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Saturn ring spokes: an overview of their near-infrared spectral properties from Cassini/VIMS data

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Abstract

The B ring of Saturn is known to periodically host weak elongated features called spokes. They have been clearly detected by the Voyagers, by the Hubble Space Telescope and by Cassini instruments ISS and VIMS. These observations were conducted during three different Saturn equinoxes in 1980, 1995, and 2009 respectively, bringing to the current view of the spoke's physical nature: thin clouds of fine electrically-charged grains levitating over the larger ring boulders. In respect to the previous available datasets, the VIMS one has widened our view of spokes outside the visible spectral range for the first time (longward of 1 micron). On the other hand, the VIMS spatial resolution is often comparable with the typical sizes of spokes, and considerable image processing is needed in order to enhance the spoke images and for the spectra extraction. Here we will report about advances in the spoke spectral analysis with VIMS data and will discuss the possible physical interpretations under the assumption of low spoke optical thickness.

1. The spokes puzzle and the VIMS data

Spokes on the rings of Saturn are one of the most intriguing and interdisciplinary phenomenon of the Saturn system. They have been always observed during the last three Saturn's equinoxes (1980, 1995, 2009) by different instruments (respectively Voyagers cameras [1], HST WFPC2 [2], Cassini ISS [3] and VIMS [4]). They always appear near the synchronous orbit, where the orbital period of the ring particles equals that of the Saturnian magnetic field, and they do not strictly move in a keplerian way. These properties, among others, brought to the current idea that the spokes are composed of charged particles moving at some distance above the main ring plane, dragged by the rotation of the Saturnian magnetic field. While electrostatic levitation may explain the small grains displacement from the ring boulders, the actual phenomenon able to charge the boulders surfaces is not well understood. Two main hypotheses are currently debated on this topic: the meteoroid bombardment [5] and the electron influx from Saturn's lightnings [6]. VIMS data can significantly contribute to our understanding of spokes expanding our knowledge in the spectral dimension, covering the range from 0.35 to 5.1 micron with a discrete resolution (7-15 nm). During the 2009 equinox, VIMS was able to imagine several spokes on the lit face of the ring, from 2008 July 2 to 2010 Jan 27. Here we will show an overview of the spectral analysis of a significant sample of spokes, studied in terms of their spectral contrast in respect to the adjacent ring reflectances. VIMS spatial resolution is often comparable with the typical spoke sizes and the instrument is not always able to resolve the fine structure of the B ring where the spokes lie. Therefore an important part of the work consists in the definition of the image processing techniques the can better enhance the spoke images and allow a meaningful spectra extraction. Once enough spoke spectra are collected, three kind of comparative analyses will be attempted: 1) average spectra of different spokes close in time or far apart, 2) spectral mapping of individual large spoke, and 3) spectral time variation of individual spokes in their evolution as captured in some VIMS image sequences. The physical interpretations of the results under the assumption of low spoke optical thickness will be discussed, together with the possible pieces that VIMS can add to the puzzle of spokes.

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