CHAPTER 2

COMETS IN MOTION

We all know the story of Newton and Halley. Thanks to his discovery of the phenomenon of gravity and the formulation of its effects in the form of mathematical laws, Newton was able to demonstrate that comets obeyed the same universal law as every other physical object in the universe. Much of this work was based upon the motion through the sky of a very spectacular comet that appeared during the latter part of 1680 (Fig. 2.1). In the process, he was able to show that the bright comet that had graced the morning skies during November and early December of 1680 was actually the same as the even more magnificent apparition that emerged from the evening twilight just prior to Christmas. He also correctly demonstrated that this comet had passed unusually close to the Sun around mid-month.

The main difference between the orbits of comets and planets lay with the fact that, whereas planets followed paths that were only slightly elliptical, comets moved through space along paths that were (or were close to) a parabola. The path of the 1680 comet was either a true parabola or a very elongated ellipse. If the first alternative was correct, the appearance of 1680 was its one and only visitation. However, as nature is about as unlikely to draw a parabola as a straight line, it was more likely that the true path of this comet was an ellipse having a period of hundreds or even thousands of years.

By applying Newton's theory of gravity, his colleague, Edmond Halley (1656–1742), calculated the orbits of 24 comets that had been recorded during the preceding centuries. Although he calculated the orbits of these objects on the assumption of parabolic motion (really for simplicity sake and due to the fact that the available observations were not sufficiently precise to enable one to distinguish between a parabola and an eccentric ellipse), he was struck by the apparent similarity between some of the orbits as well as by some regularly spaced intervals separating the appearance of a few of

D.A.J. Seargent, *Visually Observing Comets*, Astronomer's Pocket Field Guide, DOI 10.1007/978-3-319-45435-1_2

Fig. 2.1 The Great Comet of 1680 over Rotterdam. (Painting by Lieve Verschur, 1627–1686)

the catalogued comets. This led him to conclude that certain comets, at least, return at regular intervals. Perhaps they all do, albeit with periods so long that their previous returns have been lost in the mists of prehistory.

Three groups of cometary apparitions were suspected by Halley as having been repeated returns of a single object. The first was a trio of objects observed in 1531, 1607 and 1682, the last of the series having been observed by Halley himself. These objects all moved along remarkably similar orbits, and Halley strongly suspected that they were simply different apparitions of the same body pursuing an elliptical path having a period of about 75 or 76 years. In apparent support of this conjecture, Halley noted that a similarly bright comet had appeared in the year 1456. Although this one was not included in his catalogue of orbits, the time interval was suspiciously close to that separating the other three. From this, he predicted that the comet would return around the year 1758 or 1759—a prediction that was gloriously fulfilled, even though Halley did not live to witness it personally. Since then, Halley's Comet, as it became

Fig. 2.2 Comet Halley in 1986 showing rays in ion tail. (Image courtesy of NSSDC Photo Gallery, NASA, image by W. Liller)

known (although its more formal title is now 1P/Halley) has been observed in 1835, 1910 and 1986 (Fig. 2.2) when it was visited by a fleet of unmanned spacecraft, and images of the active nucleus of a comet were beamed back

to Earth for the first time. The comet is due back once more in 2061 and is scheduled to make a very close pass of Earth—to just 0.09 AU—during its subsequent return on May 7, 2134.

Halley also suspected that the comet he and Newton had observed in 1680 might have been a return of a very spectacular one widely observed in 1106, as well as one listed in Byzantine records for the year 530 and even the one seen at the time of the assassination of Julius Caesar in 44 B.C. This opinion was not based upon any orbital similarities of these bodies, as an orbit had been calculated for 1680 alone. Halley was basing his suspicions on the similar time intervals between the apparitions and the fact that all of these objects were bright. In contrast to his thoughts about the 1682 comet, we now know that the objects of 44 B.C., 530, 1106 and 1680 were different objects. Ironically, the 530 object was actually an early appearance of the 1682 comet!

Halley's orbit catalogues also included two other objects having similar orbital elements that Halley suspected as being separate returns of a single body. These were the bright comets of 1532 and 1661, the first having been observed by Peter Apian and represented by him in woodcuts depicting the orientation of its tail to be consistently in an anti-solar direction. This suggested identification was also incorrect, although the latter comet at least has turned out to be one of a relatively short period. It returned in 2002, at which time it was rediscovered by Kaoru Ikeya and Daqing Zhang, after whom it has now been named. Earlier apparitions of Comet Ikeya-Zhang have probably been found in the form of the comets of 1273 and 877. Although it cannot be identical with the 1532 comet, it is possible that these two have a common origin. Maybe they were once a single object that split apart near perihelion hundreds of years ago.

http://www.springer.com/978-3-319-45434-4

Visually Observing Comets

Seargent, D.A.J.

2017, XVII, 276 p. 55 illus., 39 illus. in color., Softcover
ISBN: 978-3-319-45434-4