DANIEL'S COMET OF 1907.
Photographed with the Yerkes forty-inch refracting telescope, the largest in the world.

Comets and Their Mystery

By WALDEMAR KAEMPFFERT.

THE year 1907 was distinguished by the discovery of a comet by Professor Daniel of Princeton Observatory. Although it has been surpassed in brilliance and size by many of its predecessors, Daniel's comet was by far the brightest object of its kind that we have seen in the northern heavens for twenty five years. When first observed, on June 9th, it was a faint nebulous spot visible only through the telescope. Rapidly increasing in brightness, it could be seen with the naked eye in July. During the latter end of August and the early part of September it was as dazzling as a star of the second magnitude. In the early hours of the morning, from two o'clock until dawn, it was a conspicuously beautiful object in the constellation of Gemini (the Twins), particularly during the first week in September. Its head had a diameter of nearly 236,000 miles, which means that it was nearly thirty times larger than the earth. Because the comet was presented to us obliquely, its tail seemed shorter than it really was; yet astronomers figured that it must have been at least twenty million miles in length.

BROOKS' COMET IN 1893,
Showing tail broken supposedly by collision with a swarm of meteors.

At the time of its greatest brilliance the comet had a speed of about sixty miles a second, compared with which the swiftest projectile fired from the most powerful modern gun would seem to crawl through space. On September 4th the comet whirled around the sun. A fortnight later it retreated so far from the earth that it could be seen only with difficulty. By the end of September the telescope alone could detect it. Thus it made its exit as modestly as it had entered. Will it ever return? Perhaps in some thousands of years it may; and on the other hand it may not. The astronomers have not as yet completed their final computation of its period. It travelled in an orbit which, although probably an ellipse, was to us an ellipse of such inconceivably vast dimensions that mathematically it must be regarded as an open curve. Although three observations made on three different nights will usually give three points from which the astronomer can determine in a general way the character of a comet's path, the problem of plotting the orbit is one of unusual complexity. The period of Halley's comet has not yet been definitely fixed, with the result that we know only in a general way that it will appear some time in 1910. Many astronomers are working hard to win a prize offered by a German astronomical society for an exact determination of the path of Halley's comet. The orbit of Daniel's comet presented difficulties because the angle made by its plane with the plane of the earth's orbit was so very small that a line drawn through three points obtained on three successive nights did not differ sensibly from a straight line. When the comet rounded the sun, however, the curve was obviously more pronounced. Once in the toils of the mathematician it becomes possible to follow the movements of the comet in the astronomer's mind's eye, even when it has disappeared, and to indicate the very spot in the heavens where it should reappear if it describes a closed curve.

When the labour of plotting the orbit of Daniel's comet is at last completed, it may transpire that it visited the earth so long ago that its visit has been forgotten even by tradition. Who knows but it may have ushered in some pregnant event when mankind was young. Who knows but it may return to us when mankind is old and decrepit and the earth is entering upon that last stage of its career which will ultimately reduce it to a cold, dead, and desolate world?

Halley and his comet are inextricably bound up not only with the history of Europe, but with Newton and his law of gravitation; for Halley was Newton's pupil, staunch friend, and counsellor. To his persuasive insistence and to his touching devotion to what he considered his scientific duty we owe the publication of that famous treatise of Newton's in which the immutable laws of gravitation were first laid down. He became the prophet of gravitation. In accordance with Newton's laws he plotted the orbit of a comet that had alarmed the world in 1682, and concluded that it was the same that had shone in 1607 and 1531, and that it would return in 1758, fifty-four years after his utterance. Past the prime of life when he made his calculation, he knew that the triumph of seeing his prediction fulfilled would be denied him. He died in 1742 at the age of eighty-five, certain that his forecast would be verified, and leaving behind him a pathetically patriotic appeal, which reads: "Wherefore, if, according to what we have already said, it should return again about the year 1758, candid posterity will not refuse to acknowledge that this was first discovered by an Englishman." With poetic fitness the comet blazed forth on Christmas day, 1758.

Newton's law of gravitation teaches us that comets must describe ellipses, parabolas, or hyperbolas, all of which curves are obtained by cutting a cone in different ways. Since Halley's time the orbits of more than three hundred comets have been plotted with more or less accuracy, and of these, sixty describe ellipses, 255 parabolas, and two hyperbolas. Of the entire number we may expect to see only the sixty travelling in elliptical orbits: for the others follow open curves which must inevitably convey them far beyond the confines of our solar system. The sixty comets which revolve about the sun in closed ellipses return to the same point after periods that vary from three years to several hundred years. On an average two or three periodical comets appear every year, and three or four of which are unexpected and will never be seen again.

Mathematics in Newton's law of gravitation have so thoroughly dispelled the dreadful divinity which once did hedge a comet that only the possibility of a collision of the earth with some large fiery wanderer gives us any cause for uneasiness in these unsuperstitious days. A gambler at Monte Carlo, however, is more likely to break the bank than the earth is to encounter a comet. Two inquisitive scientists, Arago and Babinet, have computed the possibility of such a meeting. They have soothingly concluded that such a calamity may occur once in about fifteen million years, and that the chances in favour of a collision are roughly 281,900,000 to 1. Although the earth has never struck a large comet, it has frequently swept through a

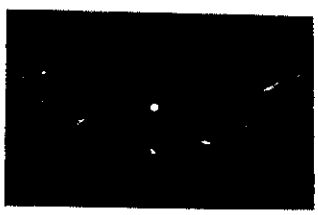

DIAGRAM SHOWING HOW THE TAIL OF A COMET IS ALWAYS DIRECTED AWAY FROM THE SUN.

comet's tail. The last passages of this kind occurred in 1819 and in 1861. In neither case was anyone the wiser until, long after, the fact was announced by astronomers. If the earth ever does collide with a very large comet it has been asserted that the impact will develop heat enough to melt granite. The effect on terrestrial life can be imagined. So remote is the possibility, however, that speculation of this kind is childishly futile. Jules Verne and the modern newspaper are largely responsible for the popular belief in such a catastrophe.

A comet is distinguished usually by a nucleus, by an envelope called the coma, which surrounds the nucleus, and, lastly, by its luminous tail streaming behind

ANOTHER VIEW OF DANIEL'S COMET, TAKEN WITH THE GREAT YERKES TELESCOPE.
In photographing a comet, the telescopic camera is timed to move exactly with the comet. Hence, in this and the picture at head of page, the comet appears sharp and the stars as streaks of light.