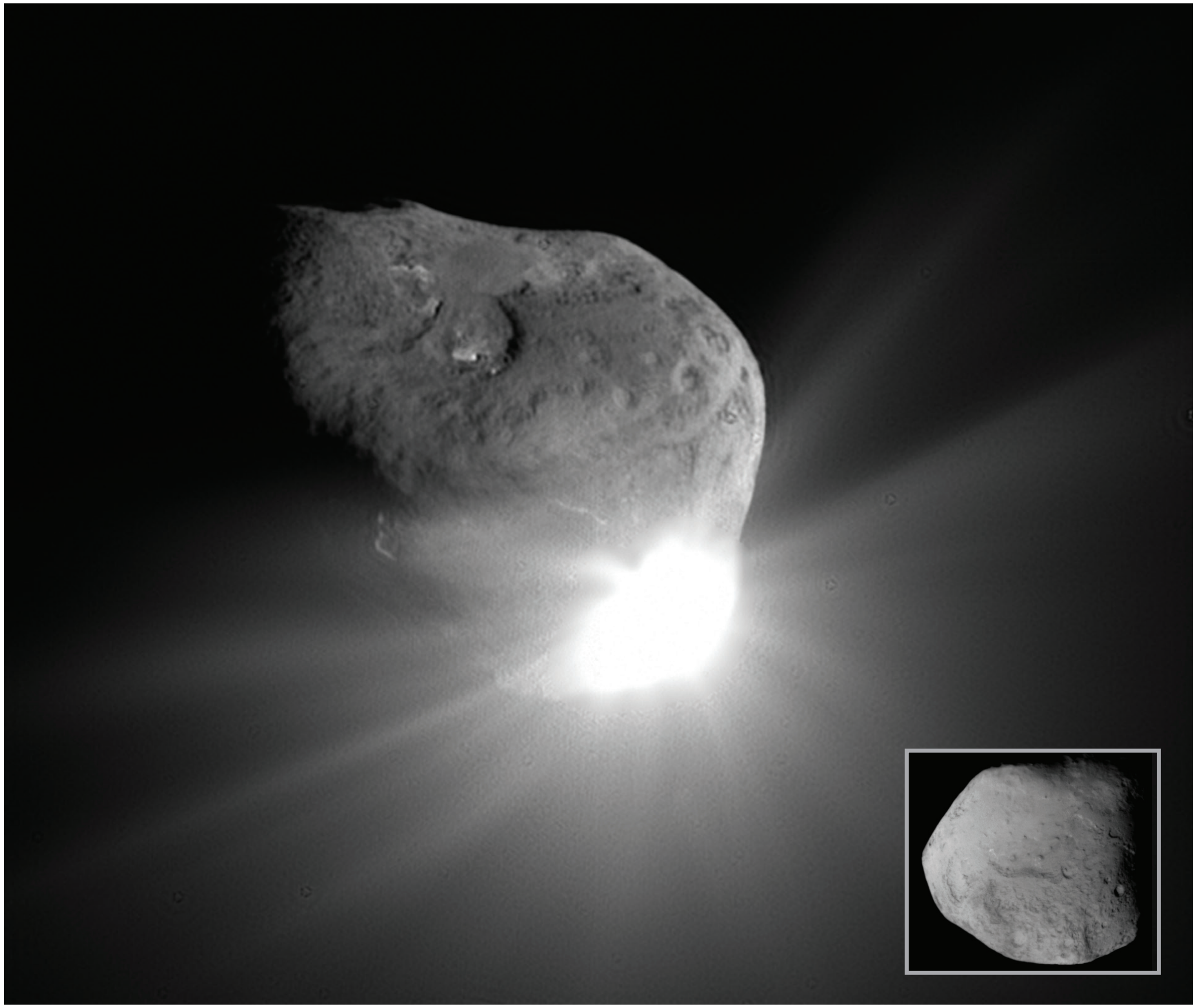
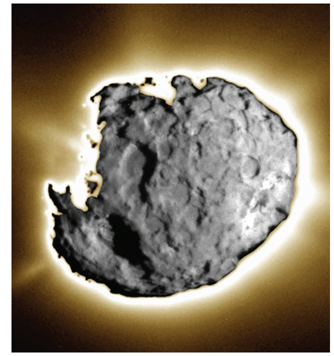
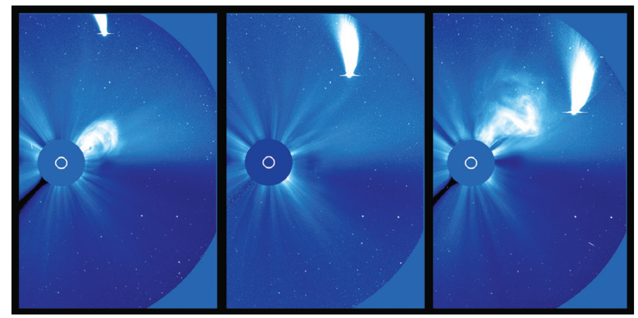
National Aeronautics and Space Administration







Comets

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In the distant past, people were both awed and alarmed by comets, perceiving them as "long-haired" stars that appeared in the sky unannounced and unpredictably. Chinese astronomers kept extensive records for centuries, including illustrations of characteristic types of comet tails, times of cometary appearances and disappearances, and celestial positions. These historic comet annals have proven to be a valuable resource for later astronomers.

We now know that comets are leftovers from the dawn of the solar system around 4.6 billion years ago, and consist mostly of ice coated with dark organic material. They have been referred to as "dirty snowballs." They may yield important clues about the formation of our solar system. Comets may have brought water and organic compounds, the building blocks of life, to the early Earth and other parts of the solar system.

As theorized by astronomer Gerard Kuiper in 1951, a disc-like belt of icy bodies exists beyond Neptune, where a population of dark comets orbits the Sun in Pluto's realm. These icy objects, occasionally pushed by gravity into orbits bringing them closer to the Sun, become the so-called short-period comets. Taking less than 200 years to orbit the Sun, in many cases their appearance is predictable because they have passed by before. Less predictable are long-period comets, many of which arrive from a region called the Oort Cloud about 100,000 astronomical units (that is, 100,000 times the distance between Earth and the Sun) from the Sun. These Oort Cloud comets can take as long as 30 million years to complete one trip around the Sun.

Each comet has a tiny frozen part, called a nucleus, often no larger than a few kilometers across. The nucleus contains icy chunks — frozen gases with bits of embedded dust. A comet warms up as it nears the Sun and develops an atmosphere, or coma. The Sun's heat causes the comet's ices to change to gases so the coma gets larger. The coma may extend hundreds of thousands of kilometers. The pressure of sunlight and high-speed solar particles (solar wind) can blow the coma dust and gas away from the Sun, sometimes forming a long, bright tail. Comets actually have two tails — a dust tail and an ion (gas) tail.

Most comets travel a safe distance from the Sun — comet Halley comes no closer than 89 million kilometers (55 million miles). However, some comets, called sungrazers, crash straight into the Sun or get so close that they break up and evaporate.

Scientists have long wanted to study comets in some detail, tantalized by the few 1986 images of comet Halley's nucleus. NASA's Deep Space 1 spacecraft flew by comet Borrelly in 2001 and photographed its nucleus, which is about 8 kilometers (5 miles) long.

NASA's Stardust mission successfully flew within 236 kilometers (147 miles) of the nucleus of comet Wild 2 in January 2004, collecting cometary particles and interstellar dust for a sample return to Earth in 2006. The photographs taken during this close flyby of a comet nucleus show jets of dust and a rugged, textured surface. Analysis of the Stardust samples suggests that comets may be more complex than originally thought. Minerals formed near the Sun or other stars were found in the samples, suggesting that materials from the inner regions of the solar system traveled to the outer regions where comets formed.

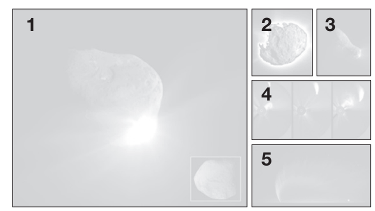
Another NASA mission, Deep Impact, consisted of a flyby spacecraft and an impactor. In July 2005, the impactor was released into the path of the nucleus of comet Tempel 1 in a planned collision, which vaporized the impactor and ejected massive amounts of fine, powdery material from beneath the comet's surface. En route to impact, the impactor camera imaged the comet in increasing detail. Two cameras and a spectrometer on the flyby spacecraft recorded the dramatic excavation that helped determine the interior composition and structure of the nucleus.

After their successful primary missions, the Deep Impact spacecraft and the Stardust spacecraft were still healthy and were retargeted for additional cometary flybys. Deep Impact's mission, EPOXI (Extrasolar Planet Observation and Deep Impact Extended Investigation), comprised two projects: the Deep Impact Extended Investigation (DIXI), which encountered comet Hartley 2 in November 2010, and the Extrasolar Planet Observation and Characterization (EPOCh) investigation, which searched for Earth-size planets around other stars on route to Hartley 2. NASA returned to comet Tempel 1 in 2011, when the Stardust New Exploration of Tempel 1 (NExT) mission observed changes in the nucleus since Deep Impact's 2005 encounter.

SIGNIFICANT DATES

1070–1080 — The comet later designated Halley's Comet is pictured in the Bayeux Tapestry, a chronicle of the Battle of Hastings of 1066.
1449–1450 — Astronomers make one of the first known efforts to record the paths of comets across the night sky.
1705 — Edmond Halley publishes that the comets of 1531, 1607, and 1682 are the same object and predicts its return in 1758. The comet arrives on schedule and is later named Halley's Comet.
1986 — An international fleet of five spacecraft converges on comet Halley as it makes its regular (about every 76 years) pass through the inner solar system.
1994 — In the first observed planetary impact by a comet, awed scientists watch as fragments of comet Shoemaker–Levy 9 smash into Jupiter's atmosphere.
2001 — Deep Space 1 flies by and photographs comet Borrelly.
2004 — NASA's Stardust spacecraft collects dust samples from comet Wild 2 and images the nucleus.
2005 — The Deep Impact impactor collides with comet Tempel 1 to enable scientists to study the interior of the nucleus.
2006 — The Stardust sample return capsule lands in Utah carrying cometary particles and interstellar dust.
2009 — Scientists announce that the amino acid glycine, a building block of life, was collected by the Stardust spacecraft from comet Wild 2.
2010 — The Deep Impact spacecraft studies its second cometary target, Hartley 2, a small, "hyperactive" comet.
2011 — The Stardust spacecraft encounters Tempel 1 and captures views of the Deep Impact impact site, the opposite side of the nucleus, and signs of evolution on the comet's surface.

ABOUT THE IMAGES



1 The collision of the Deep Impact impactor with comet Tempel 1 generated a cloud of dust. Stardust imaged the back side of the nucleus (inset).

2 Stardust revealed the nucleus of comet Wild 2 during a 2004 flyby. Tiny cometary and interstellar dust particles were captured for return to Earth.

3 Hartley 2 was very active at the time of the Deep Impact flyby, with ice jets propelled by carbon dioxide clearly seen emanating from the nucleus.

4 The tail of comet C/2002 V1 is disrupted as it comes closer to the Sun in 2003. The image is from the Solar and Heliospheric Observatory, with the Sun's bright disc covered.

5 This image of comet McNaught was captured by the European Southern Observatory in Chile in January 2007 as both the comet and the Sun were setting over the Pacific Ocean.

FOR MORE INFORMATION

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