Size and structure evolution of dust grains in nebula disks

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Dust growth is an imporatnt process because it influences planetesimal formation and disk temperature. In most of previous studies on dust growth, dust grains are simply assumed to be compact and spherical. But realistic grains are considered to have a fractal structure and a low density at least in the early stage of dust growth. If we take into account such grain structure, the growth mode and the strength of grains would be significantly changed. In order to develop the dust growth model including structure evolution, in the present study, we examine growth of fractal dust grains and estimate when the compaction of fractal dust starts. Our results are summarized as follows:

(1) The growth time of fractal dust grains is comparable to that of compact grains. On the other hand, their settling velocity is much slower than that of compact grains.

(2) If the grain size becomes larger than the gas mean free path, the growth mode becomes runaway.

(3) Accoring to our estimate, the compaction of fractal dust starts when the grains grow to several cm at 1AU of the minimum-mass nebula disk. Such large grains can remain floating up to the disk surface, which is convenient in the chondrule formation by shock heating.