Highlights of Astronomy, Volume 14
IAU XXVI General Assembly, 14-25 August 2006
Karel A. van der Hucht, ed.

doi:10.1017/S1743921307010861

Deep Impact: excavating comet Tempel 1

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Abstract. Results of the *Deep Impact* mission to impact Comet Tempel 1 are summarized.

Keywords. comets, Comet Tempel 1, space vehicles

1. Results

Deep Impact delivered 19 GJoules of kinetic energy to comet 9P/Tempel 1 on 4 July 2005. We present results both from the impact event and from the observations made prior to the impact.

The impact itself was oblique. An initial, hot plume carried away most of the delivered energy as the kinetic energy of roughly a ton of material. Most ejecta followed that and were cold, slow-moving, few-micron sized particles. These carried most of the momentum of the ejecta and totalled roughly 10^4 tons. After the first two seconds, the ejecta include small crystals of ordinary ice, indicating excavation without heating and thus without chemical alteration. The ejected gases included a large amount of CO_2 and a very large amount of organics in addition to water and species yet unidentified. The refractory to volatile ratio in the ejecta is of order unity but is sensitive to assumptions about the cutoff at the large end of the size distribution of the ejecta.

The ejecta enable us to show that the strength of the surface layers, at scales from microscopic to a few hundred meters is remarkably weak and also to show that the bulk density of the nucleus is so low that the entire nucleus must be extremely porous.

On approach, we learned that outbursts by comets are far more common than previously realized and that they can be associated with specific regions on the surface, and in one case with sunrise on that surface. We can confidently rule out exogenic sources (other than sunrise) for these outbursts. Although there are similarities, the geology of the surface is clearly different from that of the few other cometary nuclei visited and very puzzling. There are clearly distinct layers, which are likely not concentric shells but rather discrete blocks. Surface photometric properties are reasonably uniform except in a few small areas. We also showed that, although there are some small spots of ice on the surface, the bulk of the water is released near the subsolar point from sub-surface ice.

2. Mission details

Launch date: 12 January 2005

Arrival at Tempel 1: 4 July 2005

Payload mass: Impactor, 370 kg; Flyby Spacecraft, 90 kg

Primary science instruments:

Flyby spacecraft: High Resolution Instrument (HRI) and Medium Resolution Instrument (MRI): imaging, infrared spectroscopy, and optical navigation.

Impactor: Impactor Targeting Sensor (ITS): nearly identical to the MRI, as it uses the same type of telescope and CCD camera but without the filter wheel.

3. In the literature

A detailed description of the *Deep Impact* mission was presented in a special issue of *Space Science Reviews*; see Russell (2005). The first results from the mission were published in the 14 October 2005 and 10 March 2006 issues of *Science*; see A'Hearn *et al.* (2005) and Sunshine *et al.* (2006). A special issue of *Icarus* (Volume 187, Issue 1, 2007), is dedicated to the *Deep Impact* mission.

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