DETERMINATION OF PHOTOMETRIC PROPERTIES OF ASTEROID STEINS.

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Introduction: ESA's comet rendezvous mission Rosetta will flyby asteroid 2867 Steins on September 5, 2008. Steins has been classified as an E-type asteroid based on its visual and near-infrared spectrum [1] and on its high albedo [2, 3]. Rosetta will perform the first in-situ exploration of a member of this rare class of objects, which counts only a dozen of members.

The study of the reflectance of these bodies can give insights into the physical properties of the surface and allow us to identify different types of terrains. The reflectance properties also hide important information about the physical properties of the regolith. Our aim is to provide a tool which will allow us to extract the reflectance properties of 2867 Steins from visible images acquired with OSIRIS, the scientific camera aboard Rosetta. We present here preliminary results deduced from images of comet 9P/Tempel 1 acquired by the HRI instrument aboard the Deep Impact spacecraft.

Method: The shape model is assumed to be known. It is described by a mesh of triangular facets. We first extract the bi-directional reflectance (BRDF) associated to each facet, assuming that the BRDF is azimuthally invariant, from the calibrated images we want to use in the analysis. This is done in two steps: (i) the pixel coordinates of the vertices of each facet are calculated from the position and orientation of the S/C, and from those of the target body, and (ii) the BRDF of each facet is then extracted from the flux in the pixel it intersects weighted by its projected area therein. We obtain a set of BRDF measurements and their associated incident, emittance and phase angles. We then perform a least-square fit of Hapke parameters [4] to all measurements in all images. The integrated geometric and Bond albedos are calculated from the Hapke parameters.

The method has been tested and validated using synthetic images of Steins simulating the Rosetta flyby. We found that the BRDF can be extracted to accuracy better than 1% rms, and that the fit is not sensitive to shape errors, given that they are randomly distributed.

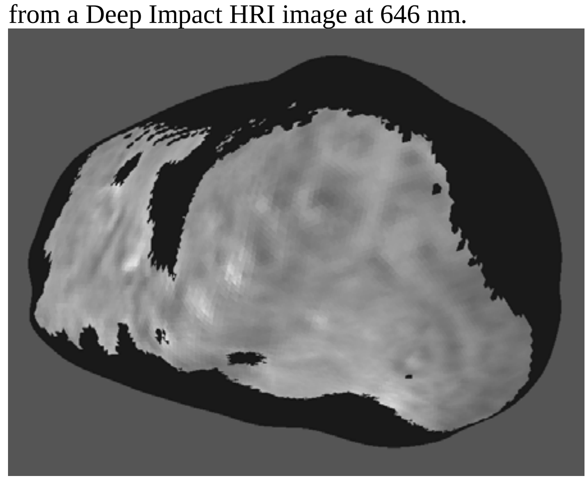
Results: We applied our method to deconvolved images of comet 9P/Tempel 1 acquired by the HRI instrument aboard the Deep Impact S/C. We then compared our results with those obtained by Li et al. [5, 6]. In both works, the following Hapke parameters have been kept constant: B0=1.0, h=0.01, g=-0.49.

The **Table** below shows the fitted single scattering albedo (SSA), roughness parameter (θ), and integrated geometric albedo (Ap). We have indicated also the rms error in %. Our Hapke parameters agree (within 10 %) with those calculated by Li et al. [5,6]. The Bond albedo (at 550 nm) is equal to 0.015, compared to 0.013 in [6].

Table. 9P/Tempel 1 photometric parameters.

λ (nm)	w	θ	Ap	1σ error (%)
454	0.037	15.9	0.053	20.0
550	0.045	20.9	0.065	21.9
647	0.050	15.2	0.071	16.2
744	0.056	16.3	0.080	17.4
843	0.064	16.7	0.090	17.3

Figure. SSA map of comet 9P/Tempel 1 deduced from a Deep Impact HRI image at 646 nm.



Our method has proven its reliability, and we will apply it to interpret the images to be acquired by OSIRIS during the Steins flyby. We also plan to apply it to images of Eros (NEAR mission), and of Itokawa (Hayabusa mission).

References: [1] Barucci et al., (2005) A&A,430, 313 [2] Fornasier et al. (2006), A&A, 449, L9 [3] Lamy et al., submitted to A&A [4] B. Hapke (1993), Cambridge University Press [5] J. Li. (2005) PhD dissertation [6] J. Li. (2007) Icarus, 191, 161-175.