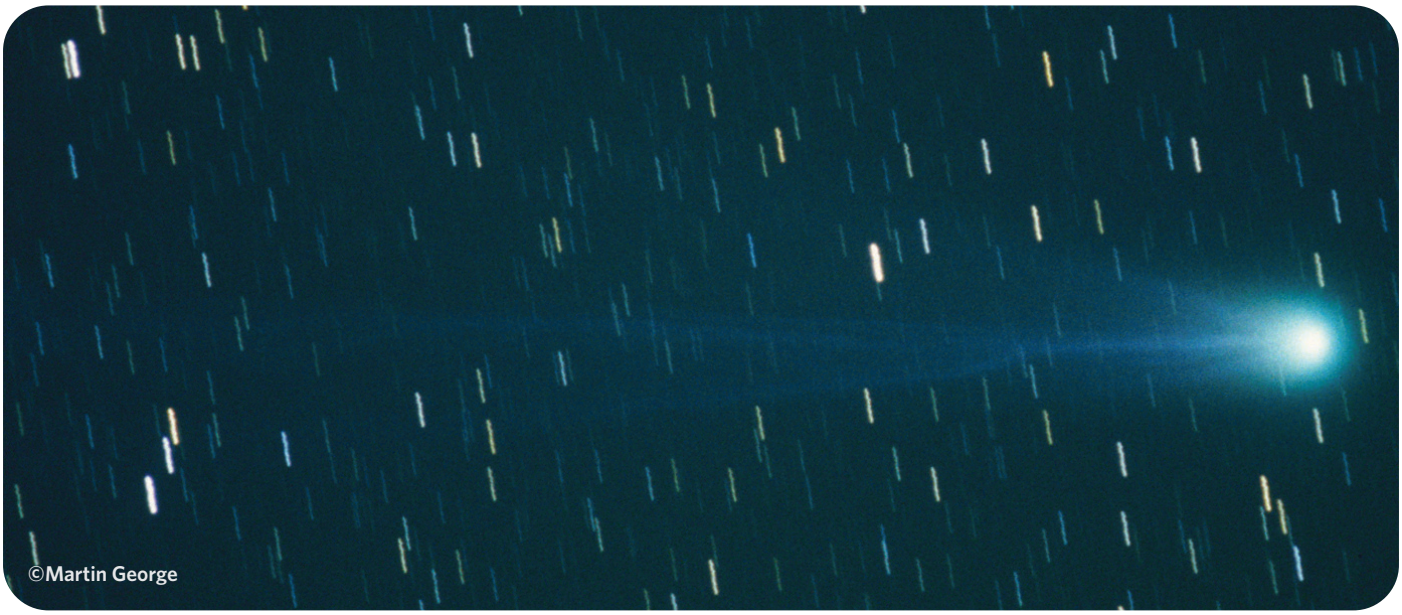
THE LAUNCESTON
PLANETARIUM
QUEEN VICTORIA MUSEUM

COMETS

Comets are objects composed of ices and dust particles, and are typically a few kilometres across. They orbit the Sun, and are therefore members of our Solar System. Comets typically move in very elongated orbits, which is why we normally see a comet easily for only part of its orbit – when it is in the inner part of the Solar System, where Earth is located. When a comet is near the Sun, some of its material is removed by the Sun's energy, forming a cloud of material called a *coma* surrounding the small, icy *nucleus*. This material can form a *tail* as it is 'blown away' by a stream of particles from the Sun called the solar wind and also by the Sun's light; the tail of a comet points away from the Sun regardless of the direction of the comet's motion. Comets shine both by reflecting sunlight and by emitting their own light after absorbing ultraviolet light from the Sun. The most famous example of a comet is Comet Halley, which was seen in our part of the Solar System in 1986 but is now too far away to be seen, even with powerful telescopes.



Comet Hyakutake, photographed from Tasmania in 1996. Stars appear as streaks because the camera was following the motion of the comet during the 15-minute time exposure. Image: Martin George

Some comets are on orbits small enough that they are seen regularly, as they repeatedly move through the section of their orbit that brings them close to the Sun and Earth. These are called *periodic* comets. Comet Halley returns about every 76 years. The comet with the shortest orbital period is Comet Encke, which moves around the Sun every 3.3 years. At the other end of the scale, there are comets that are on such large orbits that they are effectively seen only once, taking thousands of years to complete each revolution. Fine examples were Comet Hale-Bopp (seen in 1997), and Comet McNaught (seen in 2007). They are all 'new' discoveries, and because of this, we sometimes have very little warning of their appearance in our night sky.

THE ORIGIN OF COMETS

Modern opinion is that comets are remnants of the formation of the Solar System billions of years ago, and that they were formed in the cold outer reaches of the planetary system, in the region of the planet Neptune. The gravity of the outer planets then caused them to be flung out into more distant orbits beyond Neptune. It is thought that, today, there is a huge 'reservoir' of distant comets called the *Oort Cloud* after the Dutch astronomer Jan Oort. Many 'new' comets never seen before are thought to come directly from this region and to return there — after a brief passage through the inner Solar System, where they swing rapidly around the Sun. In recent years, astronomers have confirmed the existence of a closer group of icy objects orbiting in the region beyond Neptune. This is called the *Kuiper Belt* (after astronomer Gerard Kuiper, who proposed its existence). Astronomers think that the Oort Cloud is the source of comets of long orbital periods, and that short-period comets come from the Kuiper Belt. Comets with orbits entirely within the Sun's planetary system have had their orbits shaped by passing close to one or more planets.

THE COMPOSITION OF COMETS

Research over the years, including the study of comets by spacecraft, has given astronomers much information about the composition of comets. In broad terms, a comet can be likened to a big dirty snowball. The nucleus, or relatively solid part, of a comet consists of ices of various compounds of carbon, hydrogen, oxygen and nitrogen; water ice (H_2O) and carbon dioxide ice (CO_2) are major constituents. In addition to the ice, there is a good deal of dust in the form of grains containing silicon, magnesium and other heavier elements. This dust, mixed in with the ice, makes the nucleus of a comet dark. Photographs of the nucleus of Comet Halley, about 15 kilometres across, showed it to be very dark indeed. Comets' comas and tails contain both gas and dust, and have offered important clues to the composition of the nucleus itself; 80% of the molecules in the coma of Comet Halley are water molecules, while much of the remainder consist of molecules of carbon monoxide and carbon dioxide.

The dust and gas in comets' tails are blown away from the comet via different mechanisms. The gas is affected by the solar wind – the stream of electrically charged particles moving outwards from the Sun at a speed of hundreds of kilometres per second. The dust particles, however, are blown away by interacting with the light of the Sun. This means that a comet will often display separate gas and dust tails. The gas tail is generally straight, but the dust tail is often seen as a curved line of material. This is because the dust particles move away from the comet more slowly and retain much of their original motion.

The nucleus of Comet Churyumov-Gerasimenko, imaged by the European Space Agency's Rosetta spacecraft in 2015.
Image: European Space Agency

COMETS AND METEORS

The debris from comets is responsible for most of the meteors – often called 'shooting stars' – that we see in the night sky. There is a good deal of such debris and, in particular, material remaining in the orbits of comets can produce regular 'meteor showers' at predictable times as the Earth moves through it. Larger, rocky objects, some of which reach the ground, are more related to asteroids.

DISCOVERING COMETS

Some comet discoveries are made by amateur astronomers with a thorough knowledge of the night sky, using their own telescopes or large binoculars. This is largely because professionals are normally heavily involved in specific projects, while amateurs are free to choose their activities. For example, Comet Hyakutake, a very bright comet seen in 1996, was first spotted by Japanese amateur astronomer Yuji Hyakutake using very powerful binoculars. However, more and more comets today are discovered using special professional surveys specifically set up to detect both comets and asteroids. An example is the Lincoln Laboratory Near-Earth Asteroid Research project (LINEAR) which has resulted in the discoveries of many comets.

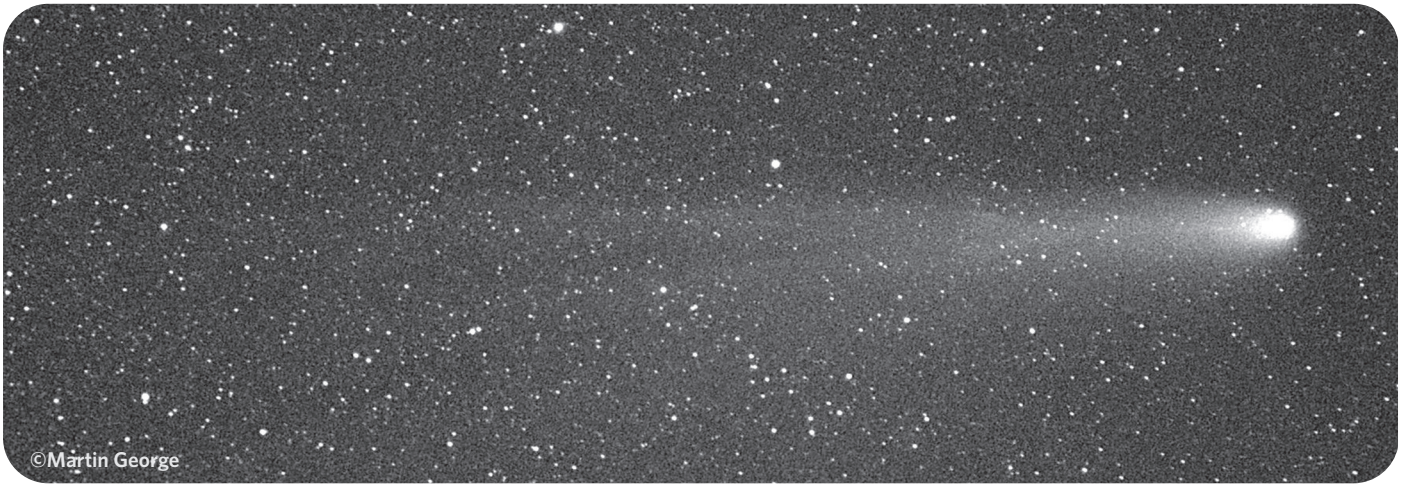
Comets are generally named after their discoverers, although in some cases two observers have found a new comet independently within a short time and the object has been named after them both. There are even some triple-barrelled names! Today many are named after the search program, such as LINEAR, that was used to discover them. A numbering and lettering system is also used.

OBSERVING COMETS

Comets do not 'dash' across the sky. Like the planets, they appear in slightly different positions each night with respect to the background stars. A comet passing very close to Earth, however, can appear to move considerably from night to night, as did Comet Hyakutake in March 1996. Most comets are observable only with telescopes; only occasionally does one become visible to the unaided eye. The brightness of a comet can be quite unpredictable, especially if has never been seen before. When there is a fine 'naked-eye' comet, the best general view is usually obtained with binoculars, not a telescope. A useful type for general astronomy, including comet observation, is a pair marked '7x50', which has lenses 50 mm across and magnifies 7 times. It is also very important to be well away from city lights, and to stand outside for some time (at least ten minutes, but preferably longer) to allow the eyes time to get used to the darkness. Dark-adapted country dwellers with binoculars obtained fine views of Comet Halley in 1986, but many city dwellers, ignoring all of this advice, failed even to notice it at all! It is important to note that time-exposure photography shows much more detail.

OLD IDEAS ABOUT COMETS

Long ago, nobody knew the true nature of comets. The Chinese called them, among other things, 'broom stars' or 'bushy stars'. Comets were often seen to be bad omens, and they were wrongly associated with such events as the deaths of important people. The appearance of Comet Halley in 1066 was thought to be a very significant event relating to the Battle of Hastings, and its presence in the sky was depicted on the Bayeux Tapestry.



Comet Halley, whose most recent naked-eye appearance was in 1986.
The comet was named after Edmund Halley, who realised that comets that were seen in 1531, 1607 and 1682 were regular appearances of the same comet. He predicted that it would return to the inner Solar System in 1758. The comet indeed reappeared in 1758, 16 years after Halley's death. This photograph was taken on the morning of 21 March 1986 from a country location in Tasmania. At that time, the comet was 119 million kilometres from Earth. Image: Martin George

BRIGHT COMETS SINCE 1900

(All except Comet Halley were previously unrecorded, because of their very long orbital periods.)

1901 The Great Comet of 1901 (Viscara's Comet)
First seen on 12 April 1901, low in the morning twilight. Faded from naked-eye view in late May.

1910 Great January Comet ('The Daylight Comet')
First seen by miners in South Africa on 12 January 1910. Seen with the unaided eye for several weeks, and visible for a time in daylight.

1910 Comet Halley
Often confused with the Great January Comet. First seen with the unaided eye on 11 February 1910, and visible until June. Its 1986 appearance was far less impressive.

1927 Comet Skjellerup-Maristany
First seen in November and visible in daylight during December.

1947 'Southern Comet'
First seen on 8 December 1947, but visible with the unaided eye for only about two weeks.

1948 The 'Eclipse Comet'
Discovered during a total eclipse of the Sun on 1 November 1948, which was seen from Kenya. Seen with the unaided eye in the morning twilight until early December.

1957 Comet Arend-Roland
Discovered photographically on 6 November 1956 and a spectacular object during April 1957.

1965 Comet Ikeya-Seki
Discovered on 18 September 1965. Seen with the unaided eye during October and November. Passed very close to the Sun on 21 October. Brightest comet of the 20th century.

1970 Comet Bennett
Discovered on 28 December 1969. Seen with the unaided eye from early February to early May 1970.

1976 Comet West
Discovered in November 1975, on photographs taken in September. Visible with the unaided eye from January until April 1976, and was a spectacular object during March from the northern hemisphere.

1996 Comet Hyakutake
Discovered in January 1996. Visible with the unaided eye from early March until mid-June. A spectacular object during late March when it passed only 15 million kilometres from Earth, and was seen from all over the world.

1997 Comet Hale-Bopp (The Great Comet of 1997)
Discovered in July 1995 when it was still over 1,000 million kilometres from the Sun. Visible with the unaided eye from late 1996 until late 1997. A spectacular object from the northern hemisphere in April 1997; southerners missed out on the very best views.

2007 Comet McNaught (The Great Comet of 2007)
Discovered on 7 August 2006 and became the brightest comet since Ikeya-Seki in 1965. It put on a spectacular display, especially from the southern hemisphere in January 2007. Shortly after its closest approach to the Sun on 12 January, it was visible in daylight for a few days.

Comet McNaught, also known as The Great Comet of 2007, was a spectacular sight in the Tasmanian night sky during January 2007. These photographs were taken after it rounded the Sun and appeared in the western evening sky, being very easily visible even in bright twilight. At left is a view looking over the Launceston suburb of Newstead in Tasmania. At right is a picture taken from a location near Longford, south west of Launceston.
Images: Martin George

Comet NEAT (C/2001 Q4), named after the Near-Earth Asteroid Tracking program, which was based in Hawaii. The comet was discovered in 2001 and reached its peak brightness during 2004. This photograph was taken on 9 May 2004 from a location in northern Tasmania.

Image: Martin George

FUTURE STUDIES OF COMETS

Much more research needs to be done on comets. Because they contain primitive material, more detailed studies may assist in understanding the early history of the Solar System. Earth-based and spacecraft studies will hopefully continue to expand our knowledge of these strange objects. Already, there have been several spacecraft studies of comets, including Comet Halley (1986) and Comet Churymov-Gerasimenko (2014-16).

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