EPSC Abstracts
Vol. 10, EPSC2015-653, 2015
European Planetary Science Congress 2015

Analysis of Opposition effect on 67P/Churyumov-Gerasimenko's nucleus from Rosetta-OSIRIS images

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Abstract

We aim to assess two mechanisms involved in opposition effect phenomenon, i.e. shadow hiding effect (SHOE) and coherent backscattering effect (CBOE), using OSIRIS images taken on the 14th of February 2015.

1. Introduction

Launched in 2004, the Rosetta spacecraft woke up on January 20, 2014 after 10 years in cruise and 30 months of deep space hibernation. OSIRIS, the Optical, Spectroscopic, and Infrared Remote Imaging System [1] is the scientific imaging system onboard Rosetta. It contains two cameras: the Narrow Angle Camera (NAC) and the Wide Angle Camera (WAC) covering the wavelength range of 250 nm to 1000 nm with total of 25 filters. NAC and WAC have been designed as a complementary pair that addresses the study of the nucleus surface such as its morphology [2] or its photometric properties [3] and the investigation of the dynamics of the sublimation processes. During the close flyby (~ 6 km) on the 14th of February 2015 zero phase angle observations were performed and acquire images taken in combination of various filters. These observations allow us to increase our understanding of the sharp spike in the brightness near zero phase angles of atmosphereless bodies. This phenomenon is called opposition effect and is of special interest among photometric studies.

2. Methodology

We apply the Hapke [4] and Shkuratov [5] photometric models since formalism of both models considers the contribution of SHOE and CBOE mechanics in the opposition effect. The main difference between SHOE and CBOE is that SHOE does not vary with wavelength, while the CBOE depends on the wavelength of incidence light.
We evaluate a spectral appearance of CBOE [6] for the regions of the images obtained at phase angles less than 3° using NAC images in three filters F84 (480.7 nm), F82 (649.2 nm) and F88 (743.7 nm). Since the CBOE mechanism is believed to occur due to multiple scattering, we also apply the Minnaert photometric modeling [7] to estimate the contribution of multiple scattering at opposition. In order to extract the intensity and the associated geometric angles for the images, we used the shape model of comet [8] and the SPICE toolkit [9].

Acknowledgements

OSIRIS was built by a consortium of the Max-Planck-Institut für Sonnensystemforschung, Göttingen, Germany, CISAS University of Padova, Italy, the Laboratoire d'Astrophysique de Marseille, France, the Instituto de Astrofísica de Andalucía, CSIC, Granada, Spain, the Research and Scientific Support Department of the European Space Agency, Noordwijk, The Netherlands, the Instituto Nacional de Tecnica Aeroespacial, Madrid, Spain, the Universidad Politechnica de Madrid, Spain, the Department of Physics and Astronomy of Uppsala University, Sweden, and the Institut für Datentechnik und Kommunikationsnetze der Technischen Universität Braunschweig, Germany. The support of the national funding agencies of Germany (DLR), France (CNES), Italy (ASI), Spain (MEC), Sweden (SNSB), and the ESA Technical Directorate is gratefully acknowledged. We thank the Rosetta Science Ground Segment at ESAC, the Rosetta

Mission Operations Centre at ESOC and the Rosetta Project at ESTEC for their outstanding work enabling the science return of the Rosetta Mission. We also gratefully acknowledge the developers of SPICE and NAIF/PDS resources.

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