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The Ultraviolet Characteristics of Enceladus

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1. Introduction

Enceladus is a unique satellite in the Saturn system, not only because of its fantastic south polar plume activity, but also because it is responsible for the production and maintenance of the E ring – which has tremendous influence on the other satellites. We review the ultraviolet spectral and photometric characteristics of Enceladus, as learned from the Cassini Ultraviolet Imaging Spectrograph (UVIS) [1].

The ultraviolet characteristics of Enceladus are important in part because they help expose compositional variations across the surface of Enceladus and show how Enceladus' surface composition compares to the other satellites in the system. The UV characteristics also reveal information about the surface structure and how it affects the light scattering properties. Because the UV probes just the uppermost layers of the grains, this short wavelength range is uniquely suited to studying the effects of the fine-grained plume fallout and E ring grain coating on the surface.

2. Spectral Characteristics

The FUV spectra of the icy Saturnian moons all show the strong signature of water ice, an absorption edge near 165 nm (e.g., [2][3]). As a result, the spectra of Enceladus and the other moons are generally bright *longward* of 165 nm and dark *shortward* of 165 nm. However, all of the satellites are significantly darker in the far-UV than in the visible, indicating a strong near-UV absorption [3].

In past analyses we have focused on the longer-wavelength end of the H_2O absorption; here we also consider the short-wavelength end of the spectrum. Pure water ice models (e.g. [3]) predict a very dark and flat spectrum in this region (110-160 nm) – but such a dark, spectrally flat spectrum is not always observed on the icy satellites such as Mimas or the other satellites. Is this due to a non-H_2O ice component of the icy regolith? Or is it an aspect of the scattering properties of the surface? This will be investigated. By comparing with the other satellites, we can understand Enceladus and its spectral behaviors better. Another aspect we investigate is the spectral shape of the H_2O ice absorption edge, which differs between Enceladus and Mimas; this could be due to the contribution of plume fallout material on Enceladus. We present new spectral models for Enceladus, improving on earlier work [3] by using new laboratory data. We also consider the "plume fallout regions" (e.g. [4][5]) on Enceladus, and what those UV spectral variations there imply in terms of plume composition.

3. Photometric Characteristics

We discuss the photometric behavior of Enceladus, considering the significant E ring grain environment in which the moon orbits, and the fine dust grains that constantly bombard the surface. Our models include the coherent backscatter opposition effect (CBOE) and the shadow hiding opposition effect (SHOE) (e.g. [6]).

Preliminary results suggest that the opposition surge behavior of Enceladus is very different from that of Mimas, likely due to grain size differences on the surfaces. We expect that, because of the relatively low UV albedo (as discussed in Sec. 2), the opposition surge of Enceladus and the other icy Saturnian satellites may be driven primarily by the SHOE (though the CBOE cannot yet be ruled out [6]). The SHOE makes its mark when the grains are larger than the wavelength of light, so that shadows can be cast and observed. At lower phase angles, the shadows disappear behind the grains themselves. But if the grains are very small, such that the wavelength is larger than the grains, the SHOE may be significant. We can thus use the opposition surge shape to study grain size differences among the icy satellites.

At larger phase angles, Enceladus exhibits a significant forward scattering peak in its UV phase curve. This is may be due to the fine grains of the surface, with a possible contribution from the (aloft) plume grains themselves. This is being investigated.

References

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