# Revealing the inclined circumstellar disk in the UX Ori system KK Ophiuchi

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UX Ori objects are young stars that exhibit brightness variations of up to two to three magnitudes in the V band. The cause of such strong variations is not yet fully understood, but they might be explained by orbiting circumstellar dust clouds that cross the line of sight and obscure the central star. Such eclipses would require a nearly edge-on disc orientation. To test this picture for UX Ori stars, we studied the inner sub-AU region of the circumstellar environment of the UX Ori star KK Oph with the VLTI and the near- infrared AMBER instrument in the H and K bands. Our derived visibilities, closure phases and the spectral energy distribution (SED; see Fig. 2) of KK Oph were modeled with two-dimensional geometric and RADMC radiative transfer models. In addition, we included mid-infrared MIDI data from literature for the RADMC modeling. Using geometric models, we derived an axis ratio of ~3.0, which corresponds to a disk inclination of ~70° (see Figure 1) and a disk ring-radius of 2.8 ± 0.2 mas, or 0.44 ± 0.03 AU at a distance of 160 pc. With our RADMC radiative transfer modeling of a ring-shaped disk with an additional extended halo, we found a similar inclination of ~70° (see model in Fig. 3 bottom). The large inclination indicated by the observations supports the hypothesis that eclipses by orbiting dust clouds near the disk plane cause the observed UX Ori variability. Furthermore, our results indicate that the disk plane of KK Oph A and the orbital plane of the companion, KK Oph B, are coplanar (Kreplin et al. 2013,A&A, 551, 21).

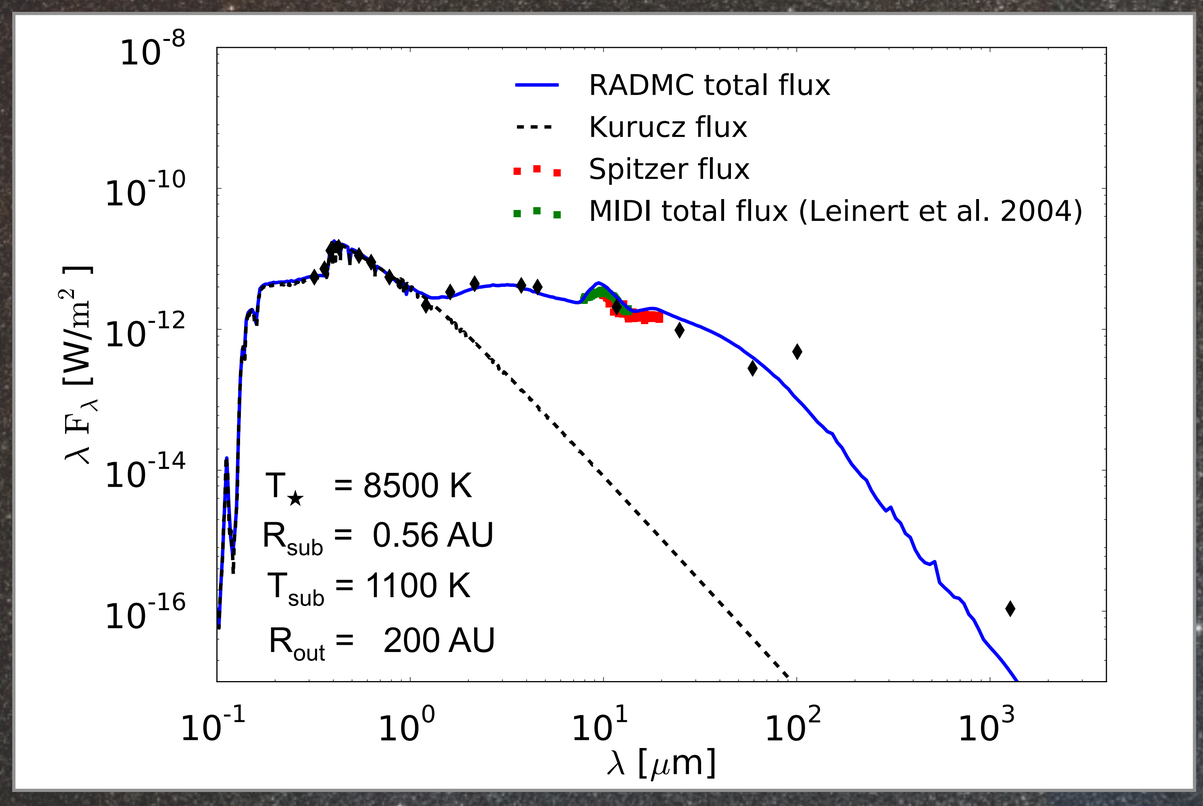


**Figure 2**: RADMC model-fit of the SED of KK Oph.

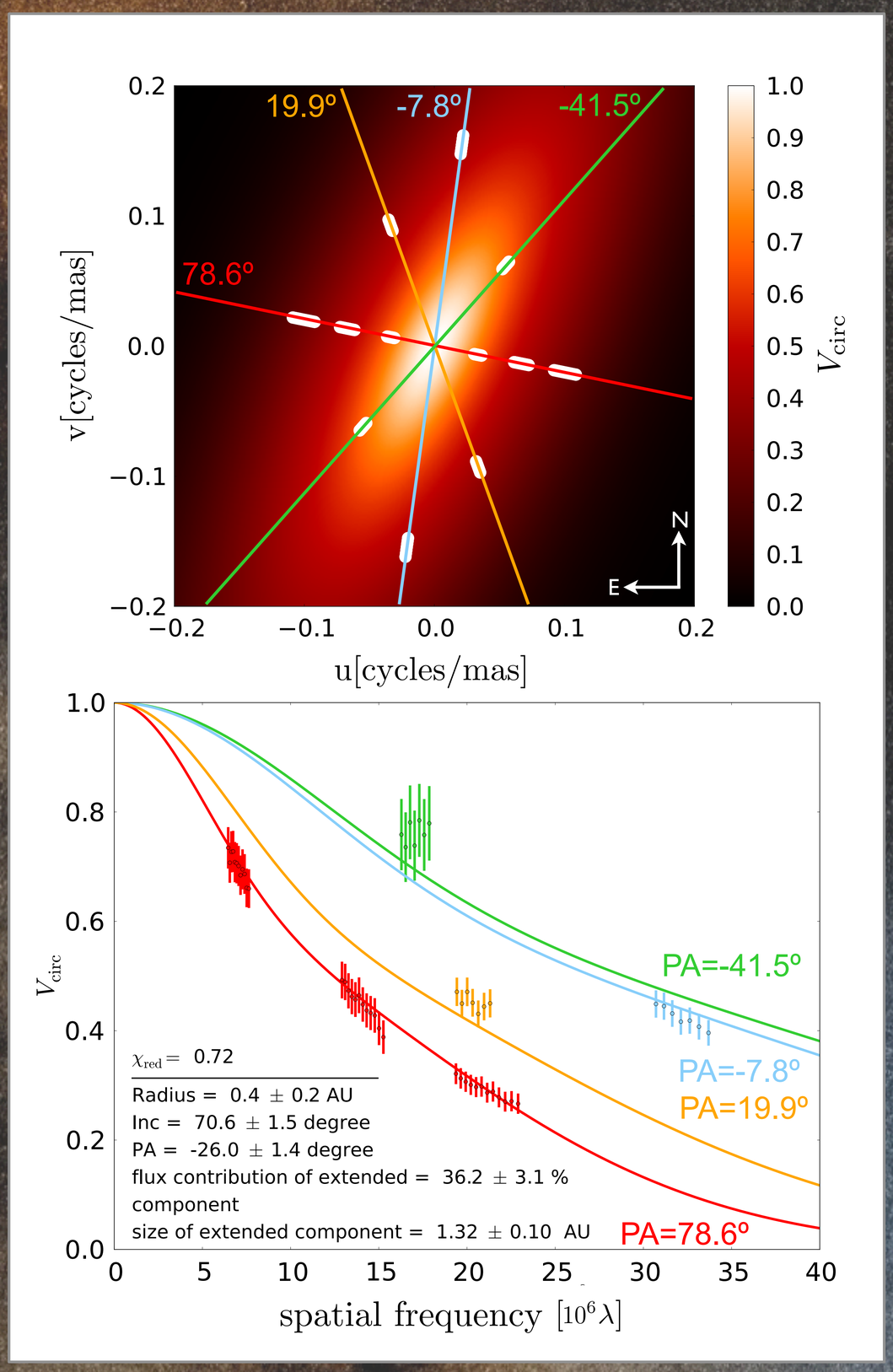


**Figure 1**: Fit of an elliptical, two-component Gaussian model to all derived visibilities $V_{circ}$ of the circumstellar environment (i.e., exclusive of the central star). Top: uv coverage of the observations (white dots) and our elliptical, two-component Gaussian model consisting of a compact and an extended Gaussian. Bottom: Observed visibilities of the circumstellar environment (at four different PAs; color- coded) and visibility cuts (four lines; same color-coding as the observations) through the visibilities of our two-dimensional, elliptical Gaussian model. We fit this two-dimensional Gaussian model to all visibilities instead of fitting one-dimensional visibility models to the visibilities corresponding to a single PA.

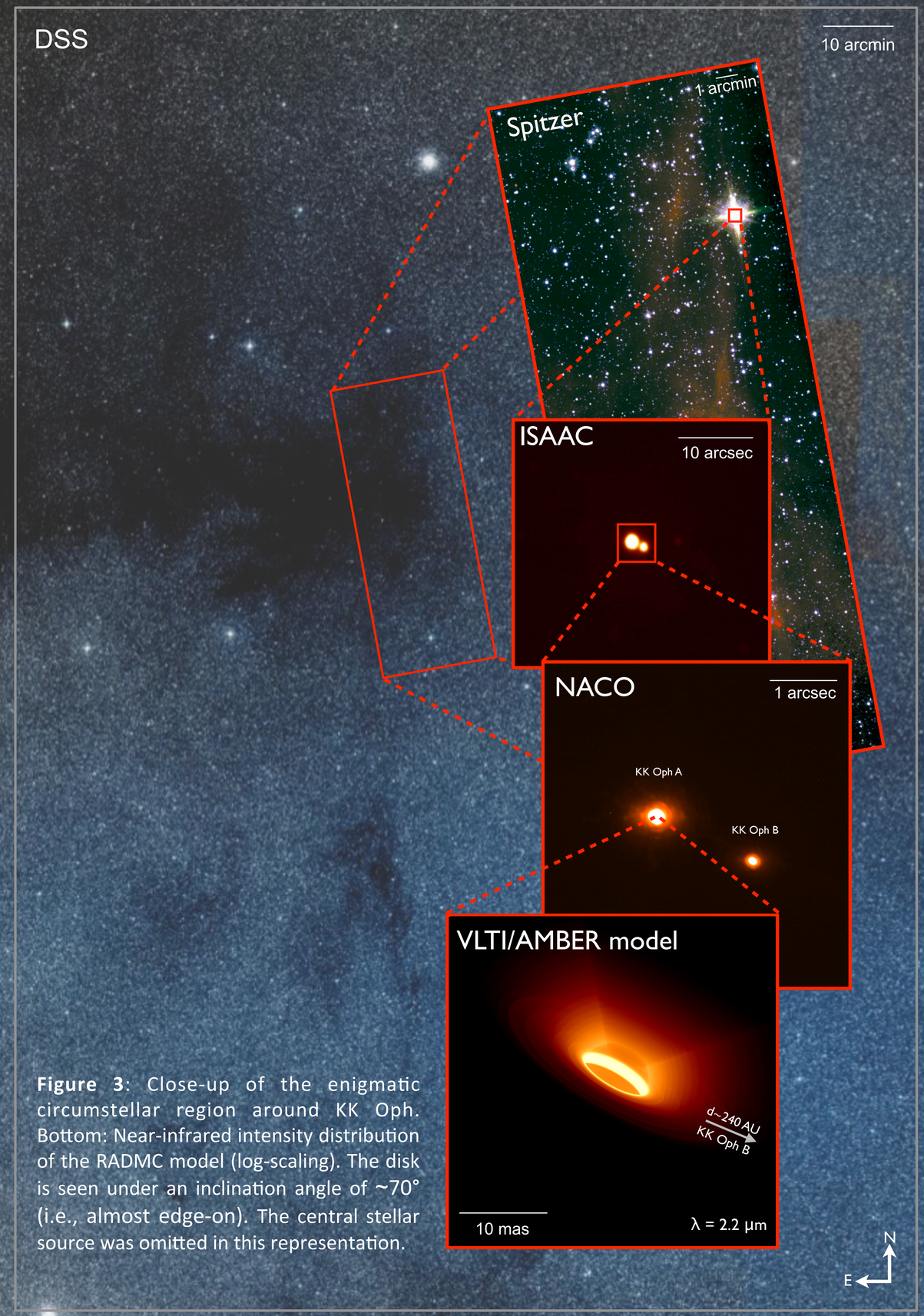


**Figure 3**: Close-up of the enigmatic circumstellar region around KK Oph. Bottom: Near-infrared intensity distribution of the RADMC model (log-scaling). The disk is seen under an inclination angle of ~70° (i.e., almost edge-on). The central stellar source was omitted in this representation.

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