On the likely effect of disk self-gravity on low mass planet migration

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Since the discovery of Jupiter-like planets around nearby stars, it is commonly believed that planets form far away from their host star and migrate inwards, as a consequence of gravitational torques exerted by a gaseous disk. Spiral density waves are excited in the disk at Lindblad resonances, leading to angular momentum exchange and making the planet drift in a time much shorter than the planet formation timescale. Two researchers (among whom A. Pierens from Paris Observatory) have for the first time determined analytically the possible effect of the disk gravity on the orbital motion of the planet, and conclude that that migration should be accelerated! Will very high resolution numerical simulations confirm this issue?

Figure 1:

Numerical simulations are a useful tool to understand planetary migration. These have confirmed that planets tend to migrate inwards in about a few hundreds of thousand years (Nelson et al. 2000, MNRAS 318, 18). Recently, the remarkable simulations by Nelson & Benz (2003, ApJ 589, 556) have recently pointed out the effect of the disk mass. Because of a lack of numerical resolution, the real effect of the disk gravity can not be clearly identified yet, and is still an unsolved problem. The main problem is that self-gravity is very time consuming, precluding high resolution numerical simulations and reliable conclusions.
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Two researchers, Arnaud Pierens (LUTH/Observatoire de Paris-Meudon) and Jean-Marc Huré (Université Bordeaux 1 and Observatoire Astronomique de Bordeaux) have shown by analytical means that, in the end, the gaseous disk should accelerate the migration of low mass planets (planets ten times less massive than Jupiter, corresponding to type-I migration). They also conclude that this result does not really depend upon the surface density profile. The effect of the disk gravity is twofold: on the one hand, the angular velocity of the planet is enhanced; on the other hand, the position of Lindblad resonances (where the amplitude of the waves is formally infinite) are shifted in comparison with the keplerian case. This analytical prediction should, hopefully, be confirmed by high resolution numerical simulations, which should take some time...

Figure 2:
In brief, if one wish to explain the presence of planets on tight orbits, a mechanism able to slow down migration must exist. It seems that the disk mass (even small) is not the good candidate!