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Saturn's Icy satellites: The Role of Sub-Micron Ice Particles and Nano-sized Contaminants (*Invited*)

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The Visual and Infrared Mapping Spectrometer (VIMS) has obtained spatially resolved imaging spectroscopy data on numerous satellites of Saturn. The spectral trends on individual satellites and as compositional gradients within the Saturn system show systematic trends that indicate variable ice grain sizes and contaminants. Compositional mapping shows that the satellite surfaces are composed largely of H_2O ice, with small amounts of CO_2, trace organics, bound water or OH-bearing minerals, and possible signatures of ammonia, H_2O or OH-bearing minerals, and dark, fine-grained materials. The E-ring coats the inner satellites with sub-micron ice particles. The Cassini Rev 49 Iapetus fly-by on September 10, 2007, provided imaging spectroscopy data on both the dark material and the transition zone between the dark material and the visually bright ice on the trailing side. The dark material has very low albedo with a linear increase in reflectance with wavelength, a 3-micron water absorption, and a CO_2 absorption. The only reflectance models that can explain the trends include highly absorbing sub-micron materials that create Rayleigh absorption. Radiative transfer models that include diffraction from Rayleigh scattering and Rayleigh absorption are necessary to match observed data. The dark material is well matched by a high component of fine-grained metallic iron plus a small component of nano-phase hematite. Spatially resolved Iapetus data show mixing of dark material with ice and the mixtures display a blue scattering peak and a UV absorption. The blue scattering peak and UV-Visible absorption is observed in spectra of all satellites at some locations where dark material is mixed with the ice. Rayleigh scattering and Rayleigh absorption have also been observed in spectral properties of the Earth's moon. Rayleigh absorption requires high absorption coefficient nano-sized particles, which is also consistent with metallic iron. The UV absorber appears to have increased strength on satellite surfaces close to Saturn, with a corresponding decrease in metallic iron signature. Possible explanations are that the iron is oxidized closer to Saturn by oxygen in the extended atmosphere of Saturn's rings, or coverage by sub-micron E-ring ice particles, or a combination of both.

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