Experimental Study on Collisional Processes of Icy Planetesimals

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It is widely accepted that icy planets were formed by collisional disruption and re-accumulation processes of icy planetesimals. It is expected that icy planetesimals had various porosities depending on their thermal evolutions, and this variation on the porosity should affect the formation processes of icy bodies such as direct sticking of two bodies and re-accumulation of impact fragments.

We conducted impact experiments of snowball targets by using gas guns set in a cold room at the temperature of -15 ˚C. Snowball targets with the diameter of 60 mm and the porosity of 40, 50, 60, and 70 % were impacted by snow projectiles with the diameter of 10 or 15 mm or by an ice projectile with the diameter of 15 mm at the velocity from 3 to 490 m/s. Impact disruption of snowball was observed by a high-speed digital video camera to analyze the velocity distributions of fragments. Recovered snow fragments were measured to study the mass distribution of the fragments.

We classified the collisional outcomes into 5 types according to the largest fragment mass normalized by the original target mass (m_l/M_t) and the fragment velocity distributions: they are rebound ($m_l/M_t = 1$), sticking ($m_l/M_t > 1$), crater formation ($m_l/M_t > 0.5$), catastrophic disruption ($m_l/M_t < 0.5$), and penetration of the projectile. The sticking of the projectile occurred when the target porosity was larger than 60 %, and we found that the minimum sticking velocity was 43 m/s for the 60 % porosity target and 13 m/s for the 70 % porosity target. We also found that the impact strength increased with the decrease of the porosity from 35 to 99 J/kg, and these values were slightly smaller than that of ice, 100 J/kg [1]. Combining the obtained sticking condition to the impact strength for each target, it enable us to estimate the direct sticking condition of icy planetesimals, and we finally obtained that the mass ratio of colliding bodies was smaller than 0.05 for the porosity of 60 % and 0.3 for the porosity of 70 %.

Keywords: impact experiment; icy bodies; sticking of snow; impact strength.

References

[1] M. Arakawa, N. Maeno, M. Higa, Y. Iijima, M. Kato, *Icarus.* **118**, 341-345 (1995).