

The orbital connection between Mimas and Enceladus

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Abstract

The observed internal heating of Saturn's moon Enceladus is driven by its 2:1 Mean Motion Resonance (MMR) with the moon Dione that excites Enceladus' eccentricity. In light of the measurements of a high dissipation rate of Saturn (Lainey et al., 2012, 2017), it is likely that this resonance is currently in (or near) an equilibrium. However, an explanation is still needed for the fact that Enceladus is currently in the e-Enceladus sub-resonance of the 2:1 MMR, as other sub-resonances should have been encountered earlier, and would have had a very high probability of resonant capture.

In this work, we attempt to explain the capture into the current Enceladus-Dione 2:1 MMR via the hypothesis of a "handoff" scenario between the Mimas-Enceladus 3:2 MMR and the Mimas-Dione 3:1 MMR. We find that Mimas would affect the Enceladus-Dione MMR by i) creating orbital overlap of resonances, during which the eccentricity of Mimas is excited to its current value, ii) pushing Enceladus outward faster and thus contributing to its capture into the present MMR. Our model can explain the time scale of less than 100 Myr for capture of Enceladus into MMR with Dione, despite their slow orbital convergence.