SURFACE TEMPERATURE OF DWARF PLANET CERES: PRELIMINARY RESULTS FROM DAWN.

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Introduction: After a 7-year cruise, and a 1-year successful mission at asteroid 4 Vesta, the Dawn spacecraft [1] is finally approaching its second and final goal, the dwarf planet Ceres. In the mission phases that have been planned, the VIR imaging spectrometer aboard Dawn will acquire a large amount of hyperspectral data of the surface, to map the surface composition and to retrieve surface temperatures on the dayside of the target.

The thermal behavior of the surface of dwarf planet Ceres is related to composition and physical properties that provide information about the nature and evolution of surface materials. The maximum temperature with the Sun overhead was estimated from measurements and modeling to be 235±4 K at 2.77 AU [2], i.e. comparable to the maximum surface temperature measured by the Rosetta spacecraft on the small asteroid Steins during its close flyby occurred in September 2008.

Here we report about the first spatially-resolved surface temperatures of Ceres retrieved on the basis of VIR infrared data, as observed by Dawn in the early Approach phase of the mission.

The VIR instrument: VIR is a hyperspectral spectrometer in the overall range 0.25-5.1 µm with imaging capability onboard the NASA Dawn mission [3]. VIR design fully accomplishes Dawn's scientific objectives at all targets of the mission. The composition of the uppermost layer of the target's surface down to depths of tens of microns, in terms of minerals, ice, organics and volatiles, can be revealed by visual and infrared spectroscopy using high spatial resolution imaging to simultaneously map the heterogeneity of the surface.

The infrared range longward of ~3.5 µm is crucial to reveal the thermal emission of Ceres on its dayside, which can be used to map surface temperature across different orbits and local solar times (LST), and therefore constrain thermal properties at different spatial scales.

Data set and analysis: Here we show the first spatially-resolved temperature data of dwarf planet Ceres derived in the early Approach phase carried out in January and February 2015, with the target seen over tens of VIR pixels in the overall spatial resolution range between 50 km/px and 12.5 km/px (since February 2015, the VIR spatial resolution is better than any observation carried out by the Hubble Space Telescope and the Keck telescope). Broadly regional trends can be derived in this way, waiting for higher resolution coverage that will be achieved at later stages of the mission, under variable phase angles, illumination conditions, and heliocentric distances.

To derive surface temperature, we rely on a Bayeasian approach to nonlinear inversion [4] that was applied to the entire dataset of infrared data acquired by the VIR mapping spectrometer aboard the Dawn spacecraft during its orbital phase at asteroid Vesta in 2011-2012 [4], as well as to Rosetta/VIRTIS data obtained during the close flyby of asteroid 21 Lutetia in 2010 [5,6] and to comet 67P/Churyumov-Gerasimenko in the mapping phase carried out since July 2014 [7,8]. This approach alows simultaneous retrieval of surface temperature and emissivity in the 4.5-5.1 µm range.

The Noise Equivalent Spectral Radiance (NESR) is the rms noise of the in-flight measurements expressed in units of spectral radiance. In the 4.5-5.1 µm range, NESR is dominated by fluctuations of the thermal emission from the spectrometer, which result in a lowest measurable temperature of ~170 K, i.e. no temperature below this threshold can be accurately retrieved by VIR. This means that VIR cannot measure temperatures on the nightside of Ceres, as well as in the northern polar region that will undergo permanent shadowing conditions throughout Dawn's nominal orbital mission phases.

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