Near-infrared imaging Polarimetry of LkCa 15: A possible Warped Inner Disk [1]

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The protoplanetary disks around young stars are considered as the main birthplace of giant gas planets. Numerous pectral energy distribution (SED) analyses on disk-host stars have suggested the presence of cavities in several disks, such as gaps and central holes. These structures are believed as a sign of transition from optically thick dust disk to optically thin debris disk, and these disks in the intermediate phase have been called transitional disks (with central hole) and pre-transitional disks (with gap). Currently, the most convincible mechanism to form cavities in the disks is gravitational interaction with planets in the disks. However, there is no clear observational evidence to explain the formation of these disk structures.

LkCa 15 is a solar-like T-Tauri star located in the Taurus-Auriga region ~140 pc away from us. Previous studies using SED and optical wavelengths imaging revealed that the disk of LkCa 15 is a pre-transitional disk with large gap and optically thick inner disk [1,2]. The pre-transitional disk of LkCa 15 could have a evidence of disk-planet interaction, and we conducted high-contrast and high-resolution near-infrared polarimetric differential imaging observation with HiCIAO and AO188 on LkCa 15 disk, as a part of SEEDS (Strategic Explorations of Exoplanets and Disks with Subaru).

From the resultant image, the wide gap structure (width $\lesssim$ 27 au) and the inner disk were resolved and clear enough to be quantitatively analysed (Fig. 1,2). It shows that the inner disk has misaligned position angle of 13° ± 4° with respect to that of the outer disk. This suggests that the inner disk is possibly warped. Warped disks were observed from several objects (e.g., AB Aurigae [5] and β Pictoris [6]), however, this is the first clear observational evidence of warped disk around young T-Tauri star. From the comprehensive discussion including previous studies on disk-planet interactions [7,8] and LkCa 15 optical imaging [2], the large gap and the warped inner disk of LkCa 15 both are indicative of a multiple planetary system with a mass of $\lesssim 1\,M_{\rm Jup}$ in LkCa 15 system.

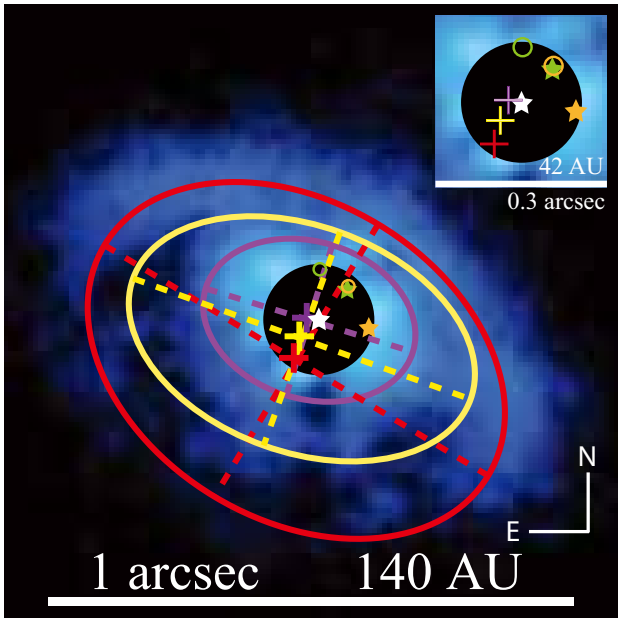

Figure 1: Elliptical fitting results of the inner disk (*purple*), the gap (*yellow*), and the outer disk (*red*). *White star* indicates the location of LkCa 15. *Green and orange stars* indicate where the planet candidates LkCa 15 b and c were detected in 2014, respectively [3]. *Empty green and orange circles* indicate the locations of two infrared sources seen in 2009-2010 [4], which are assumed as LkCa 15 b and c, respectively.

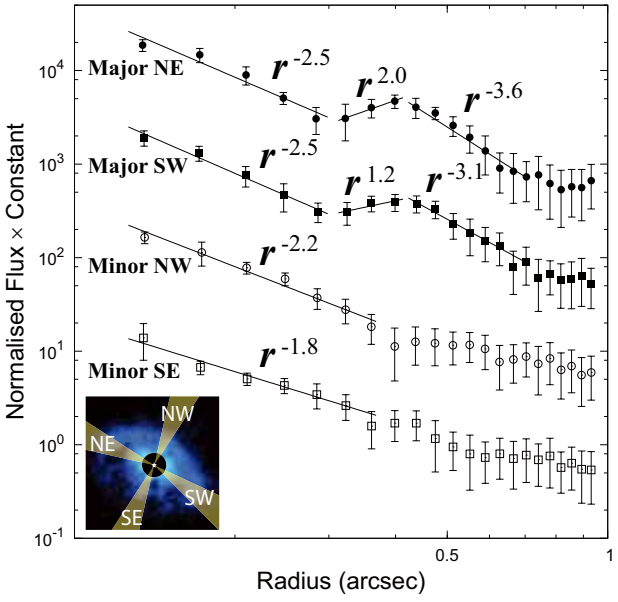

Figure 2: Radial surface brightness profiles with 1σ error bars at major and minor axes.

References

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