Growth of Dust Aggregates in Protoplanetary Disks and Reexamination of Particle Interaction model

H. Tanaka[1]

[1]*Institute of Low Temperature Science, Hokkaido University, Japan*

Dust growth is the first step of planet formation in protoplanetary disks. Dust growth also influences temperature structure and chemical reactions in protoplanetary disks. However, we still have a large uncertainty in the dust growth process. This uncertainty mainly comes from unknown factors in dust internal structure and collisional outcomes. The dust structure and the collisional outcome would be closely related with each other. In recent years, many theoretical studies on aggregate collisions and growth have been done. In the present talk, we introduce remarkable results in these theoretical studies, mainly focusing on numerical simulations of dust collisions done by our group. We obtained the following results from our numerical simulations. (1) Icy dust aggregates can grow for high-speed collisions with up to 60m/sec [1]. (2) Dust aggregates compressed with collisions have a structure with the fractal dimension of 2.5 [2,3,4] (also see Fig1). (3) Because of the low fractal dimension of compressed aggregates, collisional compression is not effective, which makes the bulk density of dust aggregates extremely low (~10^{-5} g/cm^3)[3,5]. These rather surprising results in our numerical simulations are dependent on the interaction model between sub-micron constituent particles of dust aggregates. We also have started the reexamination of the particle interaction model, by performing molecular dynamics simulation of particle collisions. We report the preliminary results of our molecular dynamics simulations, too. Our preliminary results support the particle interaction model in the previous studies [6].

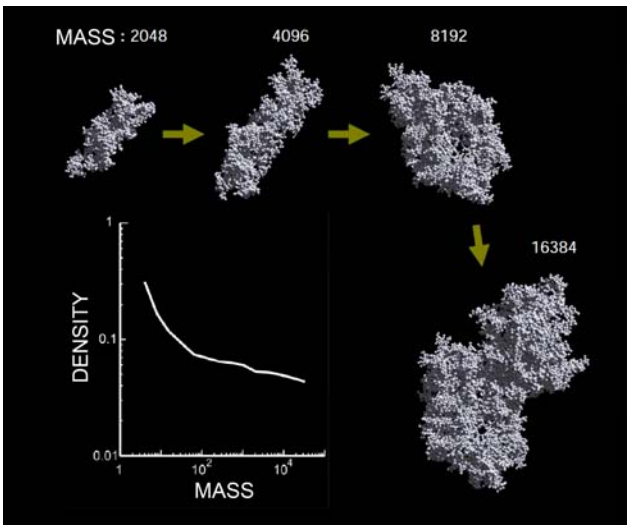

Figure 1: Structure and the bulk density of growing dust aggregates in numerical simulations[3].

References

[1] Wada, K., Tanaka, H., Suyama, T., Kimura, H., & Yamamoto, T. 2009, ApJ, 702, 1490
[2] Wada, K., Tanaka, H., Suyama, T., Kimura, H., & Yamamoto, T. 2008, ApJ, 677, 1296
[3] Suyama, T., Wada, K., & Tanaka, H. 2008, ApJ, 684, 1310
[4] Suyama, T., Wada, K., Tanaka, H. & Okuzumi, S. 2012, ApJ, 753, 115
[5] Okuzumi, S., Tanaka, H., Kobayashi, H., & Wada, K. 2012, ApJ, 752, 106
[6] Tanaka, H., Wada, K., Suyama, T. & Okuzumi, S. 2012, PThPS 195, 101