Numerical Simulations of Collisions between Different-sized Dust Aggregates

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One of the main problems with planetesimal formation is the feasibility of dust growth through collisions at velocities up to several tens of m/s[1]. Recently, we have performed numerical simulations of aggregate collisions using two kinds of aggregates of submicrometer-sized spheres: ballistic cluster-cluster aggregation (BCCA) clusters and ballistic particle-cluster aggregation (BPCA) clusters, which are fluffy and thought to well represent the dust structures. As a result, we find that fluffy aggregates represented by BPCA clusters are able to grow at collision velocities up to ~ 50 m/s if they consist of ice particles[2]. On the other hand, the critical collision velocity for aggregates consisting of silicate particles is given by ~ 5 m/s, based on a energy scaling[2]. If this is the case, silicate dust could not grow through collisions in protoplanetary disks. However, these results are obtained through collisions of equal-sized aggregates. Collisions between different-sized aggregates may increase the critical velocity since such colliding aggregates are expected to stop and stick more easily than at equal-sized collisions. We carry out numerical simulations of collisions between BPCA clusters with various mass ratios to clarify the effect of collisions of different-sized aggregates on the critical collision velocity. Based on the numerical results, we discuss the feasibility of planetesimal formation through collisions of dust aggregates in protoplanetary disks.

Keywords: dust; planetesimal formation; aggregate; collision

References

[1] S. J. Weidenschilling and J. N. Cuzzi, in *Protostars and Planets III,* 1031 (1993).
[2] K. Wada, H. Tanaka, T. Suyama, H. Kimura and T. Yamamoto, *Astrophys. J.* **702**, 1490 (2009).