EPSC Abstracts
Vol. 13, EPSC-DPS2019-84-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

A high-resolution fractal shape model to interpret the spatially resolved near-infrared observations of cometary nuclei

O. Groussin (1), L. Jorda (1), J. Sunshine (2), L. Feaga (2), J.-B. Vincent (3) and E. Kührt (3)
(1) Aix Marseille Université, CNRS, CNES, LAM, Marseille, France (olivier.groussin@lam.fr)
(2) University of Maryland, College Park, MD, United States
(3) DLR Institute for Planetary Research, Rutherfordstrasse 2, 12489, Berlin, Germany

Abstract

We present a new method to derive the thermal inertia and roughness of small bodies from spatially resolved near-infrared observations. Our method combines a high-resolution (≈1 million facets) rough shape model with a realistic thermal model. To introduce roughness, the shape model is extrapolated from image-based shape model using a fractal formalism. We applied our method to the Deep Impact data of comets 9P/Tempel 1 and 103P/Hartley 2.

1. Introduction

The in-situ observations of cometary nuclei by space missions have allowed us to make considerable progress in our understanding their physical and chemical properties. Near-infrared (1 – 5 um) spectroscopy has been used extensively, and 2D spatially resolved observations exist for three cometary nuclei: 9P/Tempel 1, 103P/Hartley 2, and 67P/Churyumov-Gerasimenko. These highly valuable data sets have been used to tackle many scientific questions, and in particular the thermal properties of the nucleus, i.e. its surface temperature, thermal inertia and roughness [1, 2, 3]. It has however always been recognized that the analysis is complex due to the nature of the surface itself, which is rough and therefore generates projected shadows and self-heating effects at the sub-meter scale, below the spatial resolution of the observing instruments.

2. Approach

In this work, we present a new approach, which combines a high-resolution fractal shape model with a realistic thermal model. To introduce roughness, the shape model is extrapolated from image-based shape model using a fractal formalism. The shape model has ≈1 million facets, which allow to overcome the sub-pixel issue introduced in the introduction, since each pixel of the instrument contains ≈500 facets on average. In parallel, we have developed a thermal model that can handle such high-resolution shape model, considering all together projected shadows effects, self-heating effects, and conductivity. Our thermal model has been extensively optimized to run in a reasonable time for such a large number of facets, typically ≈3 hours for a given set of parameters.

3. Conclusions and perspectives

With our high-resolution fractal shape model, we further reinforce the importance of the sub-pixel roughness, and provides a much better fit to the observed spectra than previous analysis on the same topic, with a self-consistent determination of the roughness and thermal inertia. So far, we only applied our model to the Deep Impact HRI-IR data of comets 9P/Tempel 1 and 103P/Hartley 2, but our model is ready to be applied to the Rosetta VIRTIS data of 67P/C-G, and could also be applied to any asteroid spatially resolved near-infrared observations.

Acknowledgements

This work was supported by CNES (Centre National d'Etudes Spatiales).

References

[1] Groussin et al., Icarus 222, 2013

[2] Davidsson et al., Icarus 223, 2013

[3] Filaccione et al., Nature Astronomy, 2019