Spiral Structure and Differential Dust Size Distribution in the LkHα 330 Disk

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Dust trapping accelerates the coagulation of dust particles, and thus it represents an initial step toward the formation of planetesimals. We report H-band (1.6 μm) linear polarimetric observations by Subaru telescope and 0.87 mm interferometric continuum observations by Submillimeter Array (SMA) toward a transitional disk around LkHα 330 [1]. As results, a pair of spiral arms were detected in the H-band emission and an asymmetric (potentially arm-like) structure was detected in the 0.87 mm continuum emission. We discuss the origin of the spiral arm and the asymmetric structure, and suggest that a massive unseen planet is the most plausible explanation [2].

The possibility of dust trapping and grain growth causing the asymmetric structure was also investigated through the opacity index (β) by plotting the observed SED slope between 0.87 mm from our SMA observation and 1.3 mm from literature [3,4]. The results imply that grains are indistinguishable from ISM-like dust in the east side ($\beta = 2.0 \pm 0.5$) [5], but much smaller in the west side $\beta = 0.7^{+0.5}_{-0.4}$, indicating differential dust size distribution between the two sides of the disk. That is dust grains grow to millimeter size in the west side, while they remain 0.1–1 micron size in the east side.

Future observations at centimeter wavelengths and differential polarization imaging in other bands (Y to K) with extreme AO imagers are required to understand how large dust grains form and to further explore the dust distribution in the disk.

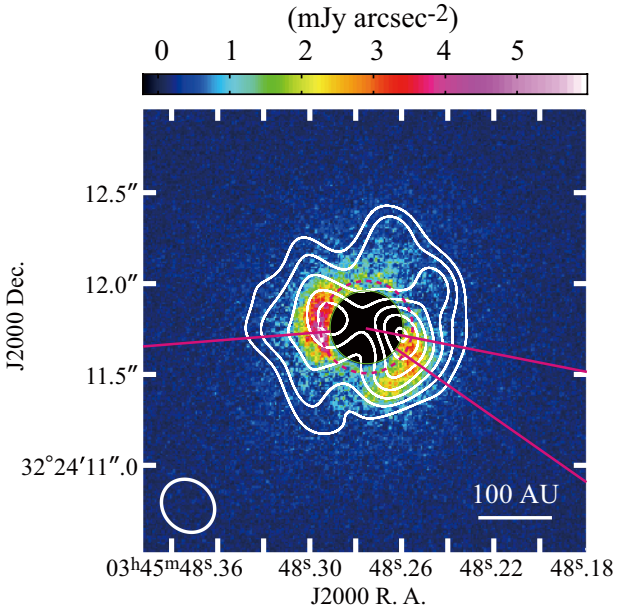

Figure 1: It represents a superposed SMA 0.87 mm continuum image on the Subaru H-band (1.6 μm) polarized intensity image. The first contour is 8σ and increases up to 20σ with 2σ steps.

References

[1] Akiyama, E., et al.: 2016, *AJ*, **818**, 158.
[2] Dong, R., et al.: 2015, *ApJ*, **809**, L5.
[3] Brown, J. M., et al.: 2008, *ApJL*, **675**, L109.
[4] Isella, A., et al.: 2013, *ApJ*, **775**, 30.
[5] Dranie, B. T.: 2016, *ApJ*, **636**, 1114.