Predator-Prey Model for Haloes in Saturn's Rings

Larry W. Esposito (1), E. Todd Bradley (2), Joshua E. Colwell (2), Prasanna Madhusudhanan (1), and Miodrag Sremcevic (1)

(1) University of Colorado, LASP, Boulder, CO 80303-7820, United States (larry.esposito@lasp.colorado.edu, 001 303 492-6946), (2) University of Central Florida, Orlando, FL

Introduction: UVIS SOI reflectance spectra show bright 'haloes' around the locations of some of the strongest resonances in Saturn's A ring (Esposito etal 2005). The correspondence of IR, UV spectroscopy, HSP wavelet analysis indicate that multiple instruments detect the same phenomenon.

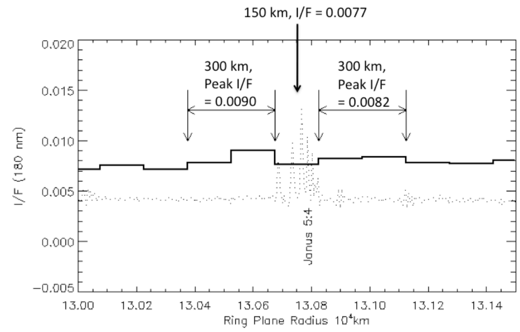
Analysis: We investigate the Janus 2:1, 4:3, 5:4, 6:5 and Mimas 5:3 inner Lindblad resonances as well as at the Mimas 5:3 vertical resonance (bending wave location). Only the strongest resonances show the haloes and aggregates 100-2000m in size.

Model: Our model is as follows: The strong resonances cause streamline crowding [1] which damps the interparticle velocity, allowing temporary clumps to grow, which in turn increases the velocity, eroding the clumps and releasing smaller particles and regolith (see the predator-prey model of Esposito etal 2011) [2]. This cyclic behavior, driven by the resonant perturbation from the moon, can yield collision velocities at particular azimuths that are large enough to erode the aggregates [3] or disrupt them [4], removing smaller particles and exposing older, purer materials. The released regolith material settles in the less perturbed neighboring regions. This is similar to the 'Brazil nut effect' where agitation segregates unlike materials.

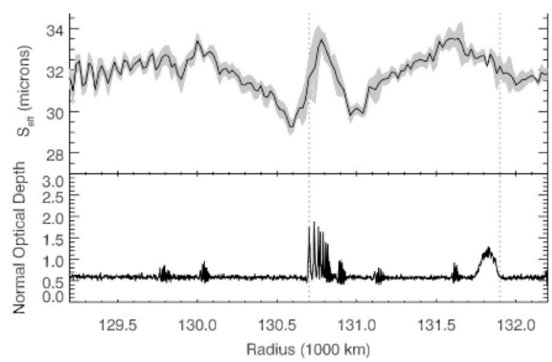
Explaining the Halo Appearance: Diffusion spreads these ring particles with smaller regolith particles into a 'halo' around the source. The strongest resonances contain large aggregates with little regolith, bordered by annuli of deeper regolith, in a balance maintained by the periodic moon forcing. Because the stirring must be vigorous enough to expose older and purer ice, the velocity threshold for eroding the aggregates can explain why only the strongest Lindblad resonances show haloes. Diffusion can explain the width of these haloes, although they are not spatially well-resolved by UVIS.

Summary: If moon resonance forcing is strong enough, large aggregates grow, stirring the resonance region and releasing smaller, brighter particles from the surfaces of the ring particles there. They form a halo around the source and gradually diffuse to give the halo morphology.

Close-up of UVIS SOI reflectance at Janus 5:4 density wave



VIMS effective grain size at Janus 5:4 resonance



From Hedman etal Icarus 2012

References::

[1] Lewis M. C. and Stewart, G. R. (2005) *Icarus 178*, 124. [2] Esposito L. W. et al. (2011) *Icarus 217,* 103. [3] Blum J. (2006) *Adv. Phys. 55*, 881. [4] Leinhardt Z. and Stewart S, (2012) *ApJ 745*, 79. [5] Hedman, M. M. etal (2012) *Icarus*, in press.