Growth and disruption of dust aggregates by collisions

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Coagulation and fragmentation processes of dust aggregates by their mutual collisions in a protoplanetary disk are important to understand planetesimal formation. To reveal the structural evolution of dust aggregates, we carry out numerical simulations of dust aggregate collisions.

Recently, we performed numerical simulations of head-on collisions between ballistic cluster-cluster aggregation (BCCA) clusters and discussed on the compression and disruption processes of dust aggregates having BCCA structures. We obtained a scaling law giving a relation between the gyration radius of compressed aggregates and the impact energy. Based on the scaling law, we also derived a “equation of state” of dust aggregates, which is useful to model the structural evolution of dust aggregates in a protoplanetary disk. These previous simulations, however, are restricted to the collisions between BCCA clusters, whose structures are very fluffy. A further study on the collisions between relatively compact aggregates is required to discuss thoroughly the growth process of dust aggregates.

In this study, we carry out 3D numerical simulations of collisions not only between BCCA clusters but also between ballistic particle-cluster aggregation (BPCA) clusters. BPCA clusters have the fractal dimension about 3 and thus most compact structures. Therefore, it is possible to discuss the criteria about the growth and disruption of BPCA clusters as an extreme case of collisions between compact aggregates. Based on the results of these numerical simulations, we will discuss the disruption and growth processes of dust aggregates.