PHOTOMETRIC MODELLING OF MESSENGER/MDIS OBSERVATIONS : INSIGHTS ON MERCURY SURFACE FEATURES AND APPLICATIONS FOR SIMBIO-SYS ON BEPICOLOMBO

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Introduction. Photometric modelling is a technique that investigates the variations in light reflection by a surface upon different viewing and illumination geometries. This technique is widely used in planetary photometry [1-5] and allows to investigate the physical properties, such as surface texture, albedo and roughness of the reflecting materials at microscopic (i.e.: particle-size) scales. Past applications to Mercury were aimed at producing global scale monochrome and colour basemaps [5]. Until recently, this method has never been used at local scales to analyze surface features such as hollows, pyroclastic deposits, bright crater rays, etc and characterize their physical properties. In [7], we investigated the scattering properties of hollows located at the Tyagaraja and Canova craters on Mercury through the photometric modelling of overlapping multi-angular MDIS/WAC observations, based on the inversion of the Hapke and Kasalaainen-Shkuratov set of models [14-17]. The analysis allowed to derive dedicated photometric corrections for hollows, allowing future more accurate spectrophotometric analyses. The estimated hollows Hapke parameters also provided new evidence for volatile-release as their forming mechanism. This abstract shows new applications of this methodology to pyroclastic deposits and fresh crater rays, with the aim of better understanding their microphysical properties.

Methods. We analyze multi-wavelength and multi-angular MDIS/WAC observations of the pyroclastic deposits called Orm Faculae, located inside the Praxiletes Crater (27.1°N, -60.3°E) and the bright rays of the fresh David crater (-17.6° N, 67.8°E). For both locations, we apply the approach described in [13], and briefly summarized here. We select all MDIS/WAC observations at each location, having phase angles from 30° to more than 100°, and project them on a DEM of the region. For Praxiletes, we mosaicked the global USGS DEM of Mercury with local DTMs from [18]. All the observations and the DTMs were resampled to 665 m/px for the subsequent analysis. For David Crater, we relied on the global USGS DTM and considered all the observations up to 1330 m/px, in order to have a complete phase angle coverage. For both locations, we defined a grid with the resolution of the DTM. For each point of the grid we collected the flux from all the available WAC observations, the incidence, emission, phase and azimuth angles and fit the resulting dataset with the Hapke model. This procedure was done for each band of the MDIS instrument, providing in a set of wavelength-dependent Hapke parameter maps.

Results

Praxiletes crater. In Fig. (1) we show the Hapke parameters maps for Praxiletes crater. In particular, we find that the pyroclastic deposits (yellow in the albedo map) are also visible in the anisotropy map (white-dashed line). They are characterized by a lower anisotropy parameter, meaning that light from these particles is reflected in a less isotropic way. The crater floor is also characterized by a higher value of the scattering direction parameter in the F band, implying a more forward scattering behaviour, with respect to the outer terrains. The same trend is also observed on the topographic roughness. This difference decreases for both parameters from the near-UV (F/420 nm) to the near IR (I/997 nm).

David crater. In Fig. (2A-D) we report Hapke parameter maps of David crater, as well as an RGB composite (E) of the I (898 nm), G (570 nm) and F (420 nm) bands at 370 m/px resolution. We also compute an RGB composite of the D/F (550 nm/420 nm), J/G (898 nm/570 nm) and J/F (898 nm /420 nm band ratios, indicative of the blue, near-IR and of the overall spectral slope. The fresh ejecta correlates with higher anisotropy parameter (Fig 2B) and lower scattering direction parameter (Fig. 2C), implying a more forward scattering behaviour, while no particular trends emerge in the topographic roughness map. The ejecta also correlate with a spectrally flatter surface (dark colour in Fig. 2F).

Discussion. We applied the photometric modelling approach previously designed for hollows to the pyroclastic deposits of Praxiletes crater and the fresh rays of David crater. We derived Hapke parameter maps for both location in multiple bands. Our results shows preliminary correlations between geological features (pyroclastic deposits, fresh rays, crater floor), and scattering properties (forward vs backward scattering, roughness). We also detected wavelength dependent properties, which suggest that some physical properties of the regolith have a well defined spatial scale. The derived Hapke parameters will be useful to provide updated photometric correction for the future analysis of SIMBIO-SYS data

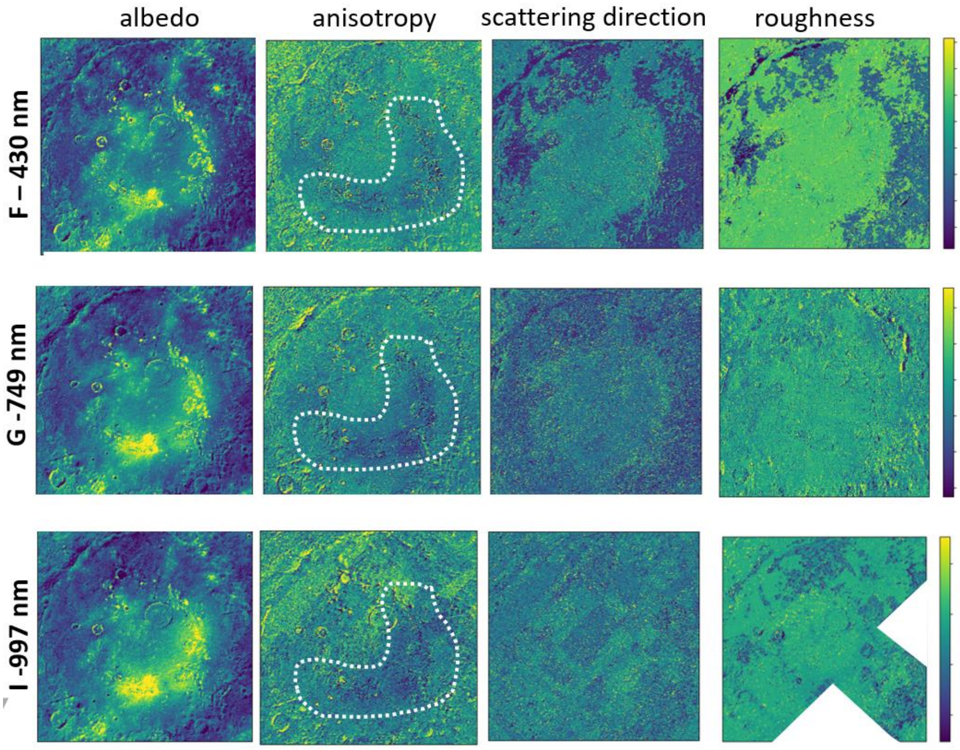

Figure 2. Hapke parameter maps for Praxiletes crater for the F, G, I MDIS bands

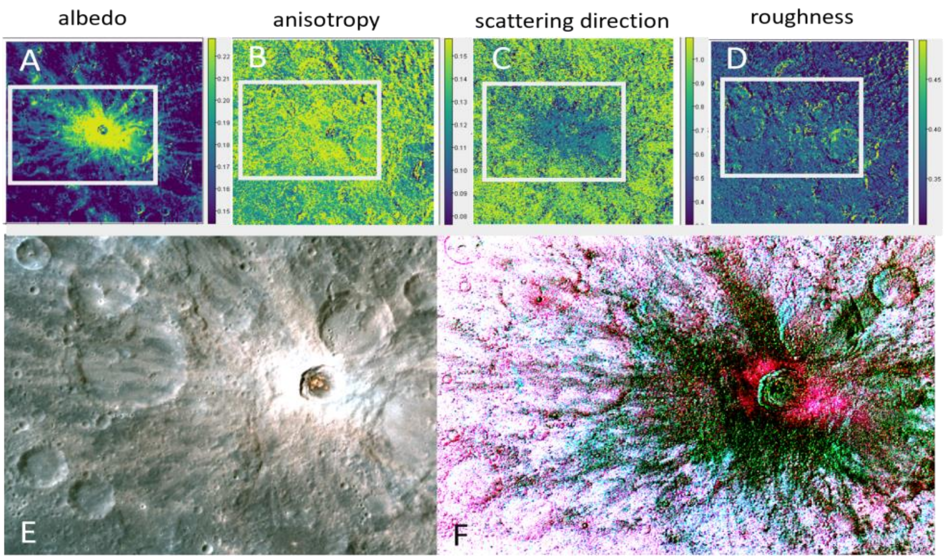

Figure 1. Hapke A) single scattering albedo, B) anisotropy, C) scattering direction and D) topographic roughness parameter maps for David Crater. E) RGB composite of the EW0221931511I (898 nm), EW0221931531G (570 nm), EW0221931515F (420 nm) MDIS bands of observation covering David Crater. F) RGB composite of the band ratios (550 nm/420 nm), (898 nm/570 nm) and (898 nm /420 nm).

on BepiColombo. A more complete characterization will be presented at the conference, including additionals targets not shown in this abstract.

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