past five o'clock; from which time until near sun rise, the appearance of these meteors was striking and splendid, beyond any thing of the kind he has ever witnessed.

To form some idea of the phenomenon, the reader may imagine a constant succession of fire balls, resembling sky rockets, radiating in all directions from a point in the heavens, a few degrees south-east of the zenith, and following the arch of the sky towards the horizon. They commenced their progress at different distances from the radiating point, but their directions were uniformly such, that the lines they described, if produced upwards, would all have met in the same part of the heavens. Around this point, or imaginary radiant, was a circular space of several degrees, within which no meteors were observed. The balls, as they travelled down the vault, usually left after them a vivid streak of light, and just before they disappeared, exploded, or suddenly resolved themselves into smoke. No report or noise of any kind was observed, although we listened attentively.

Beside the foregoing distinct concretions, or individual bodies, the atmosphere exhibited *phosphoric lines,* following in the train of minute points, that shot off in the greatest abundance in a northwesterly direction. These did not so fully copy the figure of the sky, but moved in paths more nearly rectilinear, and appeared to be much nearer the spectator than the fire balls. The light of their trains also was of a paler hue, not unlike that produced by writing with a stick of phosphorus on the walls of a dark room. The number of these luminous trains increased and diminished alternately, now and then crossing the field of view like snow drifted before the wind, although in fact, their course was towards the wind.

From these two varieties, the spectator was presented with meteors of various sizes and degrees of splendor: some were mere points, but others were larger and brighter than Jupiter or Venus; and one, seen by a credible witness before the writer was called, was judged to be nearly as large as the moon. The flashes of light, although less intense than lightning, were so bright as to awaken people in their beds. One ball that shot off in the northwest direction, and exploded a little northward of the star Capella, left, just behind the place of explosion, a phosphorescent train of peculiar beauty. This line was at first nearly straight, but it shortly began to contract in length, to dilate in breadth, and to assume the figure of a serpent drawing itself up, until it appeared like a small luminous cloud of vapor. This cloud was borne eastward, (by the wind, as was supposed, which was blowing gently in that direction) opposite to the direction in which the meteor had proceeded, remaining in sight several minutes. The light of the meteors was usually white, but was occasionally prismatic with a predominance of blue.



ORBIT OF THE LEONIDS

Prof. Olmsted's diagram showing the plane of the ecliptic and the hypothetical orbit of the meteor swarm in relation to the orbit of the earth

A quarter before six o'clock, it appeared to the company that the point of apparent radiation was moving eastward from the zenith, when it occurred to the writer to mark its place, accurately, among the fixed stars. The point was then seen to be in the constellation Leo, within the bend of the sickle, a little to the westward of Gamma Leonis. During the hour following, the radiating point remained stationary in the same part of Leo, although the constellation in the mean time, by the diurnal revolution, moved westward to the meridian nearly 15 degrees. By referring to a celestial globe, it will be seen that this point has a right ascension of 150 degrees, and a declination of about 21 degrees. Consequently, it was, when on the meridian, 20 degrees 18 minutes south of the zenith.

The weather had sustained a recent change. On the evening of the 11th, a very copious southerly rain fell, and on the 12th, a high westerly wind prevailed, by gusts. Last evening the sky was very serene; a few "falling stars" were observed, but they were not so numerous as to excite particular attention.

Prof. Olmsted wrote out for the New Haven *Herald* the account which forms the first part of this "Classic." He added an appeal for descriptions of the meteors as seen from other localities. His article was widely copied into other papers, and he received a large number of replies from scientists and amateurs. Many, like his own, were accounts which they had written for their local papers on the day of the display. From these records, Prof. Olmsted got important data bearing upon his theory that the meteorites describe a path like a comet's around the sun.

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The writings of Humboldt contain a descripton of a similar appearance observed by Bonpland at Cumana, in 1799. It is worthy of remark, that this phenomenon was seen nearly at the same hours of the morning, and on the 12th of November.

[Phenomena as observed at *New Haven,* (Lat. 41°18′ N., Lon. 72°58′ W.) and published in the New Haven *Daily Herald,* Nov. 13, 1833. The substance of this sketch is the same as that published in the New Haven *Herald,* on the day of the occurrence; but as that sketch was drawn up in haste, careful reflection has since suggested a few additions and alterations of phraseology, with a view of rendering the statement more explicit.—DENISON OLMSTED.]

The Meteors and the Earth

We have seen that the meteors appeared to be analogous, in their constitution, to the material of which the nebulous matter of comets is composed, in all the particulars in which we can compare the two. We may be permitted, therefore, in order to avoid circumlocution, to call the body which afforded the meteoric shower, a comet, while we pursue the inquiry, whether it exhibited the other attributes of that class of bodies.

The leading circumstances to be accounted for are the following: Why the phenomenon remained so long stationary with respect to the earth? Why it was seen in that particular part of the heavens? Why it returns at stated periods, having appeared at Mocha, in Arabia, just one year preceding, and, in a manner very similar to the present, as described by Humboldt, and by Ellicott, thirty-four years before?

Let the figure represent the plane of the ecliptic, with the twelve signs, AEB the earth's orbit, S the sun, and E the earth. On the morning of Nov. 13th, the place of the sun was in 21¼° of Scorpio, and that of the comet in 23¾° of Leo, (as observed at New Haven) being distant from the sun within 2½° of three signs or 90 degrees. The line of direction, therefore, as seen from the earth, was very nearly a tangent to the earth's orbit, and consequently coincided nearly with the line of direction in which the earth itself was moving. In other words, the earth was moving almost directly towards the comet. Therefore, S′ being the place of the sun among the signs, E′ that of the earth and C′ that of the comet, join EC′, and the comet's place will be in the line EC′, and, as was before shown, very near to E. Let it be at C.

Now the comet remained apparently at rest, and of course near the line EC′ for at least two hours. This it could not have done, unless it had been moving in nearly the same direction as the earth, and with nearly the same angular velocity around the sun. For had it been at rest, the earth, moving at the rate of 19 miles per second, would have overtaken it in less than two minutes; or had it been moving in the opposite direction, the meeting would have occurred in still less time; or had not the angular velocities of the two bodies been nearly equal, they could not have remained so long stationary with respect to each other. Hence we conclude, (1.) *that the body was pursuing its way along with the earth around the sun.*

Taking it for granted that the orbit of the body is elliptical, like the orbits of all the other bodies of the system, we infer that, at the time of observation, it must have been either at its perihelion, or its aphelion, otherwise its angular velocity could not have corresponded so nearly to that of the earth. The regular return of the phenomenon, at short periods, indicates that the aphelion, and not the perihelion, is near the orbit of the earth. Another reason will be stated hereafter, which, it is supposed, confirms this conclusion. As the body was very near the earth at the time of observation, it must have been at its aphelion; and being seen then, only 7¼° from the ecliptic, the plane of its orbit must be inclined at a small angle to the plane of the ecliptic, so that the body itself, if seen at all, will be seen within the zodiac. From all these considerations we conclude, (2.) *that the body revolves around the sun in an elliptical orbit, but little inclined to the plane of the ecliptic, and having its aphelion near to the orbit of the earth.*

Let us inquire, next, what is the *periodical time?* Since the same phenomenon was exhibited at Mocha, on the morning of the 13th November, 1832, and on a much larger scale than that, in various parts of the world, on the morning of the 12th November, 1799, we cannot suppose such a coincidence in the time of the year to have been purely accidental, but must conclude that the periodical time of the comet, and that of the earth, bear to each other a ratio which can be expressed in whole numbers; so that after a certain number of revolutions of the two bodies, corresponding to the terms that express their ratio, they will come together again. They could not come together, as they did, on two successive years, unless the periodical time of the comet was nearly an *aliquot part* of that of the earth, such as one half, one third, &c. Now, if the time be any aliquot part of a year, it must be one half, so that the comet would perform two revolutions, while the earth performs one; for, were its period only one third of a year, the line of the apsides would not be long enough to reach the earth. This will be obvious from the following estimate. Let D represent the axis major of the earth, and d that of the comet's orbit, their times being as 3 to 1. Then, by Kepler's Law, $3^2 : 1^2 :: D^3 : d^3$.

Taking D = 190,000,000 miles, d = 91,343,000 for the whole major axis, which is not equal to the distance from the sun to the earth. But, supposing the times as 2 to 1, we have

$2^2 : 1^2 :: D^3 : d^3$, whence d = 119,692,000 miles; giving for the perihelion distance 24,692,000, and for the aphelion 95,000,000 miles. Hence we conclude, (3.) *that the body has a period of nearly six months, and its perihelion a little below the orbit of Mercury.*

The transverse axis and the foci being determined, the ellipse may be described. Therefore, join CS, and produce the line CS and D, making SD equal to the perihelion distance, and upon CD describe the ellipse CFD, and it will represent the orbit of the comet.

This is to be regarded only as a *first approximation* to the true periodic time. The distance from the sun, instead of being taken, as here, at the *extremity* of the body, ought to be reckoned from the *center of gravity,* if we knew where to fix that. Nor can we suppose that the periodical time is very uniform, since a light nebulous body like the one in question, crossing as it does the orbits of Venus and Mercury, and having its perihelion near the orbit of the latter, would be subject to very great perturbations, sufficient to alter the dimensions of its orbit at every revolution. It might, for example, by coming into near conjunction with Mercury, have its periodic time greatly shortened, and be com-

How do we know when the thermometer is right?

LORD KELVIN

tells how he constructed the Absolute Thermometric Scale in

THE NEXT CLASSIC OF SCIENCE

pelled, for a long period, to revolve nearer to that planet than it does at present; and again by coming into a similar position with respect to the Earth, its orbit might be enlarged, and its periodic time increased, so that it might for a long period revolve nearer to the earth than before. I am not able at present to assign the amount of these disturbing forces, but it is easy to see that they exist, and must greatly influence the motions of the body.

The reader will very naturally suppose that, if a comet had approached so near to the earth, having the plane of its orbit in the zodiac, it would have been visible, first on one side of the sun, and then on the other, like an inferior planet. There are grounds for believing that such is the fact, and that a body answering to the conditions of the supposed comet, has been seen, at intervals, ever since the 13th of November, and is still (March 31st) visible in the west after sunset. . . .

1. *Such a luminous appearance was exhibited on the morning of November 13th, being seen in the east before the dawn of day. . . .*

2. *A peculiar light was seen eastward of the sun, visible in the west after sun set, as early as the first of December. . . .*

From our theory we should farther anticipate, that the comet will disappear by or before the first of May, being too near the sun to be visible; and that after the month of May, if seen at all, it will appear on the western side of the sun and rise before him, until the month of August, when it may possibly reappear for a little while in the evening sky.

Should future observations conspire with those already made, to establish such a period to this remarkable light, it will probably be regarded as a cometary body, and as the source of the meteors of Nov. 13th. But it will be remarked, that the several arguments alleged to prove the connexion of that phenomenon with a comet, are entirely independent of this light.

From all the foregoing considerations, I feel authorized finally to conclude, *That the Meteors of Nov. 13th, consisted of portions of the extreme parts of a nebulous body, which revolves around the sun in an orbit interior to that of the earth, but little inclined to the plane of the ecliptic, having its aphelion near to the earth's path, and having a periodic time of* 182 *days, nearly.*

I have supposed that a nebulous body, revolving about the sun in an eccentric orbit, might properly be called a comet, but should any one think that the analogy is not strong enough to authorise us to rank it among bodies of that class, he can apply any other name which seems more appropriate. Changing the name will not affect the validity of the theory.

Science News Letter, November 5, 1932

RADIO

The Science Service radio address next week will be on the subject,

NOVEMBER METEORS

by

Dr. Charles P. Olivier

Director of the Flower Observatory of the University of Pennsylvania and president of the American Meteor Society.

FRIDAY NOV. 11

at 12:45 P. M., Eastern Standard Time

Over Stations of

The Columbia Broadcasting System

CHEMISTRY

Octane Rating of Gasoline Not Wholly Dependable

THE MUCH-ADVERTISED "octane rating" of gasoline is not wholly dependable in selection of automobile fuel, according to Dr. Arthur Lachman, petroleum research chemist.

Since motor-car manufacturers have taken to building high-compression engines, old-fashioned straight-distilled gasoline is just not so good. Such fuel was made by simple methods much like the old process of turning out moonshine whisky. It was about the only kind of "gas" the public knew ten years ago.

A new test fuel, known commercially under the inexact name of iso-octane, and designated more precisely by chemists as 2,2,4 trimethyl pentane, has been chosen as an ideal standard of anti-knock performance. It would be wonderful if it did not cost $20.00 per gallon. The new commercial gasolines of premium and standard grades are being treated chemically so as to give a relatively high "octane number," in engineering parlances. This number indicates how closely the gas approaches the figure of 100 par for trimethyl pentane.

Dr. Lachman points out that a gasoline which has passed the anti-knock engine test with a high score does not necessarily give superior results in an engine working at a different temperature. For example, an air-cooled motor, working at high cylinder temperature, will often not recognize a high-octane gasoline as a superior fuel. On the other hand a low-temperature water-cooled motor may accept the fuel in question to great advantage. The moral for the consumer is simple: Try out the different brands on your own motor and make your own scientific decision.

Rumors have gained credence that "high octane" is just another form of commercial buncombe originating in the advertising departments. Critics voicing these rumors base their conclusions on the fact that the oil companies do not advertise the actual octane numbers of their several motor fuels. Dr. Lachman comes to the defense of the oil company. As long as one cannot with certainty predict from octane number just how good performance will be, just so long would it be misleading to coax a purchaser into line by quoting numbers.

Incidentally experiments show that gasoline which attains good anti-knock quality by addition of chemicals is more steady at different temperatures than gas of naturally high octane rating.

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ANTHROPOLOGY

Peking Man's Wrist Bones Found at Original Site

NEW FOSSIL remains of Peking Man, *Sinanthropus Pekingensis,* have been found at the Chou Kou Tien, China, site where the original skull was discovered in 1929. The new find consists of fossilized small bones from the wrist. They are reported to be definitely human in character.

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