EPSC Abstracts
Vol. 6, EPSC-DPS2011-1782, 2011
EPSC-DPS Joint Meeting 2011

The Ballistic Spreading of Debris Clouds over a Planetary Ring

J. Schmidt
Universitaet Potsdam, Physics and Astronomy, Potsdam, Germany
(jschmidt@agnld.uni-potsdam.de, FAX: +49 331 977-1142)

Abstract

In CASSINI images of Saturn's rings, taken close to the planet's equinox, elongated features were detected in the A and C rings [Tiscareno et al., 2009]. These features stand out bright in front of the darker ring and they are slightly inclined with respect to the orbital direction, with a cant angle consistent with the direction of Keplerian shear. They were interpreted [Tiscareno et al., 2009] as clouds of debris, spreading over the rings, released in a catastrophic impact of an external projectile on a ring particle. Such a bombardment of planetary rings has long been suspected [Cook and Franklin, 1970, Durisen et al., 1989, Cuzzi and Durisen, 1990, Cuzzi and Estrada, 1998, Cuk et al., 2000, Chambers et al., 2008], with consequences for origin, evolution, structure, and composition of the rings.

I develop a theoretical model for the evolution of a debris cloud, spreading from the location of the impact. For simplicity the details of the disruption are not addressed. I start with an isotropic model, assuming that a 30 km/s hypervelocity projectile, perhaps centimeter to decimeter sized, hits and destroys a ring particle (perhaps meter to tens of meters in size), leading to a cloud of debris spreading uniformly from the point of impact, with power law distributed speeds of ejection. This conceptually simple model allows us to study basic properties of the evolution of the cloud. Effects of anisotropy, arising from the direction of the projectile and the effect of momentum conservation, can be incorporated without principal difficulty in an improved model.

Other applications of the model could be the material vertically expelled from the ring plane in parts of the outer B ring edge (see e.g. Fig 5 (b) and (c) from [Spitale and Porco, 2010]), or the release of small particles in the perturbed regions of propellers [Sremčević et al., 2007].

References

[Chambers et al., 2008] Chambers, L. S., Cuzzi, J. N., Asphaug, E., Colwell, J., and Sugita, S. (2008). Hydrodynamical and radiative transfer modeling of meteoroid impacts into Saturn's rings. *Icarus*, 194:623–635.

[Cook and Franklin, 1970] Cook, A. F. and Franklin, F. A. (1970). The Effect of Meteoroidal Bombardment on Saturn's Rings. *Astron. J.*, 75:195–+.

[Cuk et al., 2000] Cuk, M., Burns, J. A., Cuzzi, J. N., and Sugita, S. (2000). Will Cassini Detect Meteors in Saturn's Rings? In *Bulletin of the American Astronomical Society*, volume 32 of *Bulletin of the American Astronomical Society*, pages 1087–+.

[Cuzzi and Durisen, 1990] Cuzzi, J. N. and Durisen, R. H. (1990). Bombardment of planetary rings by meteoroids - General formulation and effects of Oort Cloud projectiles. *Icarus*, 84:467–501.

[Cuzzi and Estrada, 1998] Cuzzi, J. N. and Estrada, P. R. (1998). Compositional Evolution of Saturn's Rings Due to Meteoroid Bombardment. *Icarus*, 132:1–35.

[Durisen et al., 1989] Durisen, R. H., Cramer, N. L., Murphy, B. W., Cuzzi, J. N., Mullikin, T. L., and Cederbloom, S. E. (1989). Ballistic transport in planetary ring systems due to particle erosion mechanisms. I - Theory, numerical methods, and illustrative examples. *Icarus*, 80:136–166.

[Spitale and Porco, 2010] Spitale, J. N. and Porco, C. C. (2010). Free unstable modes and massive bodies in Saturn's outer B ring. *Astron. J.*, 140:1747–1757.

[Sremčević et al., 2007] Sremčević, M., Schmidt, J., Salo, H., Seiß, M., Spahn, F., and Albers, N. (2007). A belt of moonlets in Saturn's A ring. *Nature*, 449:1019–1021.

[Tiscareno et al., 2009] Tiscareno, M. S., Burns, J. A., Hedman, M. M., Dinino, D., Porco, C., Beurle, K. A., and Evans, M. W. (2009). Observations of ejecta clouds produced by impacts onto Saturn's rings. *AGU Fall Meeting Abstracts*, pages A8+.