NASA Facts

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Making a Deep Impact

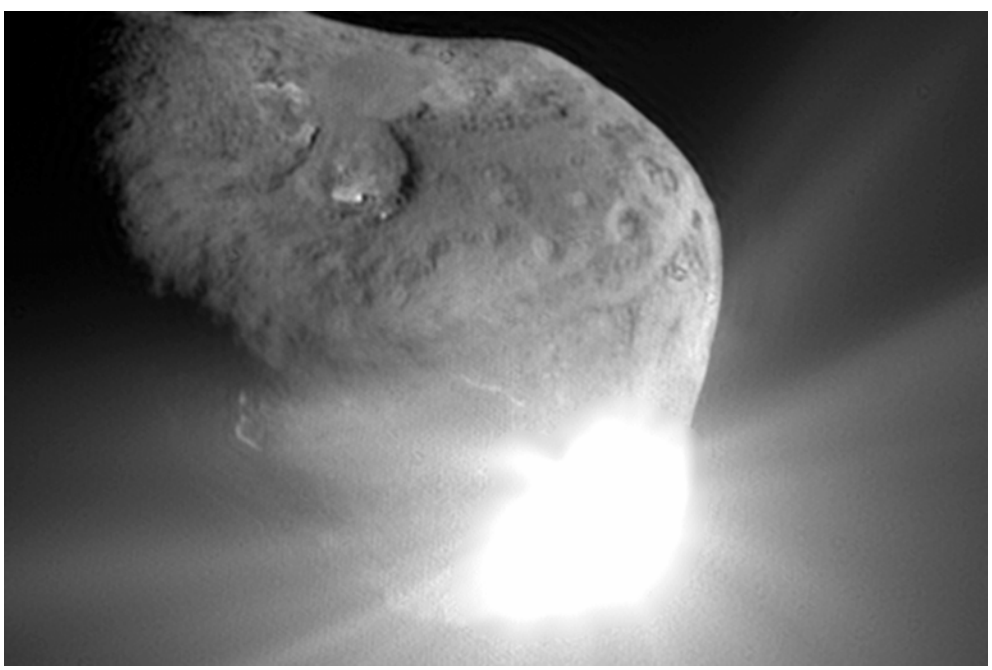
The Mission

On the evening of July 3, 2005, Deep Impact, a NASA Discovery Mission, performed an incredibly complex experiment in space to probe beneath the surface of a comet and reveal the secrets of its interior. As a larger “flyby” spacecraft released a smaller “impactor” spacecraft into the path of comet Tempel 1, the experiment became one of a cometary bullet chasing down a spacecraft bullet while a third spacecraft bullet sped along to watch.

The Result

Deep Impact's collision with comet Tempel 1 was a spectacular success! The impactor hit the comet on the sunlit side as planned.

Upon impact, there was a brilliant and rapid release of dust that momentarily saturated the cameras onboard the spacecraft. Audiences around the world watched as dramatic images were returned in near real time on NASA TV and over the Internet. All available orbiting telescopes watched from space, including the Spitzer, Hubble and Chandra telescopes. A number of Earthbound astronomers at larger and smaller telescopes positioned their instruments and succeeded in capturing a wide-field view of the impact. Although the comet brightened upon impact, it wasn’t observable with the unaided eye at Earth.



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The amount and brightness of the released debris indicates that beneath the surface of the comet, there is microscopic dust; water and carbon dioxide ice; and hydrocarbons. Signatures of these species were seen in spectra immediately after impact. New information since encounter tells us that the forces holding the comet together are gravitational forces, and the comet is extremely weak—weaker than snow.

The Experiment in Review

In early July, twenty-four hours before impact, the observing flyby spacecraft pointed high-precision tracking telescopes at the comet. After releasing the impactor spacecraft, the flyby spacecraft maneuvered to a safe point to watch the collision. During impact, the flyby spacecraft used its instruments to perform optical imaging and infrared spectral mapping of the comet and the ejected material blasted into space. The impactor, a battery-powered spacecraft that operated independently of the flyby spacecraft for just one day, took over its own navigation and maneuvered into the path of the comet. A camera on the impactor captured and relayed images of the comet's nucleus until just seconds before the collision.

The impact, while powerful, was not forceful enough to make an appreciable change in the comet's orbital path around the Sun. Ice, heated by the energy of the impact, vaporized and dust debris was ejected from the crater. Members of the science team are still at work studying data to define the resulting crater and the ejecta. Sunlight reflecting off the ejected material provided a dramatic brightening that faded as the debris dissipated into space or fell back onto the comet. After its shields protected it from the comet's dust tail, the flyby spacecraft turned to record the brilliant change in the comet’s activity as it departed. At the same time, results of the impact and aftermath observed by professional and amateur astronomers at large and smaller telescopes on Earth were broadcast on NASA TV and over the Internet. Results from this and other comet missions will lead to a better understanding of both the solar system's formation and implications of comets colliding with Earth.

Comet Tempel 1

Comets are composed of ice, gas and dust and are considered time capsules that hold clues about the formation and evolution of the solar system 4.5 billion years ago. Comet Tempel 1 was discovered in 1867 by Ernst Tempel. The comet has made many passages through the inner solar system orbiting the Sun every 5.5 years. This made Tempel 1 a good target to study evolutionary change in the mantle, or upper crust. Scientists are eager to learn whether a) comets exhaust their supply of gas and dust to space or b) seal it into their interiors. They would also like to learn about the structure of a comet's interior and how it is different from its surface. The controlled cratering experiment of this mission is already providing answers to these questions.

Technical Implementation

The flyby spacecraft used an X-band radio antenna to communicate to Earth as it also listened to the impactor on a different frequency. (For most of the mission, the flyby spacecraft communicates through the 34-meter antennas of NASA's Deep Space Network.) During the short period of encounter and impact, when there is an increase in volume of data, overlapping antennas around the world were used. Primary data was transmitted immediately and other data was transmitted over the following week. The impactor spacecraft was composed mainly of copper, which is not expected to appear in data from a comet's composition. For its short period of operation, the impactor used simpler versions of the flyby spacecraft's hardware and software. The spacecraft is currently in sleep mode awaiting a possible wake up call for further scientific investigations.

The Team

The scientific leadership for the mission is based at the University of Maryland. Engineers at Ball Aerospace and Technologies Corp designed and built the spacecraft under the management of Jet Propulsion Laboratory. The spacecraft launched on a Boeing Delta II rocket from Cape Canaveral on January 12, 2005 under the supervision of Kennedy Space Center. Engineers at JPL controlled the spacecraft after launch and relayed data to scientists for analysis. The entire team consists of more than 250 scientists, managers and engineers. Deep Impact is a NASA Discovery Mission, eighth in a series of low-cost, highly focused space science investigations. The mission offers an extensive outreach program in partnership with other comet and asteroid missions and institutions to benefit the public, educational and scientific communities.

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