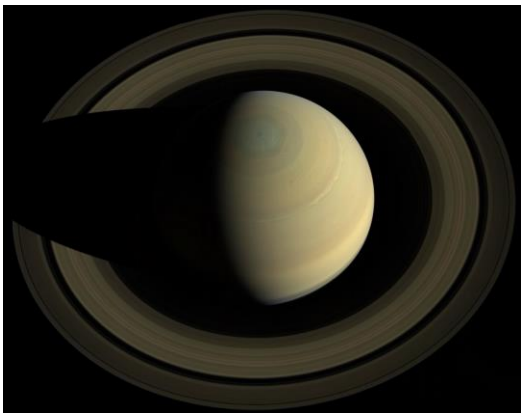
Propeller-shaped Structures in Saturn's Rings



Background:

The rings of Saturn are a system that evolves continuously and whose origin and dynamics are not yet completely understood. There are myriads of structures inside them, created by different processes and evolving in very distinct time scales. In particular, "propellers" are S-shaped density structures in the rings caused by embedded moonlets due to gravitational scattering and direct collision with surrounding particles, Figure 1.

In this project, we will extend the work done in *MercuryDPM: From a Chip to Saturn** and *The effect of realistic material properties on the onset of the propeller structures of Saturn Rings* in order to simulate propellers in equilibrium and address interesting questions such as:

- How do distinct contact models between ring particles affect the onset of the propeller state?
- What is the effect of particle self-gravity, charge or adhesion on the creation/disintegration of these structures?
- How can we derive a criterion to discern between propeller and no-propeller states, or even the onset of creation of clusters or moonlets, or planetesimals in solar ring systems?

Main Goal: Simulate realistic ring-systems (homogeneous, propellers, clusters) in equilibrium, with appropriate contact models and propose a criterion for the onset of these structures.

Methods: The first step in this project will be to simulate stationary propellers using *MercuryDPM*. As a second step, different contact models will be tested to identify the most realistic one. A criterion to discern between propeller and no-propeller state should be proposed, taking into account the long-range forces present in the simulation, such as gravity. As a challenge, a way to **efficiently** implement self-gravity between particles should be proposed and implemented in the simulations.

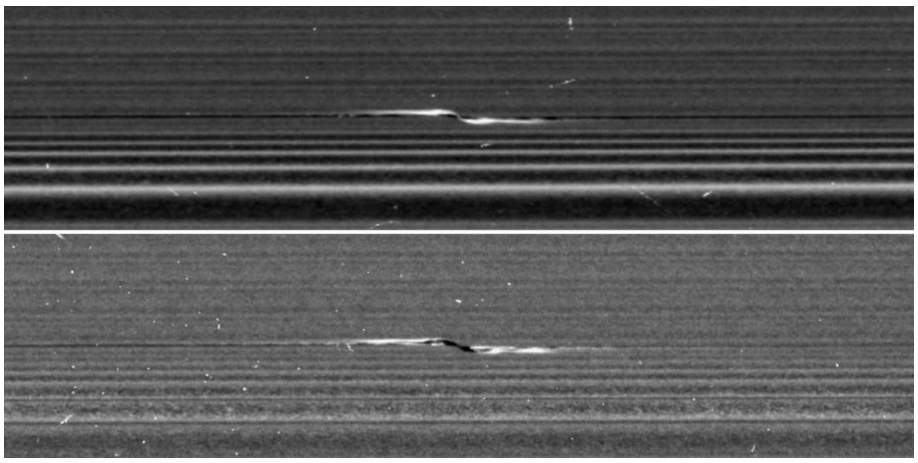


Figure 1: Biggest propeller found by the Cassini mission in the A Ring, called informally Bleriot.

Contact:

- *Edgar Ortega (Physics of Fluids), email address: e.ortegaroano@utwente.nl
- Stefan Luding (Multi-Scale Mechanics)
- Devaraj van der Meer (Physics of Fluids)