EPSC Abstracts
Vol. 11, EPSC2017-395-3, 2017
European Planetary Science Congress 2017
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Large and small-scale structures in Saturn's rings

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Abstract

Observations made by the Cassini spacecraft have revealed both large and small-scale structures in Saturn's rings in unprecedented detail. Large-scale patterns include ringlets, density and bending waves, circumferential gaps, kinematic wakes, and propellers. These are foremost created by gravitational interaction with external as well as embedded moons. Analysis of Cassini and Voyager occultation data, however, revealed the presence of another moon-induced feature. Few kilometer wide individual gaps located within a few kilometers of the Encke and Keeler gap edges are exclusively found downstream of Pan and Daphnis, respectively. Recent Cassini images provide evidence for material separating from these edges, leaving depleted regions that are most likely the gaps seen in occultations.

High-resolution measurements by the Cassini Ultraviolet Spectrograph (UVIS) High Speed Photometer (HSP) and the Imaging Science Subsystem (ISS) show an abundance of intrinsic small-scale structures (or clumping), seen across the entire ring system. Examples include self-gravity wakes (50-100m), sub-km structure at the A and B ring edges, and "straw"/"ropy" structures (1-3km). In particular, wavelet analysis and an m-test based search for gaps within the A ring show that these density wakes are predominantly found in perturbed regions of the rings such as density waves and the outer A and B ring edges. Driven by resonances with external moons, these perturbed regions undergo periodic phases of compression and relaxation that correlate with the presence of structure, implying structure formation on time scales as short as one orbit. Also, double star occultations reveal radial variations at ring eges beyond the well-known large-scale excursions, that provide further evidence for the presence of intrinsic structure.

I will review observations of gaps at the Keeler and Encke gap and discuss the analysis and features of detected small-scale structures.

Acknowledgement

This work is supported by the Cassini project.