EPSC Abstracts
Vol. 11, EPSC2017-675, 2017
European Planetary Science Congress 2017

N-body modeling of viscous overstability in Saturn's rings

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Abstract

The viscous overstability of dense planetary rings is a promising mechanism for the generation of observed 100-200 meter radial density variations in the B and the inner A ring of Saturn, detected by Cassini RSS, UVIS, and VIMS occultations [1, 7, 2]. Viscous overstability, in the form of spontaneous growth of axisymmetric oscillations, arises naturally in N-body simulations in the limit of high impact frequency and moderately weak selfgravity [3, 4, 5, 6]. The basic mechanism behind this instability mechanism is the rapid rise of viscosity with density, leading to a situation where collisional flux overshooths in trying to smooth the density variations.

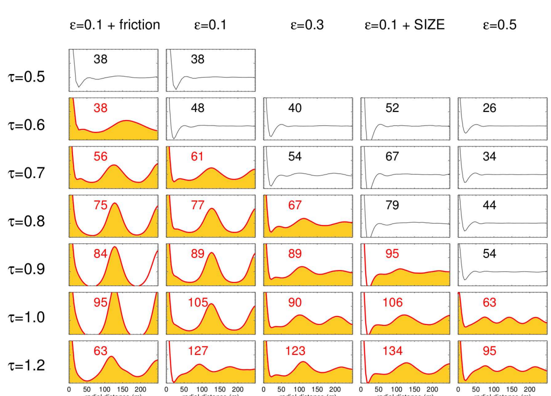

Figure 1: Survey of the onset of viscous overstability in N-body simulations with different dynamical optical depths τ and particle elastic properties (ϵ denotes the normal coefficient of restitution). The time-averaged radial cuts of the particle-particle autocorrelation function are displayed: regular undulations indicate the presence of overstable oscillations (highlighted by orange color). The labels indicate the impact frequency (imapact/particle/orbit). It is seen that increased dissipation promotes overstability.

This presentation reviews the N-body modeling of overstability, and whenever possible, ties the numerical results to Cassini observations. In particular we address the threshold optical depth for obtaining overstability, and how this depends on particle physical properties (see Fig. 1). The differences between non-gravitating simulations, and simulations including ring self-gravity with various degrees of approximations are also addressed.

Acknowledgements

This study is supported by the Academy of Finland

References

[1] Colwell, J. E., Esposito, L. W., Sremčević, M., Stewart, G. R., and McClintock, W. E. (2007). Self-gravity wakes and radial structure of Saturn's B ring. *Icarus*, 190:127–144.

[2] Hedman, M. M., Nicholson, P. D., & Salo, H. 2014, *AJ*, 148, 15

[3] Salo, H., Schmidt, J., and Spahn, F., 2001. Viscous overstability in Saturn's B-ring: I. Direct simulations and measurement of transport coefficients. Icarus, 153, 295–315.

[4] Schmidt, J., Salo, H., Spahn, F., and Petzschmann, O. (2001). Viscous overstability in Saturn's B ring: II. Hydrodynamic theory and comparison to simulations. *Icarus*, 153:316–331.

[5] Schmidt, J. and Salo, H. (2003). A weakly nonlinear model for viscous overstability in saturn's dense rings. *Physical Review Letters*, 90(6):061102.

[6] Schmidt, J., Ohtsuki, K., Rappaport, N., Salo, H., Spahn, F., 2009. Dynamics of Saturn's dense rings. In: Brown, R.H., Dougherty, M. (Eds.), Saturn after Cassini-Huygens. Kluwer, pp. 413-458.

[7] Thomson, F. S., Marouf, E. A., Tyler, G. L., French, R. G., and Rappoport, N. J. (2007). Periodic microstructure in Saturn's rings A and B. *Gephys. Res. Lett.*, 34:24203.