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Comets: Big, dirty snowballs

Comets are small, “dirty snowballs”, a few kilometres in size, composed of frozen dust and gases, that orbit the Sun. Unlike the planets and most of the asteroids, whose orbits are nearly circular, comets have highly elongated **elliptical** orbits. When nearest to the Sun, they are often nearer than the planet Mercury, but at the other end of their orbit, they may be further away than Pluto.

As comets approach the inner solar system, the warmth of the Sun melts and vaporizes their icy components, which form a glowing **coma** ranging in size from 100,000 to 1,000,000 kilometres in diameter. The coma surrounds the tiny, solid **nucleus**, which may range in size from less than ten kilometres to no more than 100 kilometres across. The pressure of the solar wind (radiation and charged particles) pushes some of the material into a long, thin **tail**, which may be several tens of millions of kilometres long, and stretches behind the comet, away from the Sun. Comets appear bright or to glow because of light reflected from the Sun. As the comet reaches **perihelion**, the point in its orbit closest to the Sun, the tail swings around. As the comet recedes from the Sun, the tail, which is still pointing away from the Sun, actually goes ahead of the nucleus and coma. As it goes further out into the solar system, the comet cools and darkens, usually for many years, before it reaches **aphelion**, its furthest point from the Sun, and once again starts its voyage towards the inner solar system.

Most people have never, or only rarely, seen a comet. Indeed, few people could name any comet, apart from **Comet Halley**, which made a rather disappointing appearance in 1985-1986. This fact leads to the widespread, but incorrect,

belief that comets are rare. In fact, comets are quite common. Several dozen comets are found every year, mostly by amateur astronomers using telescopes. Comets are usually named after the individual or individuals who make the discovery. Generally though, they are small and faint, and never get bright enough to reach visibility to the unaided eye.

Fortunately, there are exceptions to the general rule. A bright comet seen by the unaided eye occurs on

average once every three years, but this can vary by as little as a few months to as long as several decades. In recent years, we were treated to two very bright comets:

Comet Hyakutake in 1996, and **Comet Hale-Bopp** in 1997. Both comets produced very long tails, and they were easy to see in the night sky.



Hartwig Luethen, Germany

Comet Hale-Bopp, April 1, 1997.

Scientists believe comets originate from beyond the planets in two regions: one is called the **Kuiper Belt** and the other is called the **Oort Cloud**. The Kuiper Belt extends out beyond Neptune’s orbit in a huge disk of icy bodies. Pluto may in fact be the largest member of the Kuiper Belt. The Oort Cloud contains a vast number of comets surrounding the solar system

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extending more than 1,000 times as far from the Sun to Pluto. At this distance the comets are inactive because the Sun is too far away to cause the icy bodies to vaporize. A gravitational nudge, possibly from a passing star, may dislodge some of these icy bodies from their old orbits in the Oort Cloud and sent them into a highly elliptical orbits towards the inner solar system. As they race deep into the heart of the solar system, their orbits can be altered by some of the planets, particularly by Jupiter and Saturn.

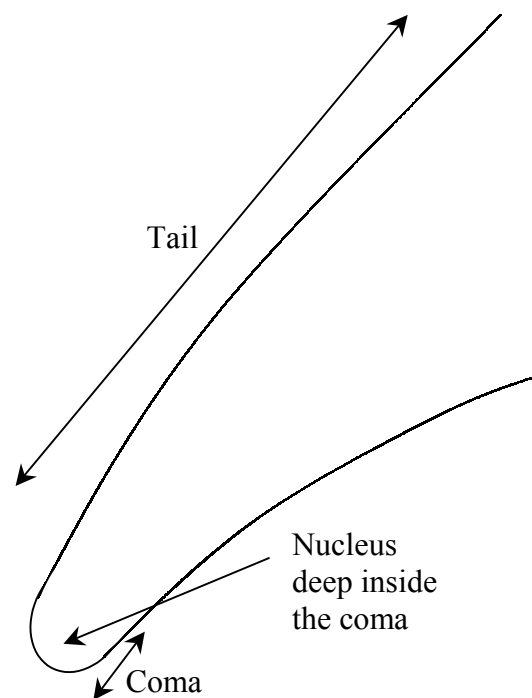
The orbital periods of comets that are in highly elliptical orbits and travel into the inner solar system can vary greatly. Orbital periods of comets are divided into two groups: short-period comets, which orbit in less than 200 years, and long-period comets, which orbit in greater than 200 years. Comet Halley has an orbital period of 76 years, whereas Comet Hale-Bopp has an orbital period of about 4,000 years. Our ancestors may see it in the year 5997! Some comets orbit the Sun in only a few years, such as **Comet Giacobini-Zinner**, which has an orbital period of 6½ years.

As comets make their passage through the inner solar system and around the Sun, they loose considerable amount of material through the release of dust and gas. Many tonnes per second are lost during their active phase. Close up photographs of Comet Halley taken by spacecraft in 1986 showed narrow jets of gas erupting from several areas of the nucleus.

Not all comets survive their inward journey among the planets. Some comets are pulled in the Sun where ice meets fire. Other comets end their journey by impacting with one of the planets. A spectacular example was witnessed during the summer of 1994, when **Comet Shoemaker-Levy 9** crashed into Jupiter. In fact, gravitational forces ripped the comet into a trail of many large pieces and countless smaller pieces. The impacts of all the pieces occurred over a one-week period in July. The larger pieces left huge impacts on

Jupiter, and these were easily visible through small telescopes. There is plenty of geological evidence that shows Earth has been impacted by large comets and asteroids in the distant past.

Observing comets in the night sky is easy if they are as large and bright as Comet Hale-Bopp was in 1997. But most comets are small and dim, and require binoculars or a small to medium-sized telescope to be seen. The coma will appear as a small fuzzy patch and you may see a small faint tail. Observing a comet over several nights will allow you to see how the comet moves relative to the star field. Making star-field sketches or taking photographs over several nights can be an interesting project to see how the comets move and change over time.



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