

body and of their possible composition. It now seems likely that in the initial stages of the formation of the Solar System (page 160), many icy bodies formed in the outer regions, and that some of these have been captured to form the icy satellites of Jupiter and Saturn (and presumably of the other outer planets as well), while many were ejected completely from the Sun's gravitational influence. Some bodies were injected into very elongated orbits, and these are likely to be the comets which we see today.

Comets

The appearance of a great comet is undoubtedly one of the most striking celestial phenomena which can be seen by the naked eye. The fact that the occurrence of comets is generally unpredictable, and that they may suddenly appear as large and prominent objects, only serves to make them the more remarkable. However, it is now known that vast numbers are so faint that they can only be observed with the largest telescopes and that many others must be missed because, as viewed from the Earth, their orbits are too close to the Sun for them to be seen. Study of their frequency and their orbits suggests that comets in the Solar System number many millions.

Like the minor planets, so many comets are known that a special classification has been introduced. It is usual for the name of the discoverer (or discoverers, up to a maximum of three) to be given to a comet, although this is sometimes varied, as in the cases of Comets Halley, Encke and Crommelin, by using the name of the person who has made extensive orbital calculations. Further identification is given by the year and a letter awarded in order of discovery. If the comet is found to be periodic the letter P is used as a prefix. At a later date, a final designation is given in accordance with the date at which the various comets came to perihelion by giving the year in which this occurred and a Roman numeral. For example Comet Bennett 1969i (the ninth to be found in 1969) became Comet Bennett 1970 II (the second to pass perihelion in that year). Recoveries of periodic comets are included in this scheme and, occasionally, when a comet has been lost for a considerable time, the name of the rediscoverer is added to that of the original finder, as with Comet P/Perrine which was not recovered for five periods, and was then found by Mrkos. The object is now known as Comet P/Perrine-Mrkos.

Orbits and periods

The vast majority of comets which have been fully studied have closed (elliptical) orbits and are thus true members of the Solar System. Some orbits are so eccentric that, initially, for computational purposes, they may be treated as PARABOLIC. Calculation shows that those comets with open HYPERBOLIC paths which are escaping from the Sun's influence have been perturbed by the planets (especially Jupiter). Despite the fact that comets have been lost by the Solar System, none have been observed to enter it from interstellar space along hyperbolic paths. There are indications

that some comets have aphelia at many thousands of astronomical units, perhaps even halfway to the nearer stars, but accurate determination of aphelion distances and periods in such cases is extremely difficult. It has been suggested that a large reservoir of comets exists at such great distances from the Sun, and that they are occasionally perturbed by the gravitational effects of nearby stars into orbits approaching the centre of the Solar System.

Comets may approach the Sun from any direction, but there are indications that the major axes of the orbits are concentrated towards the galactic plane (see p. 166) and that aphelion positions are clustered around the solar ANTAPEX. The orbital planes may have any inclination. However, the orientations in space are not completely random, as there are definite groups of objects which may be recognized from their similar orbital characteristics. This is particularly noticeable in the case of the so-called Sun-grazing comets, which have perihelion distances of 0.01–0.005 au, and are thus well within the Sun's corona (page 76). Since 1979 satellite-borne equipment has revealed three comets which have collided with the Sun, or at least have approached so close that they have been completely disrupted and have not appeared after perihelion. None of these objects was visible from the Earth, and the fact that three have been detected in such a short span of time suggests that similar comets are much more

Comet West, 1975n, photographed on 1976 March 13, showing the broad and relatively featureless dust trail above, and the narrow, blue, finely structured gas (plasma) tail below.

