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EUV Transmission Spectra of Saturn's Rings from Cassini UVIS Solar Occultations

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Abstract

We present the first transmission spectra at extreme ultraviolet (EUV) wavelengths (60 – 110 nm) of Saturn's main rings using Cassini UVIS solar occultation data. We report several instances of spectral variations across Saturn's main rings at EUV wavelengths.

1. Introduction

The Ultraviolet Imaging Spectrograph (UVIS) instrument [1] on Cassini observed 20 solar occultations by Saturn's rings, five of which included successful ingress and egress chords. Observations of the Sun as it is occulted by the rings uniquely enable transmission measurements at EUV wavelengths, though the spatial resolution of the ring profile is diminished by the projected size of the Sun (1 mrad). Solar occultations in the EUV are most sensitive to sub-millimeter ring particles, which can serve as tracers for collisional activity in the rings capable of replenishing the population of such small particles. UVIS solar occultation data were used to detect transient micron-sized dust in the F ring [2]; however, a complete analysis of the UVIS solar occultations across the main rings has not yet been achieved.

2. Spectral Variations in Ring Transmission Profiles

2.1 Transmission Profiles

During occultations, small ring particles can diffract incident starlight out of or into the instrument field of view. Shorter wavelengths are more broadly diffracted by a given particle, and therefore differences in the transmission profiles can be used to constrain the minimum particle size across the rings [3]. We produce ring profiles at different EUV wavelengths to look for variations in the minimum particle size across the rings.

2.2 Spectral Features

While an overall difference between the transmission profile at shorter and longer wavelengths could indicate the presence of sub-millimeter particles, we would not expect to observe any spectral features in the transmission spectra unless the sizes of the ring particles are on the order of the observed wavelength [4, 5]. Spectral features could therefore suggest sub-micron-sized particles in the main rings, while the wavelength of the feature could indicate composition.

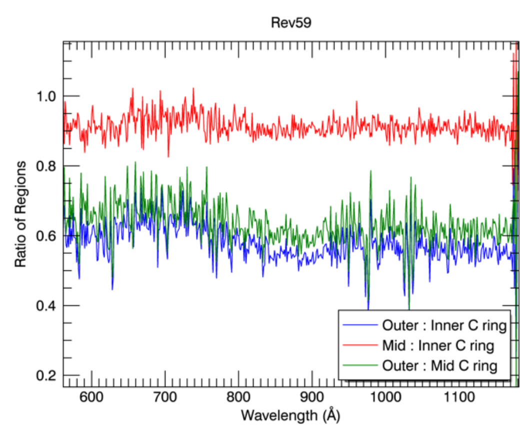

Figure 1: Spectral ratio of a 1000-km region in the outer C ring divided by a 1000 km region in the inner C ring (blue) and the middle C ring (green), and the ratio between the middle and inner C ring (red). The outer C ring appears to be spectrally distinct from the inner- and mid-C ring near 85 nm in some of the occultation data.

Initial studies of the solar occultation data do reveal spectral features in the rings. In some occultation data, we detect a broad absorption feature near 85 nm in Saturn's outer C ring when compared with the spectra from the inner and middle C ring (Fig 1). In Saturn's B ring we detect a possible sharp transmission feature near 78 nm when we ratio the occulted to the unocculted solar signal (Fig. 2). We assess whether these features could be instrumental effects, if they are revealing populations of nanometer-sized dust in the rings, or if they are caused by another phenomenon in the rings.

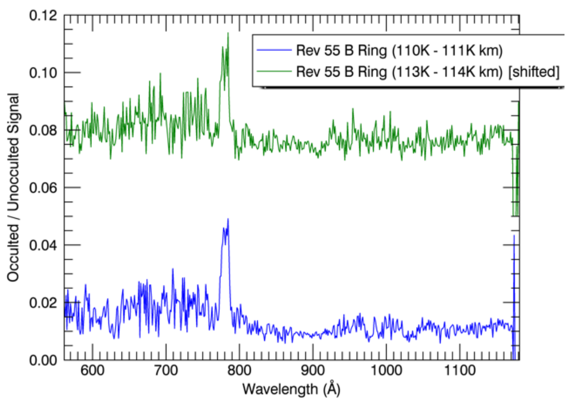

Figure 2: We detect a sharp spectral feature in the transmission profile at ~78 nm near the B ring outer edge in UVIS solar occultation data.

3. Summary

We present the first transmission profiles of Saturn's rings at EUV wavelengths, noting regions with spectral variations and features. We will discuss causes for spectral features, including possible instrumental effects, the potential implications for the size and composition of the particle populations, or other possible explanations for the EUV spectral features detected in Saturn's rings.

Acknowledgements

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