Exploring the Surface Composition of Enceladus: Water Ice, Ammonia, and Organic Tholin Models

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While the optical and near-IR spectra of the surface of the saturnian moon Enceladus is consistent with laboratory spectra of water ice, the FUV spectra are more complex than can be explained by a water-ice composition alone. One notable problem is a pervasive darkness between 170 and 185 nm, inconsistent with the water-ice absorption edge at 165 nm. Hendrix et al. (2010) use FUV spectra from the UVIS spectrograph on Cassini compared with surface models from Hapke (2002) to explore other possible surface compositions. Candidates for the water-ice contaminant include ammonia ice, carbon dioxide, and tholins. The authors conclude that carbon dioxide is an insignificant species on the surface of Enceladus.

I have written simplified Hapke surface models for the range 110–119 nm for water-ice, ammonia ice, and a type of tholin called Ice Tholin II, thought to be prevalent on the surfaces of icy moons. I have added to the work by varying the grain size of the particles modeled. Hendrix et al. (2010) assume a grain size of 1 micron. I have modeled grain sizes of 0.03, 0.1, 1, and 5 microns for each individual substance (water, ammonia, and ice tholin II). The curves change substantially with modified grain size. Additionally, I have modeled various mixtures of the three substances at these different grain sizes. Although comparison to the observations is difficult due to the low resolution of the models and the simplicity required for a brief project (due to neglecting shadow-hiding, coherent backscatter, large-scale surface roughness, and other second-order effects), I attempt to rule out certain grain sizes and mixtures.