Abstract Type	Invited or Contributed research Paper (including Dissertation Talks)
Participation Preference	In-Person
Presentation Type	Poster
First Category	Planetary Rings
Dissertation Abstract?	No
Student Status	Not a student
Newsworthy	No

Nbody Simulations of Self-Confining Narrow Eccentric Planetary Ringlets

Joseph Hahn[1], Douglas Hamilton[2], Thomas Rimlinger[3], Yuxi Lu[4]
[1]Space Science Institute, Cedar Park, TX, [2]University of Maryland, College Park, College Park, MD, [3]Goddard Space Flight Center, Greenbelt, MD, [4]Columbia University, New York, NY

Narrow eccentric planetary ringlets have interesting properties that are not well understood: sharp edges, sizable eccentricity gradients, and an unknown confinement mechanism that opposes radial spreading due to ringlet viscosity. One popular confinement mechanism proposes that each narrow ringlet is straddled by a pair of unseen shepherd satellites whose gravitational perturbations confine the ringlet radially (Goldreich & Tremaine 1979, Chiang & Goldreich 2000, Mosqueira & Estrada 2002). However the Cassini spacecraft failed to detect any shepherds near Saturn's narrow ringlets, which casts doubt on this proposal (Longaretti 2018). Note though that Borderies *et al* (1982, BGT) showed that a viscous ringlet having a sufficiently high nonlinearity parameter, $q\approx0.9$, can in fact be self-confining, which is suggestive.

This conference poster will report on a suite of Nbody simulations of viscous self-gravitating ringlets. We find that under a wide range of initial conditions, the simulated ringlet's self-gravity pumps up the ringlet's eccentricity gradient until the $q\approx0.9$ threshold is achieved, which is when the angular momentum flux reversal described in BGT is vigorous enough to halt the ringlet's viscous radial spreading.

However the ringlet's gravitational self-confinement is still only temporary, because of the ringlet's viscous friction that is a consequence of inelastic collisions among ring particles. Viscous friction also converts ringlet orbital energy into heat that is radiated into space, so a viscous planetary ringlet also suffers a slow semimajor axis decay. And because the ringlet conserves angular momentum, any decrease in semimajor axis also decreases its eccentricity. So when the ringlet's inner edge circularizes, its eccentricity gradient will henceforth decrease which in turn causes its nonlinearity parameter to drop below the $q\approx0.9$ threshold. Angular momentum flux reversal is then no longer sufficient to halt the ringlet's viscous spreading, and so the ringlet again resumes spreading to oblivion.

Main finding: ringlet self-confinement via self-gravity itself does not resolve the ringlet's short lifetime problem. But gravitational self-confinement does make that problem less severe by increasing the ringlet's lifetime by several orders of magnitude (Rimlinger et al 2016). However this ringlet lifetime problem could still be resolved if the ringlet also happens to reside in/near an orbital resonance whose e-excitation counterbalances viscous damping. Such ringlets could then be very old, and will be explored further at conference time.

Print Close