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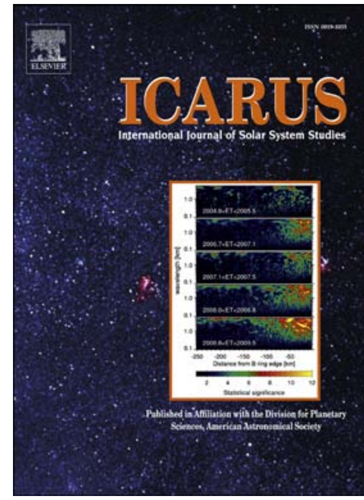

The opposition effect in Saturn's main rings as seen by Cassini ISS: 2. Constraints on the ring particles and their regolith with analytical radiative transfer models

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The opposition effect in Saturn's main rings as seen by Cassini ISS: 2. Constraints on the ring particles and their regolith with analytical radiative transfer models

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Abstract

The opposition effect in Saturn's main rings is characterized by a surge in ring brightness, when the phase angle approaches zero degree. This effect can be used to derive: physical properties of the ring particles and the ring layer, via the shadow hiding mechanism; and physical properties of the regolith grains that cover the ring particles, via the coherent backscattering mechanism. Since the exact origin of this effect is still a matter of debate, we try different combinations of the physical mechanisms cited above to derive constraints on the nature, the texture, and the disposition of the ring particles. In particular, we derive regolith grain sizes, particle sizes, differential power law indices, filling factors, and vertical thicknesses; and we compare them with independent works to validate or invalidate the assumptions of the opposition effect models used. Our coherent backscattering model provides grain sizes similar to the sizes estimated from water ice band depth modeling in the near infrared. Our shadow hiding model assuming a power law size distribution provides vertical thickness consistent with previous estimates from density waves measurements and N-body simulations. We show that the assumption of an homogeneous medium is a key parameter in the shadow hiding modeling. In the case of the B ring, we demonstrate that all previous photometric models assuming an homogeneous ring layer (i.e. uniform particle size distribution, random spacing of the particles and small filling factor) have led to a set of unconfirmed solutions. This result reinforces the idea that the Saturn's main rings should be modeled as an heterogeneous medium.

Keywords: *Planetary rings; Saturn, rings; Photometry*

Highlights

- We try different combinations of opposition effect mechanisms to model Saturn's main rings opposition effect.
- Our study brings a novel and solid proof that the coherent backscatter can explain the rings opposition effect.
- Our grain sizes are compatible with sizes derived from water ice band depth modeling in the near infrared.
- Our vertical thicknesses are in agreement with estimates from density waves measurements and N-body dynamical simulations.
- Our study finally explains the main discrepancies between previous estimates by photometry and dynamics.

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