P154-002 **Room: 201B** **Time: May 16 9:13-9:26**

The effects of collisional fragmentation on dust growth in protoplanetary disks

Toru Suyama[1]; Hidekazu Tanaka[1]

[1] ILTS, Hokkaido Univ.

Dust growth in protoplanetary disks is an important process in both the planetesimals formation and the evolution and the evolution of protoplanetary disk themselves. Collisions between dust grains result in not only their coalescence but also fragmentation. The collisional fragmentation can prevent planetesimal formation. In this paper, we examine the effects of collsional fragmentation in the process of dust growth in laminar disks and turbulent disks.

The fragmentation occurs at the mutual collisions of grains, if the collisional velocity is larger than a certain critical velocity determined by the strength of grains. If we consider compact grains consisting of sub-micron monomers, the critical velocity is roughly estimated to be 3 m/s for water ice grains and 0.3 m/s for silicate grains.

We examined the collisional velocity analytically. The collisional velocity increases as dust grains grow. If the collsiional velocity attains to the critical velocity, collisional fragmentation prevents further growth. We estimate such critical dust size for fragmentation for laminar disks and turbulent disks. In laminar disks, the collisional velocity depends on the height z. It is given by the vertical settling velocity above the midplane and by the radial velocity near the midplane. Since the collisional velocity is smaller at the midplane than at a high level, grains can grow larger at the midplane than above it. The collisional velocity at the midplane is given by the radial velocity attains to the maximum value at a certain grain size. The maximum collisional velocity is given by 20-50 m/s, depending on the disk temperature. The maximum velocity is larger than the estimated critical velocity. Thus, collisional fragmentation limits dust growth at the whole disk.

For turbulent disks, we considered homogneous and isotropic turbulence and adopted the so-called alpha model. There are two effects of turbulence on the dust growth and settling. One is the enhancement of the collisional velocity due to turbulent motion. The other one is the vertical diffusion of dust grains.

In strong turbulent disks, the collisional fragmentation is determined by turbulent effects.while in weak turbulent disks, the collisional velocity is discribed as laminar disks. On the other hand, dust grains are stirred up by turbulent diffusion. This stirring effect prevents the settling and grow of dust grains. However, as disk turbulence damps, dust grains are not stirred up and the collisional velocity decreases. Then, dust grains gradually settle and grow.

Collisional fragmentation confined not only the maximum dust size but also the velocity of dust grains. Thus, collisional fragmentation affects the moving of dust grains in disks. At midplane, the migration velocity of the maximum dust grains equals the critical velocity for collisional fragmentation. Thus, it is determined by not disk model but the material properties of dust grains.For the critical velocity is 3 m/s, small dust grains (a is larger than 10 micrometer) remain at r=100 AU, within 0.2 Myr. We also discussed the motion of dust grains trapped in turbulent eddies.In the eddy that has the lifetime as the Keplerian period and the scale as the disk scale height, the velocity necessary to pile up dust grains within the lifetime is larger than the critical velocity for fragmentation. In such a case, collisional fragmentation occurs and it prevent the dust growth. Thus, to facilitate the dust growth, it is necessary to existence of eddies that have long lifetime.