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Migration and growth of planetary embryos in radiative protoplanetary disks

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Abstract

Earth- to Neptune-mass planets launch spiral density waves in gaseous protoplanetary disks and undergo type 1 migration. In isothermal disks, type 1 migration is inward and the migration timescale is inversely proportional to the planet mass. In radiative disks migration can be directed inward or outward, depending on the planet's mass and the disk's physical properties. For a given planet mass, there exist locations within the disk where the migration is convergent. We present results of hydrodynamic simulations of systems of planetary embryos of a few Earth masses embedded in radiative disks. We concentrate on the collective behavior of the system of embryos and their collisional growth.

1. Introduction

A major problem in planet formation is the growth of giant planet cores. Convergence zones in protoplanetary disks represent one potential solution to this problem. A planet of a few $M_{\oplus}$ in a radiative disk migrates outward due to a strong corotation torque. The migration slows as the planet enters regions of the disk that cool more efficiently (i.e., have smaller optical depth), and stops when the planet reaches a region in the disk where the total torque is zero [3]. A planet of the same mass that formed farther out in the disk migrates inward to this same orbital distance. These convergence zones can thus concentrate mass within the disk [2].

2. Methods

We use the GENESIS code [1] to perform hydrodynamical simulations of the orbital and collisional evolution of systems of planetary embryos in radiative disks. We plan to test a range of embryo masses and mass distributions as well as physical properties of the disk (e.g., viscosity, density).

Simulations are underway. Figure 1 shows one simulation with 9 planets of 2-18 $M_{\oplus}$: the planet mass increases monotonically with orbital distance.

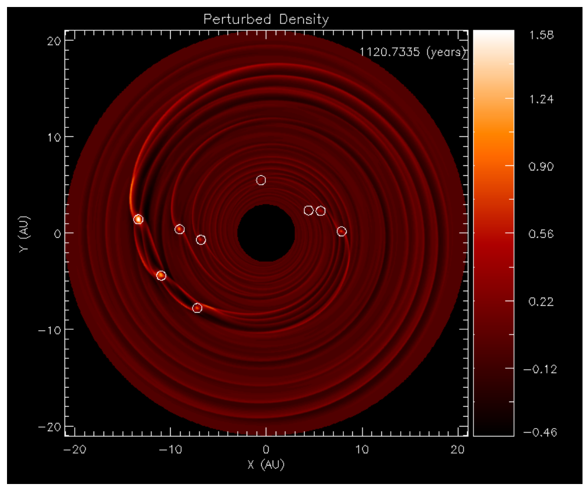

Figure 1: A snapshot from a hydrodynamical simulation with 9 planets. The color represents the disk's perturbed density on a linear scale. Notice the overlap of density waves from the different planets.

References

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