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Phase-ratio imagery of 67P/Churyumov-Gerasimenko at small phase angles using Rosetta-OSIRIS images

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Abstract

The Rosetta spacecraft reached its target 67P/Churyumov-Gerasimenko (hereafter 67P) in July-August 2014 and orbited around the comet until 30th September 2016. During the 2.5 years of mission, Rosetta did two zero-phase-angle fly-bys: the spacecraft was flying between the Sun and the comet and therefore, the angle between the Sun and the observer (known as phase angle, α) approached zero. In this phase angles range, a phenomenon, known as, opposition effect, manifests itself as a rapid increase in the surface brightness.

The opposition effect is controlled by two mechanisms: coherent backscattering (CBOE) and shadow hiding (SHOE).

During the zero-phase-angle fly-bys, OSIRIS [1], the scientific imaging system onboard Rosetta, acquired high resolution images of the comet surface in different filters in the visible wavelength range. The first zero phase angle fly-by took place on 14th February 2015, with closest approach 6km from the nucleus. A study of this fly-by is presented in [2] and [3].

The second zero phase angle fly-by took place on 09-10th April 2016. Rosetta reached a minimum distance of 30 km from the comet and OSIRIS acquired 259 images with the Wide Angle Camera (WAC) and the Narrow Angle Camera (NAC).

For our study, we have used NAC images in the F84 (480.7 nm), F82 (649.2 nm), F88 (743.7 nm) filters, spanning the phase angle range from 0.65° to 6.1°. During the fly-by the Imhotep-Kherpy-Ash region was imaged (Figure 1).

We used the phase-ratio map technique in the different wavelengths in order to gain insight into the cause of the opposition effect.

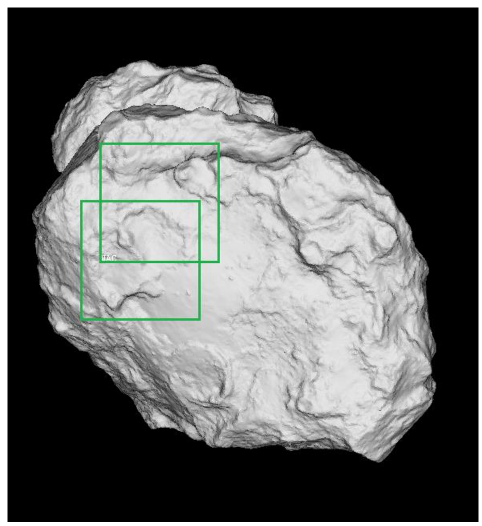

Figure 1: The location of NAC images covering the areas which are located in Imhotep-Kherpy-Ash region.

The phase-ratio (α1/α2, with α1 < α2) mapping is an effective tool to investigate surface structure in large phase angles [4, 5]. At small phase angles the phase-ratio approach is used to explore the phase function behavior when the contribution of CBOE is significant compared to SHOE [6, 7]. The phase-ratio maps are created from the map projected image pairs which are photometrically corrected. Hence, it is possible to calculate the ratio for the overlapped region. We study the phase-ratio map for the different regions of interest (ROIs) versus reflectance to analyze the phase function slope. Moreover, the wavelength dependency of the ratio allows to search for an evidence of CBOE [8].

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