

The Structure of Saturn's F Ring

C. D. Murray, N. O. Attree, N. J. Cooper and G. A. Williams

Queen Mary University of London, Astronomy Unit, Mile End Road, London E1 4NS, United Kingdom, email: C.D.Murray@qmul.ac.uk

In stark contrast to the ordered regularity of the planet's main rings, Cassini images of Saturn's F ring show a diversity of structures on a variety of scales. The ring is located $\sim 3000\text{km}$ beyond the edge of the A ring and Cassini ISS images reveal a core (radial width $\sim 50\text{km}$) with localised radial distortions ($\sim 50\text{km}$), as well as occasional spiral strands that can extend to $\sim 200\text{km}$ on either side. High-resolution images also show discrete structures on smaller scales ($\sim 10\text{km}$) in addition to several types of clumps in or around the core and the strands. Despite this the F ring can still be modelled as a uniformly precessing, eccentric, inclined ring suggesting that it has sufficient mass for the effects of self-gravity or collisions to be important in maintaining this configuration. The perturbing effect of the nearby satellite Prometheus is now well understood (Murray et al., 2005) as is its role in producing clumps of material which then interact with the ring and strands (Beurle et al., 2010). The production of the largest strands is linked to collisions between the ring's core and the object S/2004 S 6 (Murray et al., 2008) although additional objects may be involved. Such collisions produce "jets" of material that subsequently undergo Keplerian shear to produce the spiral strands. Cassini images have now provided direct evidence for the existence of a population of small objects (radius $< 1\text{km}$) colliding with the ring. The impact velocities are $\sim 5\text{ m/s}$ implying a source of objects with orbits similar to that of the F ring; this is consistent with what might be expected for objects formed in the core and perturbed by Prometheus. It is now possible to understand the morphology and dynamic nature of the F ring as being due to the gravitational and collisional effects of a variety of nearby objects, ranging in size from Prometheus (mean radius $\sim 40\text{km}$) down to sub-km objects orbiting close to the core.