Statistical Perspectives on the Study of the Ring Spokes of Saturn Emiliano D’Aversa, Giancarlo Bellucci, Francesca Altieri, Filippo Giacomo Carrozzo. Istituto di Fisica dello Spazio Interplanetario, INAF, Via del Fosso del Cavaliere 100, 00133 Rome, Italy (emiliano.daversa@ifs-roma.inaf.it)

Introduction

At the beginning of the Cassini Extended mission, the VIMS spectrometer was able to collect the first images of spokes on the Saturn rings at wavelengths longer than 1.1 µm ([1]). Previous observations refer essentially to the visible spectral range: the spokes discovering, during the Voyager 1980-81 flyby of Saturn ([2]), a long-term HST observative campaign ([3]), and recently the Cassini ISS camera images, discussed in [4]. These observations made widely accepted the idea that spokes are composed of very small ice particles, lifted up from the ring boulders’ surface by electrostatic forces [5]. The preliminary analysis of one spoke seen by VIMS has shown that the spoke should be populated by particles greater then previously thought [1]. In particular, water ice particles with a radius of 1.9 µm appear as the most abundant. The size distribution should be quite wide around this value, including both the submicron (≥0.5 µm) particles responsible for the visible spectrum and the micron-sized particles (≤5 µm) inferred from the infrared data.

Main remarks

Although a lot of physical modeling has been developed about the nature and evolution of spokes, the process of their formation is not yet fully understood and still debated (e.g. [6]; [7]; [8]). Of course the size distribution of the spoke grains is strictly related to the physical mechanism which trigger their formation. If larger (and more massive) grains form the spoke, the energy required for their levitation increases by a factor roughly proportional to the change of grain radius. For the size distribution reported in [1] in respect to the previous ones ([2] and [3]) the increment is of about one order of magnitude. Nevertheless, a non-uniform mixing of the grains inside the spoke may be invoked in order to reduce the energy requirements. Since the forces acting on the particles depend on their charge to mass ratio (q/m), a significative vertical stratification could produce, affecting the radiative transfer in the spoke itself.

Spoke statistic and perspectives

Many other spokes have been observed by VIMS during the Saturn equinox on the lit face of the rings. Even if it is already an important indication that at least one spoke exhibits this behavior, other spokes may have a larger contrast and can give a better quality spectrum, although the spatial resolution does not change very much among different observations. Once the VIMS data of other spokes will be processed, a statistically meaningful sample of spokes should be available, allowing more robust conclusions. A spoke spectral classification could also be helpful for the identification of different stages in their global evolution during the equinox or during the life of the single features. Important constraints to the nature of the spokes may also come from the variation of the spectral contrast with angles. In particular, if a phase function of the spoke particles can be partially reconstructed at infrared wavelengths, it could be very useful for better constraining the spoke microphysics.

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References


