Imaging of a Transitional Disk Gap in Reflected Light: Indications of Planet Formation Around the Young Solar Analog LkCa 15*

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The circumstellar disks of gas and dust around newly formed stars are believed to be the birthplaces of giant planets. In some protoplanetary disks, evidence of gaps or inner cavities has been revealed through analysis of the infrared spectral energy distribution (SED; e.g., [1]) or interferometry at infrared (e.g., [2]) or millimeter wavelengths (e.g., [3]). These objects have been termed "transitional" disks, since they are thought to represent a transitional state of partial disk dissipation between the protoplanetary disk stage and the debris disk stage.

We present *H*- and K_s-band imaging data resolving the gap in the transitional disk around LkCa 15, revealing the surrounding nebulosity[4]. We detect sharp elliptical contours delimiting the nebulosity on the inside as well as the outside, consistent with the shape, size, ellipticity, and orientation of starlight reflected from the far-side disk wall, whereas the near-side wall is shielded from view by the disk's optically thick bulk. We note that forward scattering of starlight on the near-side disk surface could provide an alternate interpretation of the nebulosity. In either case, this discovery provides confirmation of the disk geometry that has been proposed to explain the spectral energy distributions (SED) of such systems, comprising an optically thick disk with an inner truncation radius of 46 AU enclosing a largely evacuated gap. Our data show an offset of the nebulosity contours along the major axis, likely corresponding to a physical pericenter offset of the disk gap. This reinforces the leading theory that dynamical clearing by at least one orbiting body is the cause of the gap. Based on evolutionary models, our high-contrast imagery imposes an upper limit of 21 M_{Jup} on companions at separations outside of 0.″1 and of 13 M_{Jup} outside of 0.″2. Thus, we find that a planetary system around LkCa 15 is the most likely explanation for the disk architecture.

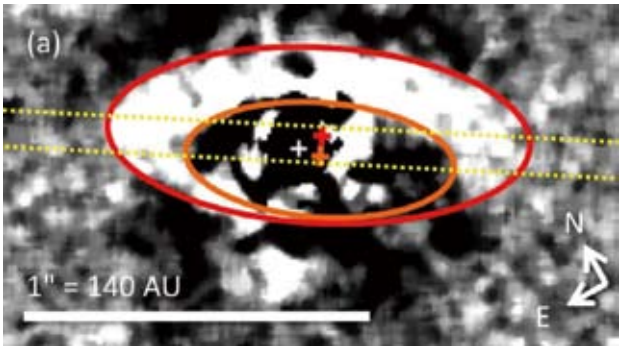

Figure 1: Ellipse fits to the inner and outer boundaries of the scattered light nebulosity seen in the HiCIAO *H*-band LOCI image after median filtering on the spatial scale of 5 pixels 1 FWHM and derotation by −29.3° (based on the position angle of 150.7 in [5]). The inner (orange) and outer (red) ellipses are offset from the star along the major axis by 51 mas and 57 mas and rotated by −4° and −3°, respectively. Their centers are marked by orange and red plus signs, respectively, while the star's position is indicated by a white plus sign.

References

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* Based on data collected at the Subaru Telescope, which is operated by the National Astronomical Observatory of Japan.