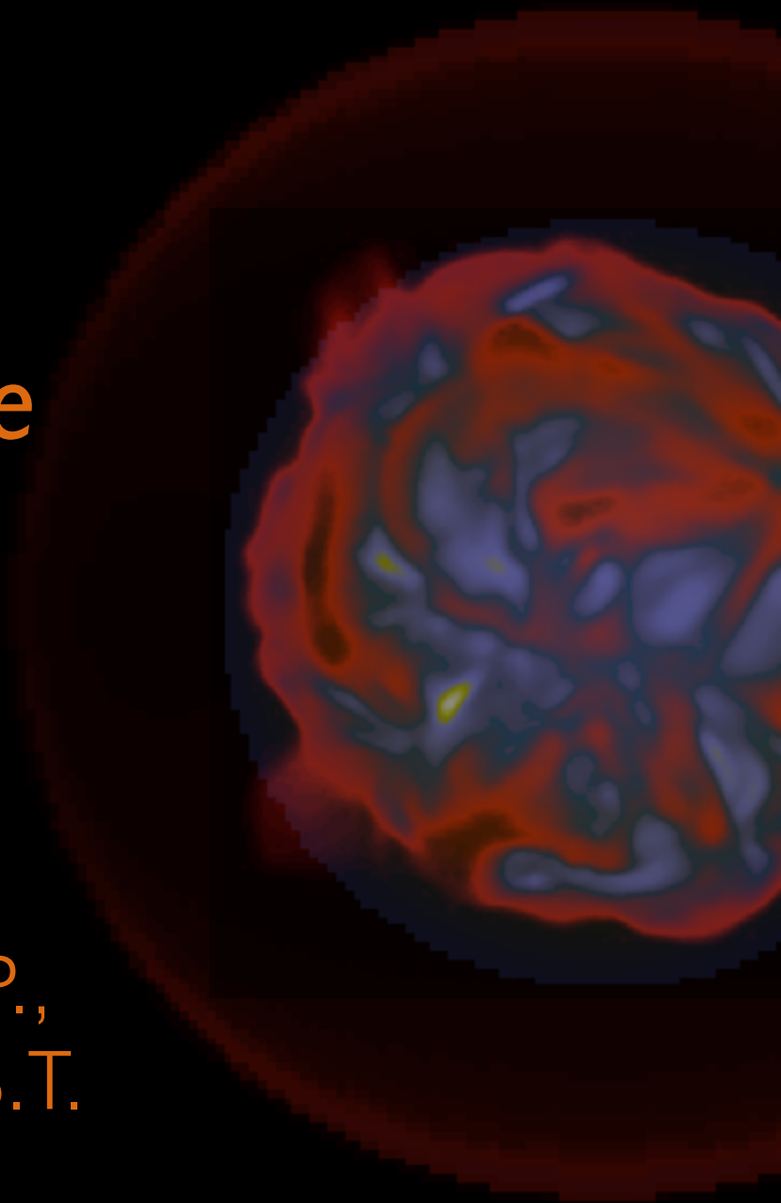
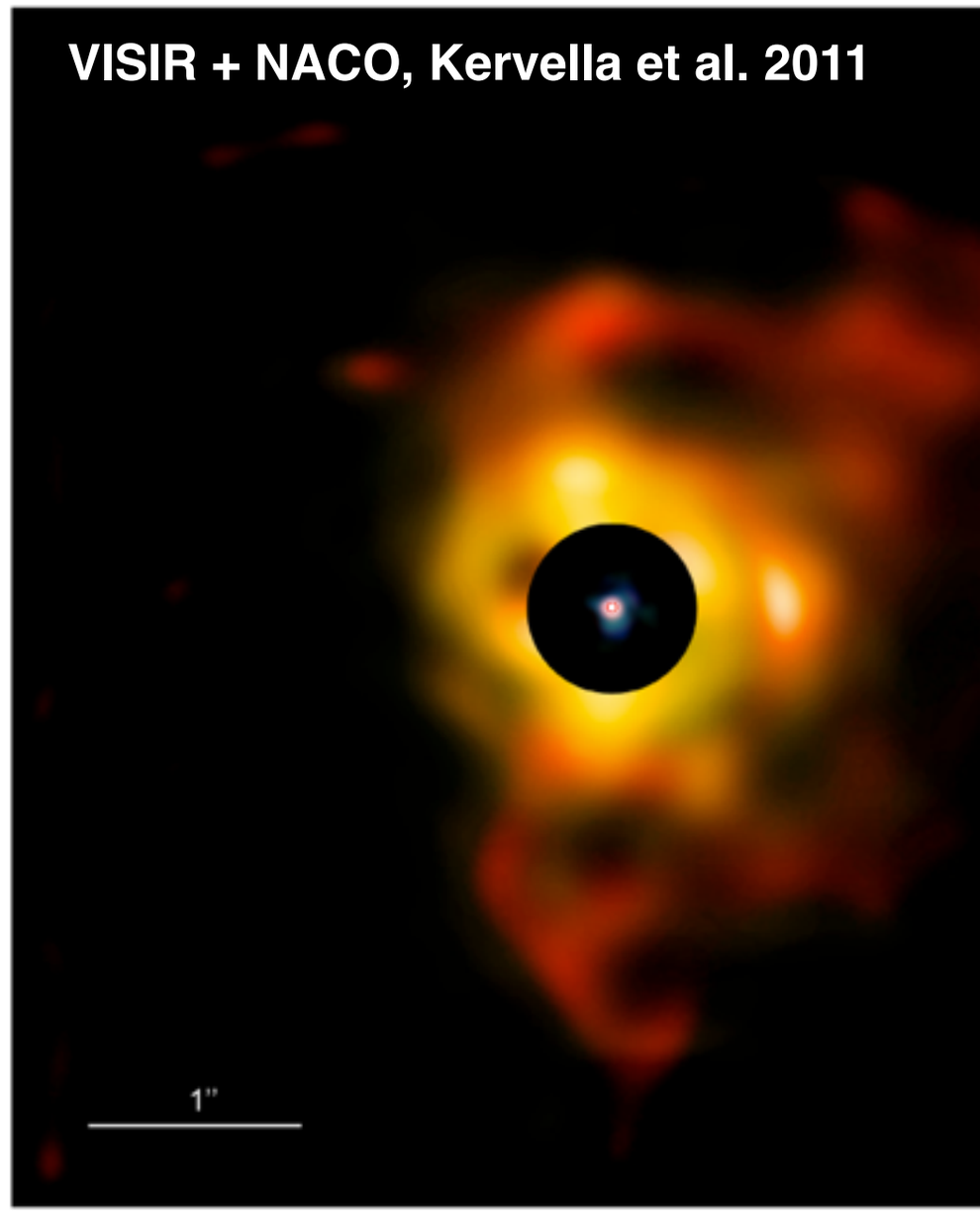
Probing the inner dust shell of Betelgeuse with Polarimetric Interferometry



Xavier Haubois, Norris, B., Tuthill, P., Kervella, P.,
Girard, J., Perrin, G., Lacour, S. and Ridgway, S.T.

Mass-loss mechanism(s) in Betelgeuse?

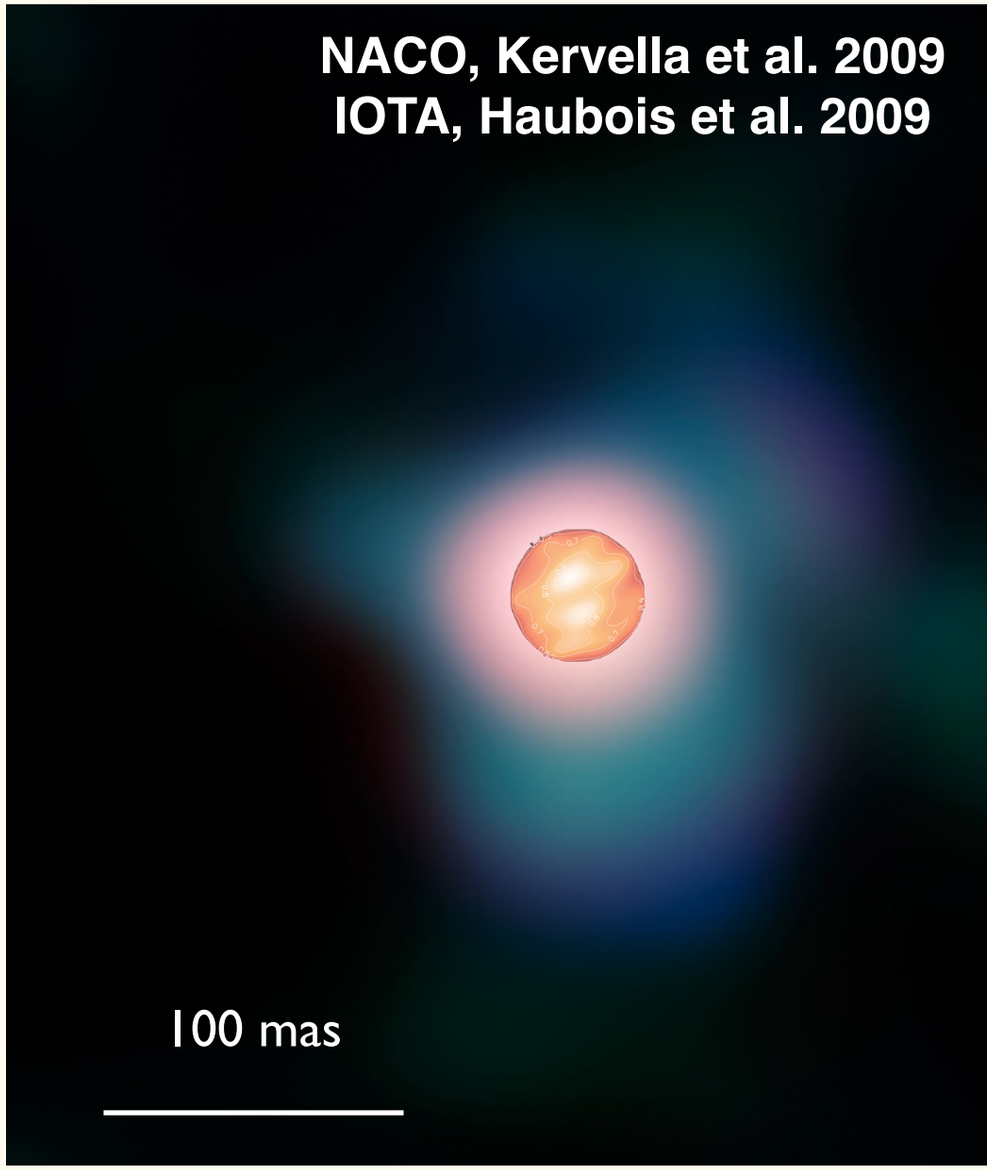
- Dust shells,
  + molecular layers



Mass-loss mechanism(s) in Betelgeuse?

- Dust shells,
  + molecular layers
  + convective photosphere

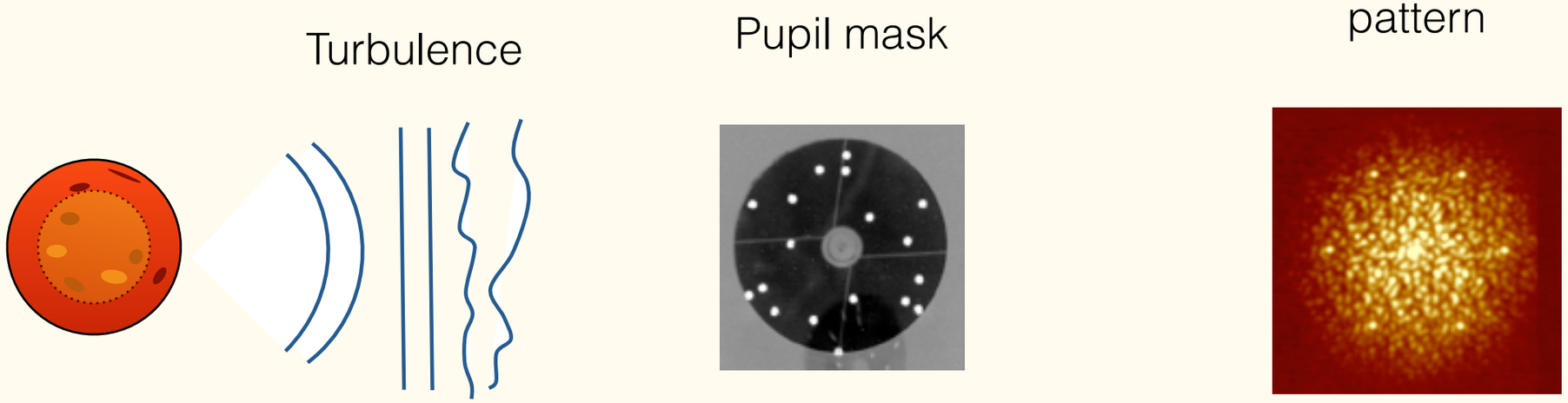
- dust is present in the close atmosphere:
  - Al_2O_3, SiO?
  (MIDI, Perrin et al. 2007, Verhoelst et al. 2006)
  But where is the original AlO? (Kaminski et al. 2013)



<u>where/how does the dust formation start ?</u>

➡ interferometry + polarimetry with NACO/SAMPol

Sparsed Aperture Masking (SAM): Coherence is gold

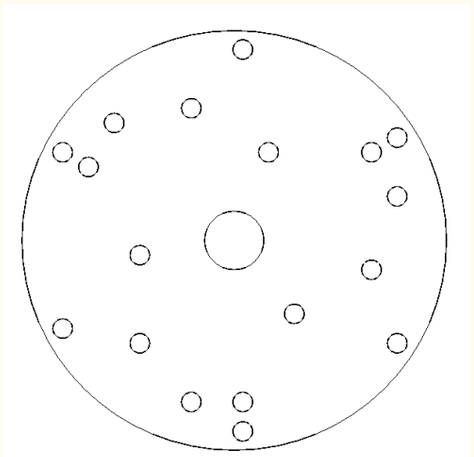


<u>Unique spatial frequencies **B**/λ</u>

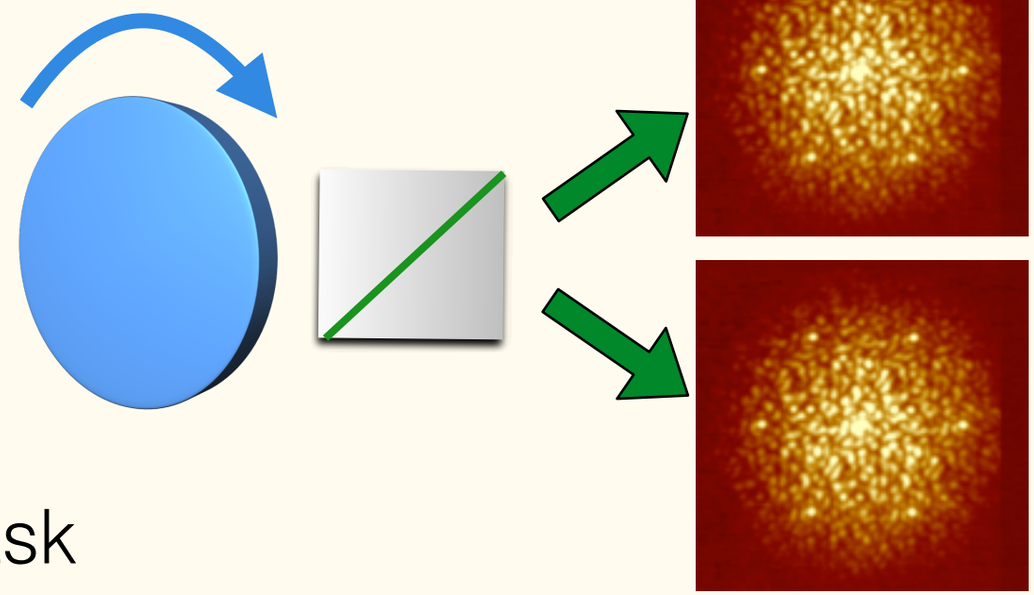
—> the phase information is preserved in the interference pattern

NACO/SAMPol observations of Betelgeuse

- Aperture masking + λ/2 plate + wollaston prism

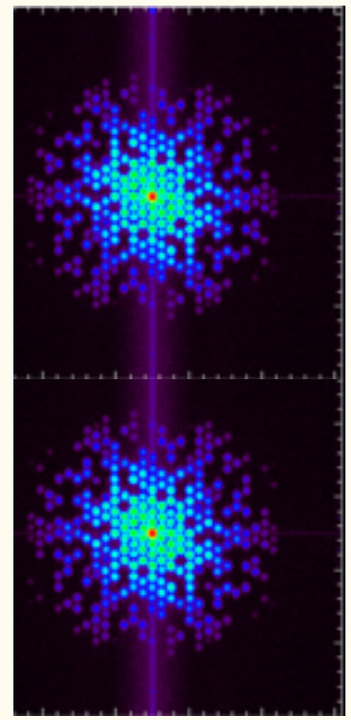


Aperture mask
in the beam
(18 holes)



Interference
pattern

TF



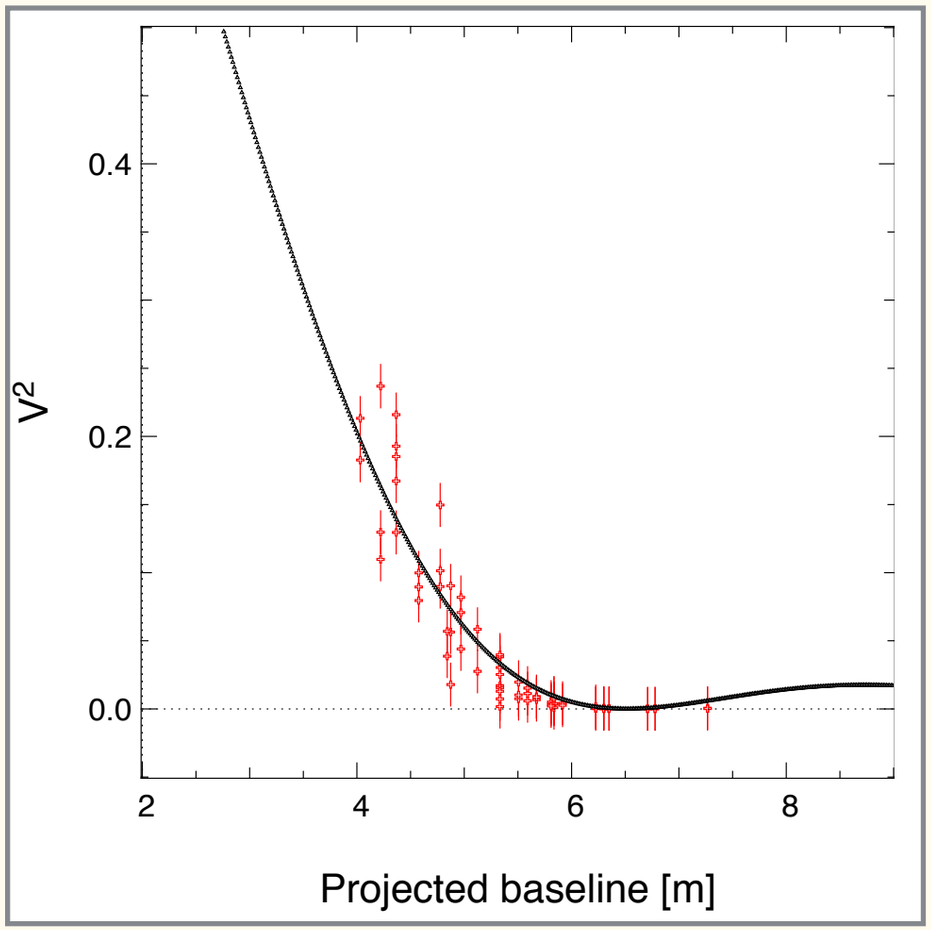
Power Spectrum

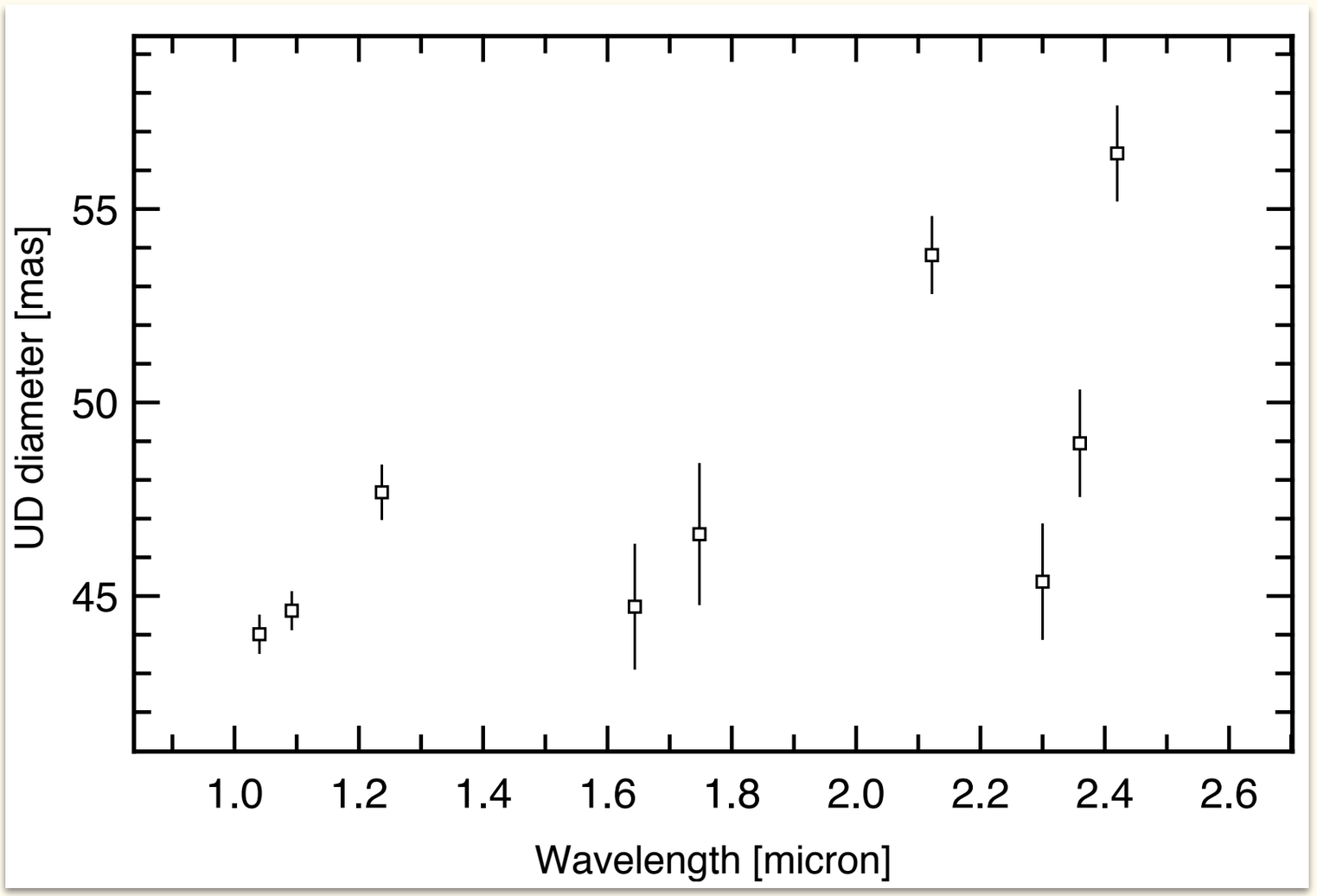
V2, CP
at two orthogonal polarisations

- 12 filters (9 with PSF calibrator)

Uniform disk diameters

- Calibrator: Aldebaran is non-dusty
(flux densities from Ducati et al. 2002)

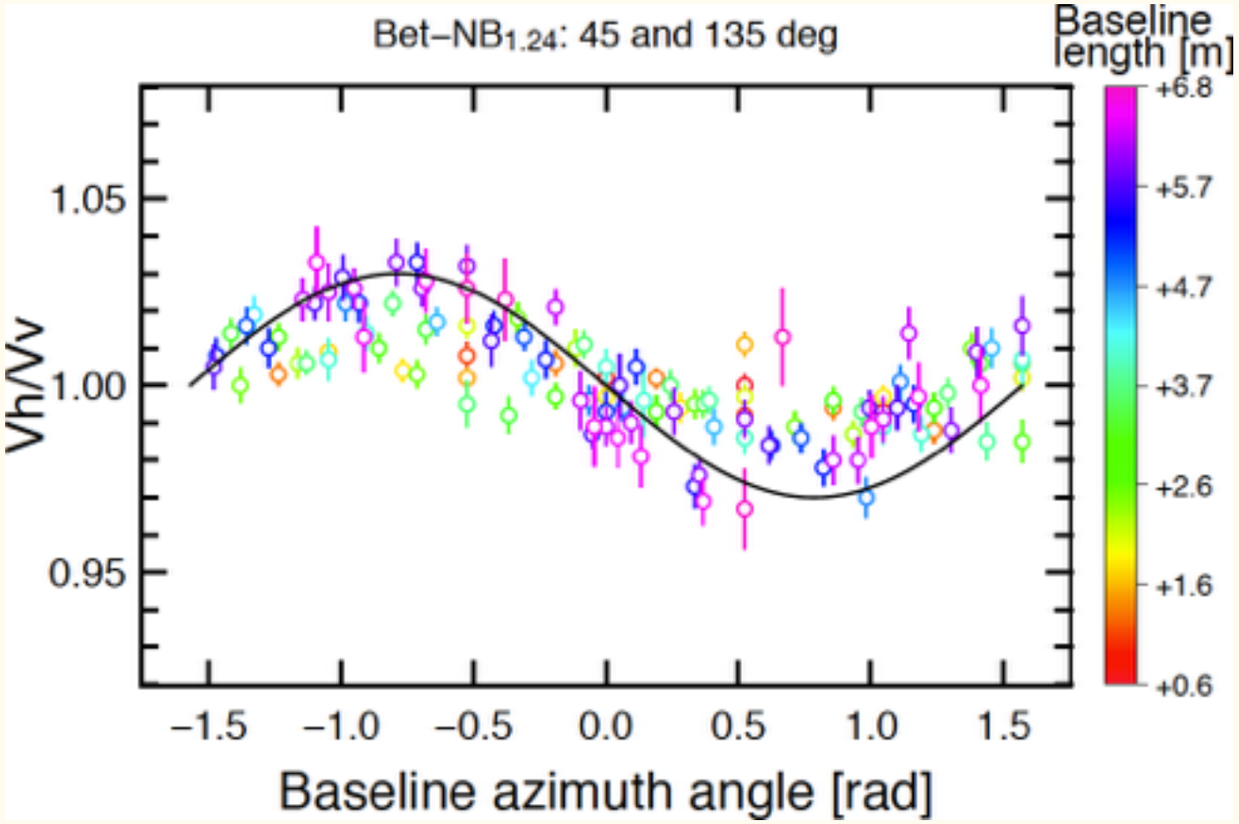




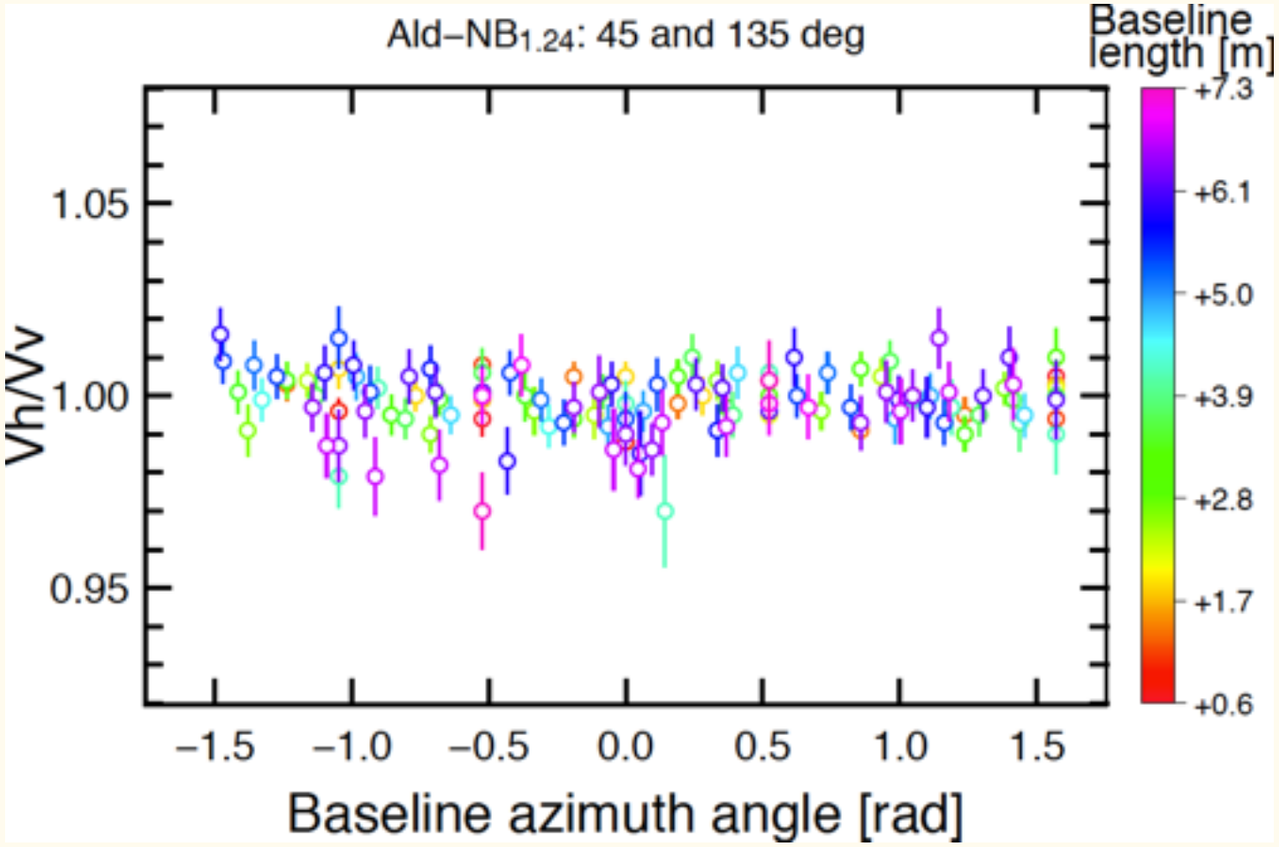
Haubois et al. 2015, in preparation

Differential polarized measurements

Betelgeuse



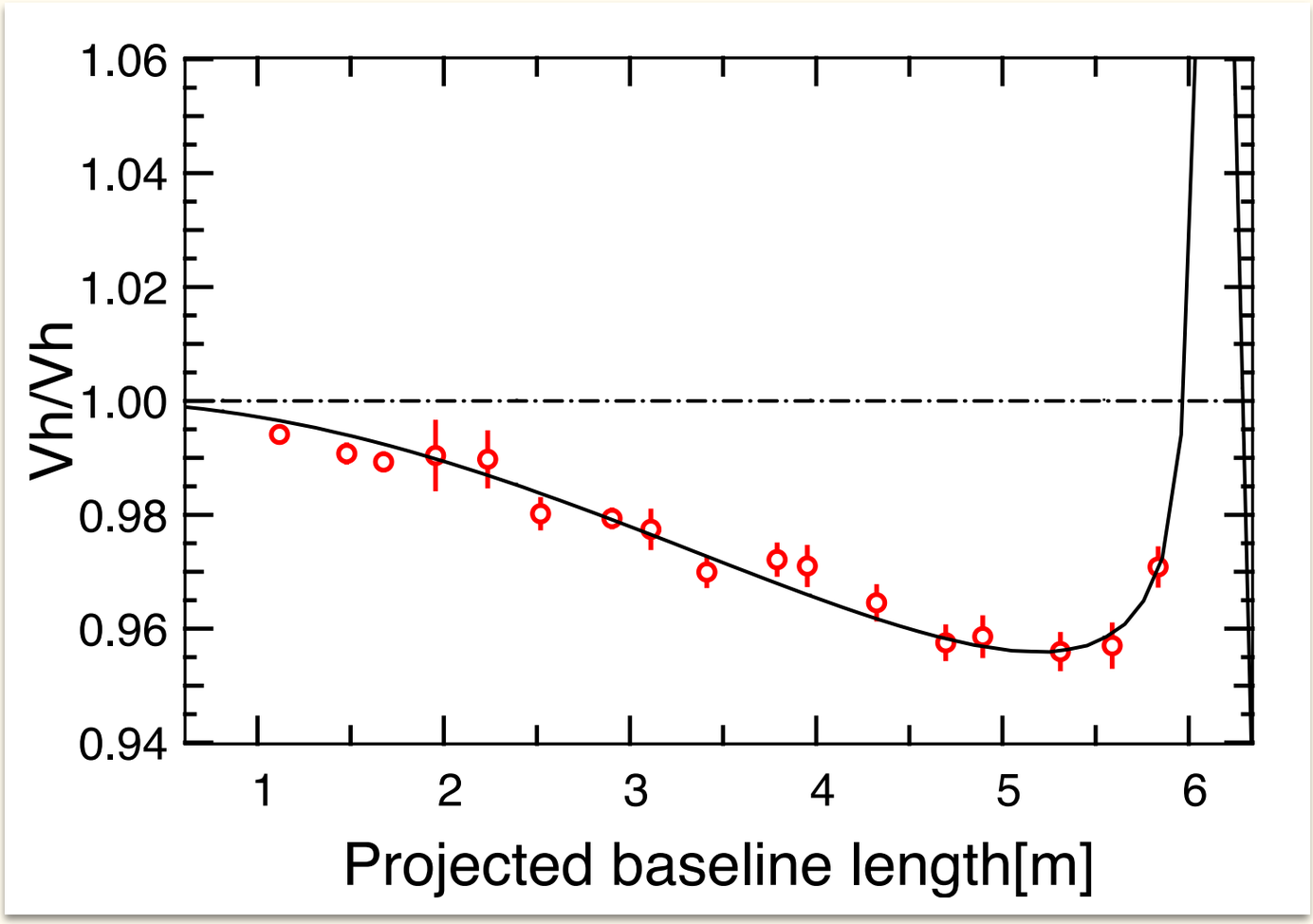
Aldebaran (calibrator)

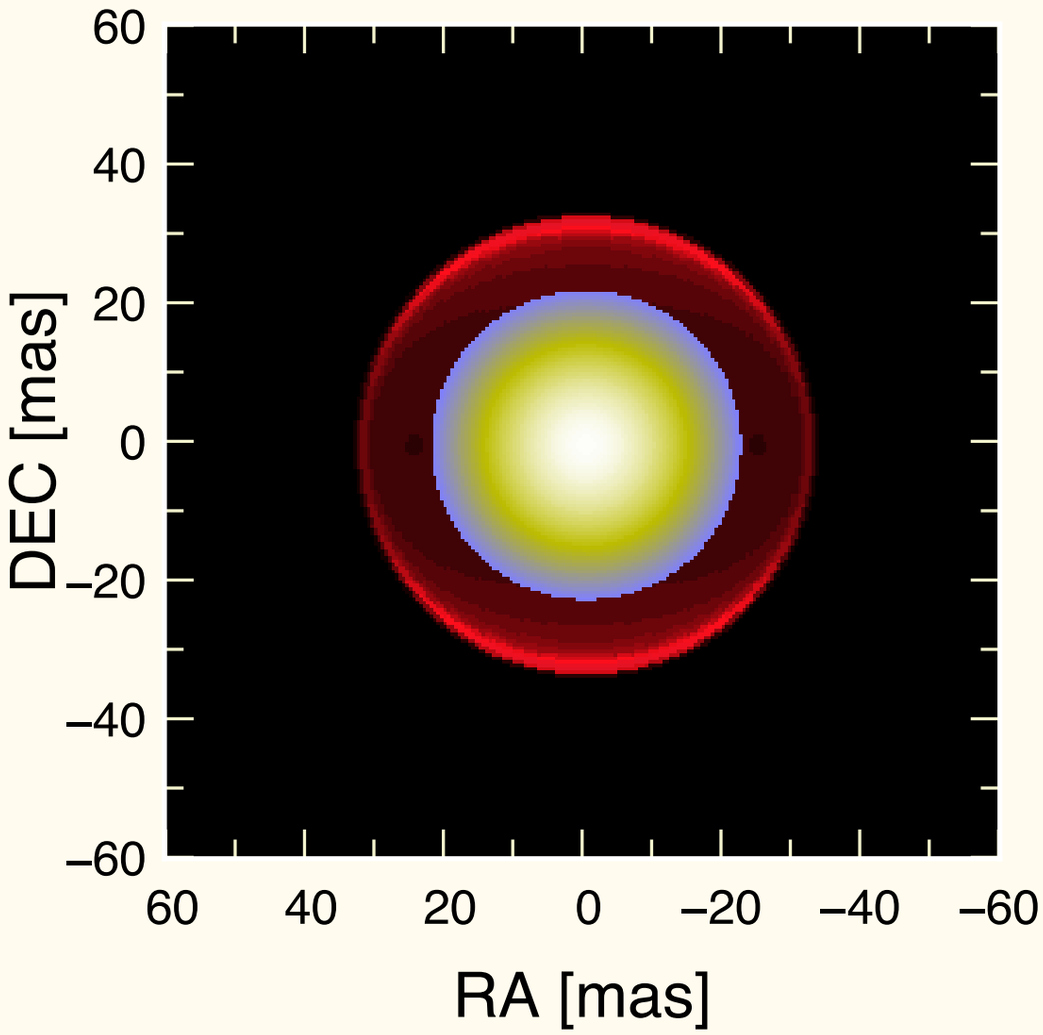


Detection of the polarizing environment: R ~1.5 R_{UD}

Haubois et al. 2015, in preparation

A thin symmetric dust shell (I)





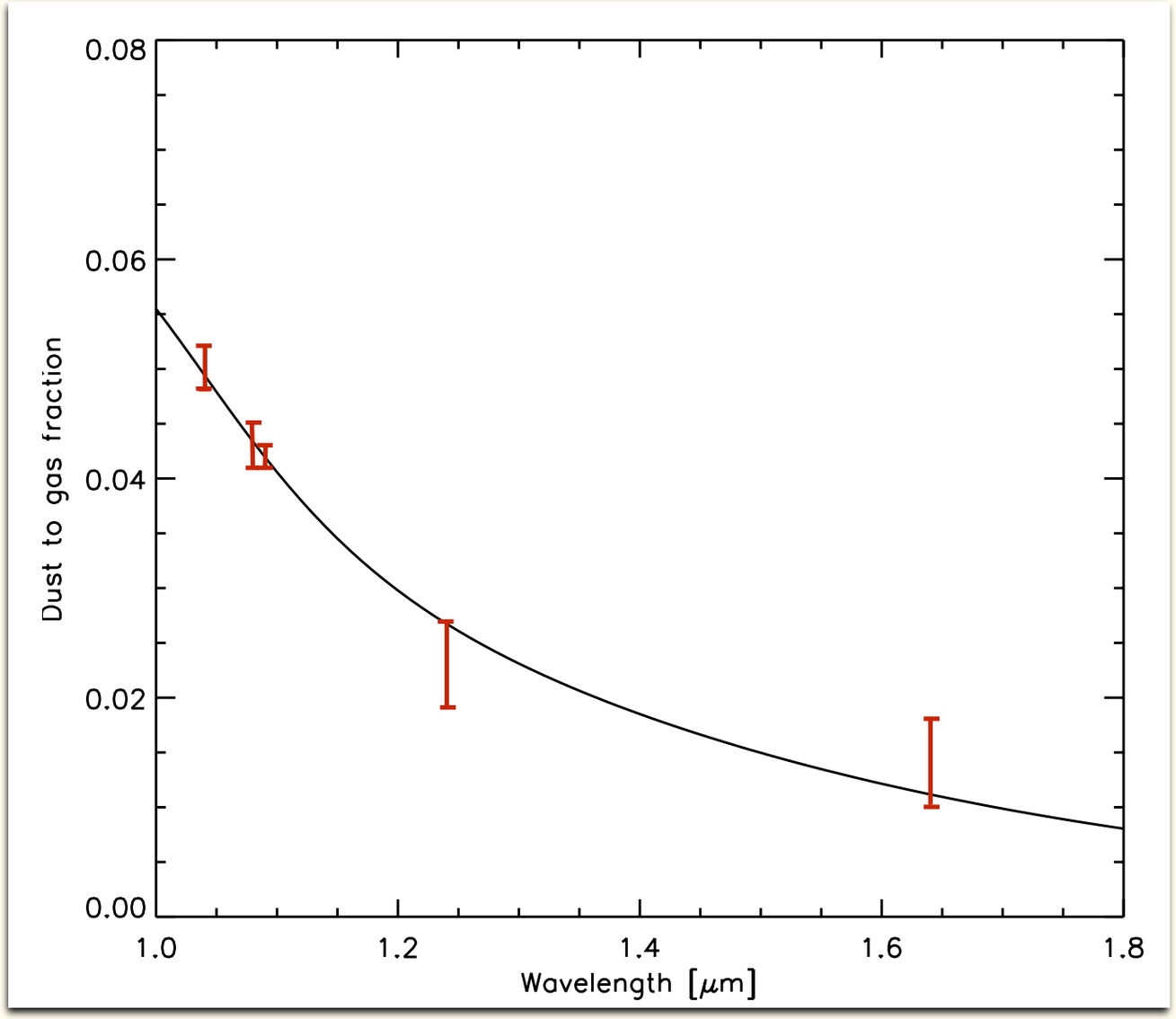
R_star: 44.-47 mas
R_shell: 62-68 mas
gas/dust flux ratio : from ~5% to 1%

Model from Ireland et al., 2005
Also used for M-type AGBs:
Norris et al., 2012, Nature

Haubois et al. 2015, in preparation

A thin symmetric dust shell (II)

- scattering opacity only
- single scattering
- Mie scattering (spherical grains)
- forsterite or enstatite or corundum



E.g., Forsterite:

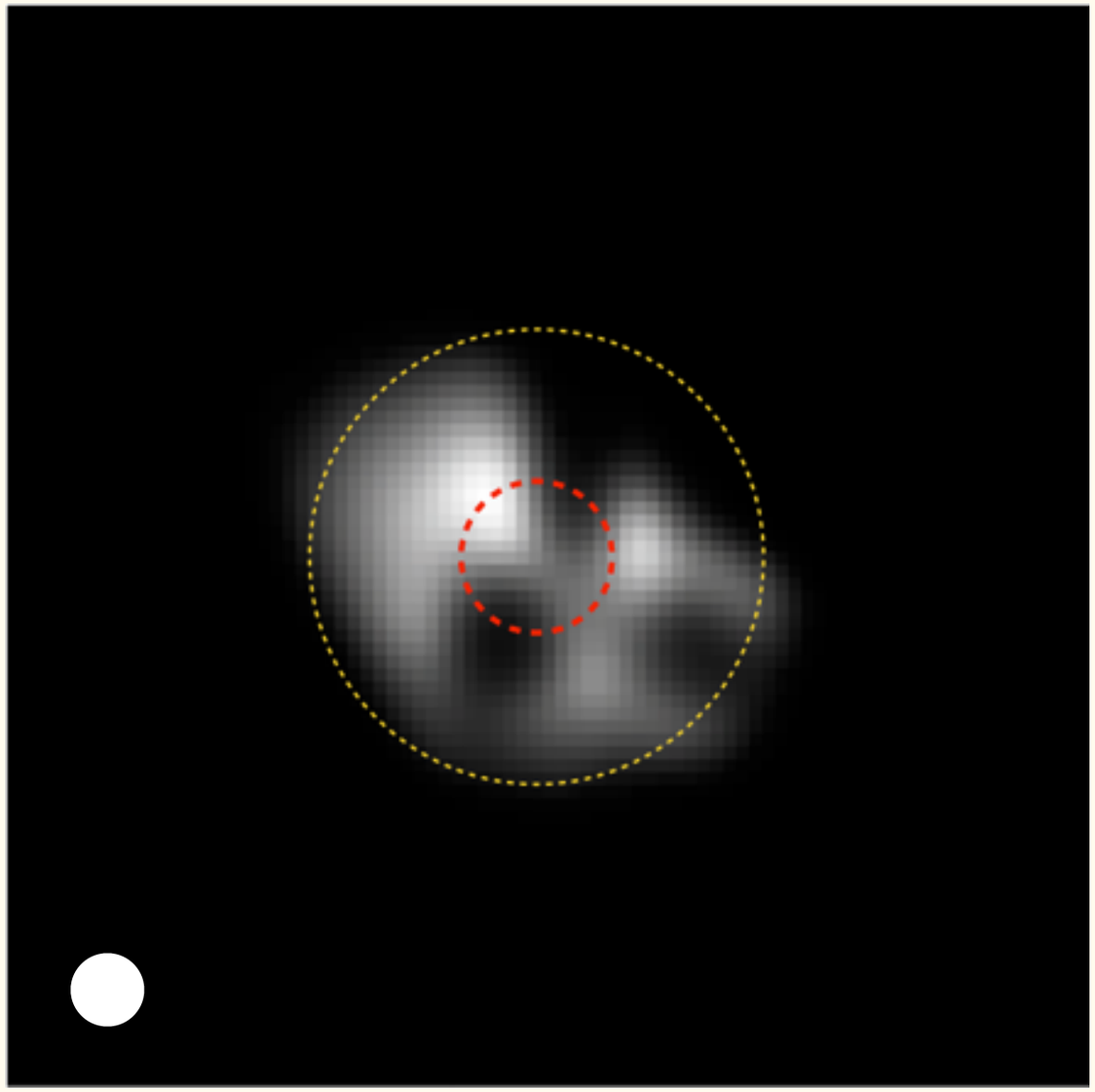
Grain radius: 0.285 +/- 0.015 micron (Höfner 2008)

Dust Shell mass ~ 2e-10 Msun

Haubois et al. 2015, in preparation

SPHERE/ZIMPOL observations

—> Spatial resolution better than 20 mas in the visible



Kervella et al., to be submitted

SPHERE/ZIMPOL observations

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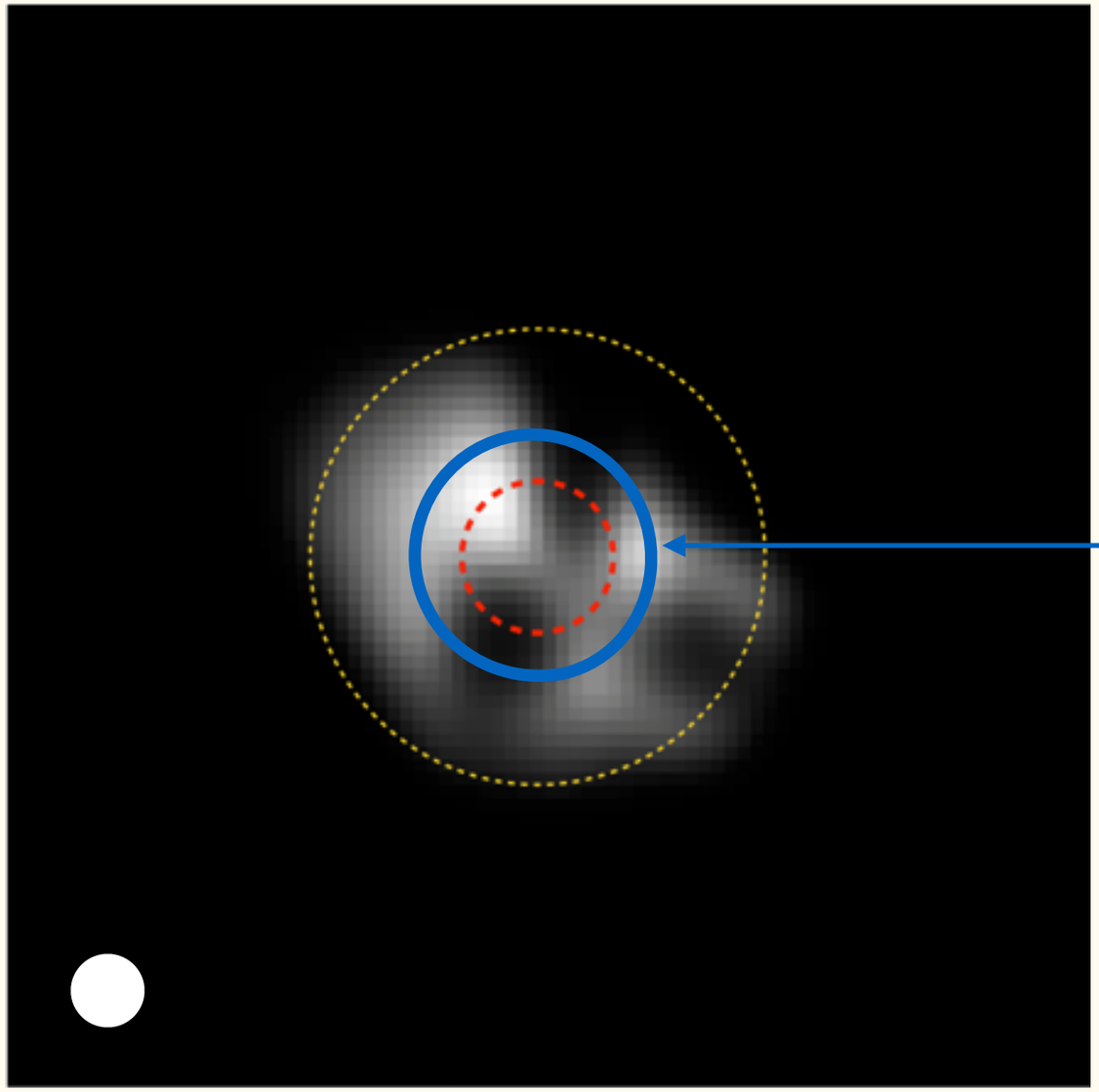

Perspectives

Need for a detailed radiative transfer/grain growth modeling

Asymmetry in the dust shell?

Observational Follow-up
(SPHERE/SAM mode is being implemented)

Global Database in Optical Interferometry

oidb.jmmc.fr

- First version released 2 weeks ago

- Goals:
  —> Promote, preserve OI data and centralise its access
  —> Connect data users with observing teams
  —> Interoperability with the VO tools

- Contents:

- Already ~5000 calibrated science-ready + published data
- Including all calibrated PIONIER data since 2011
- Weekly updated observation logs from CLIMB, CLASSIC and VEGA (since 2006)
- + your data!