3D collision simulation of sintered dust aggregates

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Dust aggregate is an aggregate of particles formed by collision coalescence of particles, become a material for the planetesimal. In order to form a dust aggregate, it is necessary that it does not break even if aggregates collide with each other. Some 3D collision simulation to research the collision velocity for catastrophic disruption has been carried out.

However, in the 3D collision simulation, the sintering effect was not taken into account. Sintering is a phenomenon that the surface molecule of the substance moves by warming the substance at a temperature slightly lower than the melting point. When sintering proceeded, the plasticity is lost and substance becomes brittle while it becomes hard. Considering aggregate sintering, the contact surface between the particles becomes thick, and the behavior when aggregates collide with each other is also change. Currently, Aggregate collision simulation with the effect of sintering in two dimensions is already done. The result of the research shows that aggregates break at lower collision velocity when sintering occurs.

In this study, a 3D collision simulation with the effect of sintering was carried out. That purpose is to compare 2D and 3D with respect to the effect of sintering on collision of dust aggregates.

First, on the basis of the model used in the 2D collision simulation with the effect of sintering, we made the model that can be applied to three dimensions. We introduced a force that is applied when the two contacting particles twist, which is not taken into account in the 2D simulation. In this simulation, we investigated the critical velocity for catastrophic disruption and how the number of contact points changed as a result of collision.

As a result of 3D simulation, depending on the progress of sintering, the different critical velocity for catastrophic disruption was obtained. The critical velocity for catastrophic disruption of sintered aggregates is lower than it of non-sintered aggregates. Also, although the qualitative tendencies of the result are similar between 2D and 3D, there are differences such as rebound.

This study showed that sintering affected collision of dust aggregates in 3D. When sintering occurs, the aggregate that collided is easily broken like the result in 2D simulation .

From now on, we need to further study the distribution of fragment and aggregate compression.

Keywords: Sintering, Dust aggregate, Simulation

