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Regional variations of the opposition effect on the surface of comet 67P using Rosetta-OSIRIS images

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Abstract

During the 2.5 years of Rosetta mission, Rosetta performed two zero-phase-angle fly-bys. The phase angle α, which is defined as an angle between the Sun and the observer, approached zero when the spacecraft was flying between the Sun and the comet.

During the zero-phase-angle fly-bys, the scientific imaging system on board Rosetta, the Optical, Spectroscopic, and Infrared Remote Imaging System (OSIRIS) [1] acquired images in different filters in the visible wavelength range. The OSIRIS images include images with the Wide Angle Camera (WAC) and the Narrow Angle Camera (NAC). Here we focus our study on the NAC images in the F84 (480.7 nm), F82 (649.2 nm), and F88 (743.7 nm) filters.

The first zero-phase angle flyby was performed on 14 February 2015 with a closest-approach distance of 6 km from the nucleus surface. The NAC images cover the surface area between Ash, Apis and Imhotep regions on 67P (Figure 1). For detailed descriptions of the 67P's morphological regions, see [2] and [3].

The second zero-phase-angle flyby is performed on 09-10 April 2016. Rosetta reached a minimum distance of 30 km from the comet surface. The NAC images cover the Ash-Khepry-Imhotep region (Figure 1).

The OSIRIS images from two different regions of the comet surface at very small phase angles provide the opportunity to analyze regionally a phenomenon known as opposition effect (OE). The OE manifest itself as a rapid increase in the variation of the surface brightness as function of phase angle, known as phase curve.

Our main goal is to characterize the OE by means of the phase curve and the phase-ratio analysis to determine the surface properties together with the physical mechanisms that are considered as the controlling contributors to the OE, specifically shadow hiding (SH) and coherent backscattering (CB).

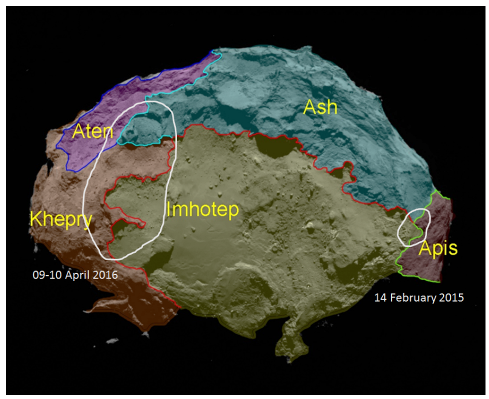

Figure 1: The white solid lines show areas on the comet surface covered by OSIRIS NAC images during two zero-phase-angle flybys on 14 February 2015 and on 09-10 April 2016. The map of 67P regions is adapted from figure 1 in [2].

We extract phase curves in three wavelengths from several regions of interest (ROIs) and fit a linear-exponential function to explore the OE behavior. The ROIs are selected and categorized based on the geomorphological classes. We investigate the variation of OE parameters with respect to the wavelength and among various ROIs. The part of this study was performed and reported by [4].

The variation of OE parameters as a function of the wavelength would suggest the contribution of CB in OE [5]. The variation of OE parameters relating to geomorphological units combined with phase-ratio analysis allows us to study the influence of structural and textural properties of the surface [6] .

We also aim to model the OE using a new light scattering modeling technique, Plane Wave Plane Parallel (PWPP) model developed by [7]. The PWPP technique represents a volume-discretized numerical approximation to the solution of Maxwell's wave equations similar to the Discrete Dipole Approximation (DDA) method [8] but for infinite plane parallel layers formed by randomly distributed particles. The PWPP technique can be applied to the particulate medium with different compositions, shapes and size of particles and their mixtures. In this study we present some preliminarily results from PWPP simulation that considers layers of different porosities formed by monodisperse spherical particles, characterized by the particle composition and size.

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