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Masking water ice on small icy bodies

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Abstract

Small bodies in the outer Solar System are characterized by low surface albedos and a variety of colors from red to black. Organic compounds and carbonaceous refractories, mixed to ices and silicates, can be responsible for some of the observed spectral characteristics, in particular the coloration.

Complex organic materials on small icy bodies probably include a primary native component accreted during the formation of planetesimals, and a secondary component that is a by-product of (cosmic and/or solar wind) ion and photon irradiation of simpler C-bearing volatile ices (CH_4, CH_3OH, etc.). In particular, these irradiation processes (space weathering) induce color variations that can reproduce the observed spectral variety of Centaurs and trans-Neptunian objects [1].

Additional clues on the surface composition of small icy bodies come from the laboratory study of cometary grains, such as some interplanetary dust particles collected in the Earth's stratosphere. These studies indicate the presence of refractory carbonaceous units that are usually sub-micron in size, i.e. smaller than the wavelength commonly used in remote sensing spectral observations of icy bodies.

Based on this evidence, it has been suggested [2] that reddening of small icy bodies may be caused by sub-micron particles of organic material of pre-solar origin trapped in ice. According to this model, the amount of reddening varies with the concentration of organics to ice.

To extend these results, we are developing a space weathering spectral model for small icy bodies that is compatible with laboratory measurements of collected cometary particles [3], and that takes into account the surface processing by solar and cosmic ions. Following the approach of Grundy [2], our model makes use of the Hapke scattering theory and of the Maxwell-Garnett effective medium theory to approximate the effect of carbon subwavelength inclusions.

Preliminary results will be presented and discussed in view of their application to icy body surfaces. The conditions for the NIR spectral detection of water ice will be estimated. We will show that up to ~50% of water ice can be spectroscopically masked at 10% detection sensitivity due to the strong absorption of the sub-micron carbonaceous component, similarly to what previously found in the case of carbon-enriched crusts [4].

References

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