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ID# P33A-1558
Location: Poster Hall (Moscone South)
Time of Presentation: Dec 15 1:40 PM - 6:00 PM

Spectrophotometric Modeling of Enceladus Surface Properties and Composition from Vims Data

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The Visual and Infrared Mapping Spectrometer (VIMS) instrument onboard the Cassini spacecraft, is an imaging spectrometer that produces monochromatic images in the 0.35 - 5.12 µm range. During the five years of Cassini mission in the system of Saturn the instrument produced more than 1400 full-disk images of the moons in a wide range of solar phase angles. This huge amount of data allows the study of the spectral and photometric surface properties of the Saturnian satellites. Our work started with the analysis of Rhea's surface properties (Ciarniello et al., submitted) and we now focus on Enceladus.
We applied the Hapke's radiative transfer model (Hapke,1993) to study the satellite's spectrum at each available phase angle and the phase curve at each wavelength in the VIMS range. This approach allows to constrain physical properties of the medium composing the surface such as grain size, amount of contaminants, opposition effect mechanisms and surface roughness.
The 1.5, 2.0 and 3.0 µm absorption bands in the spectrum indicate that the surface of the moon is mainly composed of water ice. However the spectrum shows a small UV downturn which can be explained by the presence of organic contaminants. In order to reproduce this behavior we modeled the surface using a monodisperse grain size distribution of water ice with small inclusions of contaminants. Three mixing modes have been investigated: areal, intimate and intraparticle. Four different organic contaminants have been used: Triton tholin, Titan tholin, Hydrogenated amorphous carbon and tholin from Khare et al. 1993. The best fit is obtained with an intraparticle mixture of water ice and a tiny amount of Triton tholin (0.001%) with particle radius between 60-70 µm.
The spectral fit allows to decouple spectral effects by photometric ones and represents the starting point for the phase curve fit allowing to compute the single scattering albedo of the medium.
The fit of phase curve for each wavelength shows a correlation between the parameters affecting its shape (opposition effect amplitude and width, single particle phase function parameters and surface roughness slope) with the single scattering albedo.
We compared the result of this work with our previous study performed on Rhea in order to point out compositional similarities between the two moons.
The approach we developed in this work is applicable to all the Saturn's icy moons and represents a powerful tool to characterize their surface properties and to understand the processes that model them. Additionally, this method will allow to determine the distribution of organic compounds in the Saturnian system and to study the surface evolution of the moons.
This work is supported by an Italian Space Agency grant.

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