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Preliminary temperature maps of dwarf planet Ceres as derived by Dawn/VIR

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Abstract

The NASA Dawn mission [1] spacecraft was captured by the dwarf planet Ceres on March 6, 2015. During the *Approach* phase in the months preceding capture, the remote sensing instruments on the spacecraft acquired data with increasing spatial resolution. Analogous to the observation campaign planned at protoplanet Vesta during 2011-12, Dawn at Ceres proceeds in a series of orbits, carried out at increasingly lower altitudes over the mean surface, with a consequent increase of the spatial resolution.
The Visible InfraRed (VIR) mapping spectrometer onboard Dawn [2] operates in the overall spectral range 0.25-5.1 µm, with the main goal of inferring the surface composition of the target in its uppermost layer, as thick as several tens of microns [3].
Taking advantage of the wavelength range longward of 3 µm, it is possible to use VIR as a thermal mapper, i.e. as a tool to derive thermal images and spatially-resolved temperature maps. To do this, the VIR team uses a Bayesian approach to nonlinear inversion [4] that was extensively applied to the Vesta dataset, as well as to Rosetta/VIRTIS data of small bodies [e.g., 5,6].
In the case of Vesta, this capability allowed us to build both global thermal maps for each orbit phase (spatial resolution) as well as for different local solar times [7], and to investigate the thermal behavior of specific regions of interest seen at the local scale [4]. Such investigations fall well within the broad science goals that Dawn/VIR should address at Ceres.
In February 2015, still with a coarse spatial resolution (~11.4 km/px), VIR was able to obtain temperature images of Ceres that revealed the existence of differences in the thermal behavior of two bright spots seen at broad regional scale (**Figs. 1, 2**). At that time it was too early to say if this was the result of a real difference in the physical structure of the material and/or in its composition, because low resolution has the effect of averaging together very different areas.
In this work, we focus on VIR data acquired just after capture and in the first science orbit, namely the *Rotation Characterization 3 (RC3)* and *Survey* phases, yielding VIR spatial resolution of 3.4 km/px and 1.1 km/px, respectively. We derive global/broadly regional temperature maps as well as highlight thermal anomalies that may be observed at those spatial scales.
These data allow a preliminary determination of thermal properties of Ceres: in fact, thermophysical models that simulate the diurnal temperature variation for a given surface point, returning unknown quantities such as thermal conductivity and ultimately thermal inertia, may be appropriately constrained by these measurements.

1. Figures

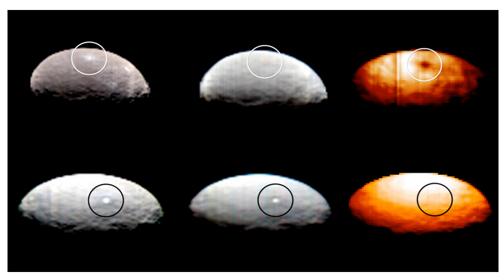

Figure 1. Region #1 (top) and Region #5 (bottom) are bright spots observed by Dawn on the surface of Ceres already in the *Approach* phase. Region #1 is located at Lon 4°N, Lon 8°E, while Region #5 is located at Lat ~20°N, 240°E. At left are images taken in visible light, close to wavelengths seen by the human eye (red = 656 nm, green = 530 nm, blue = 450 nm). The center images show the same regions of Ceres at infrared wavelengths dominated by solar reflection (red = 1.6 µm, green = 2.0 µm, blue = 2.4 µm). The right column shows Ceres in thermal infrared, where brighter colors represent higher temperatures. Region #1 corresponds to a dark spot at thermal wavelengths, which means it is cooler with respect to surrounding terrains seen under fair solar illumination (i.e., far away from the terminator). Conversely, Region #5 shows no distinct thermal behavior, which could be the result of insufficient VIR spatial resolution at the time of the observations, or the result of a different structure/composition of the surface material.
Credit: NASA/JPL-Caltech/UCLA/ASI/INAF.

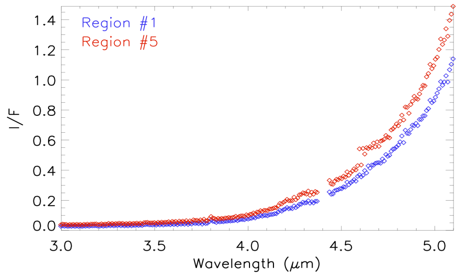

Figure 2. Spectral comparison based on VIR thermal infrared data between Region #1 (blue curve) and Region #5 (red curve). Region #1 shows a lower thermal emission compared to region #5.

Acknowledgements

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