Observing inner discs where planets form

From discs to planets: New observations, models, and theories
Pasadena, California, USA

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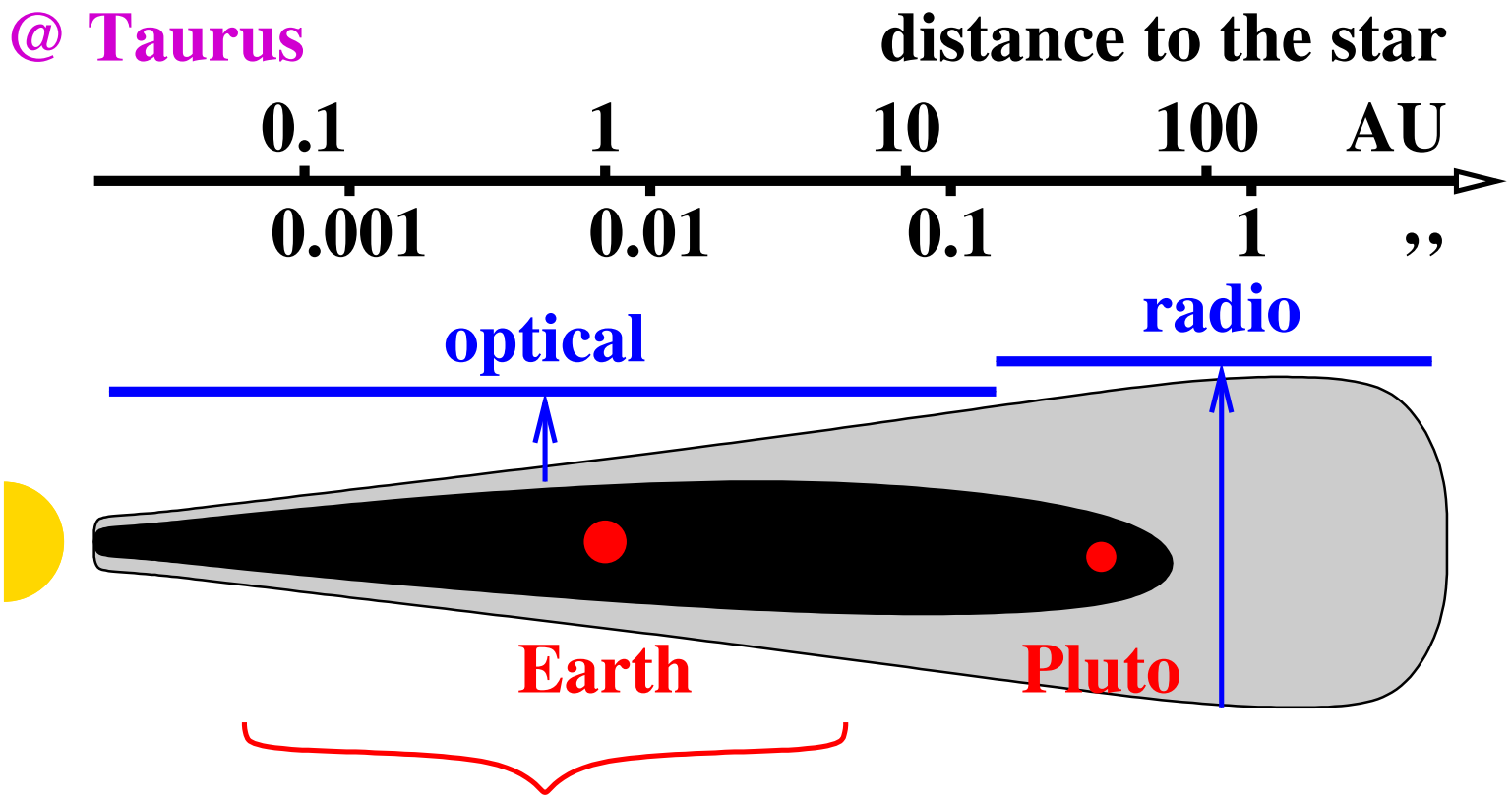
March 8th 2005

Introduction

Scales in protoplanetary discs



large column density:
giant planet formation

Kuchner 2004, ApJ 612, 1147

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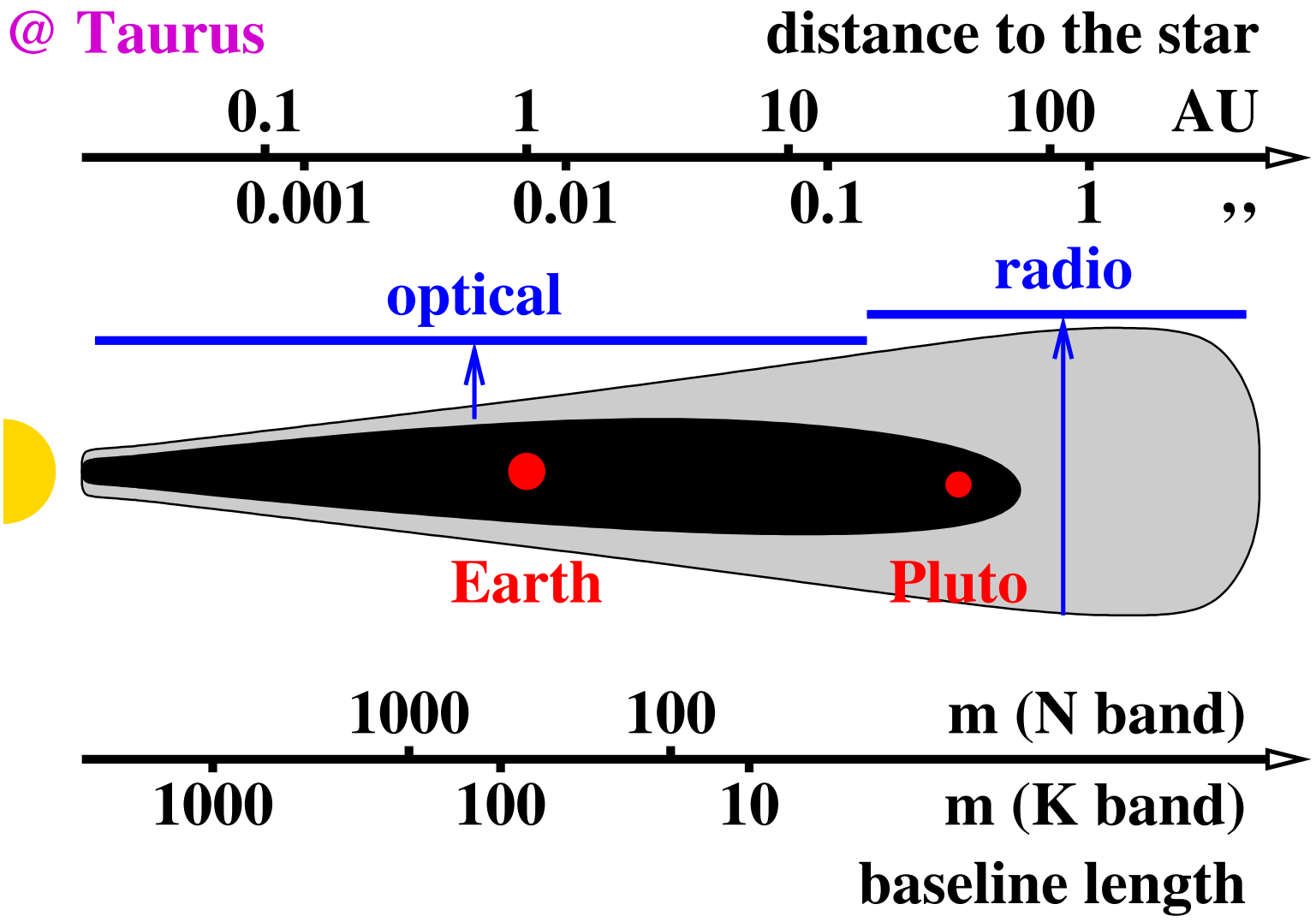
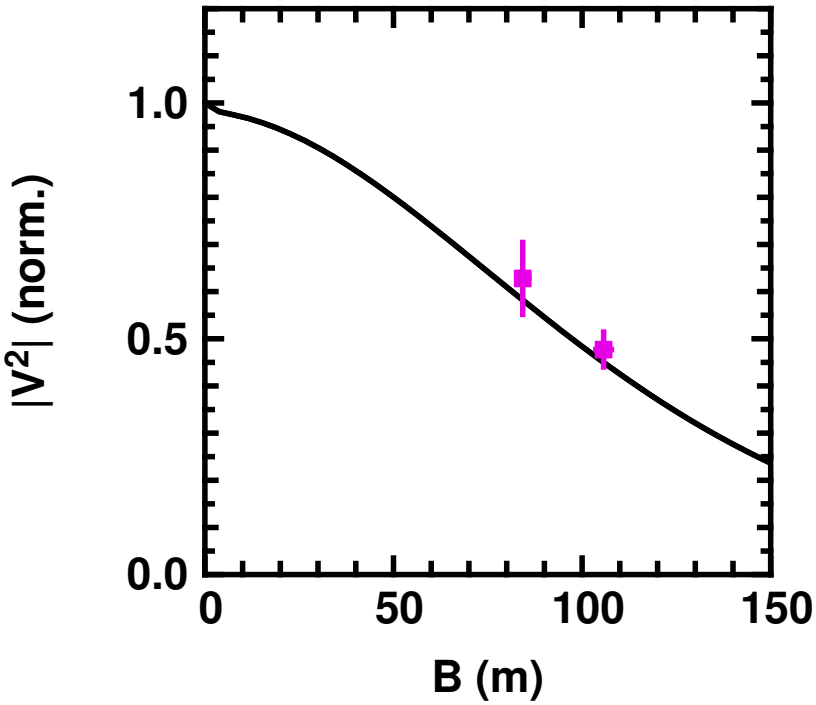


→ Optical interferometry & radiative transfer

But visibilities are are not enough! (1)

Irradiated & visous disc model for T Tauri: visibility fit.
Lachaume, Malbet, & Monin 2003, A&A 379, 515



$\dot{M} = 8.0 \times 10^{-7}\ M_\odot/\mathrm{yr}$ $\quad r_{\mathrm{min}} = 18.0\ R_\odot$

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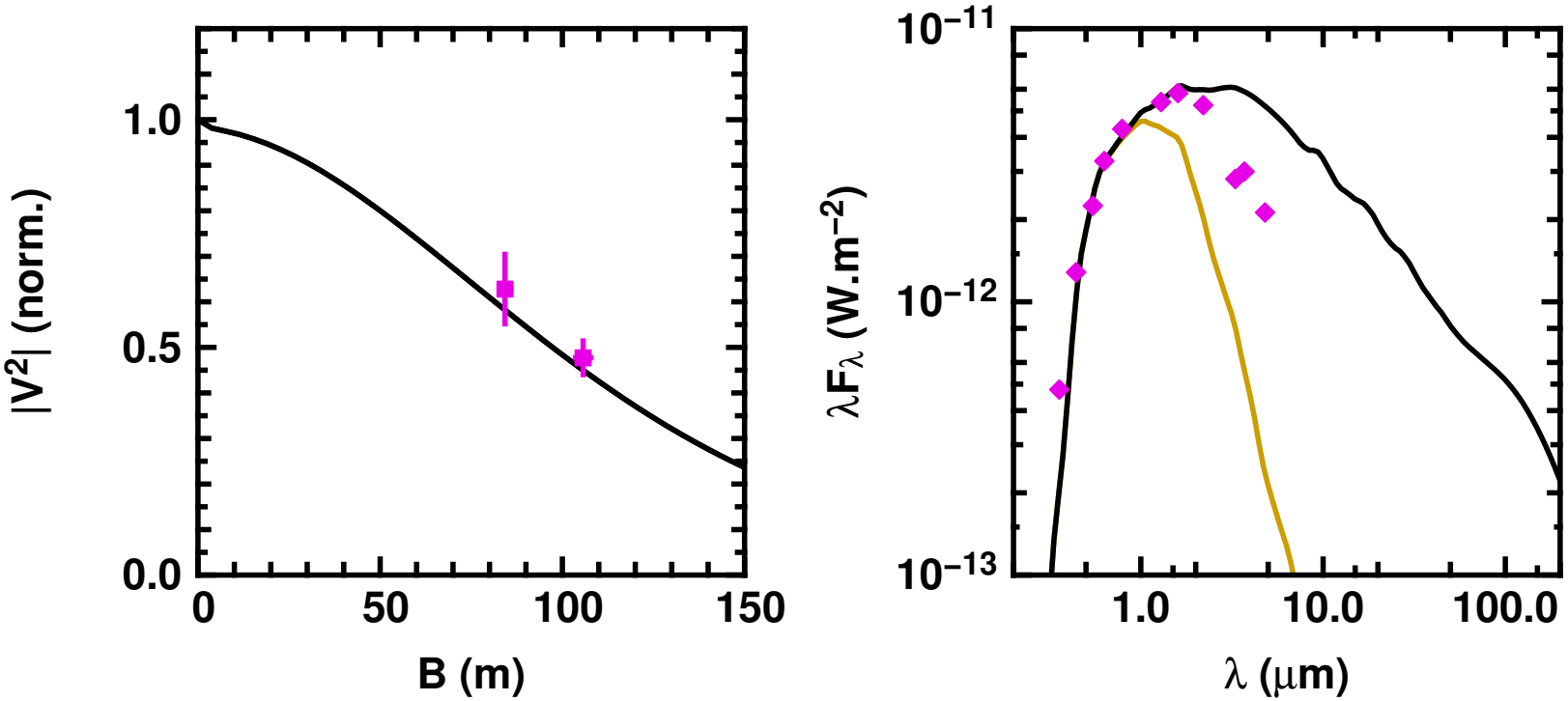

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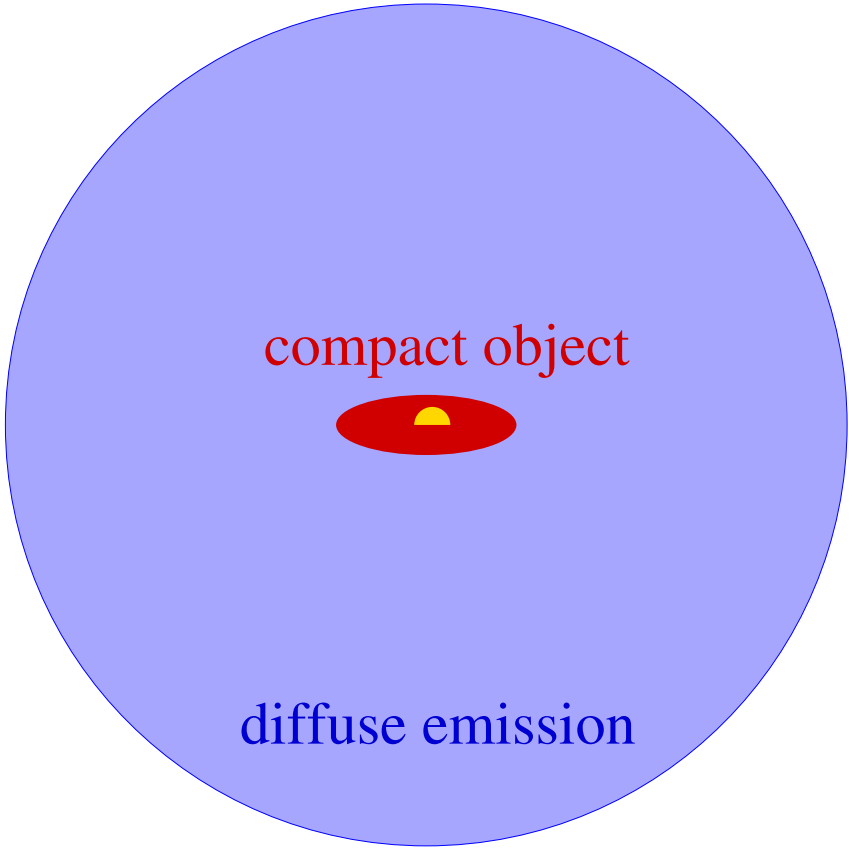
→ Combine observables, e.g. SED + visibilities

But visibilities are are not enough! (2)

The large-scale diffuse emission problem

Lachaume, 2003, A&A 400, 795



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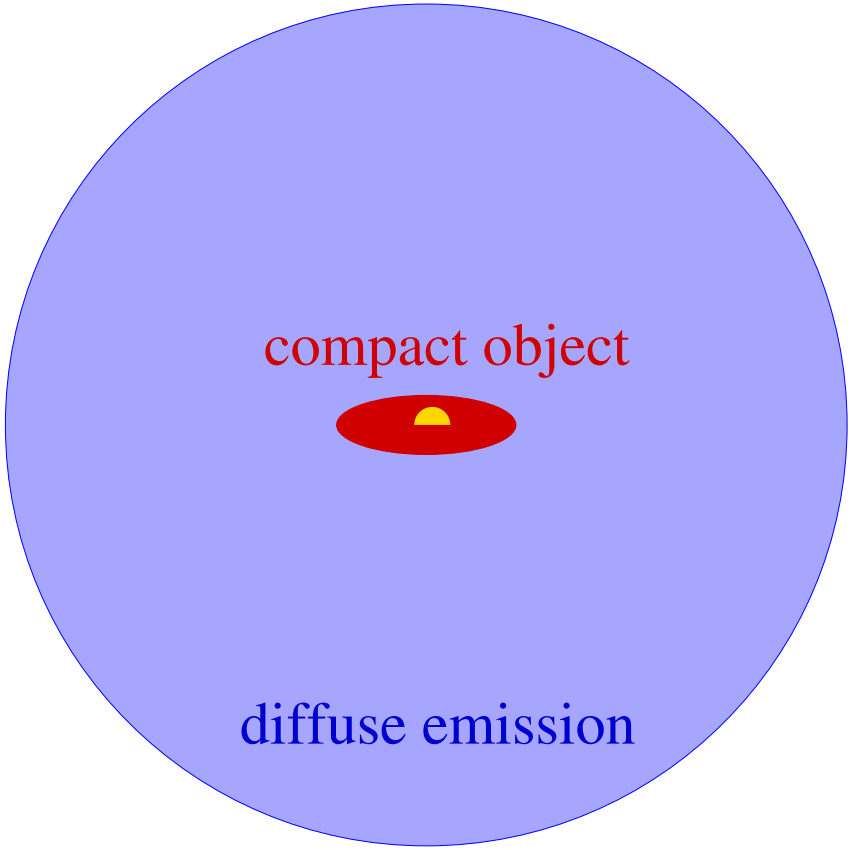
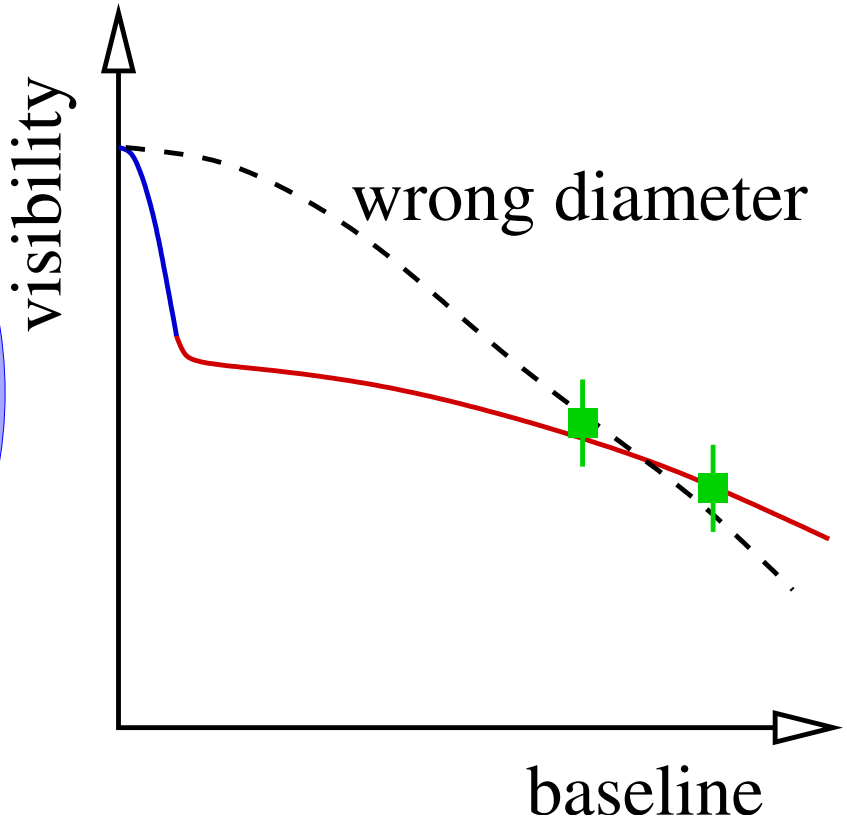




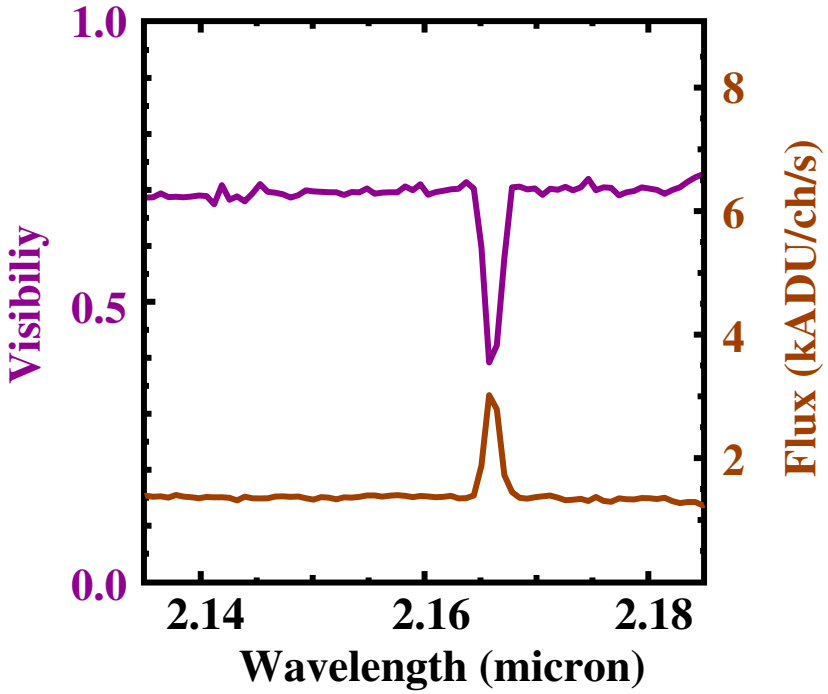
→ Adaptive optics & speckle interferometry

Ad hoc modelling

AMBER observation of MWC 297

Herbig Be star

Resolved in K, Tatulli 2005, Ph.D. thesis



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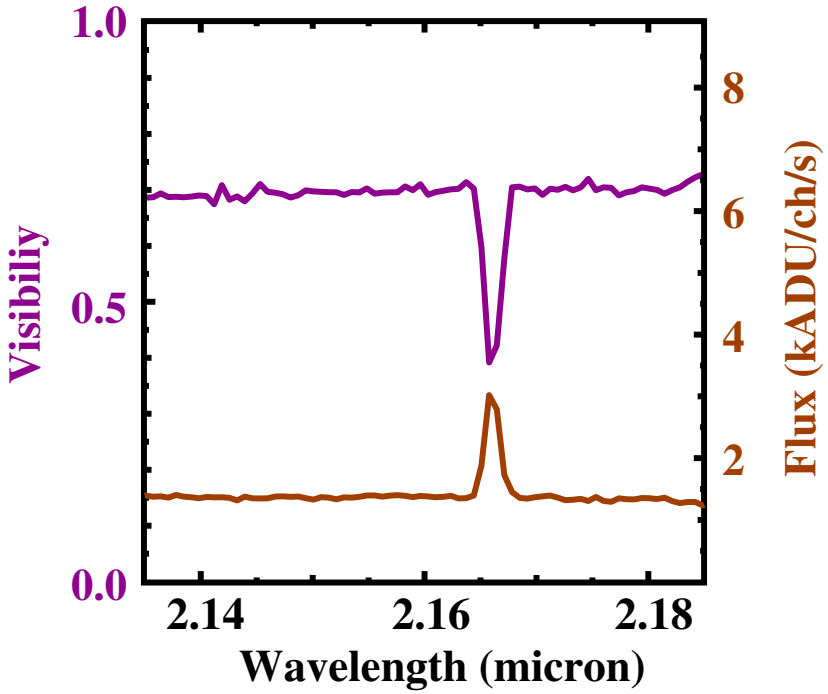
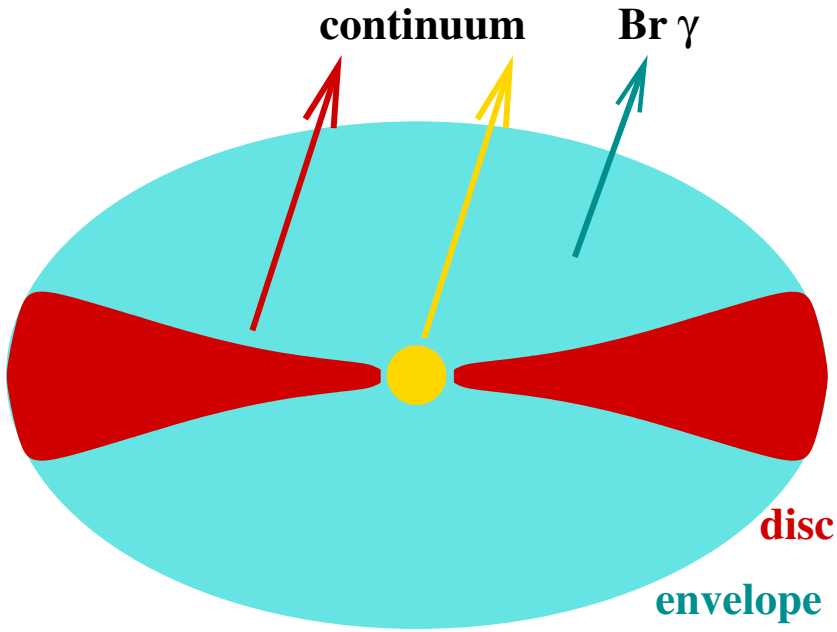




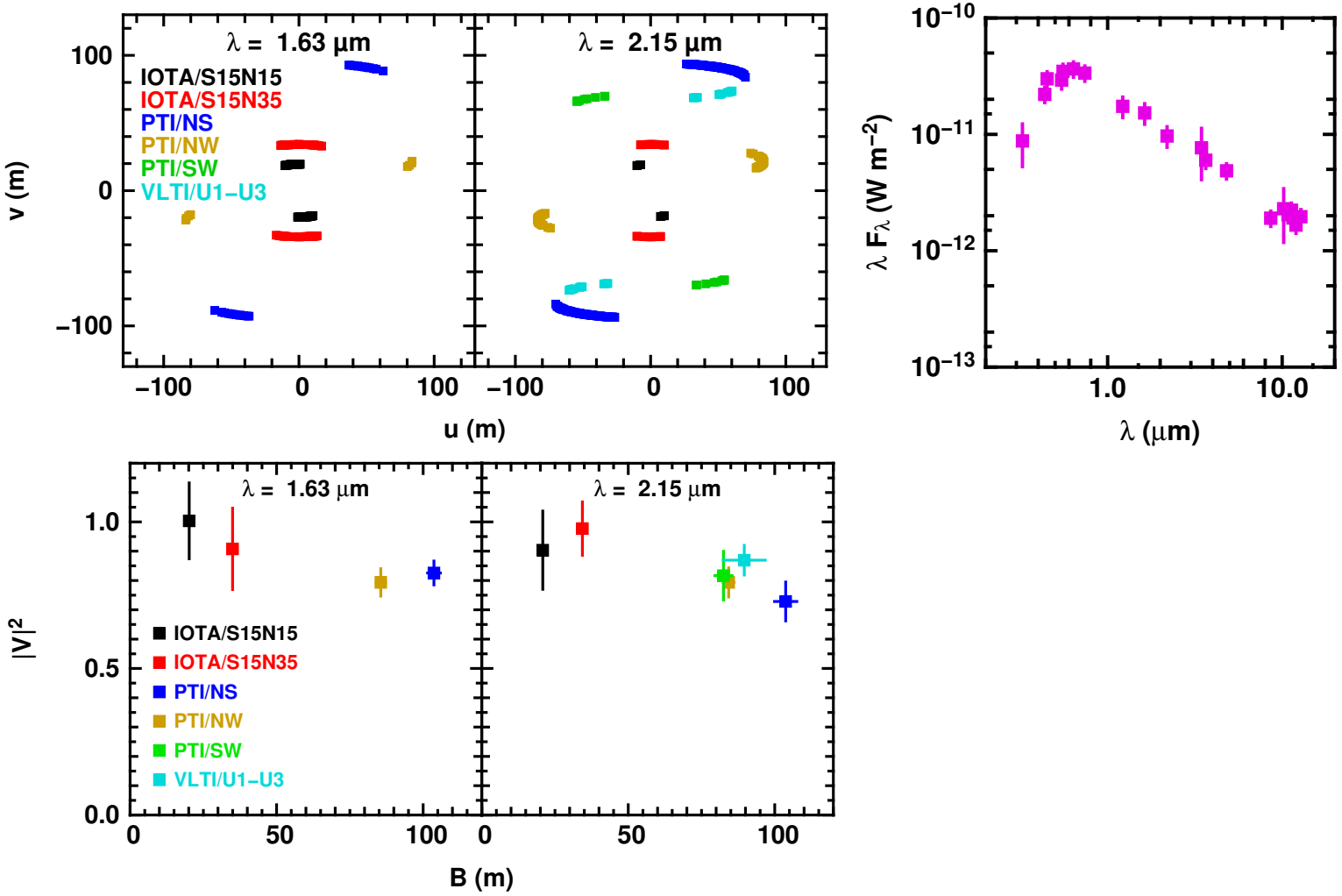
$Ø_{disc}$ = **5.8 ± 0.6** mas → **2.6 ± 0.3** AU

$Ø_{env}$ = **10.6 ± 0.8** mas → **4.8 ± 0.4** AU

PTI, IOTA, & VLTI observation of FU Ori (1)

FU Ori: YSO with accretion outburst

Marginally resolved in H & K, Malbet et al. 2005, submitted



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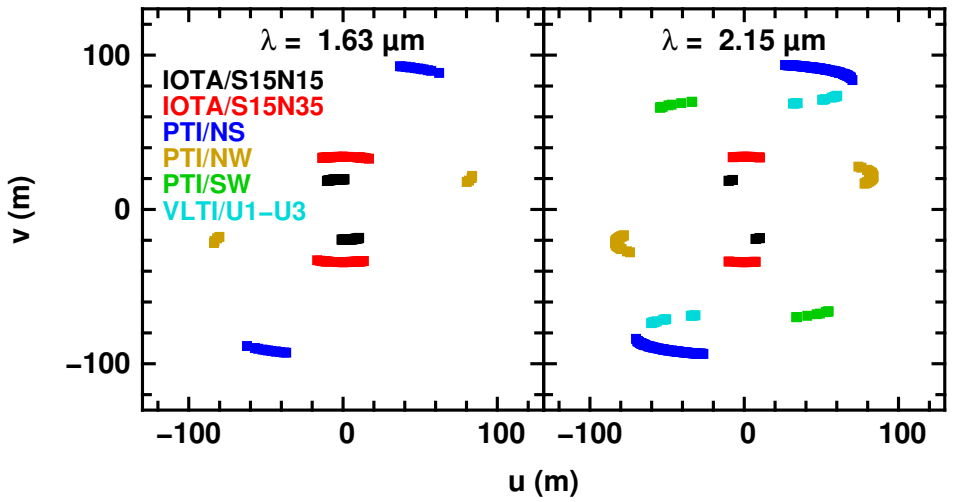
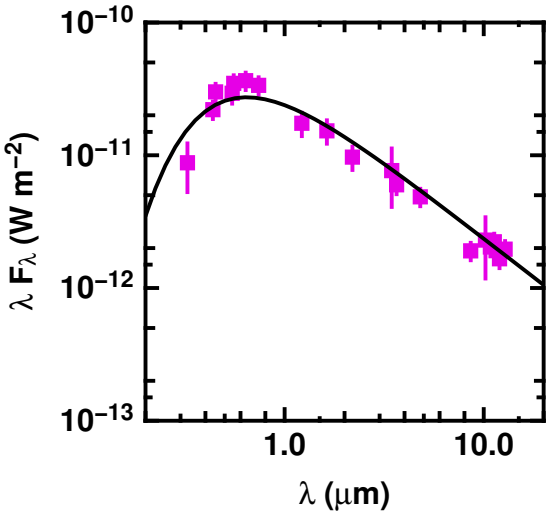
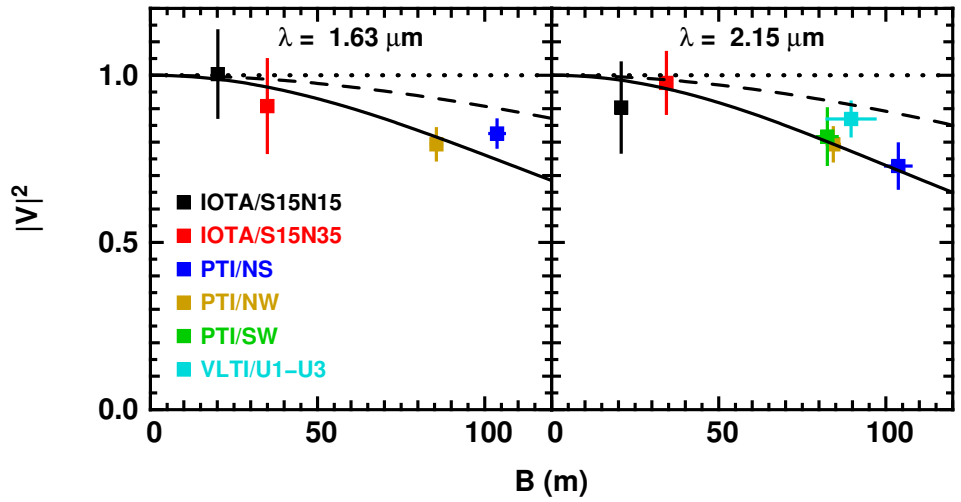






$$\dot{M} = (6.1 \pm 2.5) \times 10^{-5}\, M_\odot/\mathrm{yr}$$

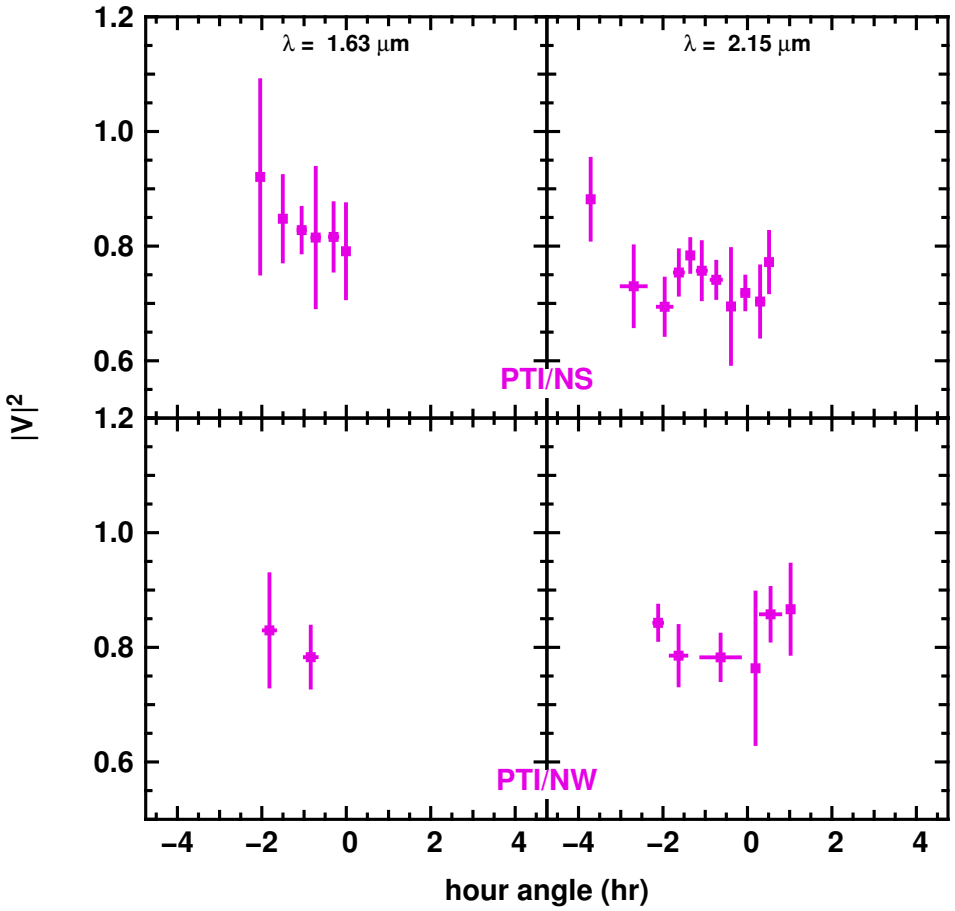
$$i = 55 \pm 7^{\circ}$$

$$\theta = 47 \pm 10^{\circ}$$

$$r_{\mathrm{min}} = 5.5 \pm 2.5\, R_\odot$$

PTI, IOTA, & VLTI observation of FU Ori (2)

FU Ori: hot spot in the disc?



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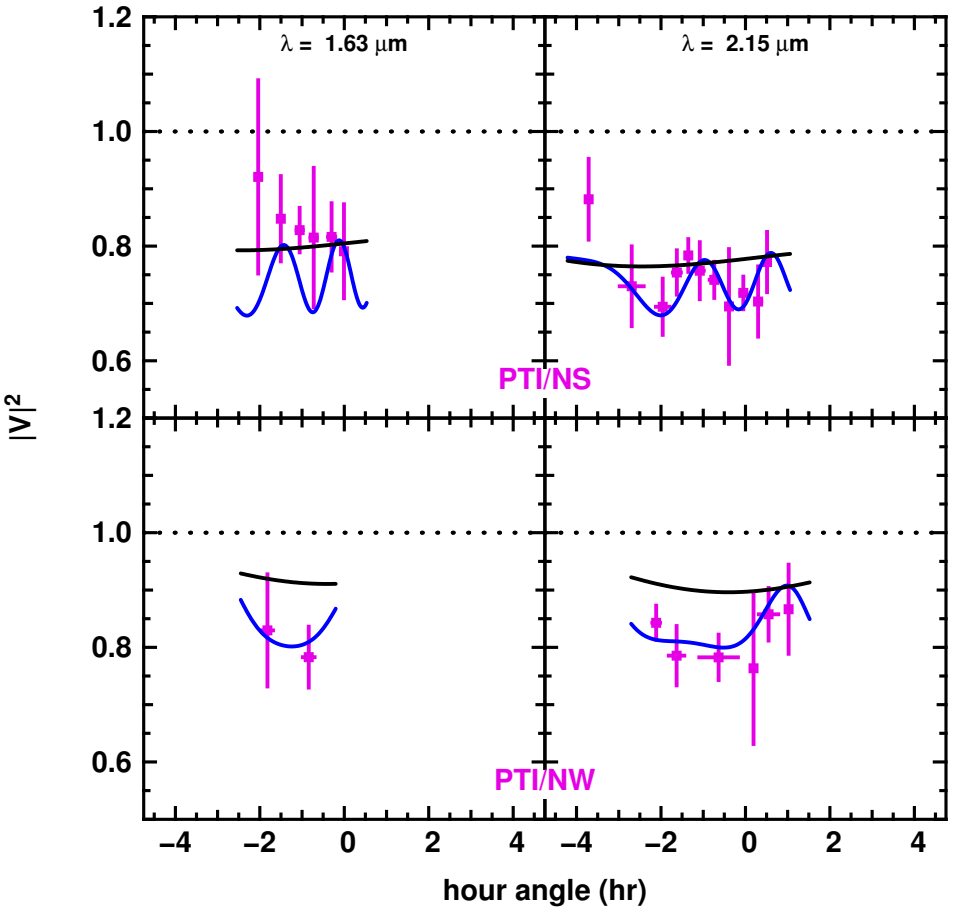
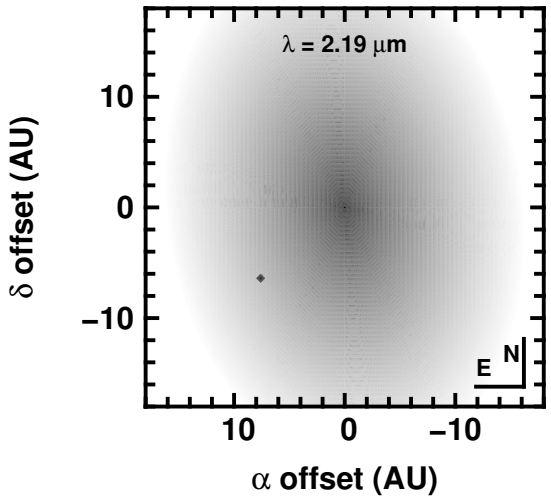


$$\Delta K = 4.2 \pm 1.1 \text{ mag}$$

$$r_{\text{spot}} = 10.1 \pm 0.4 \text{ AU}$$

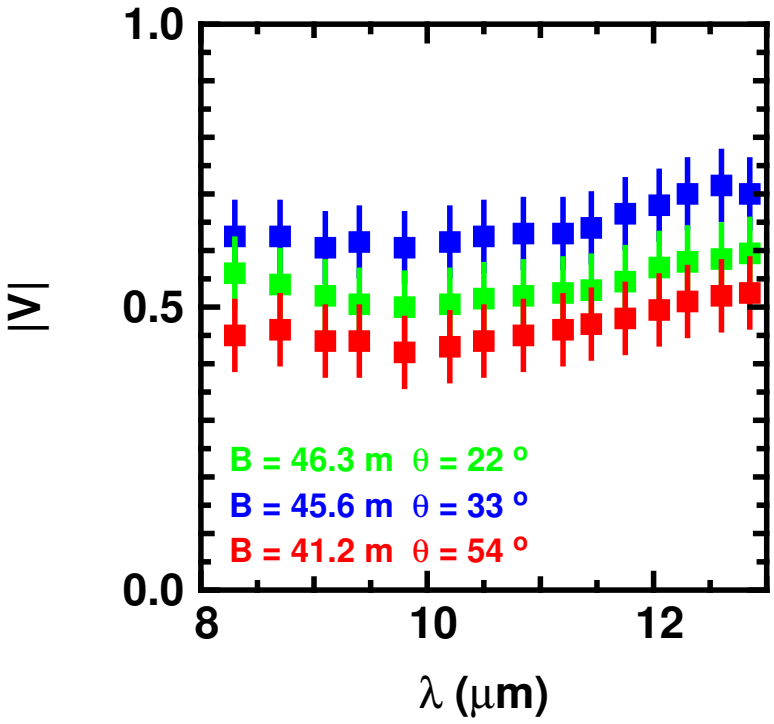
$$\theta_{\text{spot}} = 130 \pm 1^{\circ}$$



MIDI observation of Hen 3 1191 (1)

B[e] star: either YSO or proto-PN.

Resolved in N, Lachaume et al. 2005, in prep



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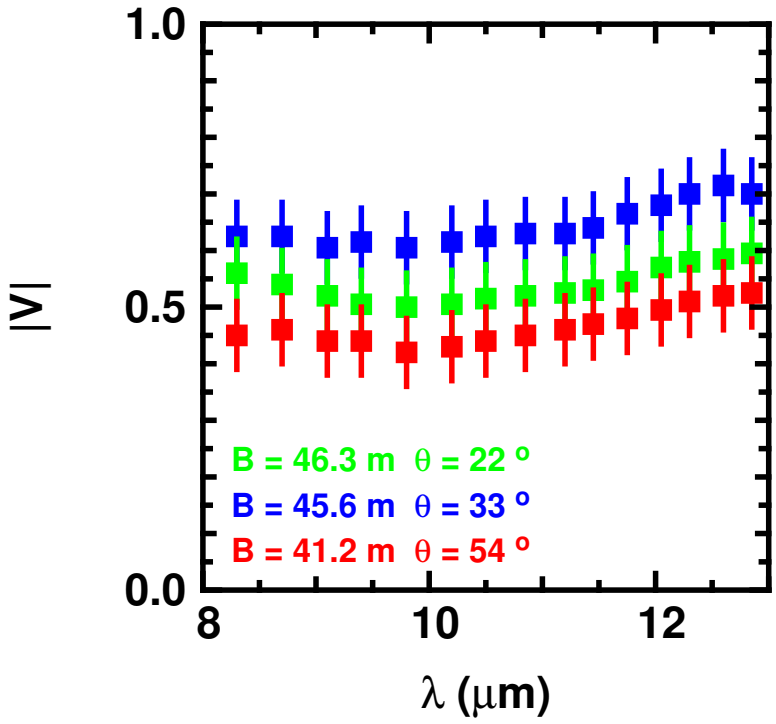

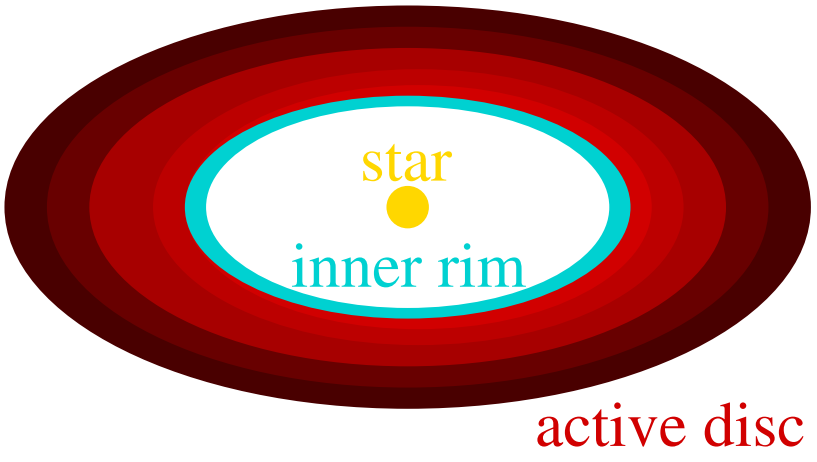

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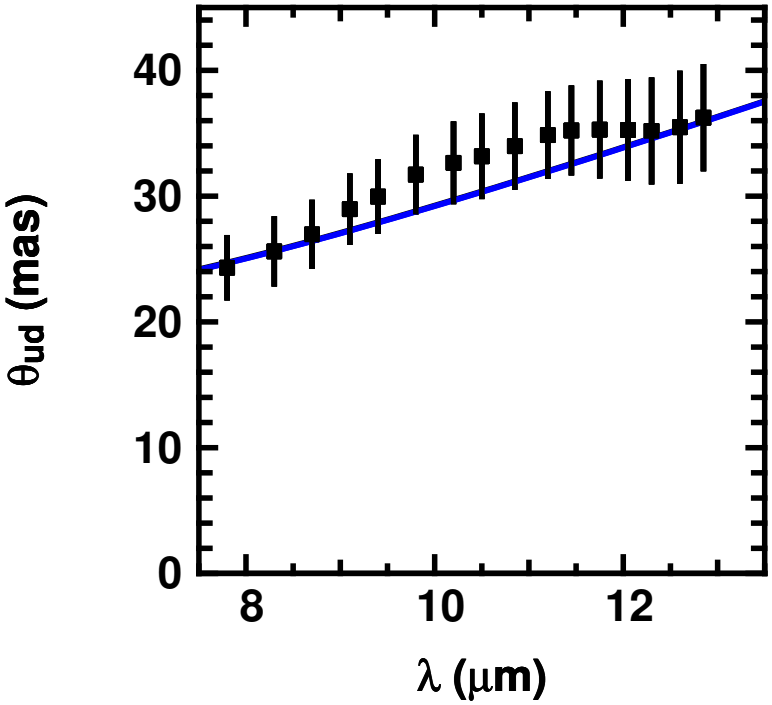
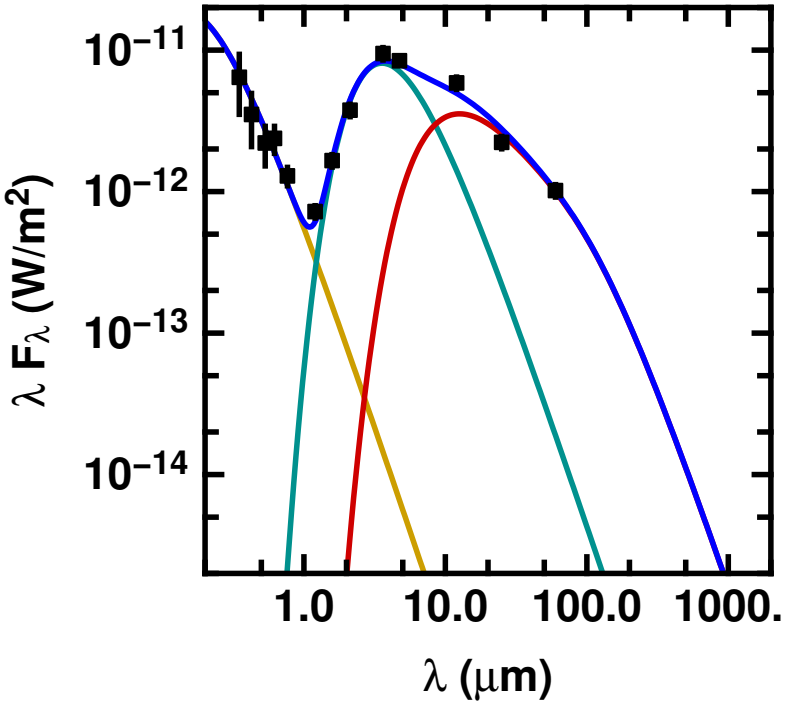




star = B1.5 star

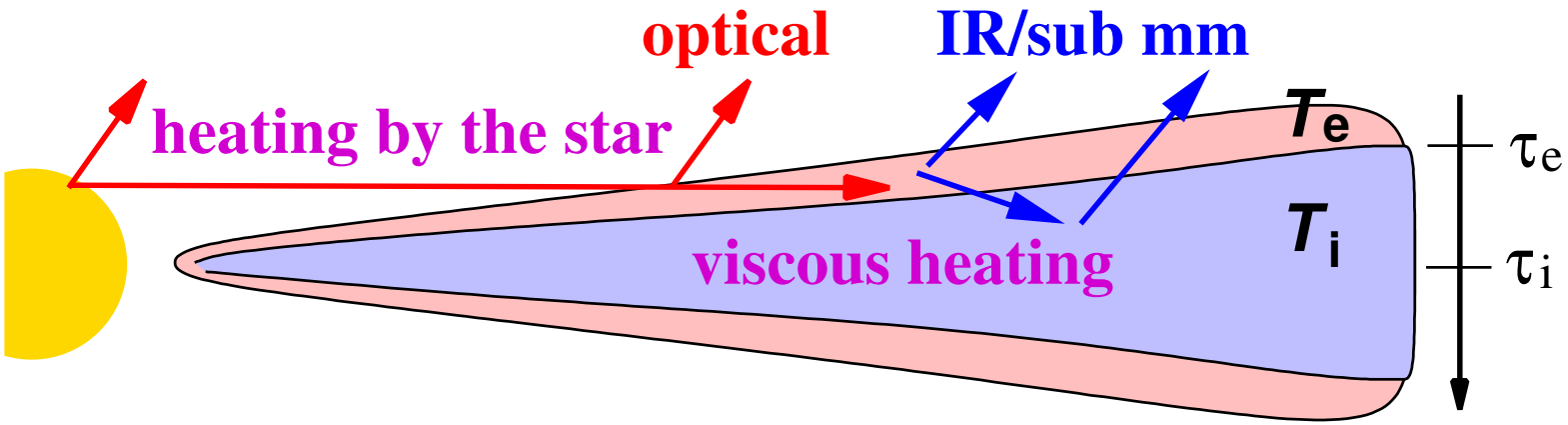
$\dot{M}/M_\star$ = **1.5 × 10^{-3}** yr^{-1} !

$r_{\rm rim}$ = **30** AU ($T_{\rm rim}$ = **1000** K)

Radiative transfer modelling

Using two-layer disc models

Generalised Chiang & Goldreich (1997) two-layer models.



- Simple implementation
- Analytical dependencies

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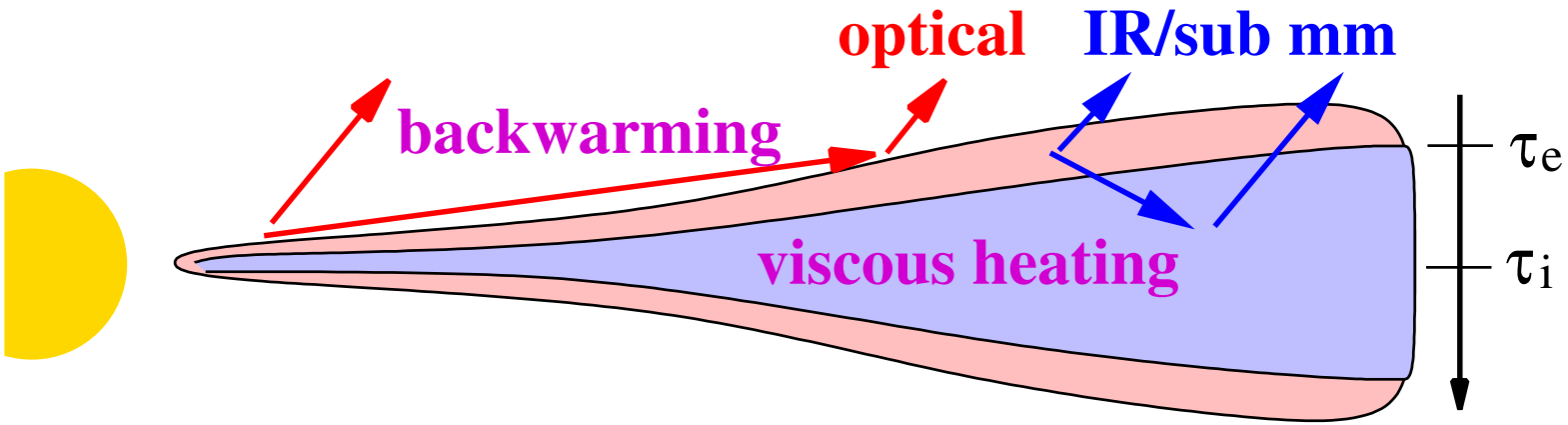

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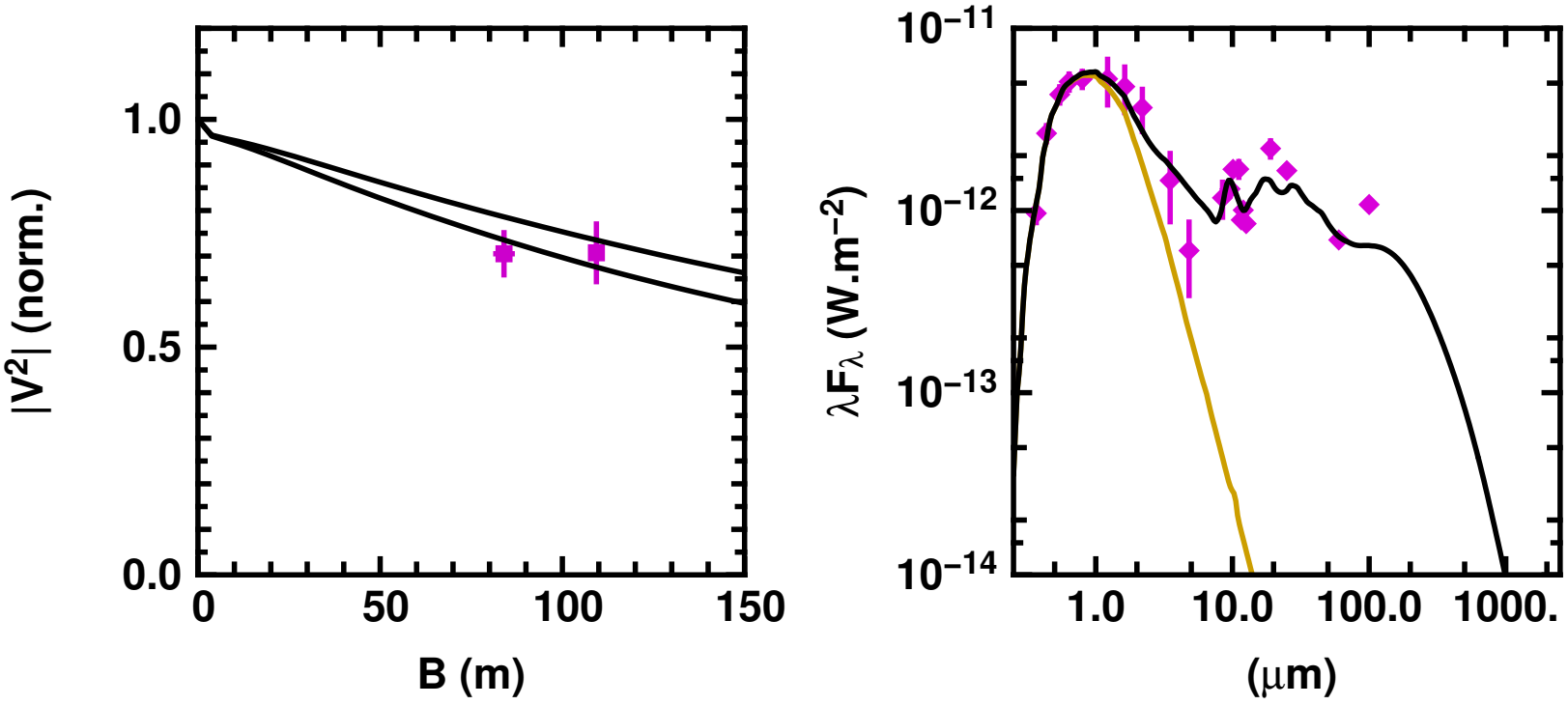
PTI observation of SU Aur

Irradiation by the star and accretion

Lachaume et al. 2003, A&A 400, 795



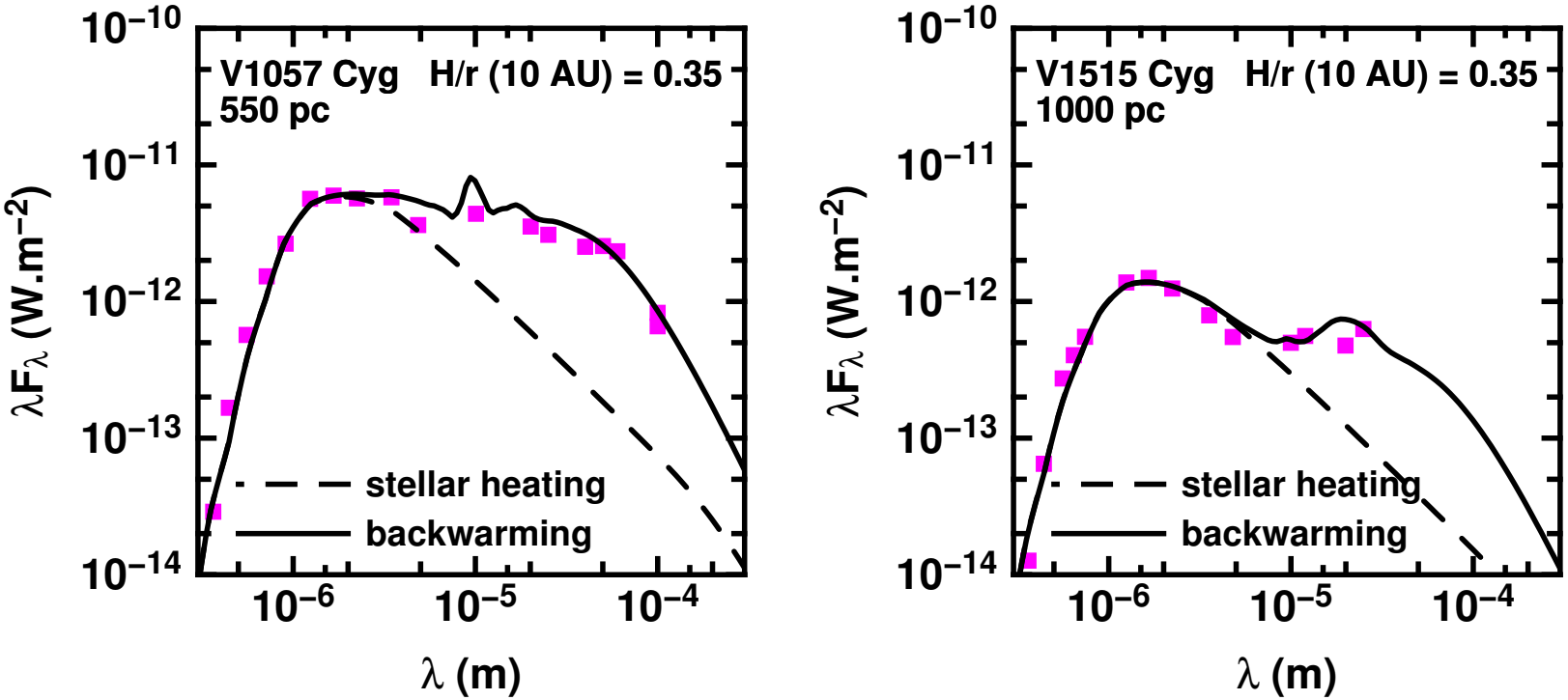
star = G2 star

$\dot{M} = 2\text{–}10 \times 10^{-8} M_\odot/\mathrm{yr}$

The mid-IR SED of FU Ori stars

Backwarming of the disc and accretion

Lachaume 2004, A&A, 422, 171



→ N-band interferometry

Conclusion

Main points

- In absence of image reconstruction, be careful:
  - count with extended contribution;
  - combine with other observables.

Still new constraints on the physics of the first AUs

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  - count with extended contribution;
  - combine with other observables.

  Still new constraints on the physics of the first AUs
- Forthcoming large data sets with the VLTI need
  - “toy models” for a first interpretation;
  - new, detailed simulations
    - Accretion and irradiation often occur together, which no current model self-consistently describes.
    - Optically thick inner parts are not directly seen, though their physics condition planet formation.