Formation of Terrestrial Planets in a Dissipating Gas Disk with Jupiter and Saturn

Junko Kominami[1], Shigeru Ida[2]

[1] Earth and Planetary Sci.,T.I.Tech., [2] Dept. of Earth and Planetary Sci., Tokyo Inst. of Tech.

http://www.geo.titech.ac.jp/lab/ida/kominami/my_home.html

We have performed N body simulation on formation of terrestrial planets, including the effect of dynamical friction of gas disk. Jupiter and Saturn are also included in the intergrations to see the effect of gas giant planets.

Terrestrial planets are formed through coagulation of protoplanets which are about the size of Mars. The protoplanets are formed from planetesimals which are about km size. Their orbits are almost circular when they are just formed(Kokubo & Ida 1998, 2000). The eccentricities are gradually pumped up by mutual gravity of the protoplanets and/or gravitational perturbation due to the giant planets (Chambers et al. 1996, Ito & Tanikawa 1999, Nagasawa et al. 2000). The orbits start to cross and the protoplanets begin to collide. Eventually, the planets isolate from each other. The eccentricities are still high(Chambers and Wetherill 1998). During this stage, it is highly possible that partly depleted gas disk is present. This partly depleted gas disk works as gravitational gas drag onto the planets, and lowers the eccentricity (Kominami & Ida 2002, Agnor & Ward 2002). By carrying out N body simulation, Kominami and Ida (2002) showed that Earth-sized planets with low eccentricities can be formed. Although the final planets' masses and eccentricities are consisitent with those of terrestrial planets, the number of final planets tends to be larger than that of our Solar system, which is 4. The average is about 7. During terrestial formation, it is highly possible that Jupiter and Saturn are already formed. Their existance may trigger further coagulation and can decrease the number of final planets. In this paper, calculations with Jupiter and Saturn are also carried out to see the effect of giant planets on formation of terrestrial planets. We found out that the average number of final planets decrease but not in great amount. The average is about 6.

Meanwhile, the amount of gas changes with time. It depletes as the orbits evolve. We carried out simulations with time dependent amount of gas as well.

By presenting the results, we would like to discuss the effect of gas giant planets onto the formation of terrestrial planets.