Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PPS21-17 Room:416 Time:April 29 15:00-15:15

The formation of gas planets from cores in type I migration

MAESHIMA, Naohiko[1*] ; WATANABE, Sei-ichiro[1]

[1]Division of Earth and Planetary Sciences, Graduate School of Science, Nagoya University

Many gas planets have been discovered. The formation of the gas planets requires that solid planets, which correspond to cores of gas planets, must achieve the critical core mass M_{crit} before the disk gas have entirely diffused. The cores moves radialy by torques caused by interaction with disk gas (type I migration). It was long thought that the cores fall into the star with very short timescale before achieveing M_{crit} by strong negative torque (Ward 1997, Tanaka et al. 2002). Recent study have showed that the region where positive torque operates is formed on the disk by corotation torque if we consider the non-isothermal process of the gas (Baruteau & Masset 2008,Paardekooper & Papaloizou 2008). As a result, equilibrium radii, where torque is zero, are created. The cores may accrete gas without falling into the star if they are trapped by equilibrium radius because the timescale of radial migration slows down to that of disk evolution. However, positive torque only operates for cores in limited mass range ($M_{p,min}$<M_p<$M_{p,max}$). If it takes long time for achieving $M_{p,min}$, the cores moves inward largely by negative torque. In this study, we examine how the orbit and mass of cores evolve depending on the disk model, and find the condition the disk must have for the gas planet formation.

The distribution of the gas surface density evolves by viscous diffusion and photoevaporation. The temperature distribution is determined by viscous heating and stellar irradiation. In the disk, an equilibrium radius is formed on the region where the main heating source shifts from the viscous heating to stellar irradiation. In this study, we investigate the possibility of the formation of gas planets at the equilibrium raidus. Cores grow by accreting planetesimals in their gravitational radius, and capture the disk gas if they achieve M_{crit}.

We find that the condition of gas planet formation is determined as follows. In diks evolving fast (α parameter of viscosity = 0.005), cores born in the middle region ($\sim$ 10AU) is captured by the equilibrium radius and capture the disk gas by achieving M_{crit} if core growth stars at the time when disk mass is still large (initial mass accretion rate $\sim 10^{-7} M\odot yr^{-1}$) and the ingredient of the cores is abundant (ratio of the solid material to gas is large $>$0.03). On the other hand, in the disks evolving slowly (α = 0.001), gas planets can be formed even if core growth stars at the stage when disk mass has been decreased (initial mass accretion rate $\sim 10^{-8} M\odot yr^{-1}$). In this case, the dependence on the ratio of the solid to gas is very weak.

Keywords: type I migration