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Title: “*Formation of Janus and Epimetheus from Saturn’s rings as coorbitals, thanks to Mimas’ 2:3 inner Mean Motion Resonances*”

Abstract. Janus and Epimetheus orbit Saturn at 151461 km on average, on mutual horseshoe orbits with orbital separation 50 km, exchanging position every 4 years. This configuration is unique and intriguing: Lissauer et al. (1985) have shown that their orbital separation should converge to zero in about 20 Myrs only, and no satisfactory model for the origin of this co-orbital resonance exists yet. Charnoz et al. (2010) have shown that Janus and Epimetheus probably formed from the spreading of the rings beyond the Roche radius. Here, we study this phenomenon in the frame of the elliptical restricted 3-body problem, where ring particles are perturbed by mean motion resonances with the outer satellite Mimas.

Two types of resonances play different roles. The Lindblad resonance (LR) confines the rings radially, and prevents their spreading (like the B-ring into the Cassini division). The Corotation resonance (CR) confines the rings azimuthally in two capture sites (akin Neptune’s arcs). Because of Saturn’s J_2 , the CR is 130 km closer to Saturn than the LR. A few hundred million years ago, the 2:3 mean motion resonances with Mimas were just inside the Roche radius; hence the rings could not spread and the two capture sites were full of ring material. When Mimas migrated outwards so that its 2:3 mean motion resonances receded past the Roche radius, the captured material agglomerated into two bodies of $\sim 10^{15}$ kg on the exact same orbit. These bodies then migrated outwards together due to their interaction with the rings, in mutual horseshoe orbits. The rings then spawn new small satellites, eventually accreted by the proto-Janus and the proto-Epimetheus following the pyramidal regime of the ring spreading model (Crida & Charnoz 2012). The two bodies then grow in mass following a Fibonacci sequence, and this excites their orbital separation, leading to a configuration close to the present one.

Joint work with Maryame El Moutamid.