

## **Dynamical Developments in Saturn's Rings**

*Luke Dones (Southwest Research Institute, Boulder, Colorado)*

The Cassini mission, which has orbited Saturn since 2004, has refined our understanding of ring phenomena first seen by Voyager 1 and 2 in 1980/81, while discovering new types of ring structure, some predicted, others unexpected. I will first review findings from Cassini's imaging and occultation experiments that bear on ring dynamics. These include the following:

- (1) "propellers," two-lobed features produced by moonlets in the rings too small to clear full gaps. Some propellers are observed to migrate inward or outward as they interact with ring material.
- (2) fine-scale axisymmetric structure, likely produced by viscous overstabilities
- (3) ubiquitous self-gravity ("Julian-Toomre") wakes in the A and B Rings
- (4) spiral density and bending waves forced by Saturn's inner satellites
- (5) vertical structure seen near equinox, particularly near the edges of the A Ring's Keeler Gap
- (6) the complicated set of unforced modes seen at the outer edge of the B Ring, in addition to the  $m = 2$  mode forced by Mimas
- (7) waves in Saturn's C Ring that appear to be forced by low-order oscillations within Saturn
- (8) rapid changes in Saturn's F Ring due to collisional and gravitational interactions with embedded moonlets and the satellites Prometheus and Pandora

After describing these results, I will discuss new models for the origin of Saturn's rings. Most likely, the rings formed either during the late stages of Saturn's formation or during the lunar Late Heavy Bombardment.

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