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Ceres photometric properties from VIR on Dawn

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1. Introduction

Dawn spacecraft [1] entered orbit around Ceres on 6 March 2015. During the approach phase to this dwarf planet and later, through the Survey, High Altitude Mapping (HAMO) and Low Altitude Mapping Orbits (LAMO), the Visible and Infrared Mapping Spectrometer (VIR) will perform detailed observations of the surface of the body. VIR [2] is an imaging spectrometer onboard the Dawn mission and it is composed of two spectral channels: the visible (VIS) covering the 0.25 µm – 1.0 µm wavelength range and the infrared (IR) for the 0.95 µm – 5.0 µm interval.

During the various phases of the mission, the surface of Ceres will be observed under different observation geometries. The measured signal is then affected by photometric issues that need to be minimized in order to exploit the intrinsic spectral variability of the surface, thus allowing the direct comparison between acquisitions taken under different observation conditions. In order to accomplish this task we perform a photometric reduction of the dataset by means of a simplified Hapke model, following the approach of [3].

2. Photometric model

The dataset has been compared to the Hapke bidirectional reflectance model [4] which links the photometric output to the surface single scattering albedo and geometry. Since Ceres is a relatively dark object we neglect, at a first stage, the contribution from multiple scattering, and in order to minimize the number of free parameters we do not include the Coherent Backscattering Opposition Effect (CBOE). In particular it cannot be constrained with the present dataset, because observation with very low phase angle ($\alpha < 1°$-$2°$) are not available. The equation of the bidirectional reflectance is then:

$$I/F(i,e,\alpha) = \frac{w}{4}\frac{\mu_{0e}}{\mu_e + \mu_{0e}}\left[1 + B(\alpha)\right]p(\alpha)S(i,e,\alpha,\bar{\theta}) \quad (1)$$

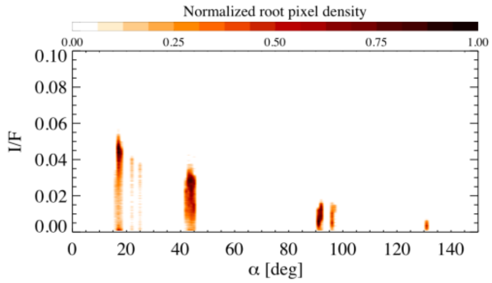
where *I/F* is the measured signal, *i*, *e* and *α* are the incidence, emission and phase angles respectively, *w* is the surface single scattering albedo (SSA), *p(α)* is the single scattering phase function (SPPF), *S* is the shadowing function depending on the average surface slope $\bar{\theta}$, μ_{0e} and μ_0 are the effective cosines of the incidence and emission angles respectively and *B(α)* accounts for the Shadow Hiding Opposition Effect (SHOE). The SPPF has been modelled following [3]:

$$p(\alpha) = \frac{1-b^2}{(1+2b\cos(\alpha)+b^2)^{3/2}} \quad (2)$$

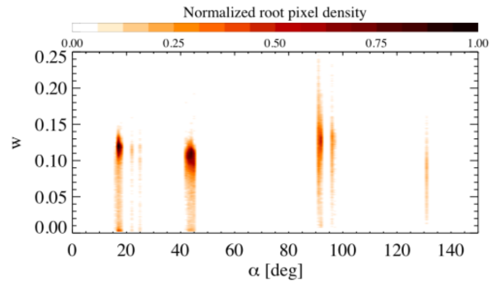
and *b* represent the asymmetry parameter.
From the comparison of the Hapke model to the whole dataset it is possible to retrieve the photometric parameters of eq. 1 and it is possible to reduce the measured *I/F* to *SSA*, which is an intrinsic property of the surface (fig.1). Given the lack of data a low phase angles ($\alpha < 10°$) we assume SHOE to be described by the parameters derived in [5], for the present analysis.

3. Results

Photometrically reduced data will be used to generate *SSA* maps of Ceres' across the VIR wavelengths range in order to investigate spectral variability of the surface. Simultaneously, Hapke's model parameters representing the average properties of Ceres will be determined: *b*, $\bar{\theta}$ and possibly the ones describing the SHOE if observations at low phase angle will be available.



(a)



(b)

Fig.1. a) I/F at 0.*550 µm* as a function of phase angle from VIR observations of Ceres during Approach phase. b) *w* at 0.*55 µm* as a function of phase angle after photometric correction. Note that dependence on α has been eliminated. Color bars indicate the root of the pixel density normalized to the maximum value.

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