# Discrimination between the effects of dust size and shape on the agglomeration process

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Introduction:
To understand the process of planetesimal formation in protoplanetary disks, numerical studies [1] and laboratory experiments [2] on the conditions for collisional growth of dust aggregates have been conducted. The density (filling factor) evolution of dust aggregates would be important with respect to whether they can grow or not [3,4]. In a free-falling granular stream, particles lose energy through repeated mutual collisions and aggregate naturally to form clusters [5,6,7]. We compared the streams consisting of 45 μm-sized irregularly shaped and spherical glass particles and showed that the irregularly shaped particles completed the evolution of filling factor and cluster formation more rapidly [7]. However, in the experiment, the mass of the irregular particle was about 1/3 of that of the spherical particle [8], which may have affected the results. Since few studies have shown the effect of particle shape on the agglomeration quantitatively, to clarify the effect of particle size on cluster formation efficiency and to discriminate between size and shape effects we investigate the evolution of filling factor of the streams consisting of spherical particles with different sizes.
Experiments:
In a vacuum chamber (0.1 atm), spherical glass particles of 30 and 60 μm size are streamed down from a circular aperture of 12 mm diameter. The streams are imaged with a flash X-ray at fall distances of 0, 15, 30, 45, 65, 85, 105, and 125 cm from the aperture. Assuming that the streams and clusters are axisymmetric and the filling factor is uniform in the horizontal plane, their width and the filling factor are determined for one-dimensional X-ray intensity profiles obtained at each fall distance [7].
Results and Discussions:
Compared to the stream consisting of 45 μm-sized spherical particles in the previous study, clusters formed faster for 30 μm size spherical particles and slower for 60 μm size spherical particles. The characteristic fall distance for the filling factor, *z*, which represents the rapidity of the decrease in filling factor, increased in proportion to about the square of the particle size, indicating that the smaller the particles are, the faster the evolution of the filling factor is completed. In the presentation, we will compare this trend with a simple analytical model. On the other hand, the previous result for 45 μm size irregularly shaped glass particles deviates from this trend for spherical particles and their *z* was smaller than predicted by the trend. Based on the simple analytical model, from the *z* of irregularly shaped particles and the particle size dependence of *z* of spherical particles, the ratio of the fraction of decrease in relative velocity per collision event between the irregularly shaped and spherical particles of the same mass is estimated to be ~5.6. This indicates that irregularly shaped particles lose energy more easily than spherical particles not only in particle-plane collisions [9] but also in particle-particle collisions and rapidly aggregate. This suggests that particle shape is important in the collisional growth process of protoplanetary dust particles.

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