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Global and Spatially Resolved Photometric Properties of the Nucleus of Comet 67P/C-G from OSIRIS Images

P. Lamy(1), I. Toth (1,2)**,** L**.** Jorda(1), O. Groussin(1), C. Capanna(1), H.-U. Keller(3), S. Hviid(4), H. Sierks(5), … and the OSIRIS Team (philippe.lamy@lam.fr)

(1) Laboratoire d'Astrophysique de Marseille, France, (2) Konkoly Observatory, Budapest, Hungary, (3)Technical University of Braunschweig, Germany, (4) Deutschen Zentrums für Luft- und Raumfahrt, Berlin, Germany, (5) Max-Planck Institute for Solar System Research, Göttingen, Germany.

Abstract

Following the successful wake-up of the ROSETTA spacecraft on 20 January 2014, the OSIRIS imaging system was fully re-commissioned at the end of March 2014 confirming its initial excellent performances. The OSIRIS instrument includes two cameras: the Narrow Angle Camera (NAC) and the Wide Angle Camera (WAC) with respective fields-of-view of 2.2° and 12°, both equipped with 2K by 2K CCD detectors and dual filter wheels. The NAC filters allow a spectral coverage of 270 to 990 nm tailored to the investigation of the mineralogical composition of the nucleus of comet P/Churyumov-Gerasimenko whereas those of the WAC (245-632 nm) aim at characterizing its coma [1].

The NAC has already secured a set of four complete light curves of the nucleus of 67P/C-G between 3 March and 24 April 2014 with a primary purpose of characterizing its rotational state. A preliminary spin period of 12.4 hours has been obtained, similar to its very first determination from a light curve obtained in 2003 with the Hubble space telescope [2].

The NAC and WAC will be recalibrated in the forthcoming weeks using the same stellar calibrators VEGA and the solar analog 16 Cyg B as for past in-flight calibration campaigns in support of the flybys of asteroids Steins and Lutetia. This will allow comparing the pre- and post-hibernation performances of the cameras and correct the quantum efficiency response of the two CCD and the throughput for all channels (i.e., filters) if required. The accurate photometric analysis of the images requires utmost care due to several instrumental problems, the most severe and complex to handle being the presence of optical ghosts which result from multiple reflections on the two filters inserted in the optical beam and on the thick window which protects the CCD detector from cosmic ray impacts. These ghosts prominently appear as either slightly defocused images offset from the primary images or large round or elliptical halos.

We will first present results on the global photometric properties of the nucleus of comet 67P/C-G, albedo, phase function and spectral reflectivity and compare with previous results obtained with the Hubble and Spitzer space telescopes [2, 3, 4].

Then observations during the approach and first bound orbits in July-August 2014 will allow mapping the surface of the nucleus with OSIRIS at a scale of up to 1 meter per pixel. The images will be used to reconstruct the 3D surface of the nucleus at high-resolution allowing separating true photometric variations from topographic effects. We will present results on the spatially resolved photometric properties of the nucleus based on a novel method developed in the space of the facets representing the three-dimensional shape of the body. This method successfully implemented in the cases of the nucleus of comet 9P/Tempel 2 and of asteroid (2867) Steins [5] has the advantage of automatically tracking the same local surface element on a series of images.

The analysis will then proceed with the determination of the global Hapke and other standard photometric parameters as well as their two-dimensional

variations across the surface. This allows defining, in the body-fixed reference frame, ``high residual regions" (HRRs) which correspond to significant relative differences between the observed and modeled photometric parameters such as the single-scattering albedo (SSA), the mean roughness slope angle, and the reflectivity gradient. Of particular interest will be the search for ice patches and possible mineralogical differences resulting from the past activity of the comet.

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