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Modeling the density profile of the outer A ring with an axisymmetric diffusion model

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Abstract

1 Abstract

Numerical and theoretical studies over the last decades have shown, that bodies embedded in protoplanetary discs or planetary rings create *a)* S-shaped density modulations, dubbed propellers, if their masses do not exceed a certain threshold or *b)* cause a gap around the entire circumference of the disc if the embedded bodies mass exceeds it [1, 2]. Two counteracting physical processes govern the dynamics and determine, which structure is created: The gravitational disturber exerts a torque on nearby disc particles, sweeping them away from their original radial location, thus depleting the disc's density in its vicinity and trying to form a gap. Diffusive spreading of the disc material due to particle interactions counteracts the gravitational scattering and has the tendency to refill the gap.

At the EPSC 2017 we presented a model that describes the azimuthally averaged surface density Σ of a planetary ring in the vicinity of an embedded moon (radial gap profile) with a diffusion equation that accounts for the gravitational scattering of the ring particles as they pass the moon and for the counteracting viscous diffusion that has the tendency to fill the created gap.

In this talk we use our diffusion equation to model the density profile of the outer A ring: Resonances with the large outer moons of Saturn cause a reduction of the outwards viscous flow of the ring material at the resonance locations. The balance of viscous flow and the inward drift caused by the perturbing moons define the profile of the ring. We show, that the density profile of the outer A ring is predominantly defined and maintained by the resonances with the moons Pandora, Prometheus, Janus, Epimetheus and Mimas. Despite its vicinity to the A ring edge, Atlas has a negligible effect on the rings' density profile. Finally we compare our model to measurements performed by [3] and [4].

References

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