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Tidal interactions in multi-planet systems

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We study systems of close orbiting planets evolving under the influence of tidal circularization. It is supposed that a commensurability forms through the action of disk induced migration and orbital circularization. After the system enters an inner cavity or the disk disperses the evolution continues under the influence of tides due to the central star which induce orbital circularization. We derive approximate analytic models that describe the evolution away from a general first order resonance that results from tidal circularization in a two planet system and which can be shown to be a direct consequence of the conservation of energy and angular momentum. We consider the situation when the system is initially very close to resonance and also when the system is between resonances. We also perform numerical simulations which confirm these models and then apply them to two and four planet systems chosen to have parameters related to the GJ581 and HD10180 systems. We also estimate the tidal dissipation rates through effective quality factors that could result in evolution to observed period ratios within the lifetimes of the systems. Thus the survival of, or degree of departure from, close commensurabilities in observed systems may be indicative of the effectiveness of tidal disipation, a feature which in turn may be related to the internal structure of the planets involved.

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