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Interactions between planets on inclined orbits and a disc

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Abstract

We study the dynamics of planets on orbits inclined with respect to a disc. We show that, if the initial inclination of the orbital plane relative to the disc is larger than some critical value, the planet undergoes Kozai cycles due to the gravitational potential of the disc [1,2]. This leads to large amplitude variations of the inclination and eccentricity of the planet. On the other hand, both the inclination and the eccentricity are damped by the frictional force that the planet is subject to when it crosses the disc. We find that Neptune and lower mass planets may remain on inclined and eccentric orbits after the disc dissipates, whereas orbits of Jupiter or higher mass planets would align and circularize. We further extend this study to multi-planet systems. We show that, in most cases, the interaction of the planets with the disc tends to dominate the evolution of the system. Finally, we study the case of a system of two planets, where the outer one migrates through the disc while the inner one is on an orbit inclined relative to the disc. We show that resonant capture still happens despite the large mutual inclination, which can lead to convergent migration of the two planets with possible strong inclination resonances.

References

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