NASA Facts

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Making a Deep Impact

The Mission

Deep Impact, a NASA Discovery Mission, performs 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 releases a smaller “impactor” spacecraft into the path of an approaching comet, the experiment becomes one of a cometary bullet chasing down a spacecraft bullet while a third spacecraft bullet speeds along to watch.

The Experiment

In early July, twenty-four hours before impact, the observing flyby spacecraft points high-precision tracking telescopes at the comet and releases the impactor spacecraft, then maneuvers to a safer point to watch the collision. During impact, the flyby spacecraft uses its instruments to perform optical imaging and infrared spectral mapping of the structure and composition of the crater’s interior and the ejected material blasted into space. The impactor, a battery-powered spacecraft that operates independently of the flyby spacecraft for just one day, takes over its own navigation and maneuvers into the path of the comet. A camera on the impactor captures and relays images of the comet's nucleus just seconds before collision.

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The impact, while powerful, is not forceful enough to make an appreciable change in the comet's orbital path around the Sun. The crater produced is expected to range in size from that of a house to that of a football stadium, and two to fourteen stories deep. Ice and dust debris ejected from the crater reveals fresh material beneath. Sunlight reflecting off the ejected material provides a dramatic brightening that fades slowly as the debris dissipates into space or falls back onto the comet. After its shields protect it from the comet's dust tail passing overhead, the flyby spacecraft turns to record any changes in the comet's activity as it departs. While the flyby spacecraft and impactor do their jobs, professional and amateur astronomers at large and smaller telescopes on Earth observe the impact and its aftermath from certain locations, and results are broadcast 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 makes Tempel 1 a good target to study evolutionary change in the mantle, or upper crust. Scientists are eager to learn whether comets exhaust their supply of gas and dust to space or 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 provides answers to these questions.

Technical Implementation

The flyby spacecraft uses an X-band radio antenna to communicate to Earth as it also listens to the impactor on a different frequency. For most of the mission, the flyby spacecraft communicates through the 34-meter antennae 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 are used. Primary data is transmitted immediately and other data is transmitted over the following week. The impactor spacecraft is 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 uses simpler versions of the flyby spacecraft's hardware and software.

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 the Jet Propulsion Laboratory (JPL). The spacecraft launched on a Boeing Delta II rocket from Cape Canaveral on January 12, 2005, under the supervision of the Kennedy Space Center. Engineers at JPL control the spacecraft after launch and relay 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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