JET ACTIVITY IN COMET 103P/HARTLEY 2 AS OBSERVED BY THE DEEP IMPACT SPACECRAFT.

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Introduction: On November 4, 2010, the Deep Impact (DI) flyby spacecraft passed within 700 km of Comet 103P/Hartley 2 [1], providing high-resolution images and spectra of a nucleus that is uniquely active among cometary spacecraft targets. In addition to the data from closest approach, observations were also obtained during the approach and departure phases, resulting in an extensive, high-quality data set that can be used to follow the comet's spatial and temporal variability in many different species, for several months around the time of the encounter.

Observations: Images were obtained with the DI Medium Resolution Instrument (MRI) and the High Resolution Instrument Cameras (HRIVIS) from September 5 through November 26, 2010, with sampling intervals as short as 2 minutes. The bulk of the images were obtained with broadband clear filters, and thus are dominated by the continuum reflected from grains in the coma. However, monitoring was also done with narrowband filters to track different gaseous species, including CN (387 nm), C_2 (514 nm) and OH (309 nm) [2]. The continuum coma shows strong variability, dominated by a primary jet (Fig. 1) whose activity fluctuates with the rotation of the nucleus. The lightcurve measuring this variability indicates that the nucleus is in an excited spin state [3].

Infrared spectra, with a wavelength range from 1.05 to 4.85 μm, were obtained with the HRI Infrared Spectrometer (HRI-IR) from October 1 through November 26, 2010. Spectral scans were produced by moving the slit over the comet at a rate of one slit width per exposure time, allowing for the creation of a spatial image at each wavelength channel. Typically, these scans were performed hourly, though sampling was as frequent as every 15 minutes during departure. The wavelength range of the spectrometer includes the emission from two significant volatile species, H_2O (2.7 μm) and CO_2 (4.3 μm). In the days around encounter, both species exhibited temporal and spatial variability. The upper panel of Fig. 2 shows a two-day sequence of CO_2 'images'. The lower panel shows the lightcurve measured from these images indicating how the CO_2 production changes with time and rotation.

During the closest approach, observations were obtained every few seconds to record the resolved nucleus as the viewing geometry changed through 180º.

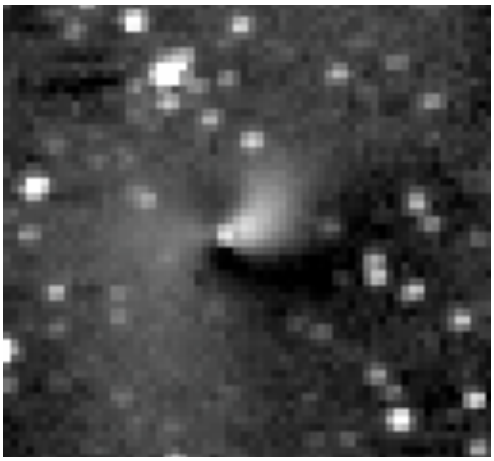

Fig 1. MRI image of Comet Hartley 2 from October 25, 2010. The clear filter image has been enhanced by removing an azimuthally-averaged profile [4] to reveal the primary jet structure. The Sun is to the right.

The MRI images reveal numerous highly collimated dust jets, with the densest concentration at one end of the nucleus. Other sources are more sparsely distributed across the surface, including jets that emanate from unilluminated areas beyond the terminator (e.g., Fig. 3). The spectral scans show spatial structure in both CO_2 and H_2O [5], though the structures in the two species appear to be uncorrelated. These data provide a wealth of information that can be used to explore where the activity originates on the nucleus, however, they also represent only a snapshot of the comet at a single point in time. They contain little information about the temporal aspects that produce the observed variability.

Objectives: The variability recorded in the long-term observations will be used to investigate how the comet's activity changes with respect to rotation and solar illumination conditions [6]. These results will be incorporated with the close approach data to derive the locations and relative strengths of the active areas on the nucleus and to determine how the different species react to the changing illumination. Analysis of the jet morphology will also provide additional constraints for an improved analysis of the nucleus' complex rotation state.

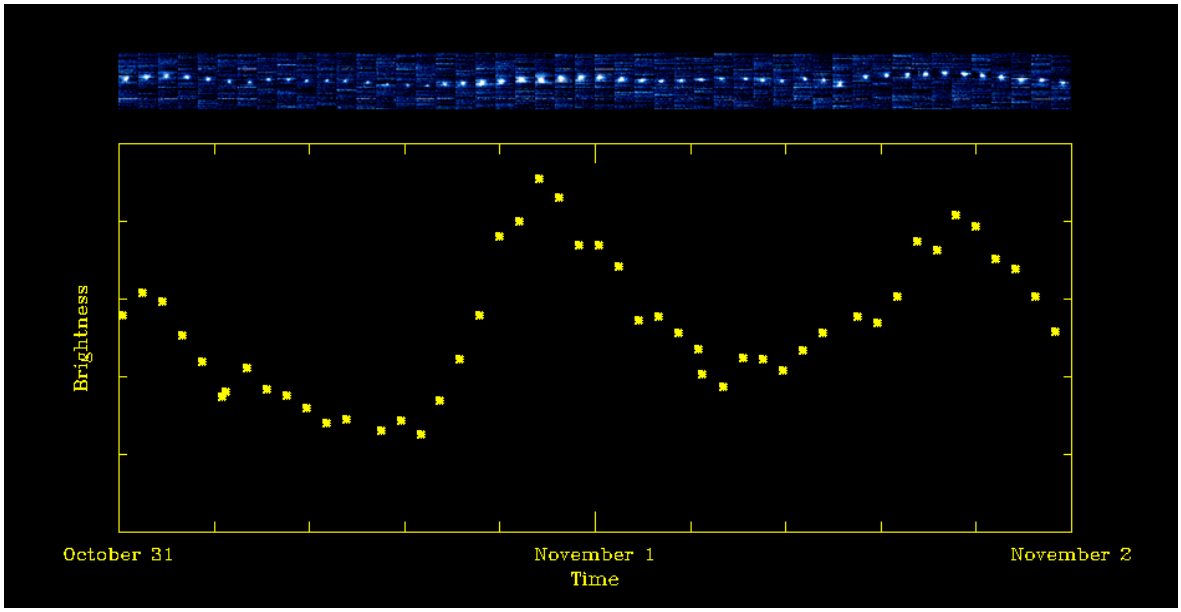

Fig 2. Two-day sequence showing the variability of CO_2 activity. Upper Panel: Spatial images of the coma at 4.26 μm. Lower Panel: Lightcurve measured from the images, showing the CO_2 production changing with time by as much as a factor of three.

Fig. 3. DI image of the nucleus of Hartley 2, showing jet activity emanating from the unilluminated regions beyond the terminator. The Sun is to the right.

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