P137-011 Room: 304 Time: May 24 14:24-14:37

Three-dimensional thermo-hydrodynamics simulations: Melting and splitting of the dust particle in the high-speed gas flow.

Seiji Yasuda[1]; Taishi Nakamoto[2]; Hitoshi Miura[3]

[1] Pure and Applied Sciences, Tsukuba Univ; [2] Tokyo Tech; [3] none

Chondrules are mm sized, spherical shaped, once-molten particles that are the main inclusion of the chondritic meteorites. They are considered to have formed from dust particles in the early solar nebular; Dust particles were heated and melted due to flash heating events and cooled to re-solidify and form chondrules (Jones et al. 2000). Chondrules have characteristic size distribution and it is one of the most important constraints of for heating mechanism.

Shock-wave heating model is one of the plausible models for chondrule formation (Boss 1996, Jones et al. 2000). In this model, dust particles are heated by gas frictional heating due to the relative velocity between gas and dust particles generated by shock waves. One of the most remarkable features of shock-wave heating model is that dust particles are melted from the surface exposed to gas flow because they are heated from the surface and inside of them are heated by heat conduction (Yasuda and Nakamoto JSPS 2005). Then, the surface of the dust particle is expected to be molten first, and the inside to be molten later. In that case, the ram pressure of the high-speed gas may split and/or strip the molten part; Kato et al. (2006) analytically showed the maximal size of chondrules may be determined by stripping of the molten part. Kadono and Arakawa (2005) experimentally showed that the size distribution of the chondrules might be resulted from splitting of the molten part. While they assumed, however, that the liquid part is on the solid part, which means that the temperature distribution in the dust particle is not taken into consideration, the degree and distribution of the melting can depend on the size and rotation of the dust particle, shock velocity, and number density of gas and these parameters may change situation of splitting and stripping.

It is important for chondrule formation to investigate both the thermal and hydrodynamic processes of the molten dust particles. We are nowhave been developing a three dimensional thermo-hydrodynamics simulation code. We are planning to show the progress of our code development and some numerical results comparing with droplet deformation and breakup experiment (Hsiang and Faeth 1995, Kadono and Arakawa 2005). In order to examine the accuracy of our numerical simulation, we compare our results with droplet deformation and breakup experiment (Hsiang and Faeth 1995, Kadono and Arakawa 2005).

To examine how the deformation and breakup of droplets depend on the Weber number (We :the ratio of the ram pressure and the surface tension) and the Ohnesorge number (Oh : the ratio of the liquid viscous force to the surface tension), we compared our results with results by drop deformation experiment (Hsiang and Faeth 1995). We found that the results are in good agreement with the experiment with respect to four points. (1) When Oh is less than 0.1), the degree of deformation and the threshold for breakup depend only on We, and (2) the breakup occurs where We is greater than 10. (3) Oscillatory deformation caused by a competition between the ram pressure and the surface tension appears between the breakup regime and the deformation regime. (4) When Oh is large, the droplet breakup does not occur.

Moreover, in order to examine the accuracy of the size distribution of fragments, we compared our results with results by experiment of the breakup of liquid (Kadono and Arakawa 2005). We are planning to discuss the result of comparison on our presentation.We have found again that our numerical results agree well with the experimenal results.