Collisional sticking of ice dusts and the mechanical properties of its aggregates

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Coagulation of small particles is the most fundamental physical process in the early solar nebula. It is expected recently that the planetesimals were made through the coagulation process of dusts in the nebula turbulence. Therefore, it is worthwhile to investigate the sticking probability of dusts at the physical conditions of nebula turbulence. The sticking probability of silicate dusts have been studied by Blum et al. and they found that the micron-size silicate particles stick each other at the impact speed lower than 0.1 m./s. In our study, another important material in the solar nebula, that is water ice, was studied to derive the sticking condition in the collision. Water ice is the most abundant material in the outer solar system, so that we should know the sticking property of this material.

We developed a new technique to control the impact speed of micron-size ice particle. This technique uses a strong electric field to accelerate the ice particle smaller than 10 micron. Under the strong electric filed, water ice is polarized and attracted by the electrode. This method enables us to control the speed of ice particles from 0.5 to more than 10 cm/s. As a result, we found that the micron-size ice particles stick each other at the impact speed lower than 11cm/s at least. The aggregates of ice particles grow through this process on the electrode. The aggregates growing larger than 100 micron were accelerated by the electric field and jump toward the opposite electrode at the speed from 10 to 500 cm/s. Our observation showed that the impact speed lower than 100 cm/s gave no damage to the aggregates, that is the aggregate sticks on the electrode intact. The aggregates were disrupted at the impact speed higher than 3m/s.