VLTI Proposal:

Search for Circumstellar Disks around Massive Stars

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What is the motivation to find circumstellar disks around high-mass stars?

- Distinguish between non-spherical accretion theory and merging theory for high-mass star formation
- Compare massive star formation/evolution to solar-type star formation/evolution
- Determine photo-evaporation time scale / find lifetime of disk / evolutionary stages
- Check whether the disk is in Keplerian rotation
- Determine if massive stars host planets

What are the important VLTI and other λ observable parameters?

- Direct observations
  - Outer disk radius
  - Radius of gap if present
  - Observed asphericity due to inclination
  - K-part of SED
  - Light Scattering off grains
  - Rotational velocity
- Inferable observations
  - Temperature of star
  - Mass/age of star
  - Mass of disk

What challenges do we face?

- Massive stars form in clusters
  - Embedded disk
- Massive stars produce powerful radiation
  - Photo-evaporation of disk in short time
- Massive stars are rare
  - Massive stars are distant
  - Smaller sample size

Previous achievements:

F. Millour and colleagues have recently detected Keplerian rotation in a disk around B star.

- "First direct detection of a Keplerian rotating disk around the Be star alpha Arae using the VLTI/AMBER instrument"

- Meilland et al. (including Florentin!) A&A accepted Jun. 2006

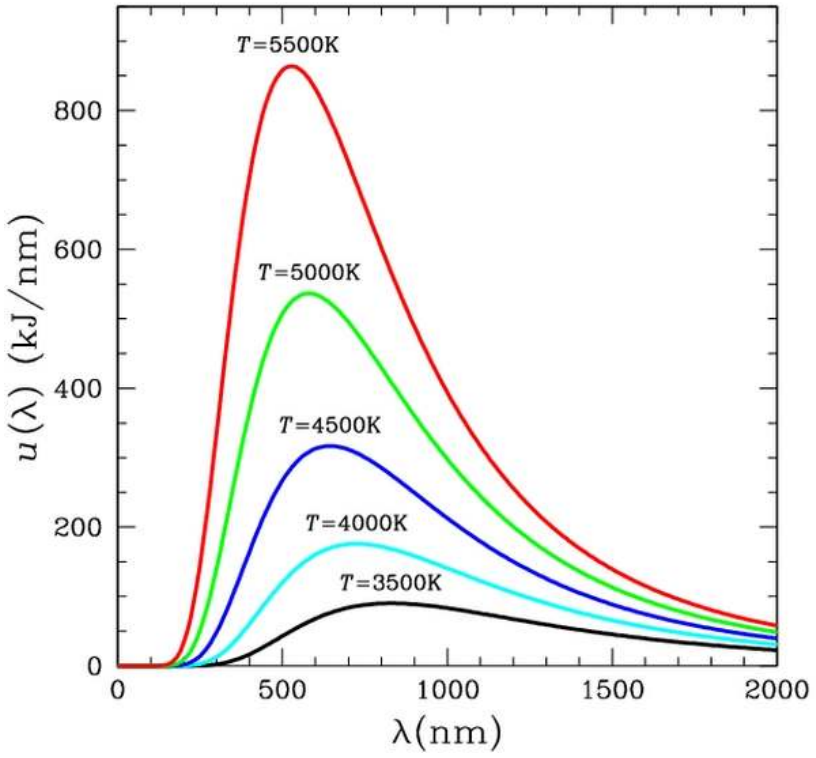
- alpha Arae
  - HD 158427
- Be star
  - 10 M_{sun}
  - d = 74 pc
- MIDI/N
- AMBER/K

Candidate observing targets

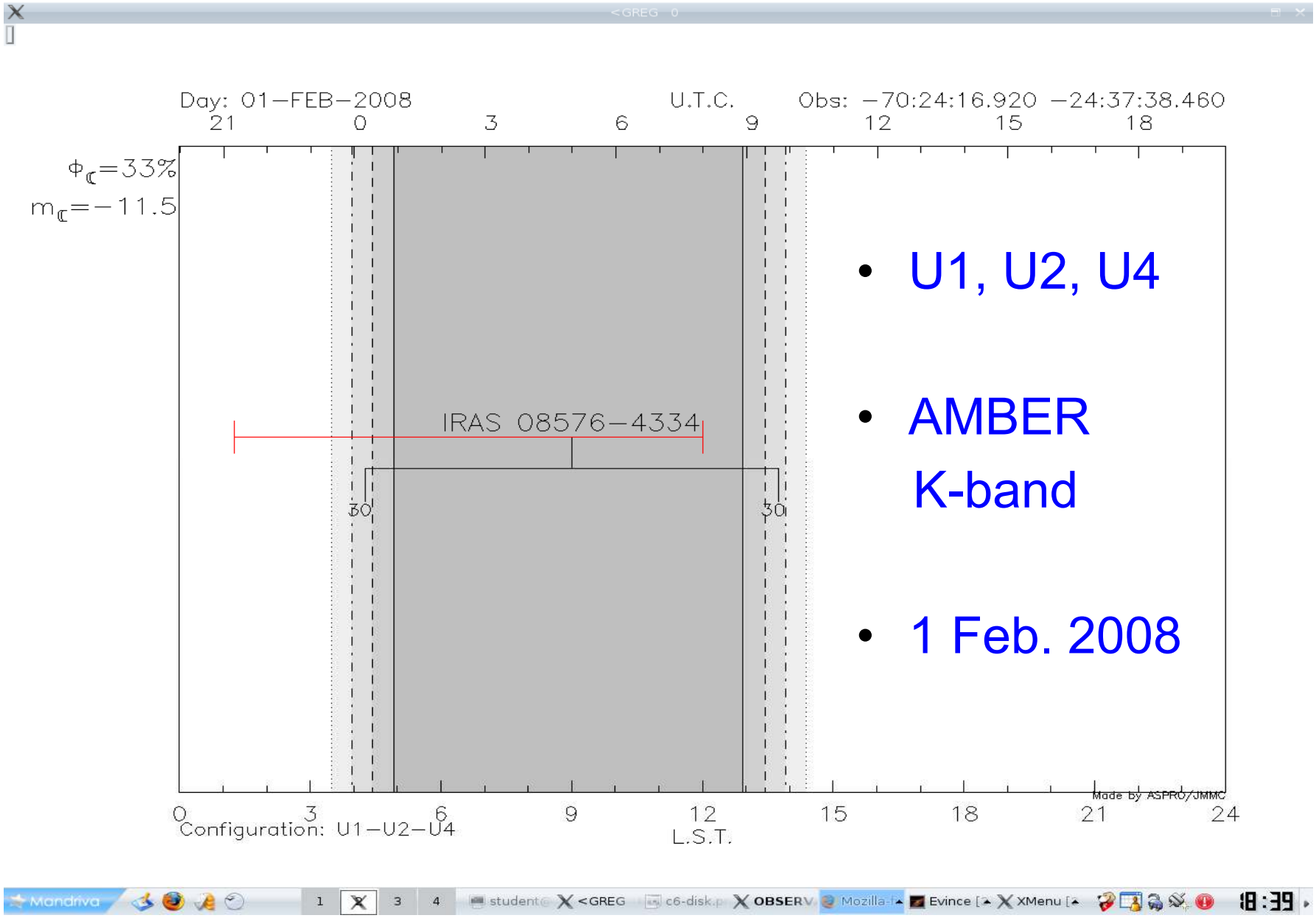
- NGC 2024 -IRS2
  - FK5 2000 05 41 43 -01 50.5
  - Late O-type star in cluster
  - Has been observed by Lenorzer et al. 2004 at VLT to get SED from 1 μm to 2.7 mm
  - Model fit to SED: T_{eff} = 25 000 K, R = 10 R_{sun}, log g = 3.67
- IRAS 08576-4334
  - FK5 2000 08 59 25.2 -43 45 46
  - d = 700 pc (W.-F. Thi & A. Bik 2007)
  - 6 M_{sun} -- Early A-star or late B-star; Assuming A0
  - K mag 9.4, J-K color 4.7
  - Inclination 27 degrees

We determined K-band flux of underlying star based on spectral type

- Estimates based on observations:
  - Peak wavelength of A0 star: 240nm
  - SED of A0 star: K-band flux = 20% peak flux

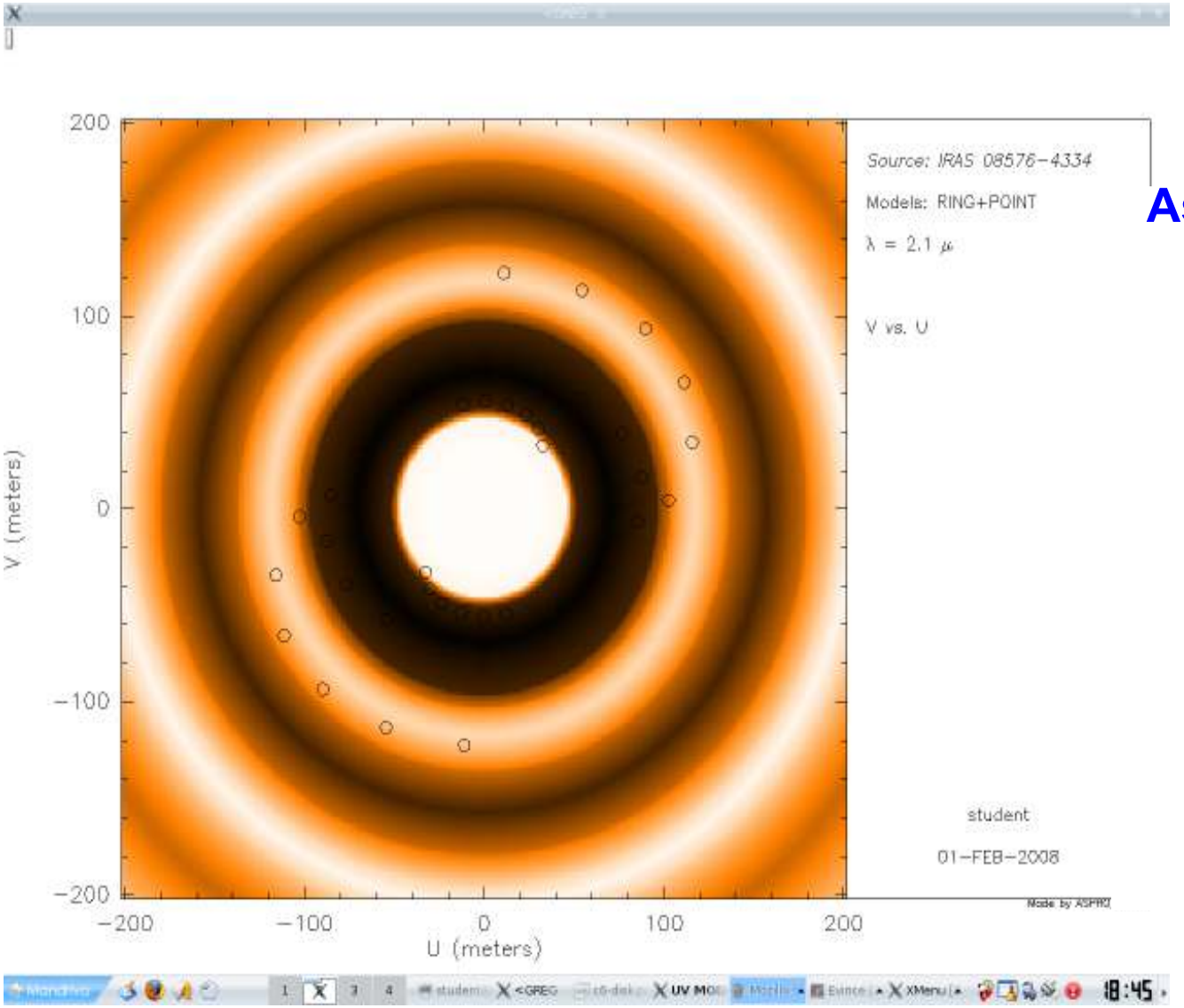


Observations



- U1, U2, U4
- AMBER
  K-band
- 1 Feb. 2008

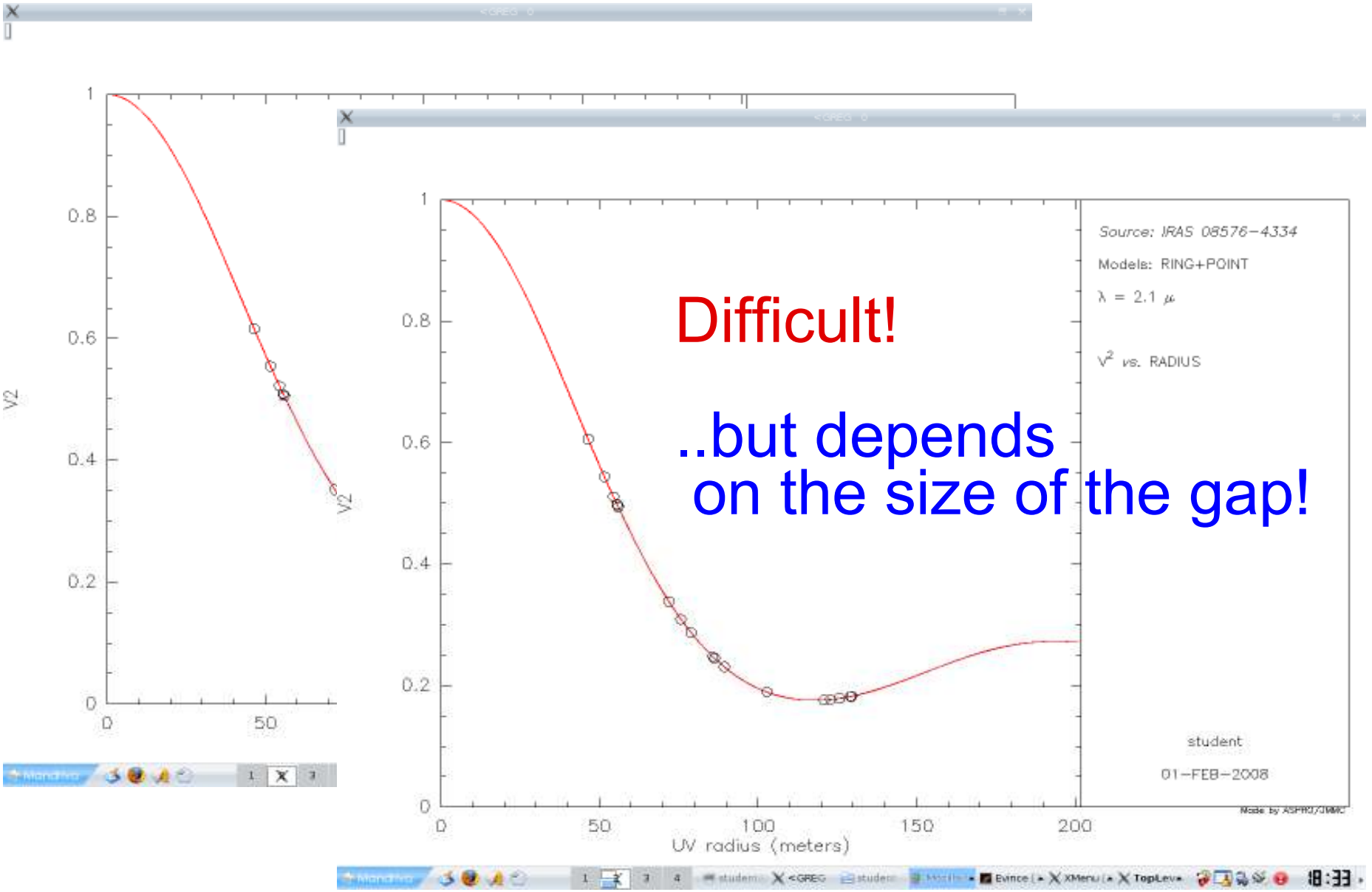
UV coverage and Toy Model Predictions



Assumptions for ASPRO model:

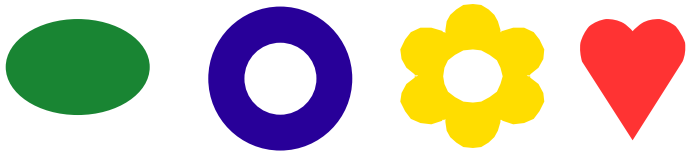
- Unresolved star plus disk
- Disk to star flux ratio in K-band: 1
- Outer radius, warm species = 4AU = 6mas
- Inner radius (gap) = 0.6AU = 1mas

Can we infer the presence of a gap?



Using observations from VLTI in conjunction with data in the literature we will...

- Use toy models of:
  - solid disk
  - ring
  - double-system...



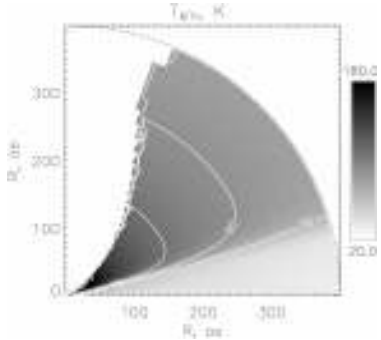
with different parameters

- inner and outer radii
- flux ratios,
- and so on for preliminary analysis of visibility data.

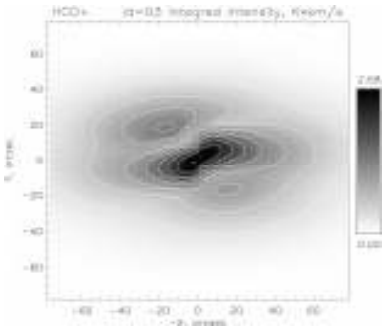
- We will use closure phase to study asymmetry of the disk to verify the predicted inclination of 27 degrees.

Further detailed analysis..

- We will use passive disk model to do detailed radiative transfer modeling of system.



- Based on our findings we will attempt to verify either the non-spherical accretion or the merger scenario for massive star formation.



Conclusions

- VLTI AMBER K-band observations of A0-type star at 300pc in which disk was detected previously in CO and H2O

- Will be able to verify outer radius and perhaps detect gap to inform structure and evolution theories for the disk

- This work will be a major contribution to our PhD thesis and fortunately to the field of star formation!