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Second-order mean-motion resonances in a system of two low-mass planets

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Abstract

It is well known that first-order mean-motion resonances are common outcomes of the con- vergent orbital migration of low-mass planets in gaseous protoplanetary discs (Papaloizou and Szuszkiewicz, 2005). The attainment and maintenance of these resonances by migrating planets in the terrestrial mass range have been extensively studied by means of hydrody- namic simulations, simple analytic modelling and N-body investigations. The number of planetary systems in which the period ratios are close to a commensurability is increasing thanks to an ongoing intensive search for planets from the ground and space. However, among the observed period ratios one can find not only the first-order commensurabilities but also those of the second-order, like for instance 5:3, 7:5 or 9:7. The latter are of course less numerous than first order resonances but for sure not less intriguing. Are such resonant configurations easily induced by orbital migration? What are the conditions occurring in the protoplanetary disk which favour their formation? With these questions in mind we explore the attainment of the 9:7 resonance in a system which con- tains a pair of migrating low-mass planets. We have performed a series of hydrodynamical simulations with a variety of different initial disc parameters and planet mass ratios. We con- clude from our investigations that the resonance capture is possible if the relative convergent migration is slow and the planets have moderate eccentricities. We have compared our results with the simple analytic theory presented in the paper of Xiang-Gruess and Papaloizou (2015) which provides the conditions for the formation of the second order commensurabilities. It has been found that these conditions are consistent with our simulations. Moreover, our results are also accordant with the general model of resonance capture discussed in Mustill and Wyatt (2011).

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