TEMPORAL EVOLUTION OF COMET 67P/CHURYUMOV-GERASIMENKO SURFACE PROPERTIES AS OBSERVED BY VIRTIS-M FROM PRE-PERIHELION TO POST-PERIHELION

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Introduction: The Visible and Infrared Thermal Imaging Spectrometer [1] on board the Rosetta spacecraft acquired disk-resolved images of the nucleus of comet 67P/Churyumov-Gerasimenko for more than two years from August 2014 to September 2016. The observation campaigns have been carried out using both the visible (VIS) and infrared (IR) channels of the instrument covering the 0.25-5.1 µm spectral range up to May 2015 and by means of the sole VIS channel (0.25-1 µm) for the remaining part of the mission. This allowed monitoring the spectral properties of the comet surface as a function of the heliocentric distance for the inbound part of the orbit from 3.6 AU to perihelion (1.3 AU) and the outbound part up to 3.3 AU. Throughout this period the surface evolution was further complicated by the combination of the relatively large orbital eccentricity, of the irregular shape of 67P/CG's nucleus and of the inclination of its rotational axis (52° [2]) which amplify the seasonal effects.

Method: The long-term variability of 67P's nucleus is described by means of spectral indicators as defined in [3] which are represented by the spectral slopes in the VIS (0.55-0.8 µm) and IR (1.2-2.0 µm) spectral ranges, the single scattering albedo at 0.55 µm [4] and the band area and band center of the 3.2 µm absorption feature [5]. These quantities are computed from photometrically corrected spectra [4], in order to remove observation geometry effects [5]. The spectral indicators are projected onto latitude-longitude maps of the nucleus at different times, in order to monitor both spatial and temporal variations. In parallel, the evolution of selected areas on 67P/CG's surface as selected by [3] is followed to monitor local variability.

Preliminary results: The analysis of the VIS slope from observations taken from August 2014 to June 2016, corresponding to the Rosetta mission Medium Term Planning (MTP) observation phases from MTP006 to MTP030, indicates a progressive reduction (bluening) while the comet was approaching perihelion (August 2015, MTP019) during the inbound orbit leg, followed by an increase (reddening) starting immediately after perihelion passage along the outbound leg. This is in agreement with the seasonal color variations reported by OSIRIS [6]. Comparison of the average VIS spectral slope between MTP006 (3.4 AU) and MTP030 (3.2 AU), when the comet was along the inbound and outbound orbit respectively, at comparable heliocentric distance, indicates that the average spectral slope has increased on average by about 16%. We interpret these observations in terms of transport of water ice and dust. After perihelion the decrease of the cometary activity implies that the cometary dust grains expelled from the southern hemisphere fall back on the surface, thus mantling the nucleus. These dust grains are drier, at least on their surfaces, and cause a spectral reddening. The fact that the surface was "bluer" in August 2014 when we first observed the nucleus, means that a mechanism of transport of water ice, probably form the interior of the dry grains redeposited after the previous perihelion, was acting replenishing the water content of the surface layers. This is a strong evidence of the presence of a seasonal cycle of water ice, similar to the CO_2 ice cycle observed by VIRTIS in the Anhur region [7].

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References:

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