Opposition Effect Produced by Icy Particles: Spectral Manifestation

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When light experiences multiple scattering in a medium containing closely spaced dust particles, the rays, which travel along the same path but in opposite directions, interfere constructively, producing the coherent backscattering effect (CBE). Photometric (opposition spike) and polarimetric (narrow negative polarization feature) manifestations of CBE have been repeatedly observed for many Solar System objects including Saturn's ring, the icy satellites of the outer planets, bright asteroids, and Kuiper Belt Objects (KBOs).

We discuss a new effect: spectral manifestation of CBE. According to the physics of coherent backscattering, the decrease in reflectance as solar phase angles increase depends strongly on the absorption of the material, resulting in photometric phase curves of different steepness within and outside of the absorption bands. Thus, different depths of the absorption bands occur for different solar phase angles. Neglecting this effect in the analysis of spacecraft and ground-based spectral data may lead to erroneous conclusions about compositional and size differences of dust studied at different solar phase angles.

We study Cassini VIMS (Visual and Infrared Mapping Spectrometer) spectra of Saturn's mid-size icy satellites in order to identify and characterize the solar phase angle variations of the spectra, including changes in the depth and shape of the water ice absorption bands as well as the general slope of the spectra. We also analyze the results of ground-based observations of icy satellites of Saturn and Uranus. We compare the observational results with theoretical modeling that we perform using the MSTM (Multi Sphere T-matrix) code by D. Mackowski (http://www.eng.auburn.edu/users/dmckwski/scatcodes/). Such modeling allows us not only to separate phase angle effects from particle and composition effects but also to study properties of the regolith particles, specifically their size and packing.

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