Star-disk interplay in the resolved emission of young stellar objects

The case of MWC158 observed with the VLTI

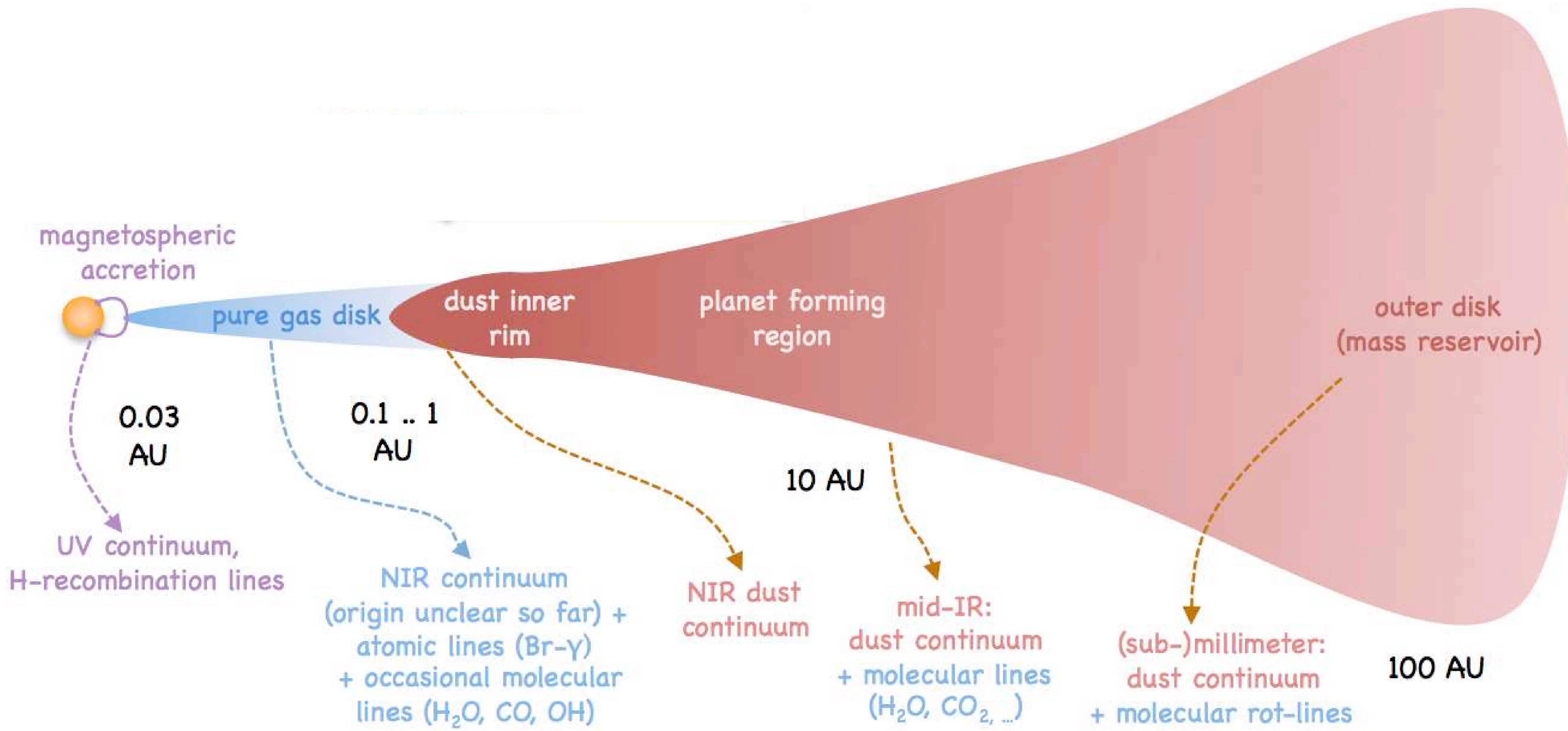
F. Malbet, J. Kluska, J.-P. Berger, F. Ménard, C. Pinte, J.-B. Le Bouquin, B. Lazareff, R. Millan-gabet, W. Traub, M. Benisty

IPAG
Institut de Planétologie et d'Astrophysique de Grenoble

OSUG
Observatoire des Sciences de l'Univers de Grenoble

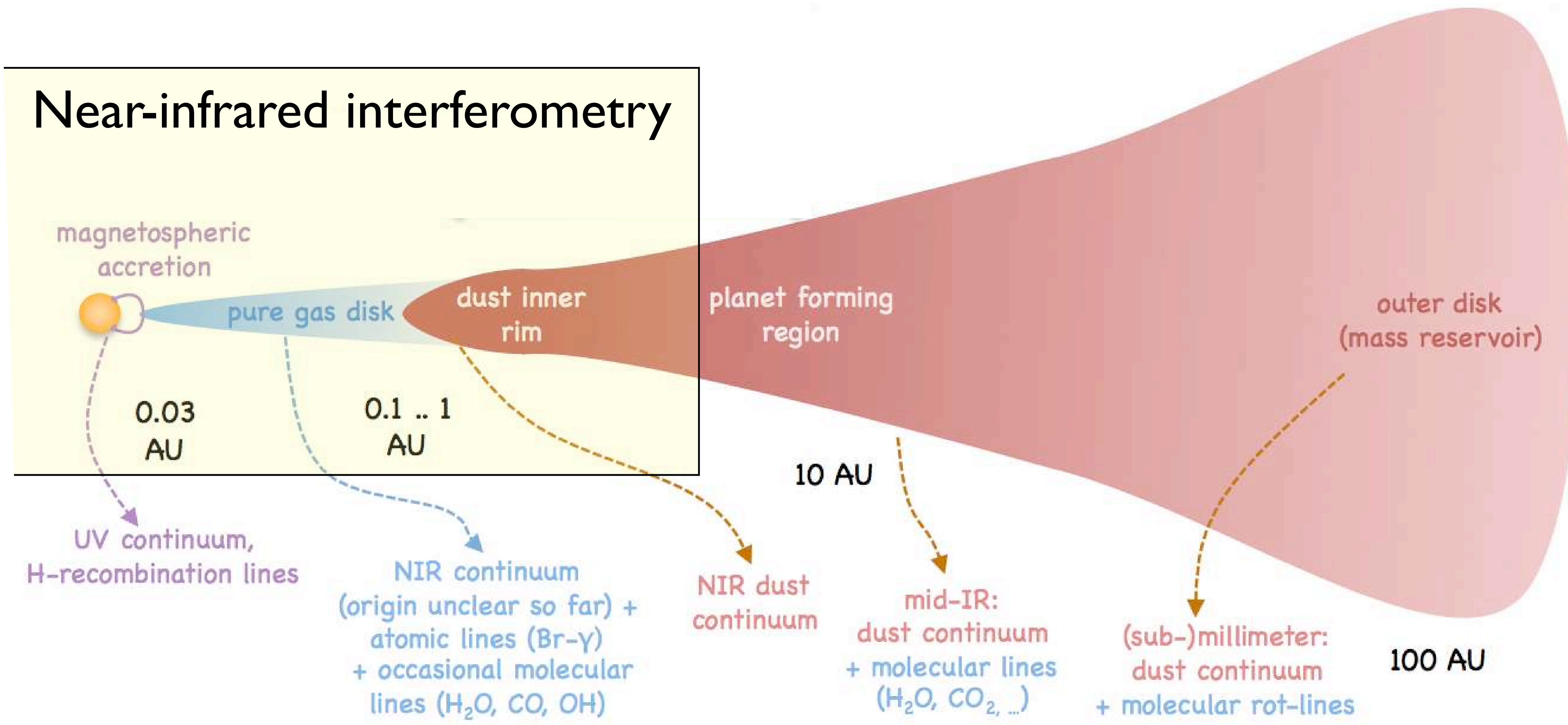
ESO conference *« Ten years of VLTI: from first fringes to core science »*
Garching, 24-28 October 2011

Close environment of young stars



Dullemond & Monnier (2010, ARAA)

Close environment of young stars

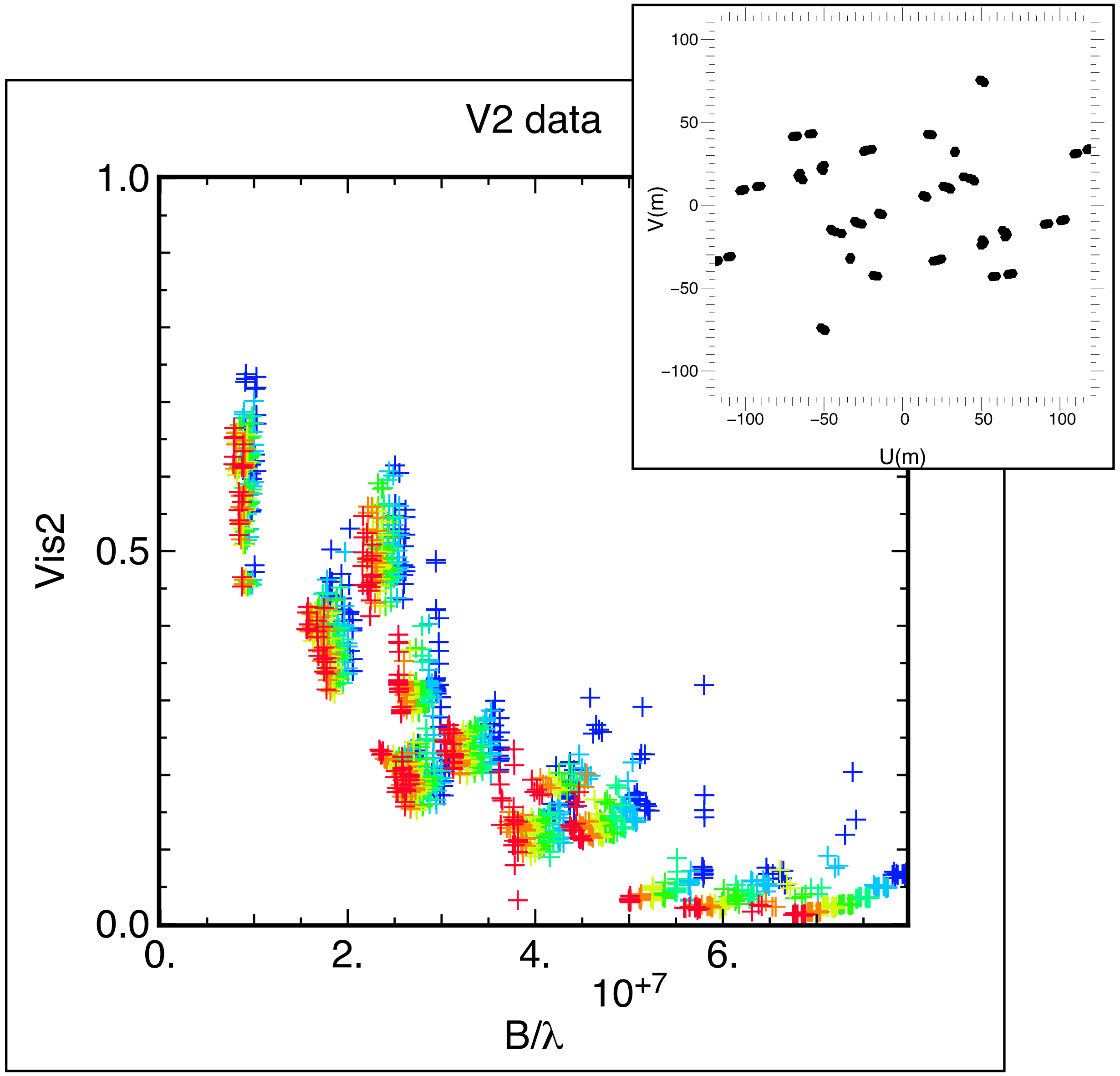


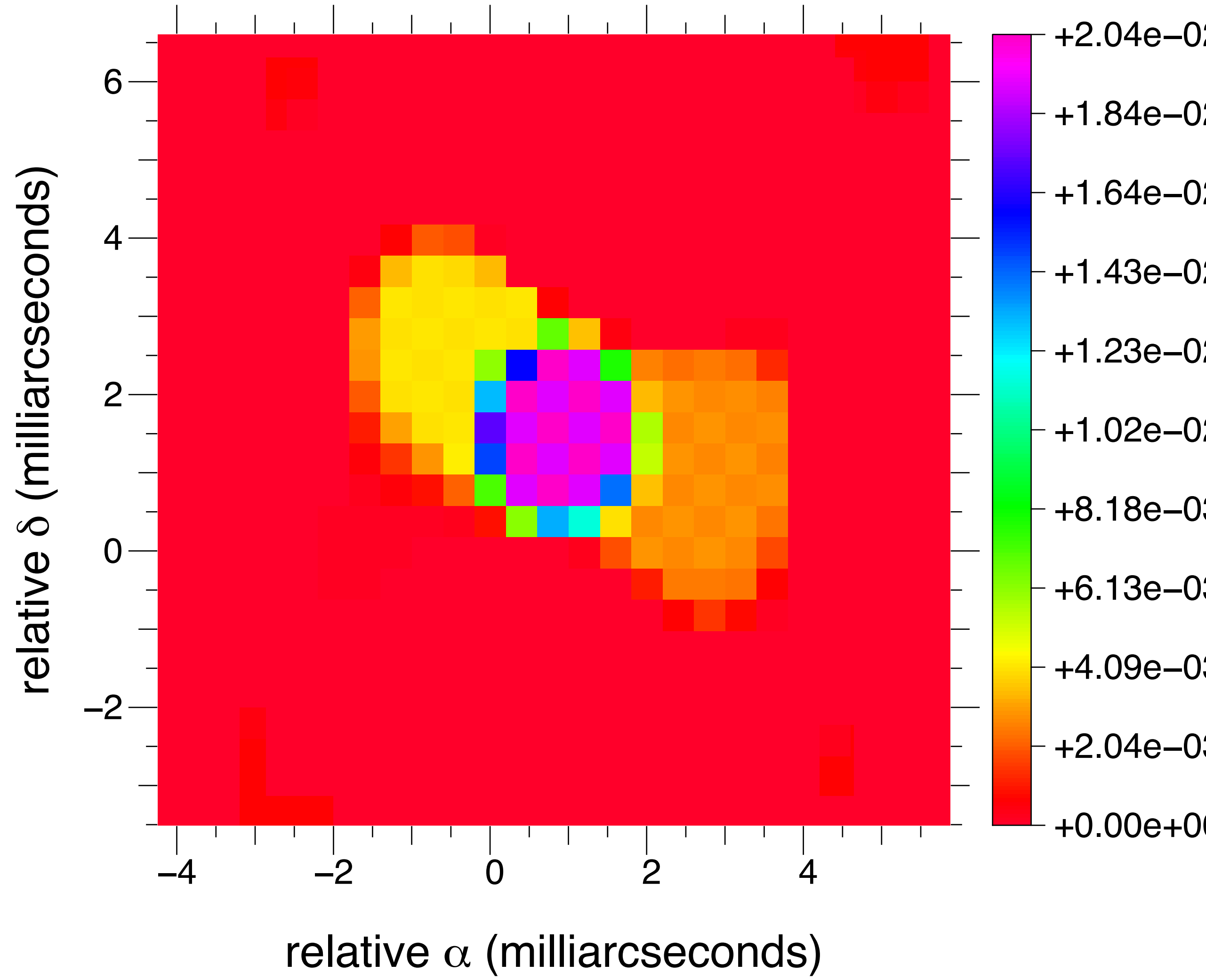
Dullemond & Monnier (2010, ARAA)

VLT Interferometry is now mature enough to provide:

- Enough data to perform a precise modelling of the environment
- Image reconstruction using aperture synthesis

Can we perform **gray** image reconstruction?

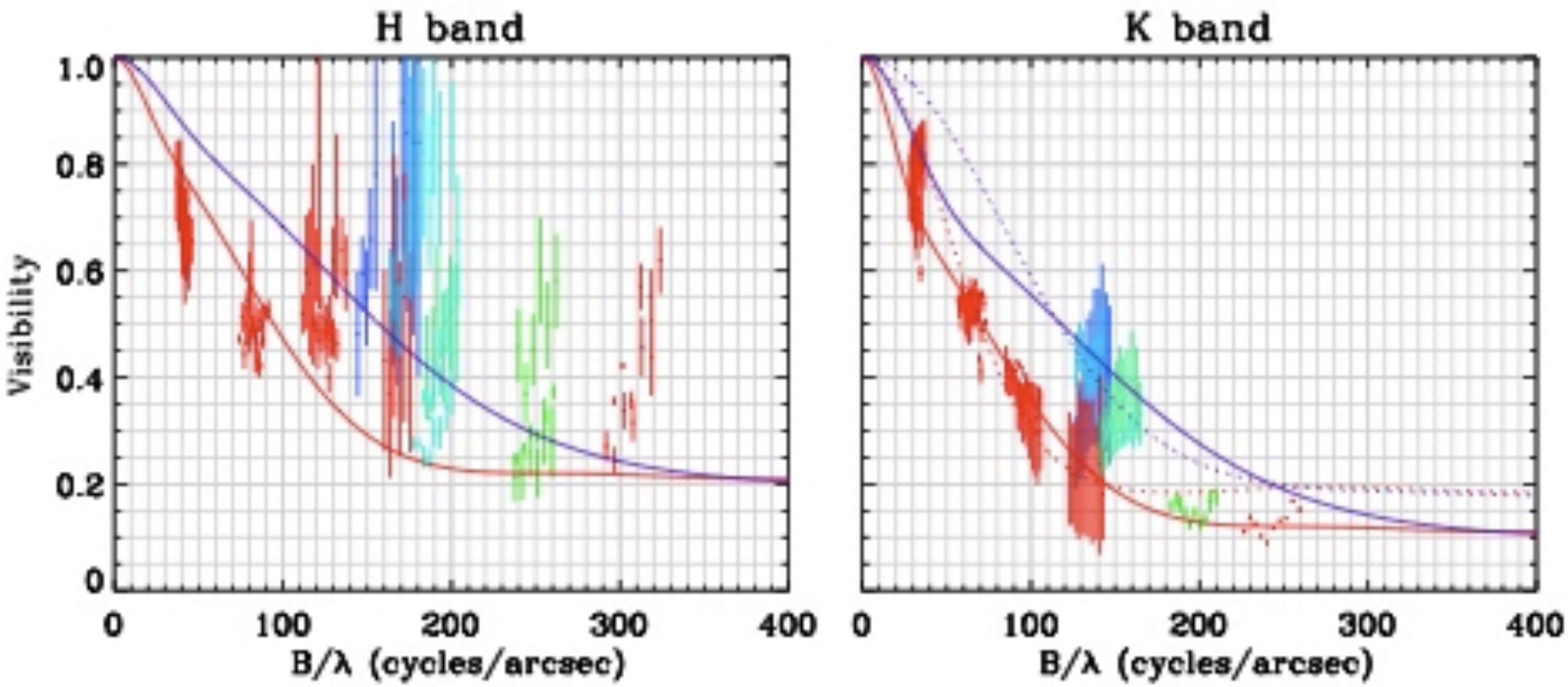




MWC 158 data obtained with VLTI/PIONIER.

- Why is there such a large visibility dispersion with wavelength?
- Is **image reconstruction** using wavelength synthesis and gray hypothesis still valid?

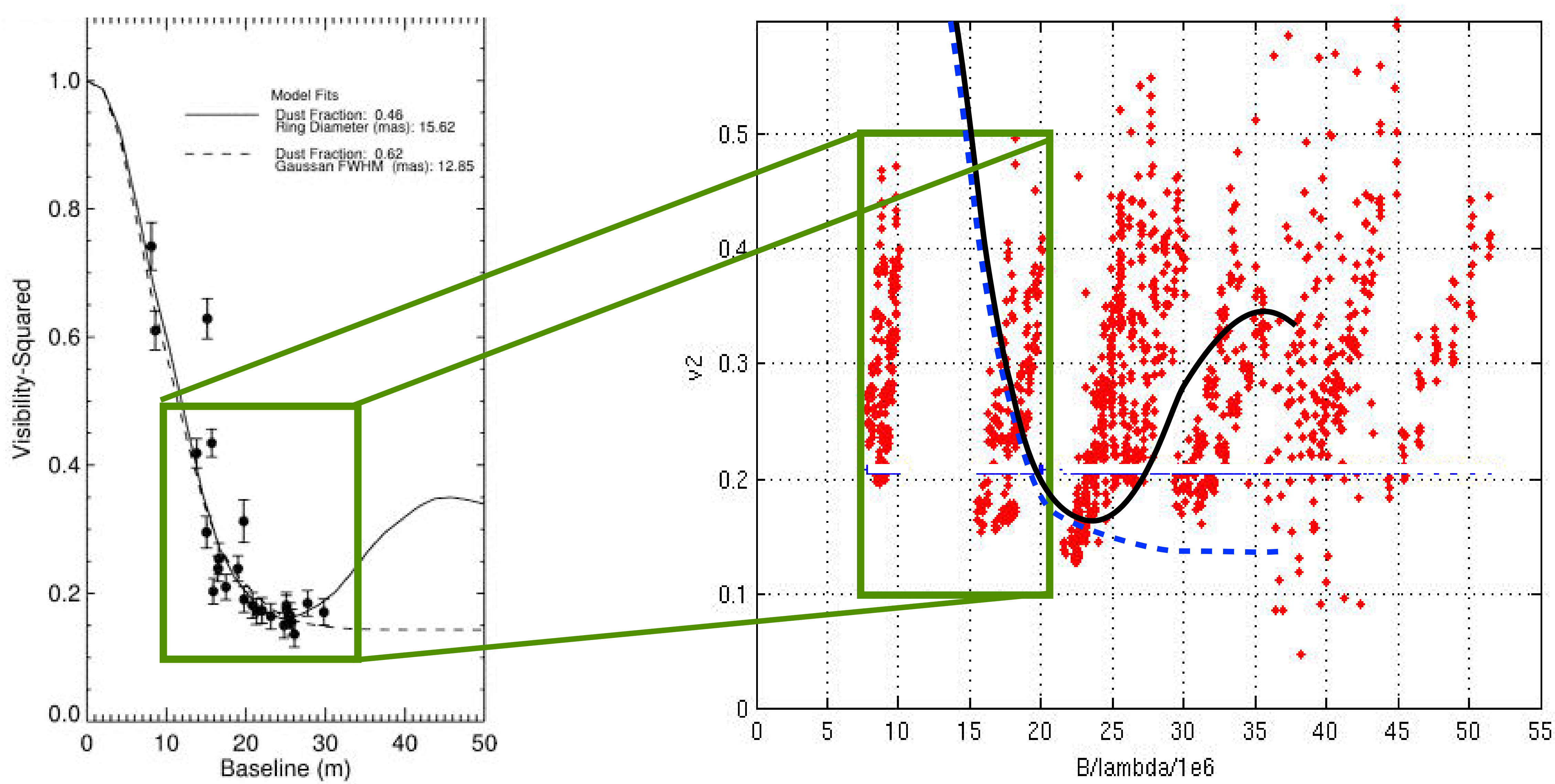
MWC158 observed with AMBER



Borges Fernandes et al. (2011, A&A 528, A20)

- ✓ Precise modelling of a disk with: θ = 72±7° and i = 56±4°
- ✓ H-band data more dispersed than K-band data:
  - ➡ Is it because of the instrument and the atmosphere?

H-band: difference between broad-band data and spectral dispersed data in HD 45677



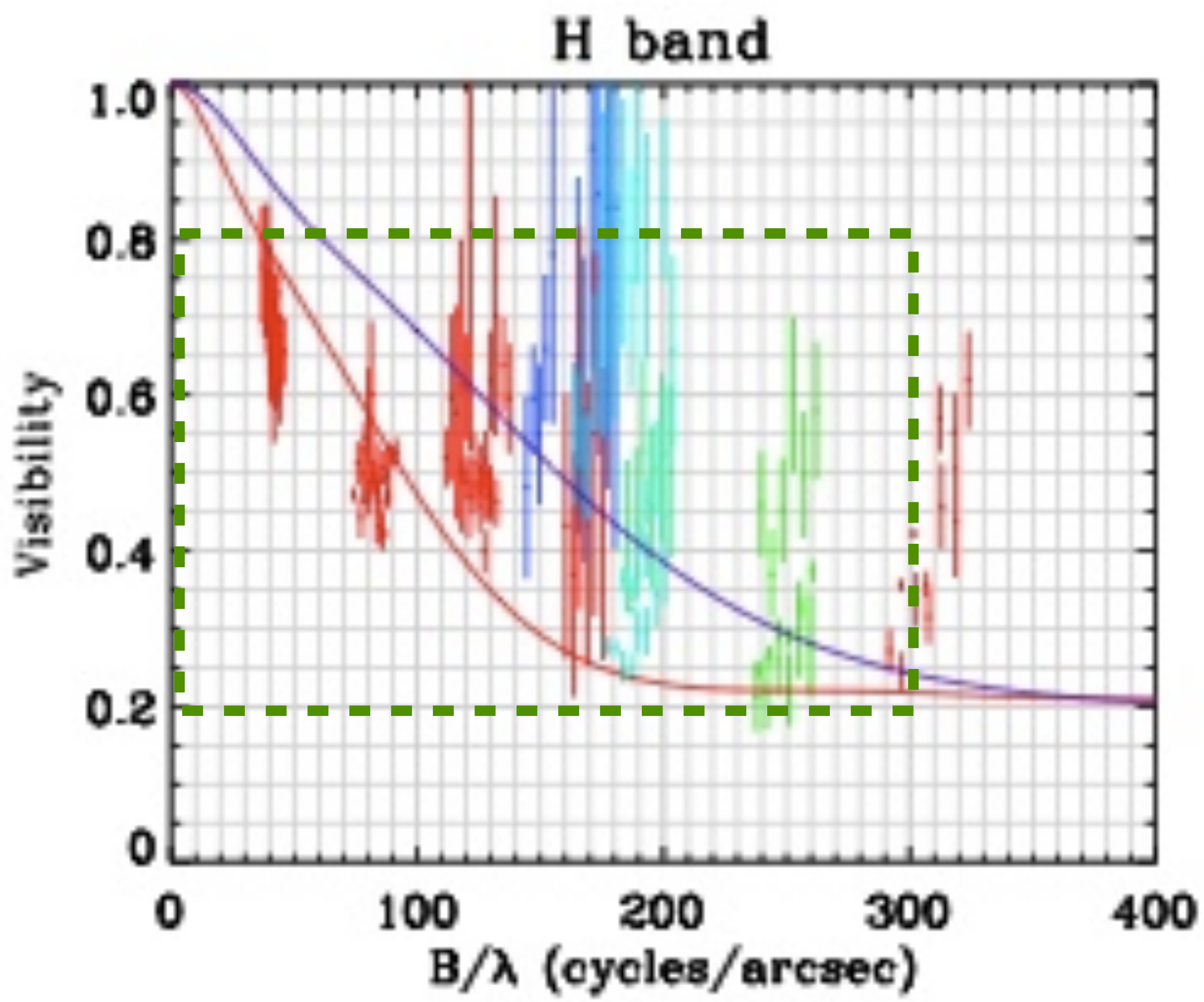
IONIC

Monnier et al. (2006, ApJ 647, 444)

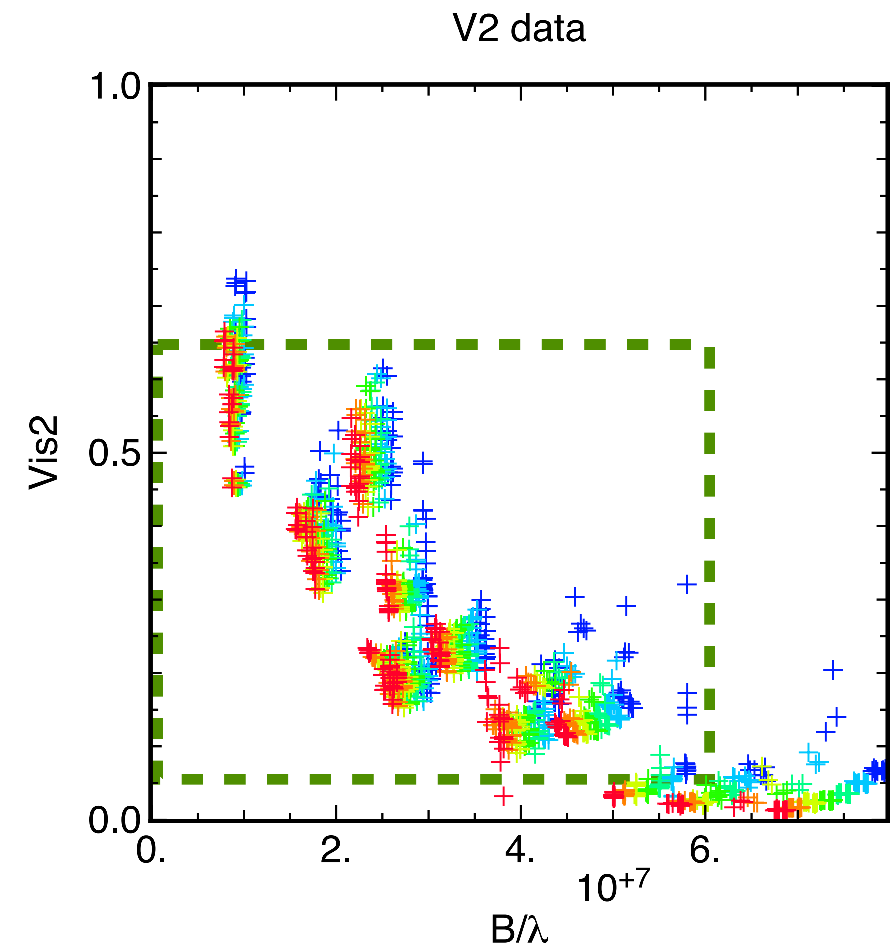
PIONIER

Lazareff et al. (2011, in prep.). See Wed talk.

MWC 158 in H-band with PIONIER and AMBER

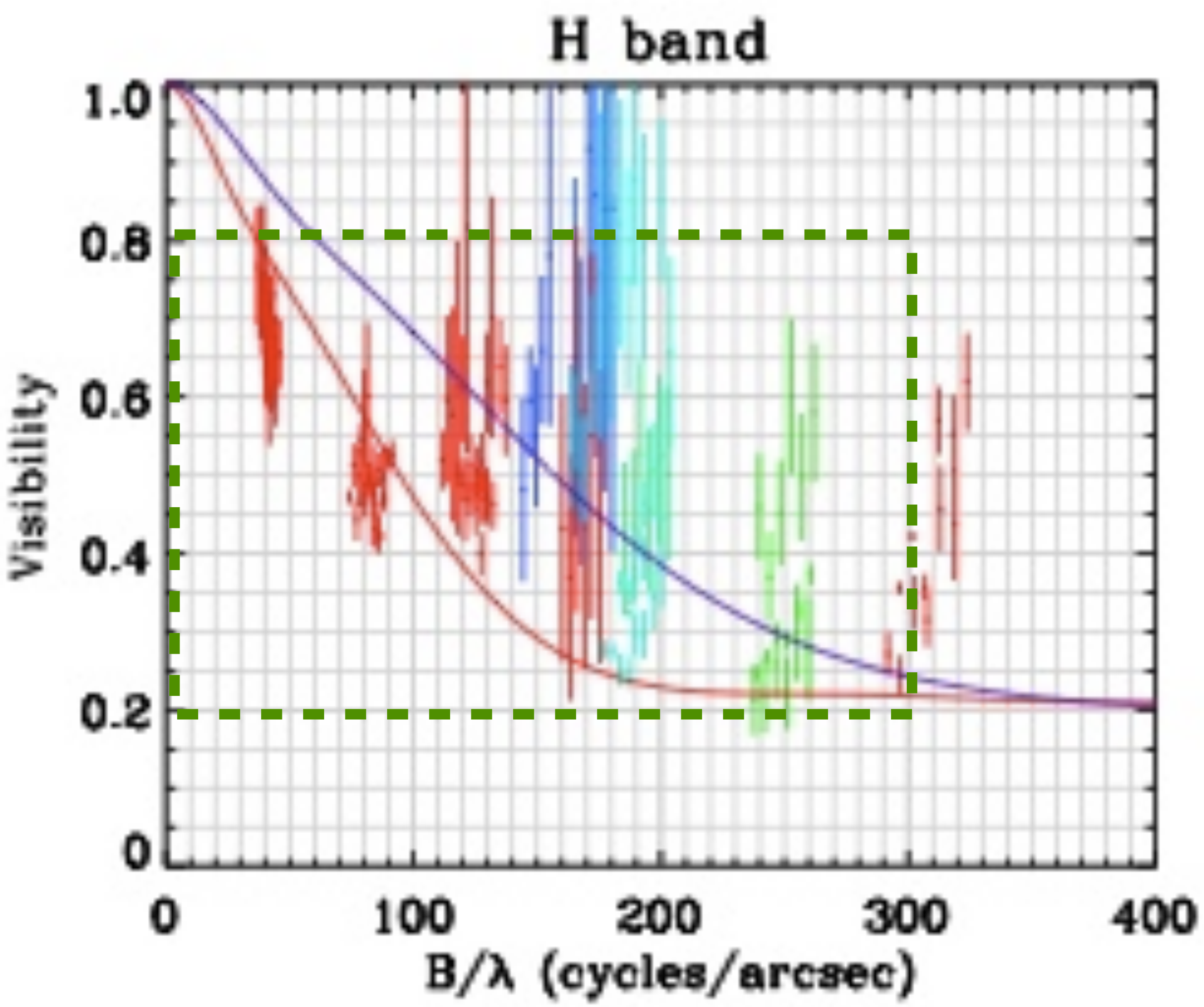


AMBER

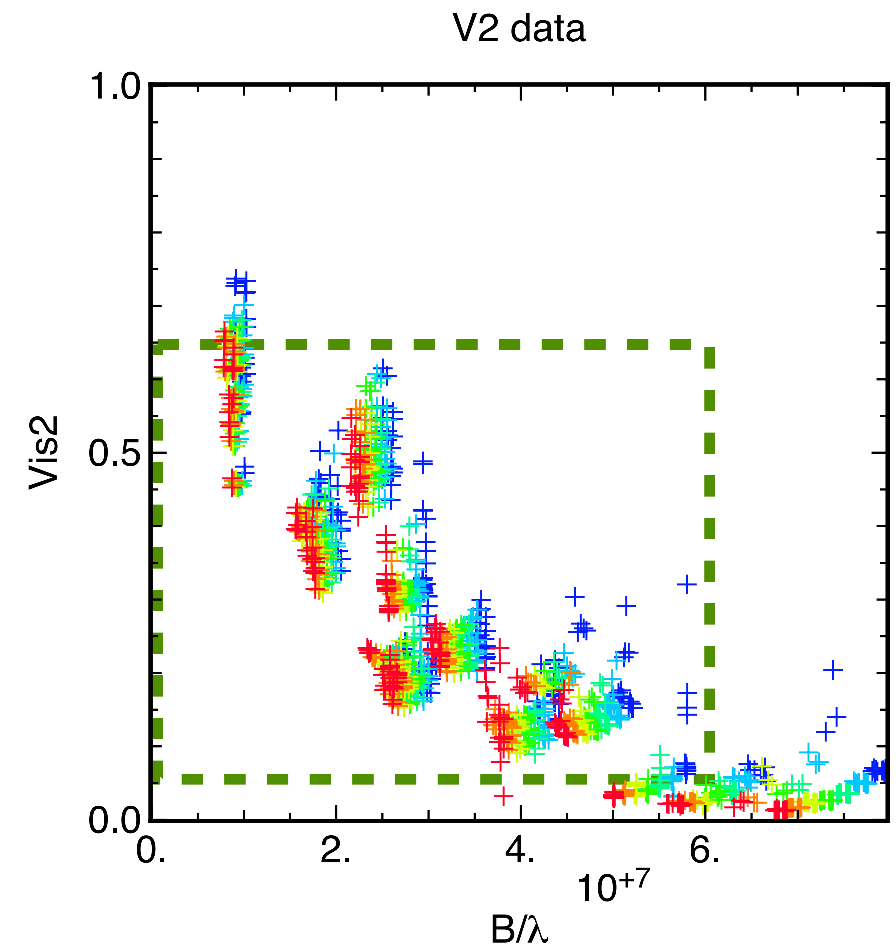


PIONIER

MWC 158 in H-band with PIONIER and AMBER



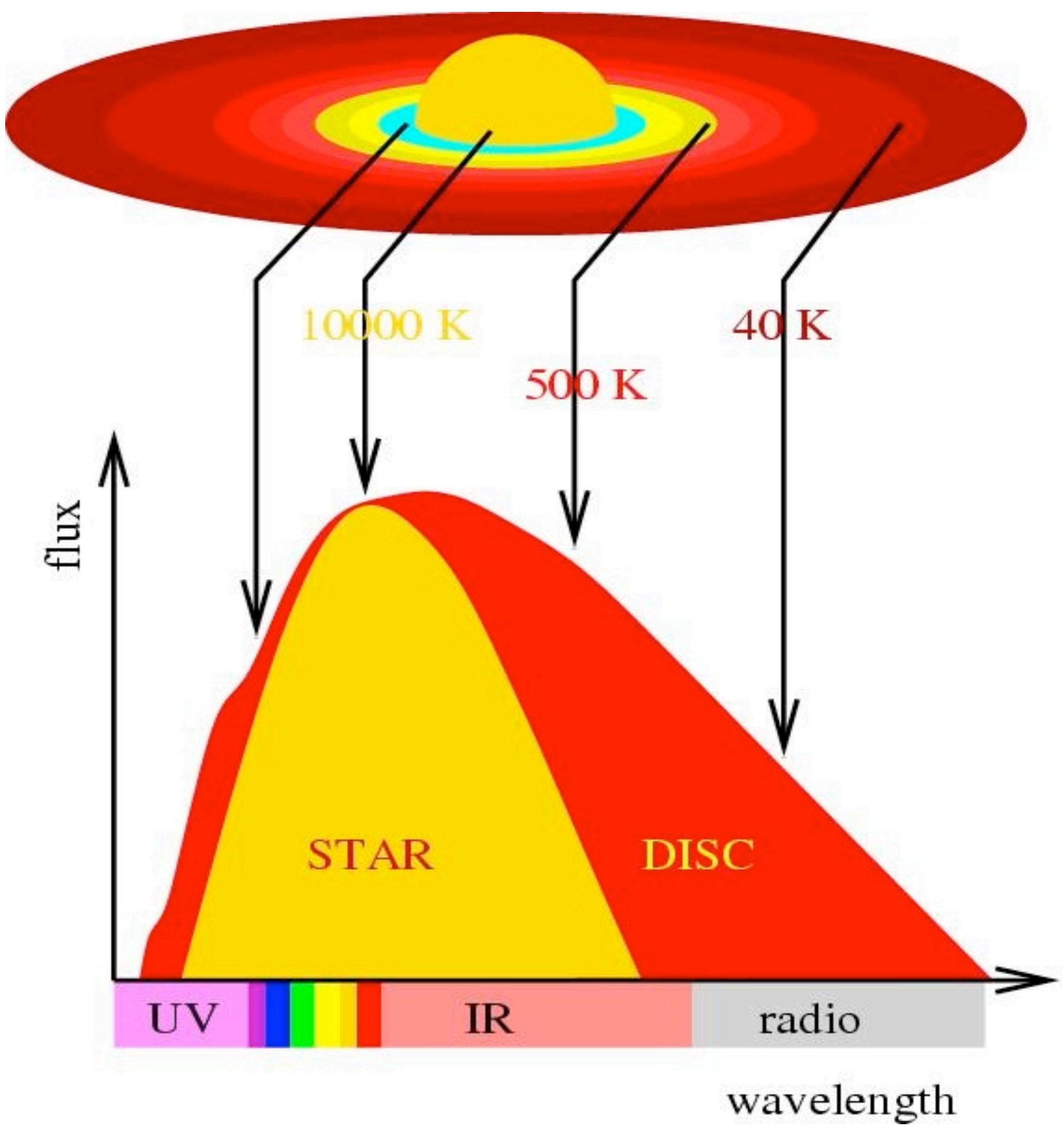
AMBER



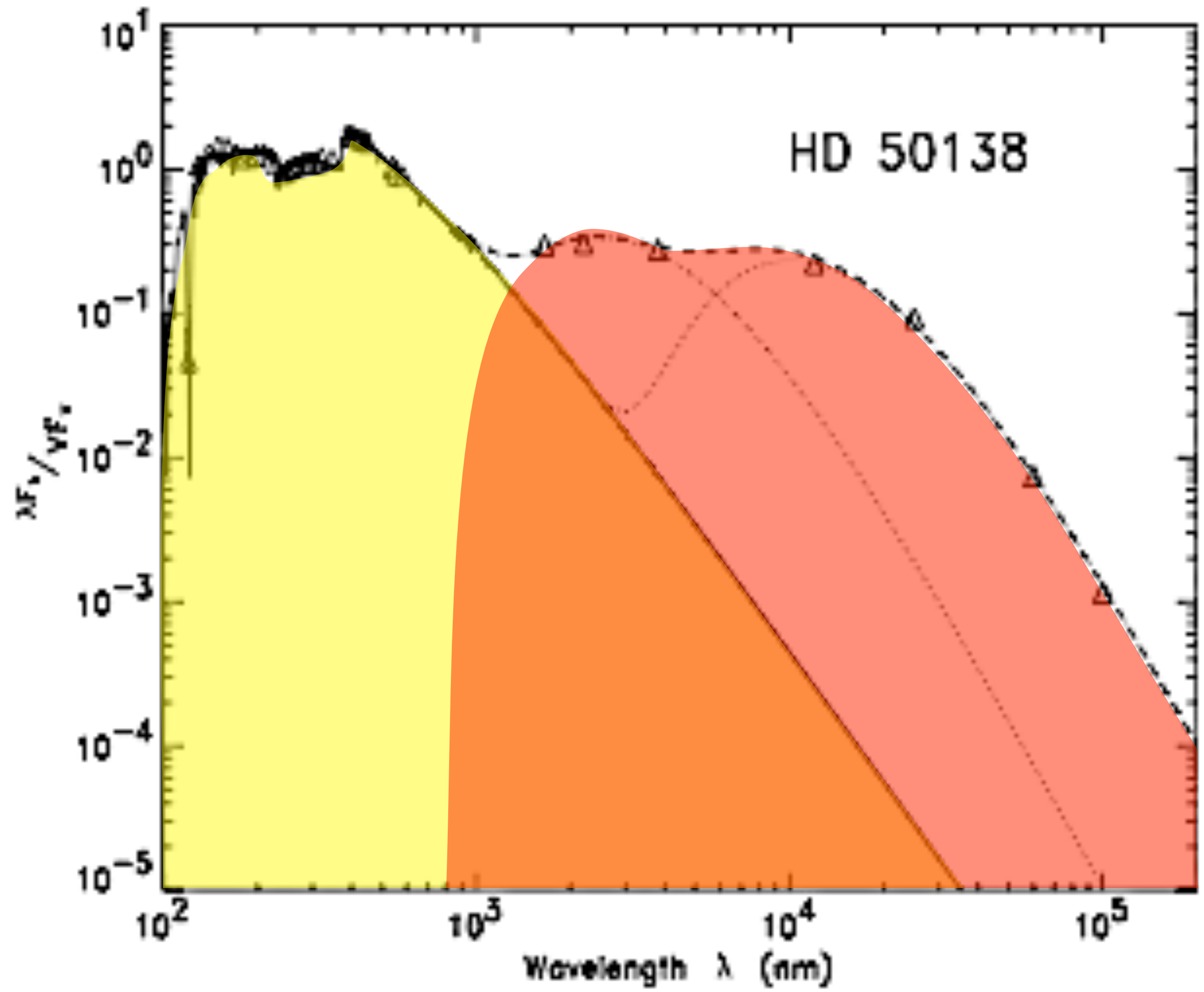
PIONIER

➡ this is not an instrumental defect !!

Components in the Spectral Energy Distribution



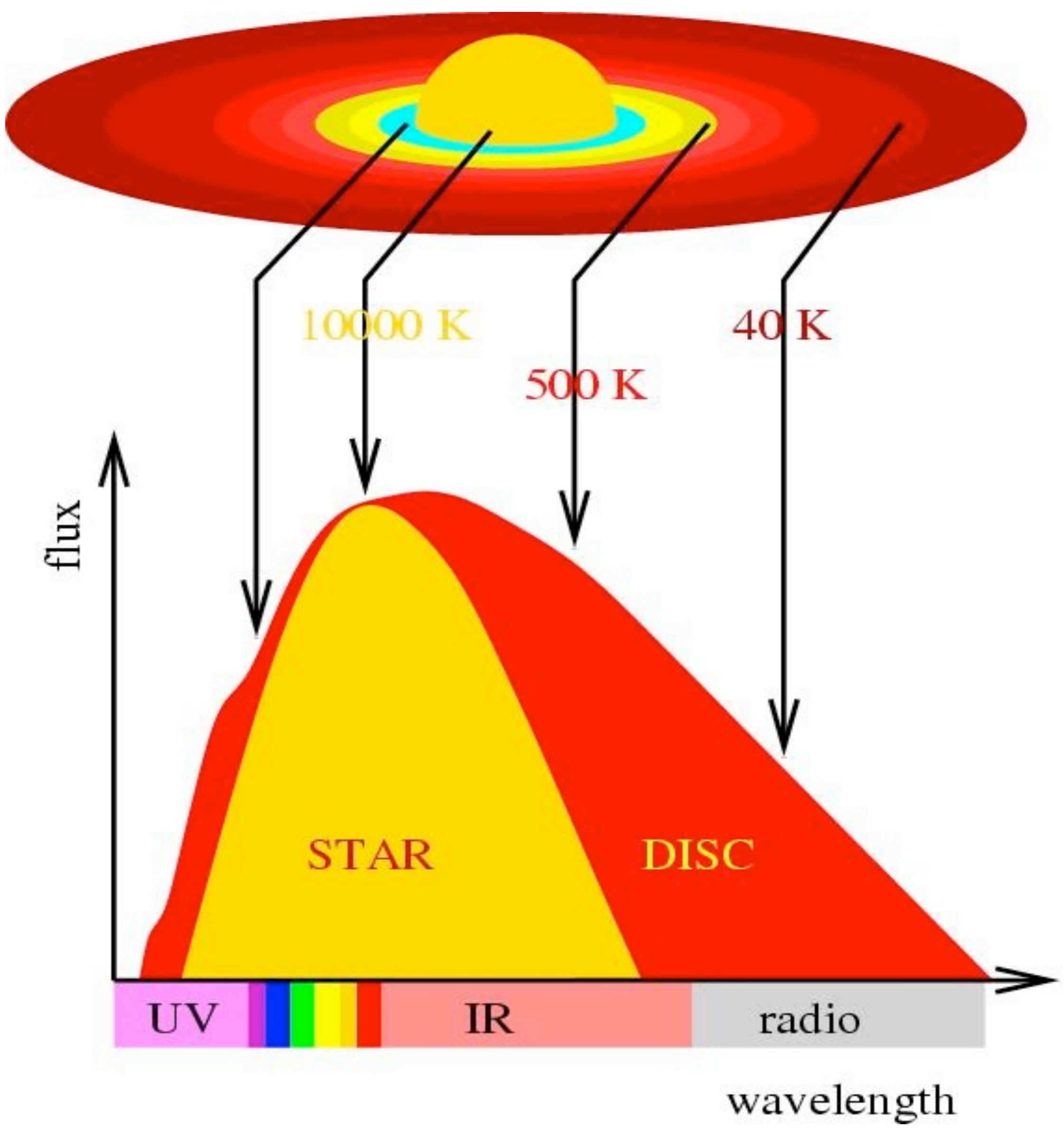
Lachaume (2004)



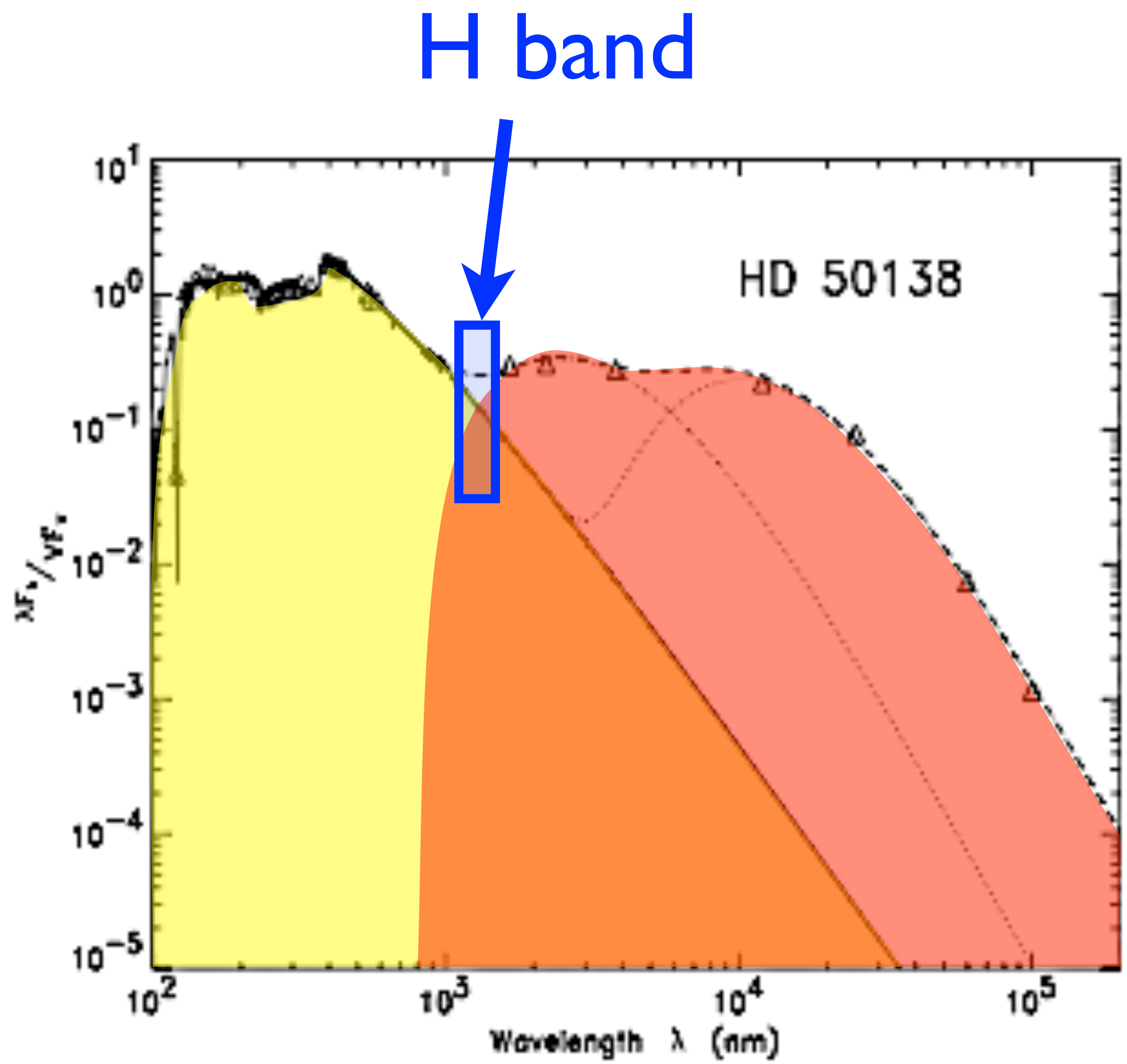
Malfait et al. (1998)

$$Ft = Fs + Fd \qquad Ft\ Vt = Fs\ Vs + Fd\ Vd$$

Components in the Spectral Energy Distribution



Lachaume (2004)

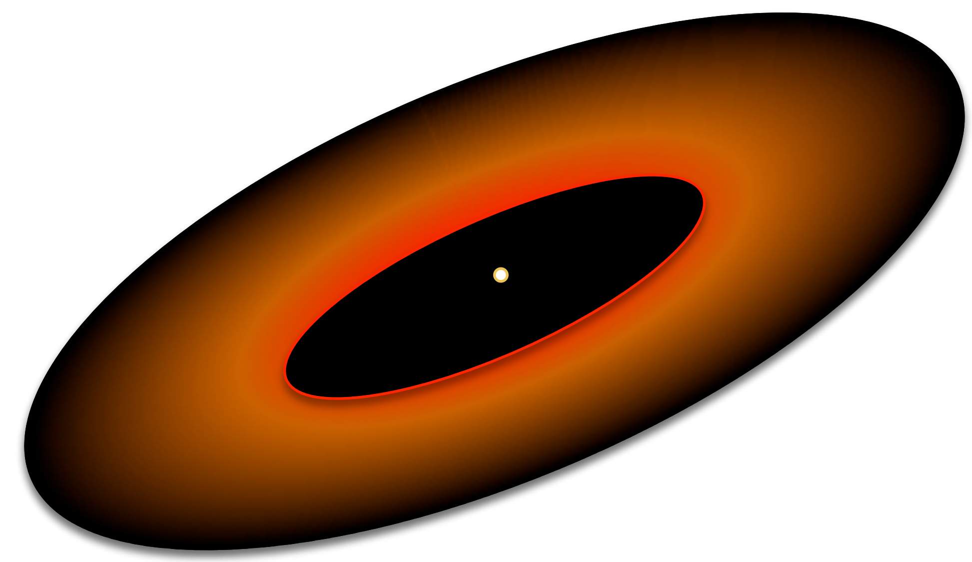


Malfait et al. (1998)

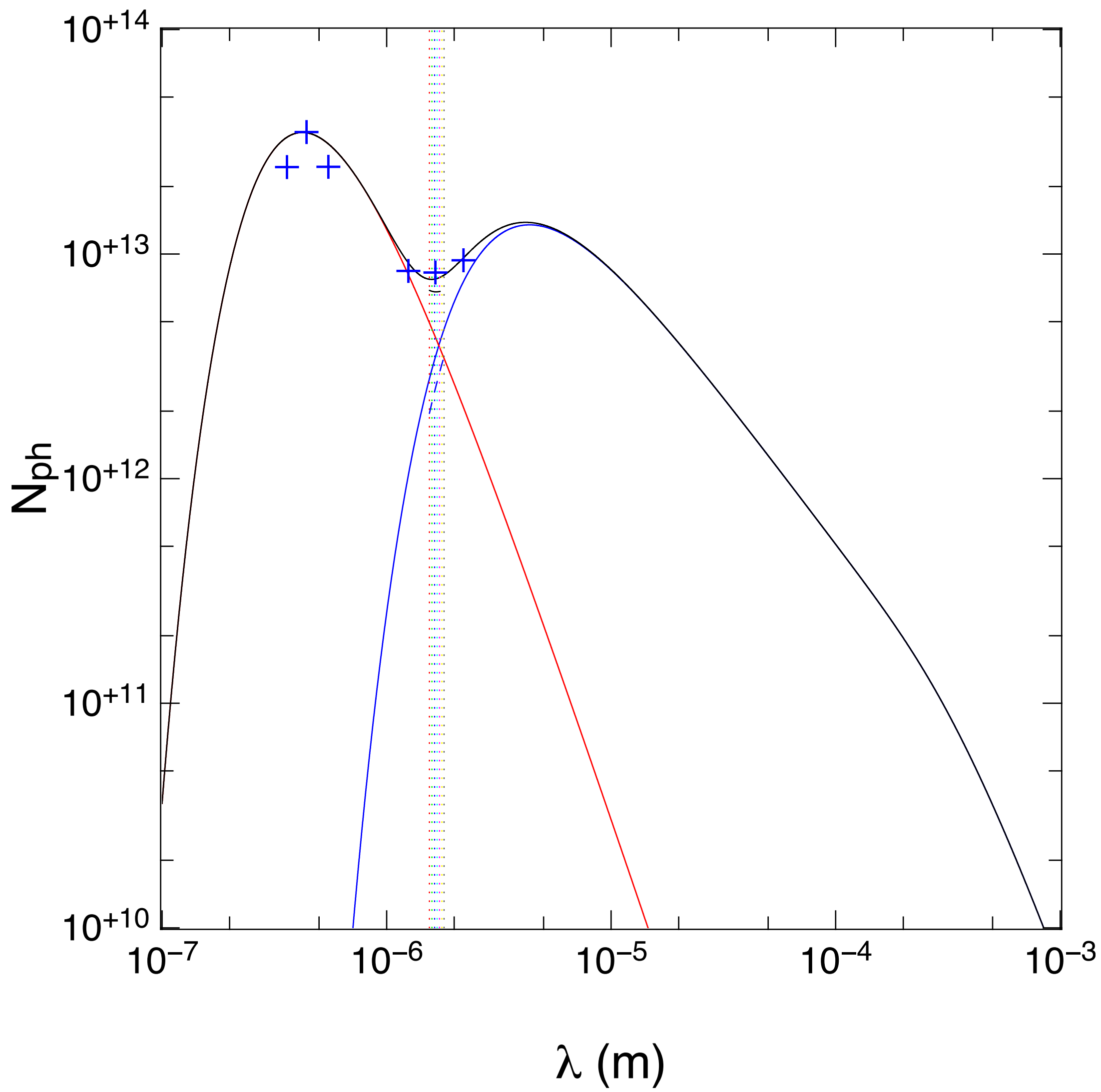
$$Ft = Fs + Fd \qquad Ft\ Vt = Fs\ Vs + Fd\ Vd$$

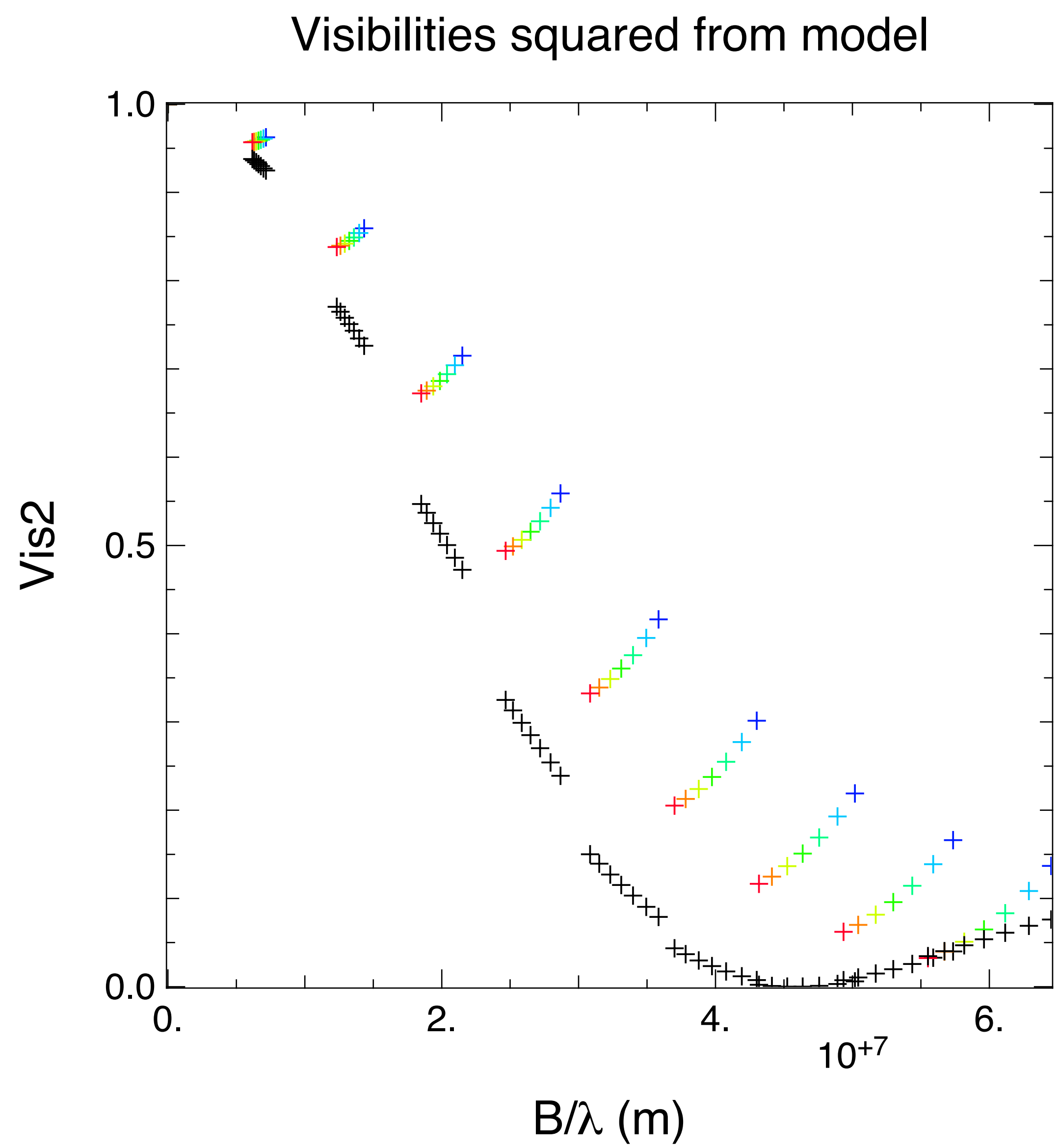
Polychromatic Model: standard disk + star

- Centro symmetric model
- Non-resolved star
- Rings-modelized thin disk
- SED modeling
- Interferometric data modeling



Polychromatic Disk Model + star: simulations

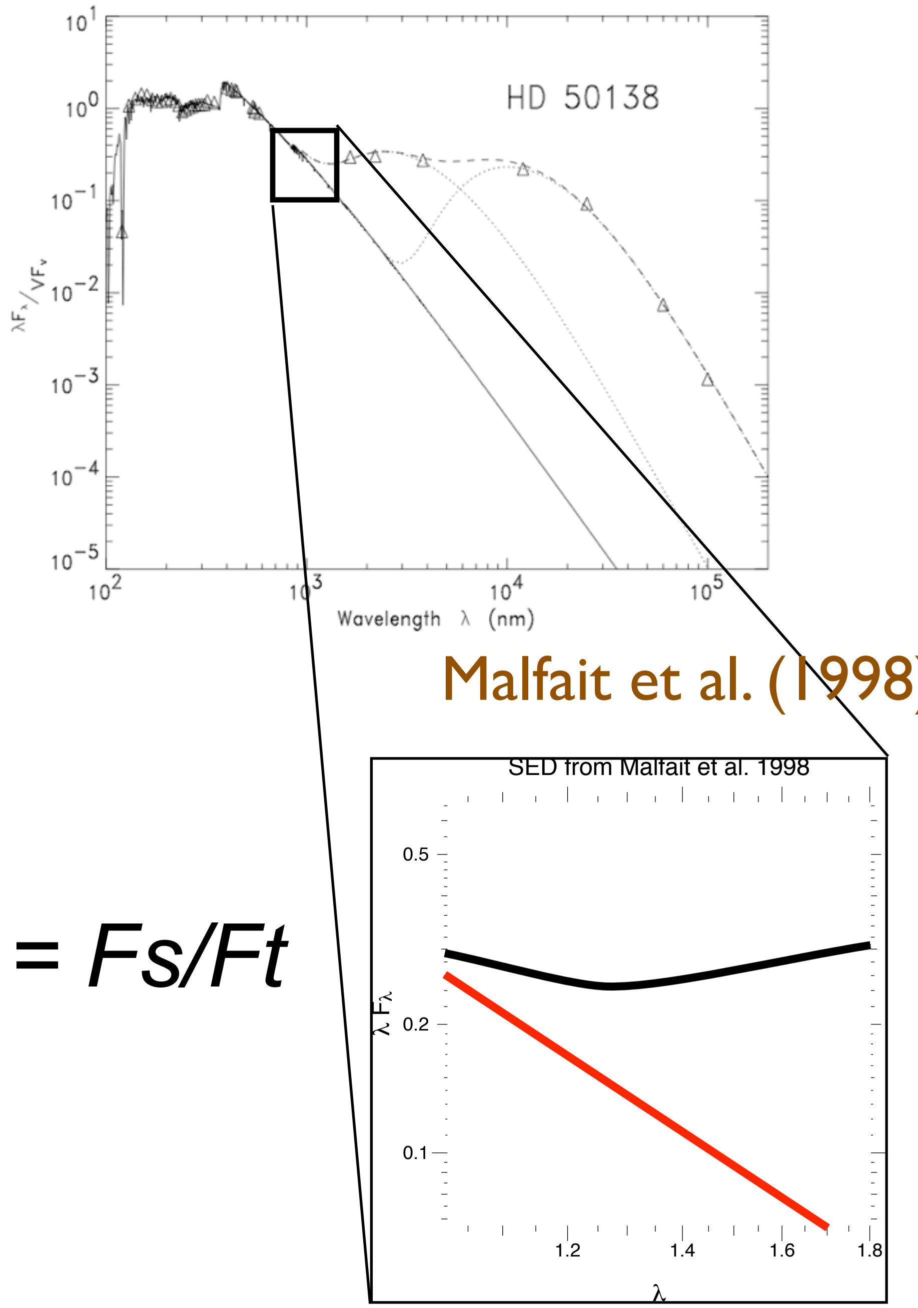




$Vt = f + (1\text{-}f)\ Vd$ => $1\text{-}Vt = (1\text{-}f)\ (1\text{-}Vd)$

Degenerescence between $f = Fs/Ft$ and Vd. We need f

« Correcting » from star contribution

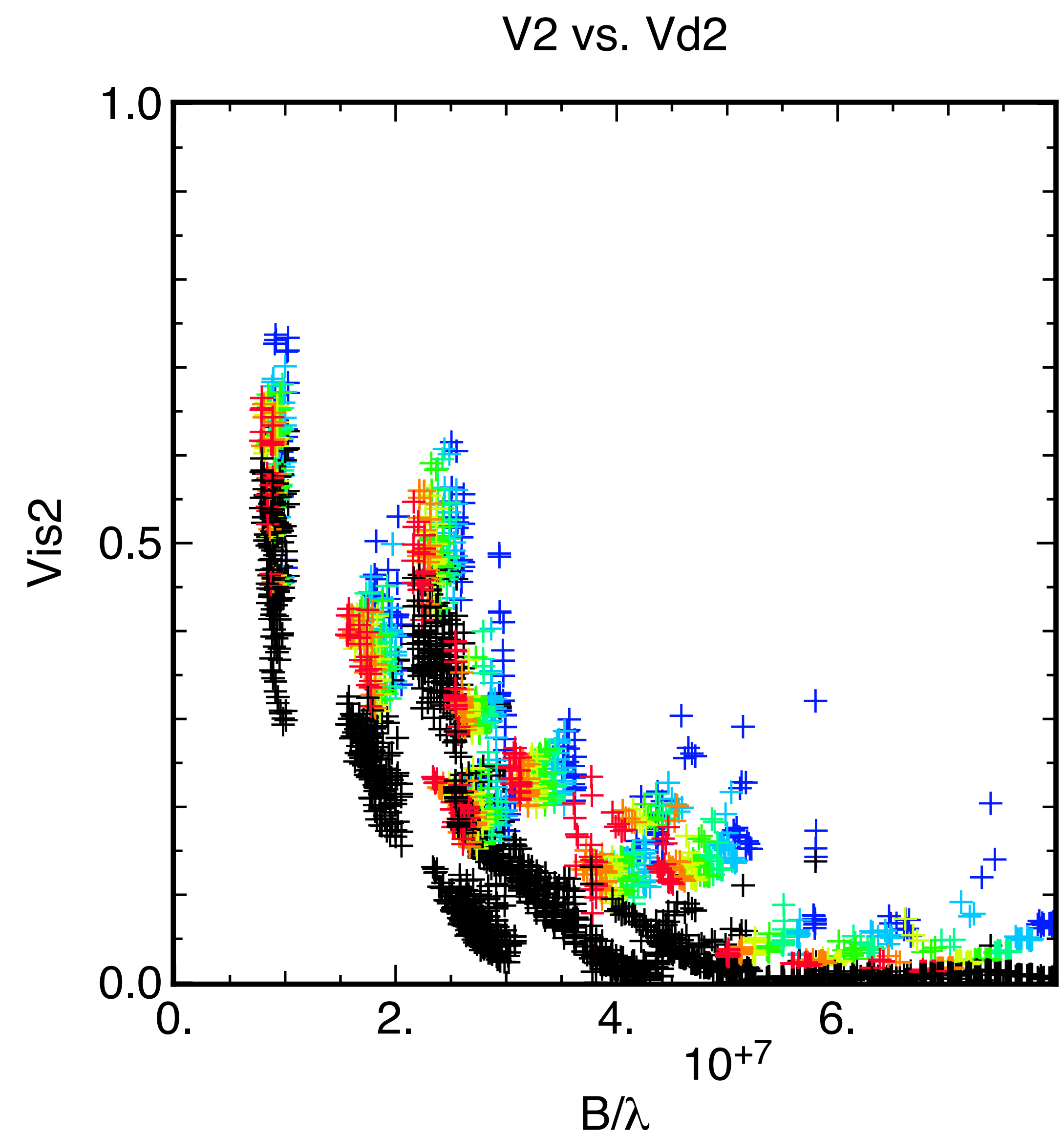


Malfait et al. (1998)

Ft

Fs

$f = Fs/Ft$

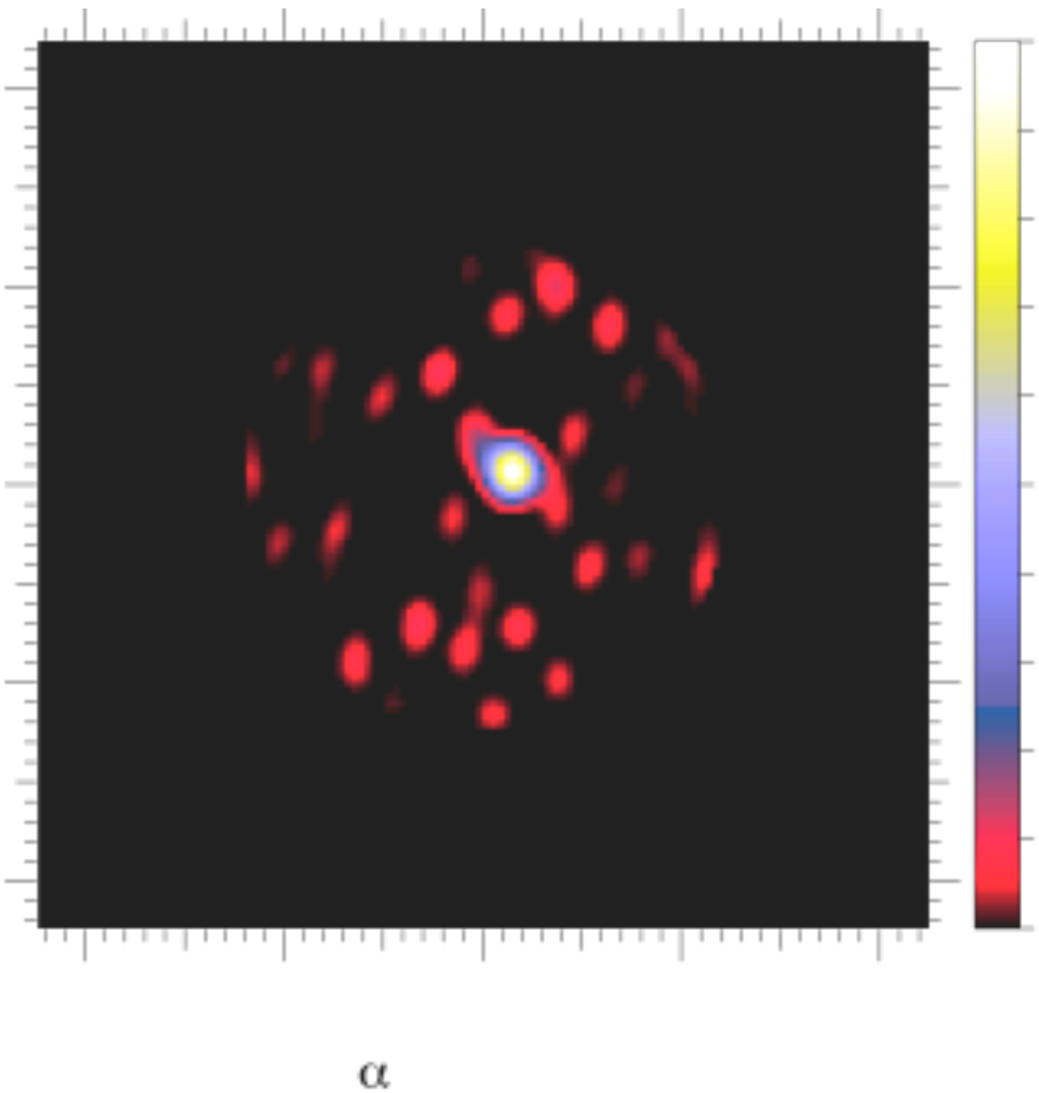


$Vd = 1-(1-Vt)/(1-f)$

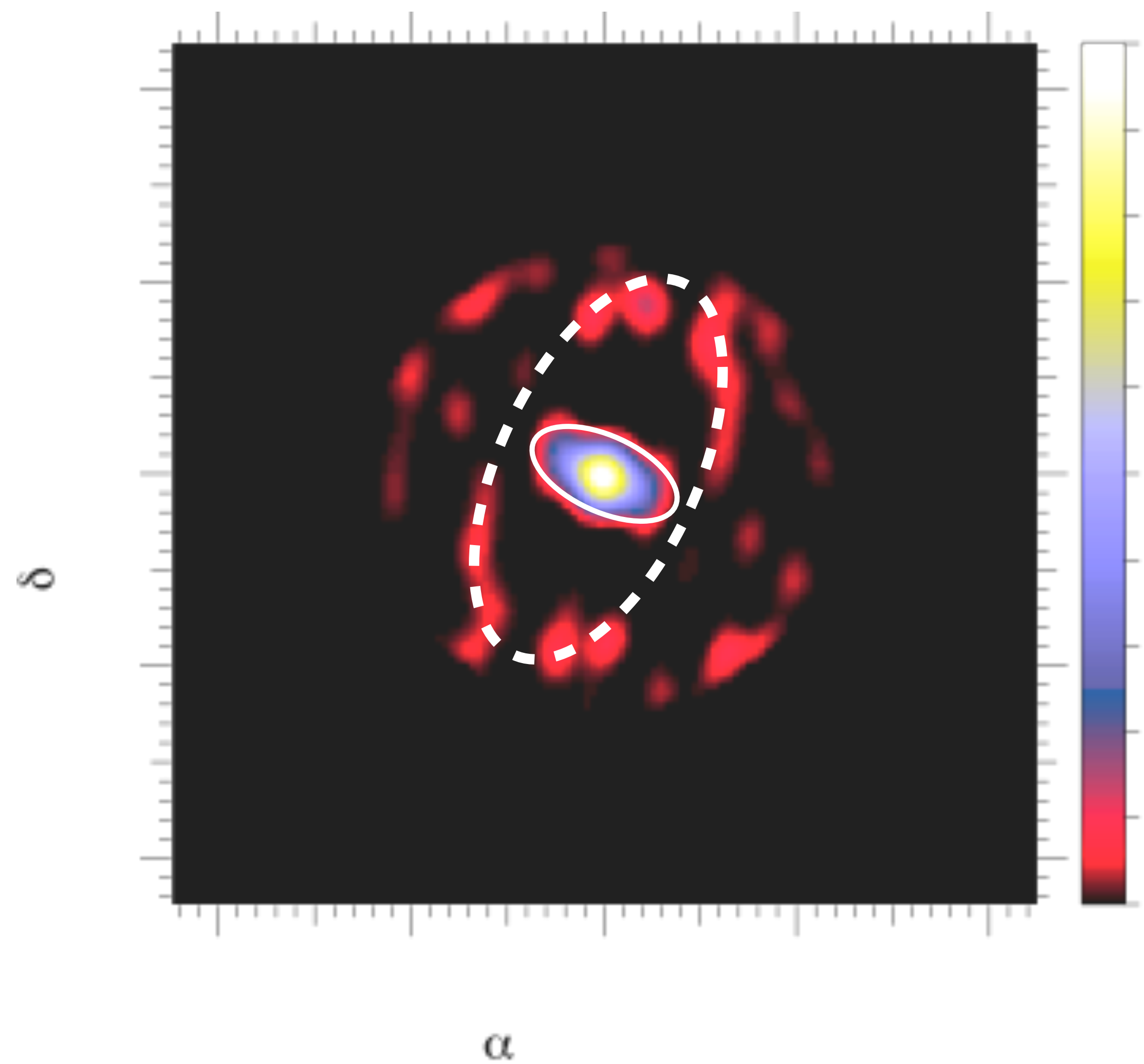
Corrected data seems to be more resilient to chromatic effects

Image reconstruction

With original visibilities



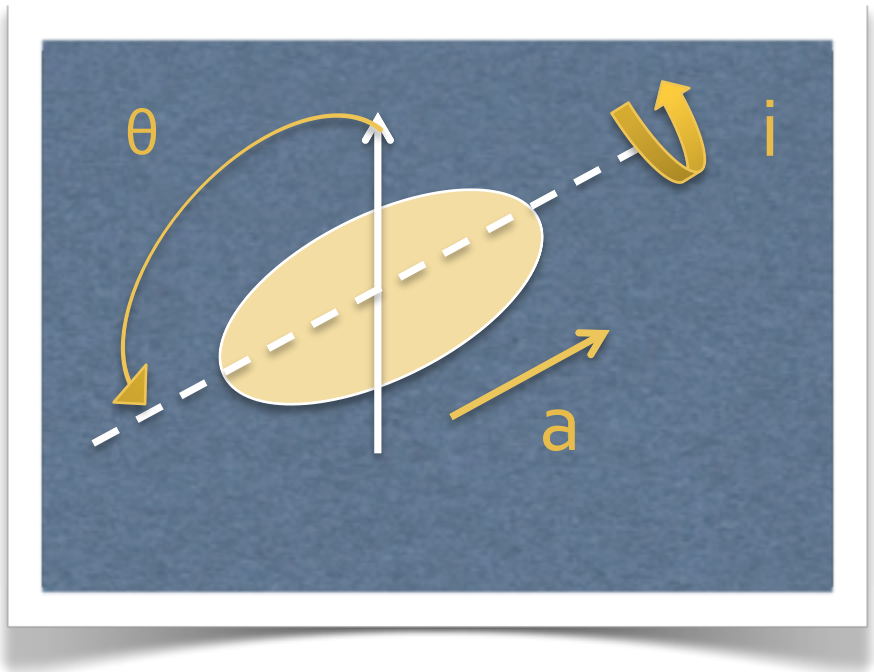
With modified visibilities, w/o star

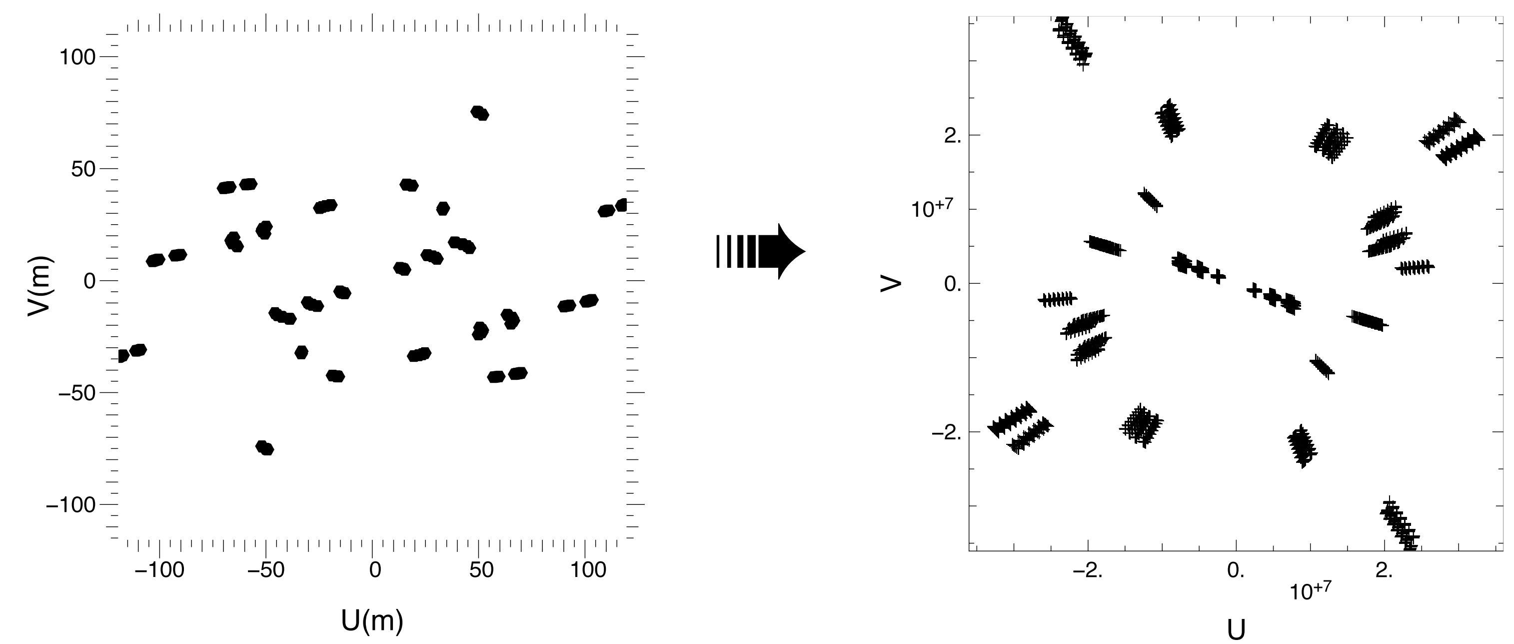


Radical differences:

- presence of central extended emission
- presence of a ring of emission
- directions of elongations are different

Modelling





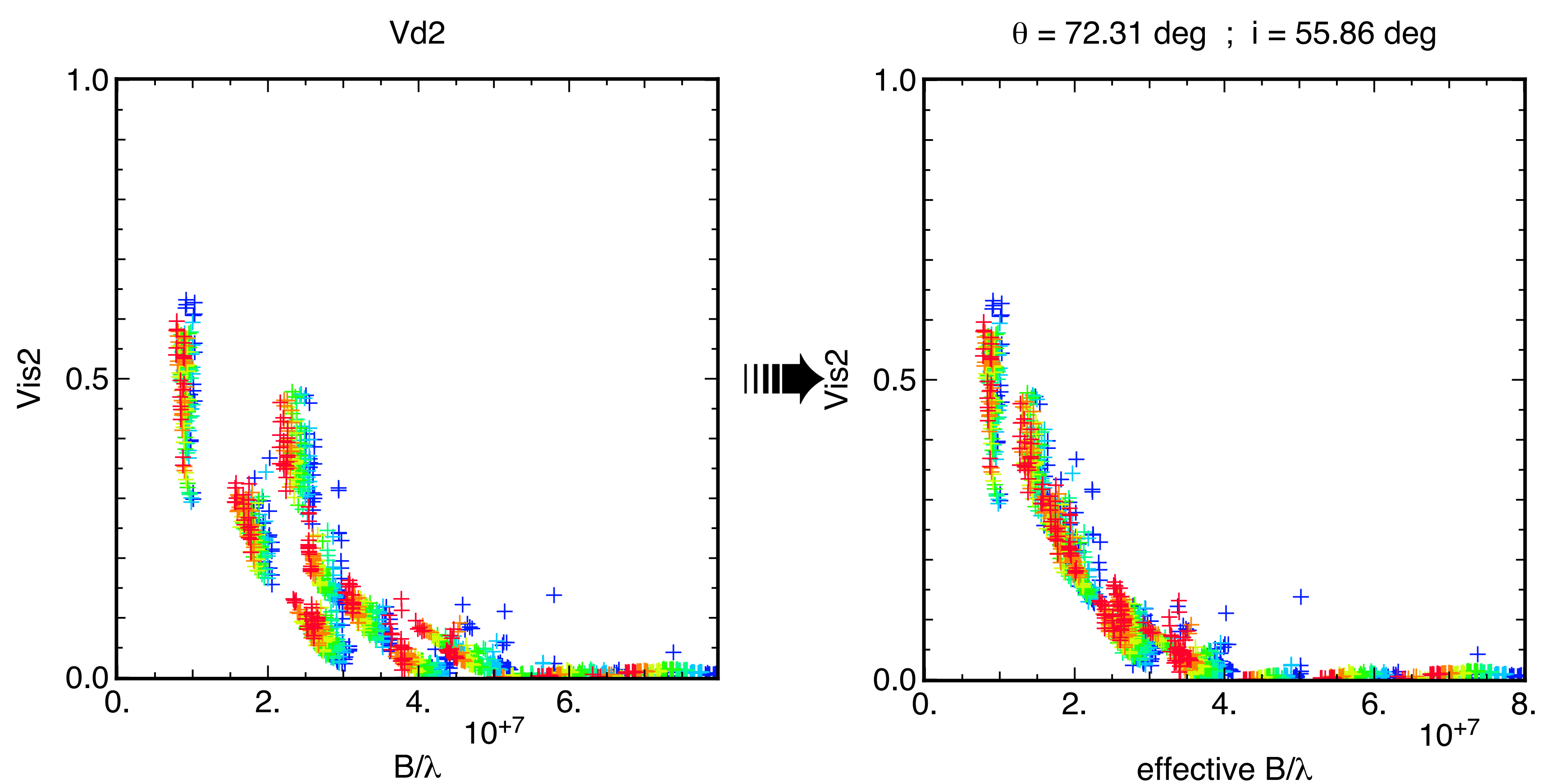
size (FWHM) :

a = 2.82 ± 0.04 mas

Object orientation :

θ = 72 ° ± 1 °

i = 55.9 ° ± 0.9 °



Star flux ratio : ~30%

Gaussian flux ratio : ~50%

Ring flux ratio : 15-20%

Summary and Conclusion

- Interplay between the disk and the star emissions and not an instrumental effect.
- Polychromatic changes due to astrophysical properties of the objects are important in H-band
- Possibility to correct from this effect
- Be careful with modeling and image reconstruction !!

Work in progress:

- Closure phases may be significant
- Carefull modeling wih minimum components
- PMS nature is not yet definitive
- Application to other objects
- New image regularization