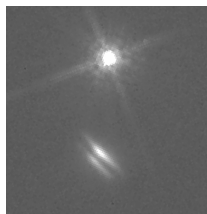


KECK LASER GUIDE STAR ADAPTIVE OPTICS OBSERVATIONS OF HK TAU B AT 3.8 AND 4.7 MICRON

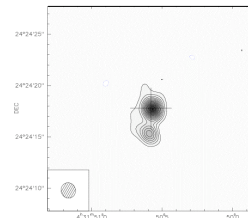
C. MCCABE, G. DUCHENE, A.M. GHEZ, F. MENARD, C. PINTE & K. STAPELFELDT
JPL-GRENOBLE-UCLA



HK Tau resolved at 0.6 micron
Stapelfeldt et al. 1998

HK TAU B - AN EDGE-ON DISK IN A BINARY SYSTEM

- HK Tau is a 2."4 PMS binary system with a mass ratio of ~1 (M1/M2 spectral types)
- Both stars have near and mid-IR excesses indicating the presence of optically thick circumstellar disks
- The disk around the secondary star, HK Tau B, is in an edge-on configuration ($i=86^\circ$), and has been spatially resolved in the optical (R,I bands; Stapelfeldt+98), near-infrared (Koresko 98), Menard+, in prep.), mid-infrared (11.7 micron; McCabe+03) and millimeter (Duchene+03).
- Dust population modeling of disk (Duchene+03) finds that a single grain size distribution cannot reproduce both the observed thermal emission and near-IR scattered light, suggesting that the dust in the disk has settled toward the midplane.

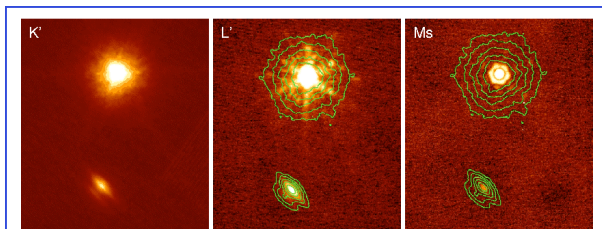
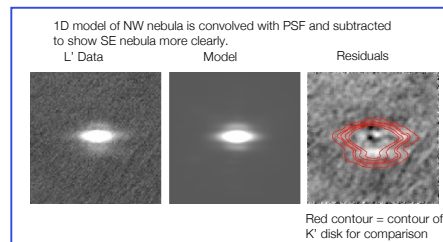


1.4 mm image of HK Tau A and B
Duchene et al. 2003

HK Tau B is an ideal disk candidate to use scattered light at $\lambda > 2$ micron to investigate grain growth and dust settling.

KECK LGS-AO SPATIALLY RESOLVES DISK AT 3.8 AND 4.7 MICRON

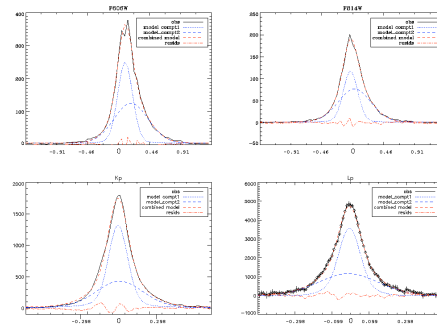
- Observations at L', Ms were made with NIRC2 behind the Keck LGS-AO system
- Strehls of 0.71 and 0.75 were reached at L' and Ms respectively.
- While HK Tau A remains a point source, HK Tau B is spatially resolved at both wavelengths.
- Comparison with K' observations taken with NIRC2-AO suggests that disk is detected in scattered light at 3.8 and 4.7 microns.
- At L', NW nebula has FWHM of 0."18 and 3σ extent of 0."64.
- SE nebula also detected.
L' darklane width = 0."17
NE:SW nebula flux ratio ~ 25
- In Ms image, SE nebula not detected. NW nebula resolved with FWHM = 0."18.



Keck Adaptive Optics images of the HK Tau system at K' [2.12 μm], L' [3.78 μm] and Ms [4.67 μm]. The K' band flux levels are shown as green contours on the L' and Ms images, showing that the peak of the scattered light occurs at the same position at all three wavelengths and that the disk is spatially resolved along the same position angle (~42°).

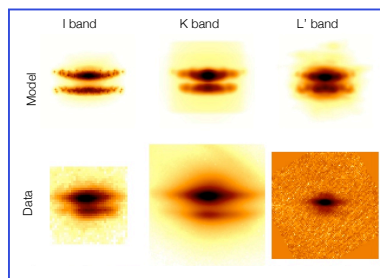
SUMMARY OF RESULTS FROM 0.6 - 4.7 μm

- Two scattered light nebula spatially resolved from 0.6 - 3.8 micron.
- NW nebula (the brightest) alone is detected and resolved at 4.7 and 11.7 micron.
- Profile fitting of NW nebula using 2-gaussian "core" plus "halo" model finds:
 - FWHM of both core and halo decrease with λ .
 - Core is ~x2 more prominent than halo at $\lambda > 2$ micron.
- Dust is not "gray" - width of dark lane (prop. to κM)
Decreases with wavelength:
0.6 μm $d=0."$ 24
2.1 μm $d=0."$ 21
3.8 μm $d=0."$ 17



CAN A SINGLE GRAIN SIZE DISTRIBUTION RECREATE 0.8 - 3.8 MICRON DATA?

- A grid of ~1000 Monte Carlo models of an azimuthally symmetric, flared circumstellar disk With $R=105$ AU have been run at I, K and L' bands
- Models vary both disk geometry (disk mass, scale height, inclination, surface density and scale height exponents) and dust population parameters (maximum grain size and power law exponent of distribution).
- Multi-wavelength χ^2 minimization is done on a number of observables - e.g., dark lane width, peak to peak nebula flux ratio, FWHM of brightest nebula and degree of flaring - to find the model that can best recreate all three wavelengths simultaneously.
- The best matching simultaneous fit to I, K and L' band data is shown.
This model does not adequately recreate the L' data, specifically the flux ratio between the two nebula.



$A_{\text{min}} = 0.03$ micron, $a_{\text{max}} = 10$ micron, $n(a) \sim a^{-4.7}$
 $\beta = 1.05$, $p = -1.5$, $M = 2.7 \times 10^{-5}$ Msun.

Currently, no single power law grain size distribution can simultaneously reproduce all three wavelengths.

Models that include vertical dust settling can also not adequately reproduce all 3 datasets.