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Comparison between Dione' and Helene' surfaces using Cassini VIMS

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With 1122 km in diameter, Dione is the second largest inner moon of Saturn. The Voyager spacecrafts observed Dione in 1980 and revealed a complex surface structure. Afterwards, Dione was closely observed by the Cassini-Huygens spacecraft from 2004 to 2011. Dione's surface is composed primarily by water ice with minor abundances of volatiles such as CO_2 and CN. The satellite's surface can be divided into some distinct classes: most notably, heavily cratered terrains and less cratered plains. Most of Dione's surface is covered by the heavily cratered terrains, located mainly in the trailing hemisphere and crossed by high-albedo wispy streaks. The origin of the dark material that covers the heavily cratered terrains is still unknown, while wispy units are likely tectonic features. Helene is a Dione's trojan moonlet, which orbits around Saturn in Dione's lagrangian point L4.

The Visual and Infrared Mapping Spectrometer (VIMS) instrument onboard the Cassini Orbiter is able to acquire hyperspectral cubes in the overall spectral range from 0.35 to 5.1 μm. We have selected 76 VIMS cubes of Dione in the IR range between 0.85 and 5.1 μm. These data show at the same time a spatial resolution better than 100 km and a good S/N ratio. We have normalized all of the spectra at λ=2.23 μm in order to minimize photometric effects due to different observation conditions. To emphasize the existence of spectral units, we have applied the supervised clustering technique Spectral Angle Mapper (SAM) to the infrared spectra of each cube. A classification method applied to hyperspectral data shows up to be crucial to understand geochemical processes taking place on the icy satellites' surfaces, and, in this particular case, to investigate the possible presence on the surface of Dione of non water-ice materials, such as methane and ammonia. Some classes show also a peculiar trend with respect to the phase angle, possibly related to surface structure. Moreover, the use of this technique allowed us to emphasize the dichotomy existing between Dione's trailing and leading hemispheres.

For each terrain unit and for selected values of the phase angle (25°, 38°, 43°, 47°, 63°, 70° and 78°), we evaluated the difference between the mean spectrum of Dione and the mean spectrum of Helene. The spectral comparison shows that the most prominent difference is related to the water-ice absorption bands at 1.5 and 2.0 μm and the CO_2 absorption band at 4.26 μm, indicating that the dark material is more abundant on Dione' surface than on Helene's. Moreover, the relative maximum in reflectance located around 3.5 μm is a marker of the average size of ice grains. By comparing Dione' and Helene's spectra, it turns out that Helene's ice grains are on an average larger than those of Dione.