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Imaging Survey of Protoplanetary Disks around T Tauri Stars with the Nobeyama Millimeter Array

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High-resolution imaging of protoplanetary disks around T Tauri stars is an important key to understanding of planet formation processes. The standard model for the origin of our solar system has predicted a compact disk with a radius of 36 AU, i.e., the primordial solar nebula around the proto-Sun 4.5 billion years ago (Hayashi et al. 1985). High-resolution and high-sensitive observations have demonstrated the presence of such compact disks with radii of ~ 100 AU, i.e., the protoplanetary disks toward several T Tauri stars (e.g., Kitamura et al. 1996; Mundy et al. 1996; Wilner et al. 1996; McCaughrean & O'Dell 1996). However, the physical properties of the disks have not been well understood yet. In particular it is vital to reveal the diversity of the disk properties that is closely related to the diversity of resultant planetary systems, such as Hot Jupiters (e.g., Butler et al. 1997).

In order to understand the initial conditions of planet formation, we have conducted a one-arcsecond imaging survey of protoplanetary disks around T Tauri stars with the Nobeyama Millimeter Array (NMA) over the three winter seasons from 1998 to 2001 (e.g., Yokogawa et al. 2001). All our target sources are thought to be single and are located in the Taurus molecular cloud (140 pc).

We have succeeded in imaging the disks around 13 T Tauri stars with spatial resolutions of one to two arcseconds. To discuss the diversity of the disks, we have derived the disk properties of the outer radius, the surface density distribution, the mass, the temperature distribution, and the beta index of the dust opacity, by analyzing both our images and the known SEDs on the basis of disk models.

We have found an increase in the disk radius with evolution. The increasing trend can be interpreted as the expansion of an accretion disk. Furthermore, we have revealed some diversity in the disk properties. The disk radius has a scatter of a few hundreds AU. The surface density at 100 AU is consistent with the extrapolated value in the Hayashi model. The power-law index of the surface density distribution ranges from 0 to ~1 suggesting a flatter mass distribution than that in the Hayashi model. The disk masses agree well with those by Beckwith & Sargent (1996). Our SED fitting well reproduces the temperature variations previously obtained by Beckwith et al. (1990). The index beta of the dust opacity is distributed around 1, a typical value in T Tauri stars.