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***METEORIC  
ASTRONOMY:  
A TREATISE  
ON SHOOTING-  
STARS, FIRE-  
BALLS, AND  
AEROLITES***

**Daniel Kirkwood**

# **Meteoric astronomy: A treatise on shooting-stars, fire-balls, and aerolites**

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# PREFACE.

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Aristotle and other ancient writers regarded comets as meteors generated in the atmosphere. This opinion was generally accepted, even by the learned, until the observations of Tycho, near the close of the sixteenth century, showed those mysterious objects to be more distant than the moon, thus raising them to the dignity of *celestial* bodies. An achievement somewhat similar, and certainly no less interesting, was reserved for the astronomers of the *nineteenth* century. This was the great discovery that *shooting-stars, fire-balls, and meteoric stones, are, like comets, cosmical bodies moving in conic sections about the sun.* DR. HALLEY was the first to foretell the return of a comet, and the year 1759 will ever be known in history as that which witnessed the fulfillment of his prophecy. But in the department of *meteoric* astronomy, a similar honor must now be awarded to the late DR. OLBERS. Soon after the great star-shower of 1833 he inferred from a comparison of recorded facts that the November display attains a maximum at intervals of thirty-three or thirty-four years. He accordingly designated 1866 or 1867 as the time of its probable return; and the night of November 13th of the former year must always be memorable as affording the first verification of *his* prediction. On that night several thousand meteors were observed in one hour from a single station. This remarkable display, together with the fact that another still more brilliant is looked for in November, 1867, has given meteoric astronomy a more than ordinary degree

of interest in the public mind. To gratify, in some measure, the curiosity which has been awakened, by presenting in a popular form the principal results of observation and study in this new field of research, is the main design of the following work.

The first two chapters contain a popular view of what is known in regard to the star-showers of August and November, and also of some other epochs. The third is a description, in chronological order, of the most important falls of meteoric stones, together with the phenomena attending their descent. The fourth and following chapters to the eleventh inclusive, discuss various questions in the theory of meteors: such, for instance, as the relative number of aerolitic falls during different parts of the day, and also of the year; the coexistence of the different forms of meteoric matter in the same rings; meteoric dust; the stability of the solar system; the doctrine of a resisting medium; the extent of the atmosphere as indicated by meteors; the meteoric theory of solar heat; and the phenomena of variable and temporary stars. The twelfth chapter regards the rings of Saturn as dense meteoric swarms, and accounts for the principal interval between them. The thirteenth presents various facts, not previously noticed, respecting the asteroid zone between Mars and Jupiter, with suggestions concerning their cause or explanation.

As the nebular hypothesis furnishes a plausible account of the origin of meteoric streams, it seemed desirable to present an intelligible view of that celebrated theory. This accordingly forms the subject of the closing chapter.

The greater part of the following treatise, it is proper to remark, was written before the publication (in England) of Dr. Phipson's volume on "Meteors, Aerolites, and Falling-stars." The author has had that work before him, however, while completing his manuscript, and has availed himself of some of the accounts there given of recent phenomena.

CANONSBURG, PA, *May, 1867.*

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# **INTRODUCTION. A GENERAL VIEW OF THE SOLAR SYSTEM.**

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THE SOLAR SYSTEM consists of the sun, together with the planets and comets which revolve around him as the center of their motions. The sun is the great controlling orb of this system, and the source of light and heat to its various members. Its magnitude is one million four hundred thousand times greater than that of the earth, and it contains more than seven hundred times as much matter as all the planets put together.

MERCURY is the nearest planet to the sun; its mean distance being about thirty-seven millions of miles. Its diameter is about three thousand miles, and it completes its orbital revolution in 88 days.

VENUS, the next member of the system, is sometimes our morning and sometimes our evening star. Its magnitude is almost exactly the same as that of the earth. It revolves round the sun in 225 days.



THE EARTH is the third planet from the sun in the order of distance; the radius of its orbit being about ninety-five millions of miles. It is attended by one satellite—the moon—the diameter of which is 2160 miles.

MARS is the first planet exterior to the earth's orbit. It is considerably smaller than the earth, and has no satellite. It revolves round the sun in 687 days.

THE ASTEROIDS.—Since the commencement of the present century a remarkable zone of telescopic planets has been discovered immediately exterior to the orbit of Mars. These bodies are extremely small; some of them probably containing less matter than the largest mountains on the earth's surface. More than ninety members of the group are known at present, and the number is annually increasing.

JUPITER, the first planet exterior to the asteroids, is nearly five hundred millions of miles from the sun, and revolves round him in a little less than twelve years. This planet is ninety thousand miles in diameter and contains more than twice as much matter as all the other planets, primary and secondary, put together. Jupiter is attended by four moons or satellites.

SATURN is the seventh planet in the order of distance—counting the asteroids as one. Its orbit is about four hundred millions of miles beyond that of Jupiter. This planet is attended by eight satellites, and is surrounded by three broad, flat rings. Saturn is seventy-six thousand miles in diameter, and its mass or quantity of matter is more than twice that of all the other planets except Jupiter.

URANUS is at double the distance of Saturn, or nineteen times that of the earth. Its diameter is about thirty-five

thousand miles, and its period of revolution, eighty-four years. It is attended by four satellites.

NEPTUNE is the most remote known member of the system; its distance being nearly three thousand millions of miles. It is somewhat larger than Uranus; has certainly one satellite, and probably several more. Its period is about one hundred and sixty-five years. A cannon-ball flying at the rate of five hundred miles per hour would not reach the orbit of Neptune from the sun in less than six hundred and eighty years.

These planets all move round the sun in the same direction—from west to east. Their motions are nearly circular, and also nearly in the same plane. Their orbits, except that of Neptune, are represented in the frontispiece. It is proper to remark, however, that all representations of the solar system by maps and planetariums must give an exceedingly erroneous view either of the magnitudes or distances of its various members. If the earth, for instance, be denoted by a ball half an inch in diameter, the diameter of the sun, according to the same scale (sixteen thousand miles to the inch), will be between four and five feet; that of the earth's orbit, about one thousand feet; while that of Neptune's orbit will be nearly six miles. To give an accurate representation of the solar system at a single view is therefore plainly impracticable.

COMETS.—The number of comets belonging to our system is unknown. The appearance of more than seven hundred has been recorded, and of this number, the elements of about two hundred have been computed. They move in very eccentric orbits—some, perhaps, in parabolas or hyperbolas.

THE ZODIACAL LIGHT is a term first applied by Dominic Cassini, in 1683, to a faint nebulous aurora, somewhat resembling the milky-way, apparently of a conical or lenticular form, having its base toward the sun, and its axis nearly in the direction of the ecliptic. The most favorable time for observing it is when its axis is most nearly perpendicular to the horizon. This, in our latitudes, occurs in March for the evening, and in October for the morning. The angular distance of its vertex from the sun is frequently seventy or eighty degrees, while sometimes, though rarely (except within the tropics), it exceeds even one hundred degrees.

The zodiacal light is probably identical with the meteor called *trabes* by *Pliny* and *Seneca*. It was noticed in the latter part of the sixteenth century by Tycho Brahé, who "considered it to be an abnormal spring-evening twilight." It was described by Descartes about the year 1630, and again by Childrey in 1661. The first accurate description of the phenomenon was given, however, by Cassini. This astronomer supposed the appearance to be produced by the blended light of an innumerable multitude of extremely small planetary bodies revolving in a ring about the sun. The appearance of the phenomenon as seen in this country is represented in Fig. 2.

Fig. 2.



For general readers it may not be improper to premise the following explanations:

Meteors are of two kinds, *cosmical* and *terrestrial*: the former traverse the interplanetary spaces; the latter originate in the earth's atmosphere.

*Bolides* is a general name for meteoric fire-balls of greater magnitude than shooting-stars.

The *period* of a planet, comet, or meteor is the time which it occupies in completing one orbital revolution.

The motion of a heavenly body is said to be *direct* when it is from west to east; and *retrograde* when it is from east to west.

*Encke's Hypothesis of a Resisting Medium.*—The time occupied by Encke's comet in completing its revolution about the sun is becoming less and less at each successive return. Professor Encke explains this fact by supposing the interplanetary spaces to be filled with an extremely rare fluid, the resistance of which to the cometary motion produces the observed contraction of the orbit.

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# **METEORIC ASTRONOMY.**