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Saturn's ring spokes in the Cassini/VIMS data

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Abstract

During the last saturnian equinox, Cassini observed several spokes on the Saturn's B ring, imaged by both the ISS camera and the VIMS spectrometer. We will report here about the analysis of the spoke spectra as acquired by VIMS in different observative conditions. The evaluation and modeling of the spectral variations among spokes and inside single spokes can give further constraints to the formation and evolution models of these intriguing features.

1. Introduction

Spokes on the Saturn's B ring are transient features appearing close to the saturnian equinoxes. They have been observed and monitored since the 1981's Voyager flybys, arising the idea that they consist of fine charged grains of water ice electrostatically detached from the surfaces of the ring boulders. Several models have been constructed in order to study the evolution of these structures but their formation process is still poorly constrained by the observations [1], [2], [3].

2. Data analysis and spoke spectra

The first spectroscopic measurements of spokes have been only obtained in the middle 2008 by Cassini-VIMS (*Visual and Infrared Mapping Spectrometer*). VIMS can acquire multispectral images in the range 0.35-1.05 μm with a VIS channel and between 0.85 and 5.15 μm with an IR channel. In particular, the infrared data were the most interesting, since spokes have never been observed before in this range.

However, the quantification of the spectral features really due to the spoke is not trivial, since the reflectance of the rings is highly variable on a spatial scale of the same order of the instrumental resolution or less. Therefore, an accurate geometric registration of the images is essential in identifying those spectral changes likely to be ascribed to the spoke and not to the fine ringlet structure which characterizes the B ring. A further complication comes from the misalignment between VIS and IR channels.

3. Spoke modelling and statistics

Preliminary analyses and modeling of the VIMS data suggested the grains forming the spoke to be quite larger than previously thought [4], implying a larger amount of energy to be involved in their formation. However, this result have been obtained from a single spoke, while the VIMS spoke dataset includes several multispectral images and movies which can be very useful for a statistically more meaningful analysis.

Following the modeling approach used in [4], we try to fit directly the spectral contrast of the spoke (i.e. the relative difference in reflectance between the spoke and the adjacent ring), in order to avoid the full modeling of the B ring spectrum itself. In this way a grain size distribution can be retrieved from each spectrum, together with a column density map of the spoke.

The spectral variations inside a single spoke and among different spokes can be especially important. Three main kinds of variation have been considered, each of them giving clues to a particular spoke feature: 1) the variations among different spokes with phase, incidence, and emission angles of the grains radiative properties can better constrain their microphysics; 2) the spatial variation inside a single spoke can be indicative of the forces acting on it which determine its shape, density distribution and size distribution of the water ice grains. 3) The temporal spectral variations of a spoke can give direct clues to its evolution and to the energy dissipation processes which accompanies its fading. Of course, the discrimination among the sources of variation is not always possible given the intrinsically spurious nature of the data.

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