AVERAGE PHOTOMETRIC PROPERTIES OF CERES SPECTRAL PARAMETERS. A. Longobardo[1], E. Palomba[1], M.C. De Sanctis[1], M. Ciarniello[1], F. Tosi[1], F. G. Carrozzo[1], A. Raponi[1], F. Zambon[1], E. Ammannito[2], J-Y. Li[3], C. A. Raymond[2], C. T. Russell[4], [1]Istituto di Astrofisica e Planetologia Spaziali, INAF, via Fosso del Cavaliere, Rome, Italy (andrea.longobardo@iaps.inaf.it) [2]UCLA, Earth Planetary and Space Sciences, Los Angeles, CA, USA, [3]Planetary Science Institute, Tucson, AZ, USA, [4]JPL, California Inst. Techn., Pasadena, CA, USA

Introduction: Ceres is the most massive body in the Main Asteroid Belt and in 2006 has been catalogued as dwarf planet by IAU. According to ground-based observations (e.g. [1]), this body could be composed by CC-like materials and host OH-bearing minerals, produced by water alteration [2,3]. Moreover, its density [4] suggests a high ice content.

The current NASA Dawn [5] exploration of Ceres can shed light about these scientific key issues. In particular, Dawn is taking hyperspectral images of the Ceres surface by means of the Visible and InfraRed mapping spectrometer (VIR) [6].

A fundamental process of data reduction to perform on VIR data is the photometric correction, aimed at removing the trend of reflectance with incidence, emission and phase angles. This allows the study of physical and optical properties of the asteroid surface, which drive the reflectance vs illumination angles behavior, such as regolith grain size, surface roughness, presence of contaminants, role of multiple and single scattering (e.g. [7], [8]).

In this work the average photometric behavior of spectral parameters which describe the Ceres surface is obtained, by analyzing VIR data at low spatial resolution (taken during the Approach, Rotational Characterization and Survey mission stages), i.e. from 1 to 12 km, and a photometric correction is obtained.

Method: The photometric empirical model developed here is based on a statistical analysis of all the VIR spectra acquired during the first stages of the Dawn mission to Ceres. Whereas the statistical analysis applied by [8] on VIR data of Vesta was based on an empirical definition of reflectance families, in this case we simply derive an average photometric behavior of the spectral parameters considered., due to the Ceres albedo homogeneity [9].

In particular, we studied the reflectance behavior at six wavelengths in the visible/NIR (0.55, 0.75, 0.85 μm) and in the infrared range (1.2, 1.9, 2.3 μm), respectively, in order to evaluate the phase function behavior across the spectrum. This correction is applied in three steps: 1) Removal of topography effects, by checking the disk function among those available in literature (i.e. Lambert, Lommell-Seeliger, Akimov) which best removes the influence of incidence and emission angles; 2) Retrieval of the relation between equigonal albedo (i.e. reflectance divided for a disk function) and phase angle (phase curve); 3) Retrieval of the reflectance which would be observed at a defined observation geometry (e.g., normal illumination and observation, 30° illumination and normal observation).

Moreover, we retrieved the photometric behavior of the visible slope (between 0.55 μm and 0.85 μm), the infrared slope (between 1.2 μm and 1.9 μm), and the band depths at 2.7 μm and at 3.05 μm (ascribed to OH and to NH_4, respectively [10]). Ceres spectra shows also carbonate absorption bands at 3.3-3.4 μm and 3.9 μm band [10], and the analysis of the photometric properties of these bands is in progress.

Results: ***Reflectance.*** The Akimov disk function is the only one which correctly removes the topography influence on reflectance at all the wavelengths. The obtained phase curves are flatter at wavelengths where reflectance is larger (i.e. 1.9 μm and 2.3 μm) and steeper in the visible range: this can be explained by a more important role of multiple scattering at infrared wavelengths. The obtained albedo map are in good agreement with HST results [11], since the bright and dark spots observed by [11] are well reproduced in the map obtained in this work (Figure 1).

Spectral slopes. A phase reddening is observed both in the visible and in the infrared range (Figure 2). In the first case, phase reddening is three times larger, since the reflectance difference is constant with phase in the VIS range and decreasing with phase in the IR.

Band depth at 2.7 μm. This band becomes deeper at increasing phase up to 55° (Figure 3). At larger angles, the band depth is constant with phase. This behavior is analogous at that observed for Vesta's pyroxene absorption bands [8] and could be explained in terms of different role of single and multiple scattering at band shoulders and band center..

Band depth at 3.05 μm. This band seems to be independent of incidence, emission and phase angles.

Conclusions: The statistical analysis here performed allowed to obtain albedo maps, which match the HST results. The visible phase reddening is larger than the infrared one, band depth at 2.7 μm increases with phase, whereas band depth at 3.05 μm does not seem to necessitate a photometric correction.

It is possible that the photometric behavior of the analysed parameters could be different in particular regions, due e.g. to different regolith physical properties or to a different albedo, as observed on Vesta [8]. Due to large-scale homogeneity of the Ceres surface, we did not observe such variations on low spatial resolution data (or, if observed, are within errors). Therefore we expect that the extension of this analysis on HAMO and LAMO data (currently in progress) may reveal variations of photometric functions across the Ceres surface.

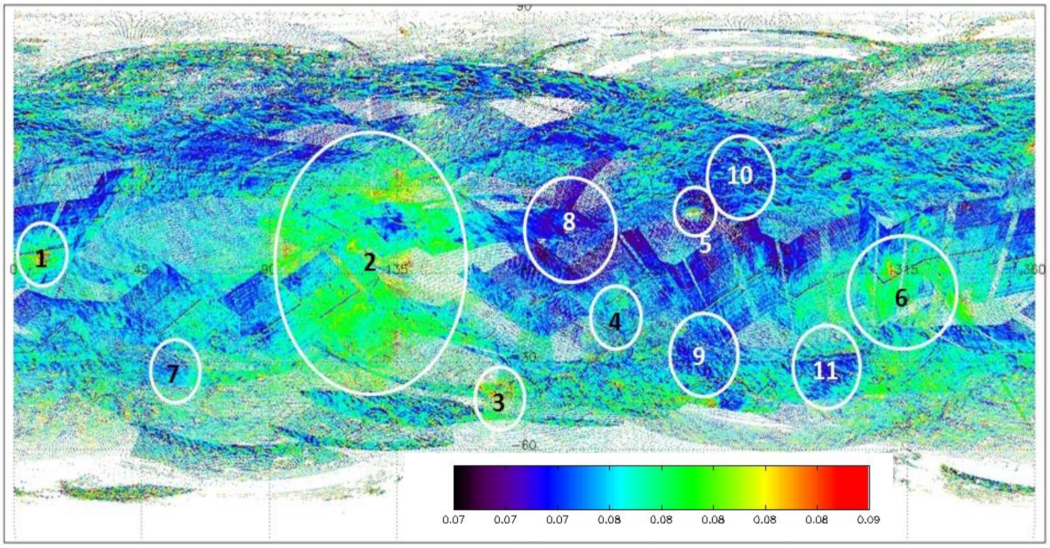

Figure 1. Normal albedo map at 0.55 μm. The circles labelled by numbers indicate the bright and dark spots observed in the Ceres albedo map obtained by HST [12].

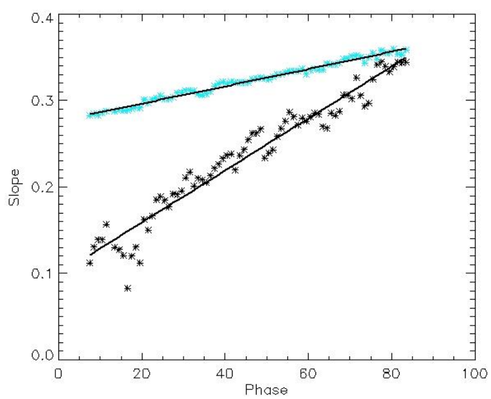

Figure 2. Visible (black asterisks) and infrared (cyan asterisks) slopes as a function of phase angle. Black lines are the obtained linear fits.

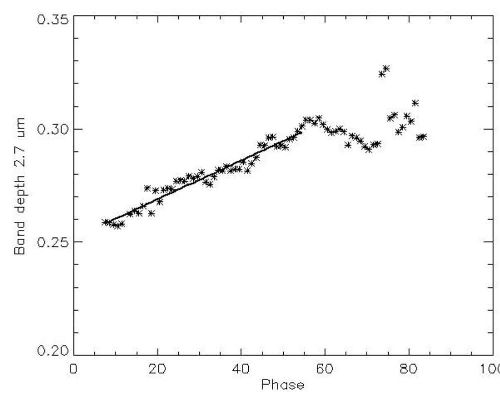

Figure 3. Average behavior of band depth at 2.7 μm as a function of phase angle. The black line is the obtained linear fit at phase angles up to 55°.

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