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Spatial heterogeneities of organic gases in the coma of 103P/Hartley 2

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Abstract

During its 2010 apparition, contemporaneous high spatial (spacecraft) and high spectral (ground-based) resolution infrared data were acquired of comet 103P/Hartley 2. Signatures of volatile organics were detected in the coma and indicate heterogeneous outgassing from the nucleus. Combining the unique data sets enables detailed modeling and a better understanding of Hartley 2's source regions.

1. Introduction

On 4 November 2010, NASA's Deep Impact (DI) eXtended Investigation encountered 103P/Hartley 2, a Jupiter-family comet (JFC) with a 6.5 year period and perihelion distance of 1.05 AU. The near-nucleus observations revealed a small, bilobed and highly active nucleus with H_2O ice particles dragged from the subsurface primarily by sublimated CO_2 jets, a smooth waist area between the two lobes where H_2O gas emanated, and a spectrum rich in organic gases that when mapped near closest approach appeared to roughly correlate with the strong CO_2 jet [1,2]. When examined closer, distinct differences emerged in the spectral shape of the bulk organic feature at opposite lobes of the nucleus as measured by DI, suggesting heterogeneity in the distribution of organic species akin to that of the primary gases and highly consistent with clear differences in spatial profiles in CH_3OH, C_2H_6, C_2H_2, and HCN measured in nearly simultaneous ground-based IR observations [3,4,5,6].

Motivated by these early spacecraft and ground-based results, we have initiated a detailed study to probe the organic gases (bulk abundance and spectral content) in the near-nucleus coma of Hartley 2 using high-resolution IR spectroscopic measurements and techniques in order to understand the relationship between the primary volatiles comprising Hartley 2.

2. Observations

DI's High Resolution Instrument near-infrared spectrometer (HRI-IR) collected 30 spectral scans of the nucleus and coma per day prior to the flyby date (30 min cadence), 96 scans per day post encounter (15 min cadence), and 60 scans within ± 18 hours of closest approach to Hartley 2, with each spatial pixel along the slit having a unique spectrum covering the wavelength range of 1.05 – 4.83 microns. The closest approach data achieve ~7 m/pixel spatial resolution providing a view of the chemistry and spatial distribution of volatiles in the innermost coma not able to be resolved from Earth. These sequences resulted in over 4 million spectra measuring the coma signal and having spatial, temporal, and rotational richness like no other IR cometary data set.

3. Results

We present a subset of the data and show persistent heterogeneities in the distribution maps throughout the flyby as well as decompose some spectral components in the well-blended HRI-IR spectra.

Acknowledgements

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