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On the dynamics of the Saturn's small satellites

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Abstract

Many satellites in the Solar System are involved in mean motion resonances. The simplest case of all is that of two satellites, one of them with negligible mass (test particle), orbiting in the same plane and close to a mean motion first order resonance of the type m+1:m. In this situation, two critical resonant angles appear, respectively called the Corotation Eccentric Resonance (CER) and the Lindblad Eccentric Resonant (LER) arguments. Each of them has very different physical effects on the test particle, but surprisingly, no general treatment of the coupling between these two resonances has been presented so far in the literature. Here we present a generic dynamical study of this coupling, that we call the CoraLin model. It uses non-dimensional quantities, and describes all possible configurations between the satellites near horizontal first order mean motion resonances. We apply this model to several recently discovered small Saturnian satellites dynamically linked to Mimas through first mean motion resonances : Anthe, Methone and Aegaeon [1, 2, 3, 4], all associated with ring arc material. The presence of these three structures are consistent with their confinement by CER with Mimas : Aegaeon is trapped in an inner 7:6 CER with Mimas, while Anthe and Methone are respectively near the outer 14:15 and a 10:11 CER resonances. All satellites are also perturbed by the associated LER's, in a way described by the CoraLin model. Poincaré surfaces of section reveal the dynamical structure of each orbit, and for some of them, their proximity to chaotic regions. Those sections may reveal the dynamical origin of those bodies. In particular, we discuss the probability of capturing a satellite into one of the CER's with Mimas as the orbit of the latter evolves through tidal effects. We will discuss the potential implications of this work, in particular the constraints it may provide on Mimas' orbital evolution.

References

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