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Modeling the size-distribution and granular velocity distribution in Saturn's rings

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Abstract

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To understand the dynamics of Saturn's rings and its vertical structures at the B-ring-edge it is crucial to investigate the common evolution of the size- and granular velocity-distribution of the ring particles. Both distributions form a coupled dynamical system which we try to study in the following way:
First, for a given size-distribution we model the evolution of the velocity-distribution by assuming a Maxwellian including mass-dependend granular temperatures $T(m)$. A weighted average of the Boltzmann-equation yields expressions for the time derivative of the granular temperatures. The time-evolution of $T(m)$ is then dominated by collisional cooling (inelastic collisions) and viscous heating in the Keplerian shear. As an expression of the nonequilibrium, particles of different mass develop different granular temperatures (temperature-vector).
The development of the size-distribution can be obtained by a simulation of the particle-collisions using an erosive model in which every collision adds a distribution of smaller particles to the system and leaves a rest behind using collision parameters from [1] and [2]. The stationary size-distribution has the form of a power-law, assumed also in the former investigation of the velocity-distribution. In future we plan to derive a consistent coupled kinetic model of either distribution.

References

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