The effect of gas disk on protoplanet formation

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/~kominami/my_home.html

It is generally accepted that terrestrial planets are formed through

the accretion of small bodies. The formation is divided into 2 stages. The first stage is the formation of Mars sized bodies(protoplanets) from km sized bodies called planetesimals. Their orbits eventually become eccentric and begin to cross. They start coagulating and form terrestrial planets in the following stage.

Such accretion takes place in the nebular disk. Since the disk gas is present, the bodies in the disk suffer the gas drag and the gravitational drag due to disk-planet interaction. The drag forces cause the damping of eccentricity, inclination and semimajor-axis of the bodies. The gas drag works more efficiently on smaller bodies. The gravitational drag due to the disk-planet interaction has stronger effect on larger bodies. When the protoplanet's mass reaches the mass of the moon, the gravitational drag becomes stronger than the gas drag. In fact, it has already been shown that during the second stage (accretion of the protoplanets), a mostly depleted disk gas damps the eccentricity and inclination of the planets. When the protoplanets are formed through the accretion of planetesimals, probably there is more disk gas than the second stage. Moreover, the mass of the protoplanets are larger than the moon. Past N-body simulations on formation of protoplanets have not included the gravitational drag. Including the effect may change the result; the distribution and the mass of protoplanets may change. It is important to investigate the protoplanet distributionto understand the formation of terrestrial planets.

We carried out N-body simulation on formation of protoplanets from the planetesimals, including two drag forces, the gas drag and the gravitational drag due to the gas disk. We investigated how the drag forces effect the accretion stage.