Dispersal of millimeter emission of protoplanetary disks induced by dust growth

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Millimeter observations of classical T Tauri stars have suggested the following. (a) The dust in circumstellar disks sustains millimeter emission for 1-10 Myr. (b) Dust particles have grown to at least 1 mm.

We expect that millimeter flux from circumstellar disks declines with time. Dust particles are being lost because gas drag on them induces an accretion to central stars.

We calculated the life time of dust particles that undergo an accretion to a star, and found that particles of 1mm-1m cannot survive more than 10^5 yr. With this result, the life time of millimeter flux suggests that: (a) dust particles grow slowly enough that they can remains in the disk more than 1Myr, or (b) dust particles grow fast enough that their sizes reach 1m in 10^5 yr.

In the case (a), planet formation probably does not occur, because the dust particles accrete rapidly to the star when they become as large as 1m, while in the case (b) we expect planet formation.

Dust growth time depends on the initial mass of the dust component in a disk. If the disk mass is less than 0.01 Msun, the growth time is longer than that required to realize the case (b), and no planet forms. In such a disk, most of the dust will be lost before the gas dispersal, and millimeter emission also attenuates quickly.