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Global viscous and dynamical evolution of Saturn rings

J. Salmon (1), S. Charnoz (1), A. Crida (2)

(1) Université Paris Diderot/ CEA Saclay FRANCE charnoz@cea.fr fax: +33 1 69 08 65 77
(2) Center for mathematical sciences, Cambridge, UK , A.Crida@damtp.cam.ac.uk

Abstract

Saturn's rings have been studied for more than 400 years and still remain a puzzling object of our Solar System. While most popular scenarios for their formation are based on phenomena occurring in the early ages of our Solar System (Pollack et al. 1973, Dones 1991, Charnoz et al. 2009), several recent observations come to the conclusion that the rings must be quite young (Esposito 1986, Doyle et al. 1989, Cuzzy & Estrada 1998).

The evolution of Saturn's rings share a lot of similarities with other disks in the universe : protoplanetary discs, accretion discs, … They evolve through 3 main physical processes : viscous spreading, resonant interactions with nearby satellites, and meteoritic bombardment. In the present study we investigate the effects of non-constant viscosity that has been quantified recently in small scale N-body simulations.

The viscous spreading is responsible for the flattening and the widening of the rings. During this process, mass is lost when material falls onto the planet, or crosses the Roche limit and accretes in satellites. Constraining the timescales for this physical process is thus fundamental to determine the age of Saturn's rings.

We use a 1-dimensional hydrodynamic code to simulate the global evolution of the rings through viscous spreading, including satellites torques. While previous studies, using constant viscosities, suggest a rapid spread out of the ring system in a few hundred million years (Esposito 1986), we show that new viscosity prescriptions derived from N-body simulations such as the one of Daisaka et al. 2001 would dramatically affect the large scale evolution of the ring system, allowing for a survival of the rings over 5 billion years.

We show also that transitions form self-gravitating to non self-gravitating regions would produce large scale structures. Surprisingly the final state of the ring system seems somewhat independent of the initial mass using the viscosity of Daisaka et al. 2001. The effects of ring particle size and meteoritic bombardment are also discussed. The possibility of confinement by nearby satellites is still under investigation but first results suggest that they could significantly lengthen the rings viscous age

References

Pollack et al. (1973) *Icarus 20, 263–278*
Esposito (1986) *Icarus 67, 345–357*
Doyle et al. (1989) *Icarus 80, 104–135*
Dones (1991) *Icarus 92, 194–203*
Cuzzy & Estrada (1998) *Icarus 132, 1–35*
Daisaka et al. (2001) *Icarus 154, 296–312*
Charnoz et al. (2009) *Icarus 199, 413–428*