Planetesimals formation from dust aggregates having various histories: Effects of growth and radial motion of dust aggregates

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Context: Planetesimals are seeds of planets and have a close relation with comets and meteorites, so it is very important to understand how and when they are formed in the solar nebula. Theoretical studies show that dust aggregates move in radial direction dynamically in the solar nebula due to the gas drag (e.g. Weidenschilling 1977[1]). Dust aggregates motion in radial direction in the aggregate growth phase to planetesimals is very important because dust aggregate properties are infuluenced by the local temperature, pressure, and so on of the solar nebula and these physical quantities might be recorded in comets or meteorites.

Aim: In this study, we consider that both the evolution of the gas disk and the growth of dust aggregate take place simultaneously. We investigate the dust aggregate motion in radial direction and histories of dust aggregates that form planetesimals. Unlike the previous work (e.g. Okuzumi et al. 2012[2]), we consider the time evolution of gas and dust disk from beginning of molecular cloud core collapse, so we can see when planetesimals are formed and how dust aggregates move and grow to planetesimals in the solar nebula.

Method: We calculate the time evolution of the radial size distribution of dust aggregates using disk evolution model including the mass accretion from molecular cloud core. In order to simplify the situation, we assume perfect stiking in aggregate collisions which is valid for icy aggregates.

Results: Planetesimals are formed inside the centrifugal radius where infalling matter from molecular cloud core falls onto the solar nebula within a few hundered thousand years after the begining of molecular cloud core collapse. In addition, there are some paths from dust to planetesimals. Some dust aggregates which grow to planetesimals are once carried outside the centrifugal radius by the gas advection, and after the size becomes of the order of one meter, they drift toward the sun and grow to planetasimals inside the centrifugal radius. This dynamic radial motion of dust aggregates suggests that material large scale mixing. For example, figure1 shows that planetesimals formed at a few 10AU are mixed objects of dust aggregates which accrete inside centrifugal radius and dust aggregates which excursion to 50AU.

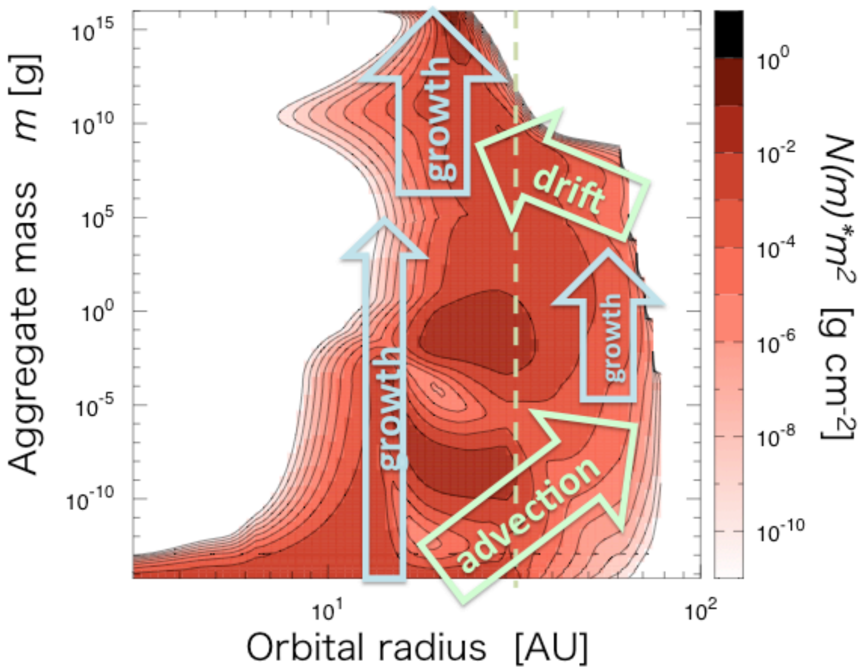

Fig1: Aggregate size distribution $m^2N(m)$ at 0.35Myr after the beginning of molecular cloud core collapse as a function of orbital radius (horizontal axis) and the aggregate mass *m* (vertical axis). The dashed line represents the centrifugal radius.

Reference: [1] Weidenschilling, S. J. 1977, MNRAS, 180, 57. [2] Okuzumi, S., Tanaka, H., Kobayashi, H., & Wada, K. 2012, ApJ, 752, 106.