Betelgeuse (and Red Supergiants) at VEGAS resolution

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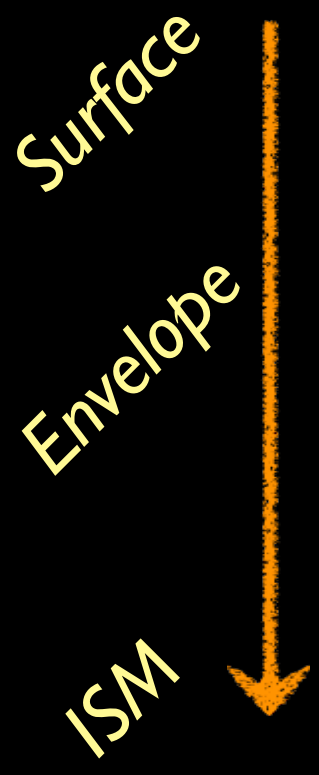
- ~10-20 Msun, Teff ~ 3600 K, L > 100 000 Lsun
- R ~ 650 - 1000 Rsun
- Density ~ 40 mg/m^3 (Sun: 1400 kg/m^3)



- What is the structure of the convection ?
- How does the star lose its mass ?
- What is the structure of its envelope ? Molecular and dust chemistry ? Dust-gas coupling ?
- How does the star interact with the interstellar medium ?

Betelgeuse

0.025 arcsec | 0.25 arcsec | 2.5 arcsec | 4 arcmin

Photosphere

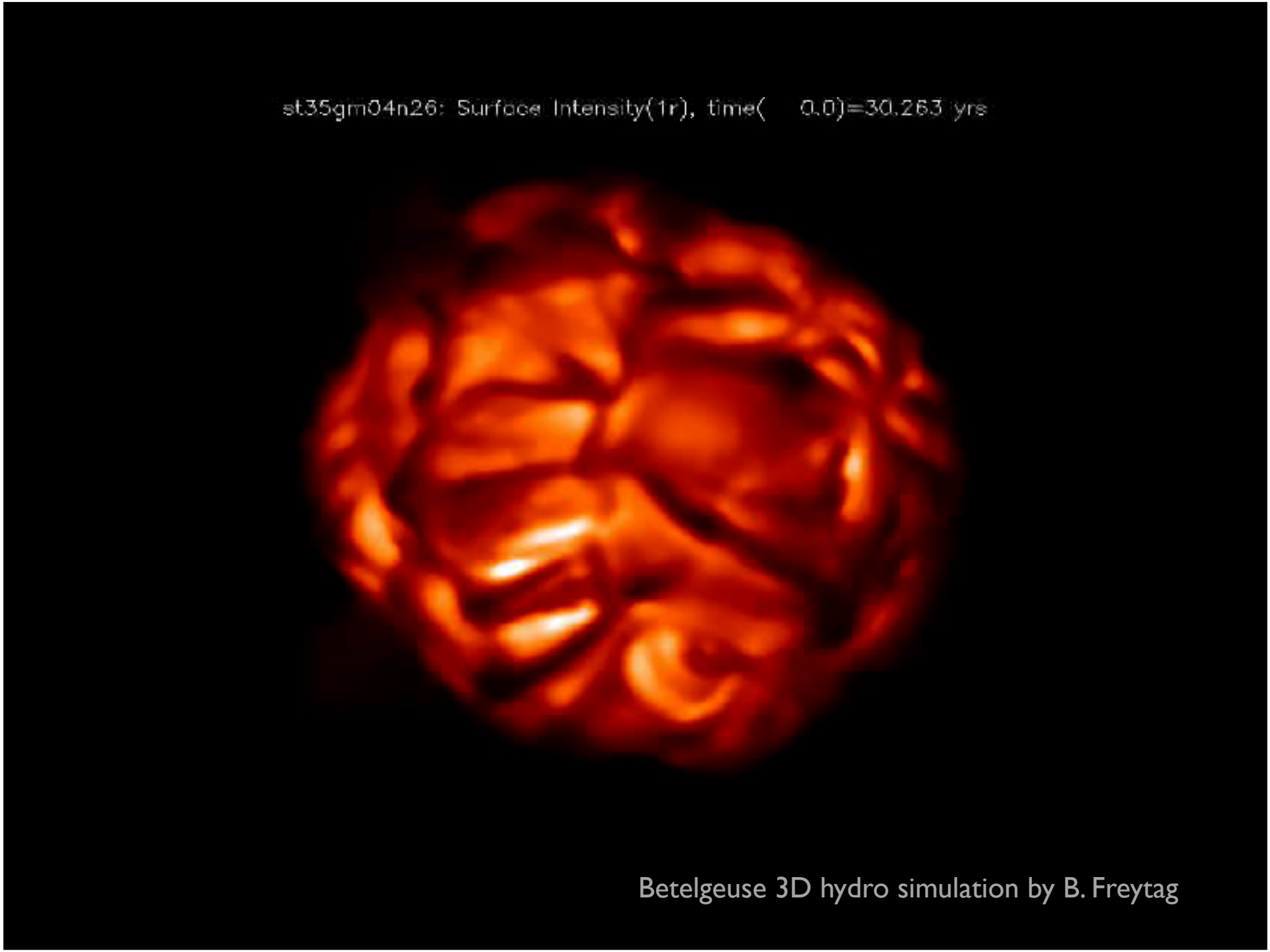
Internal envelope 1-10 R_*

Intermediate envelope 10-100 R_*

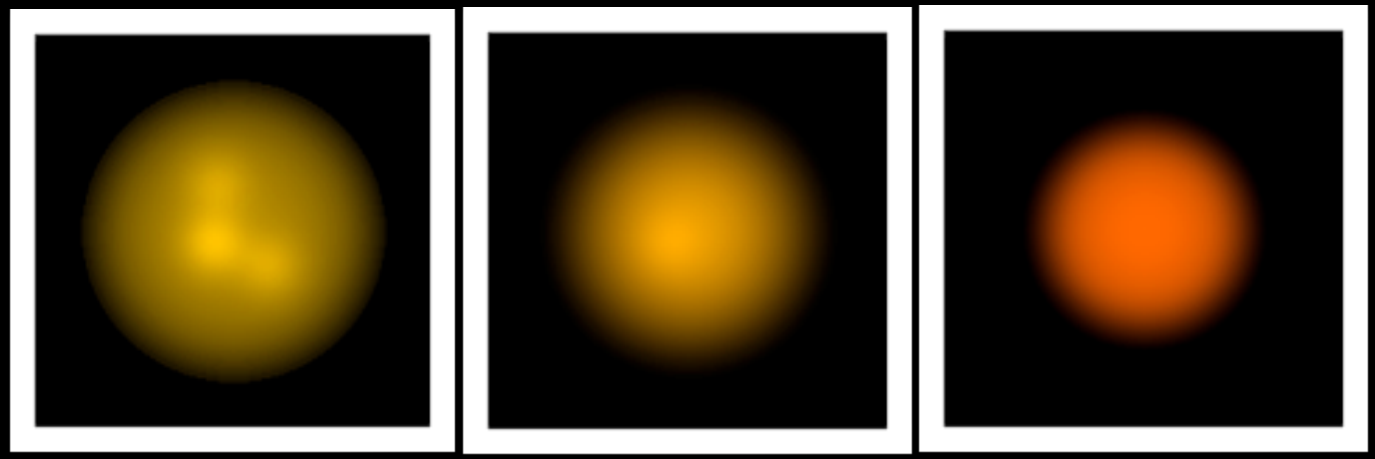
External envelope 100-10^4 R_*

ISM

VEGAS

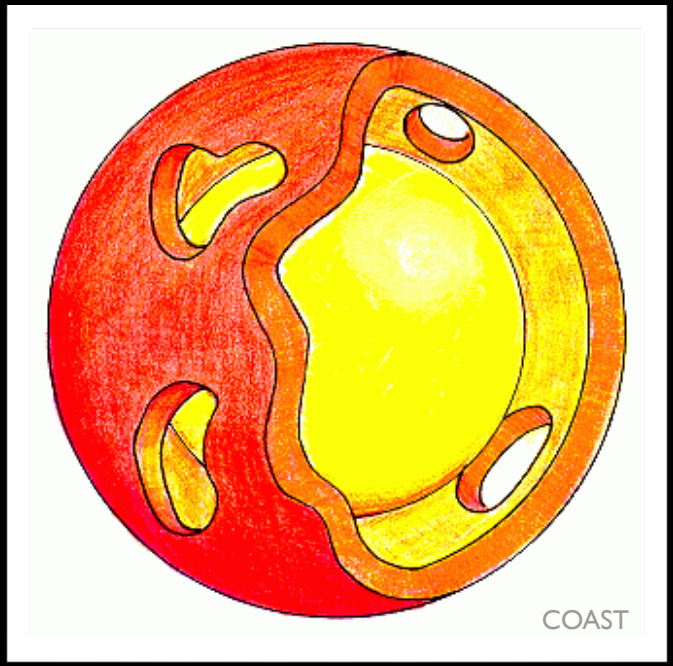


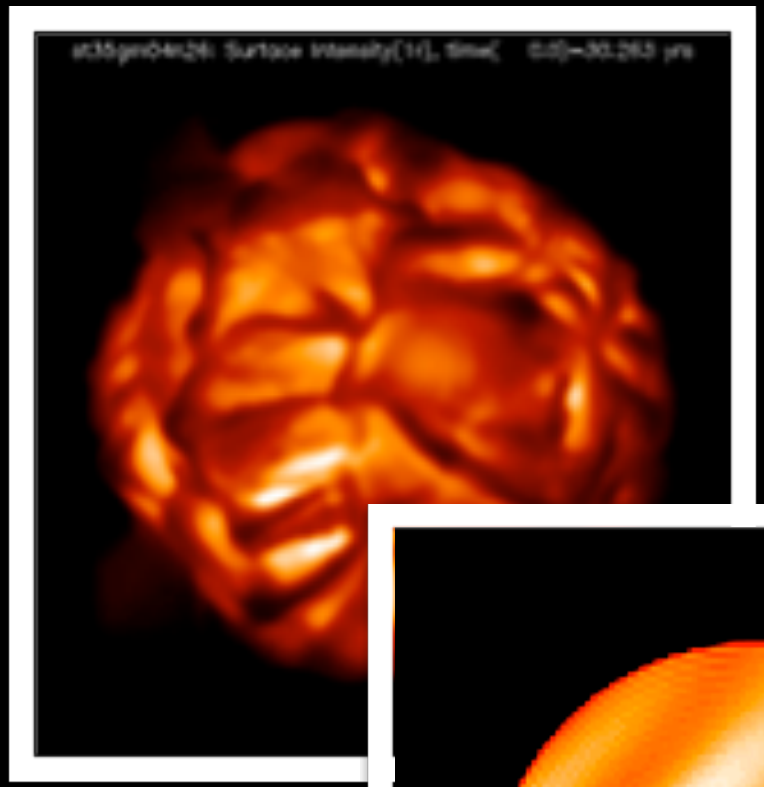
Betelgeuse 3D hydro simulation by B. Freytag

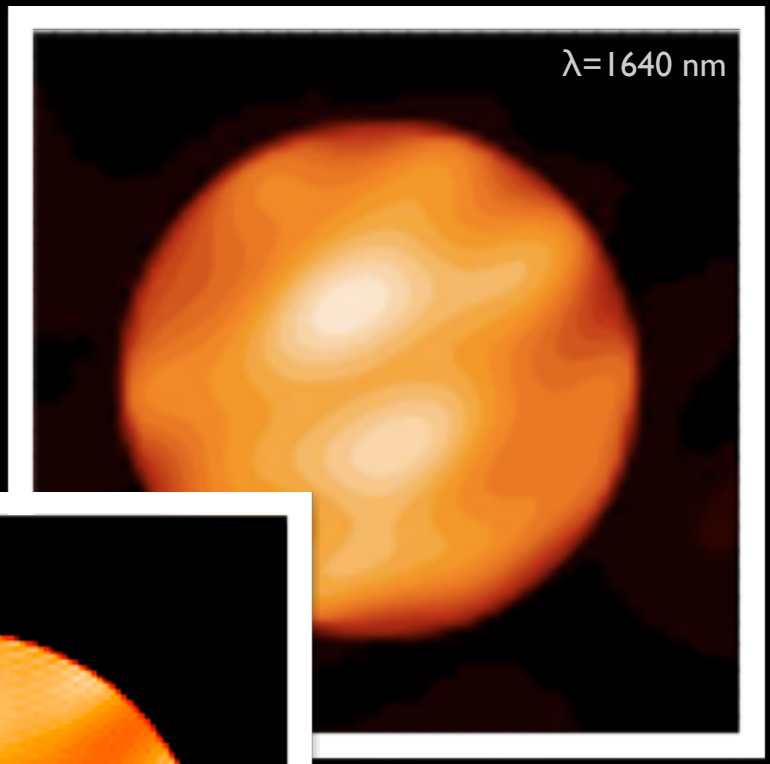


700 nm 905 nm 1280 nm

Young et al. (2000)





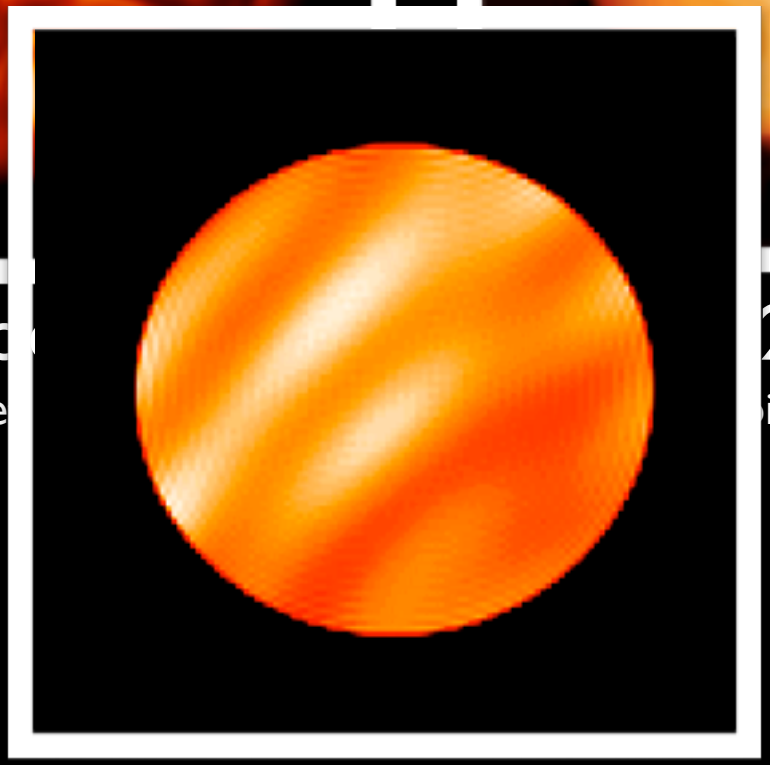


Mo

Freytag e

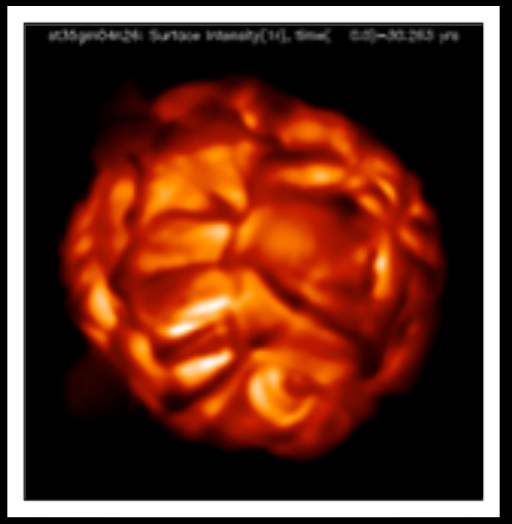
2005 image

is et al. (2009)

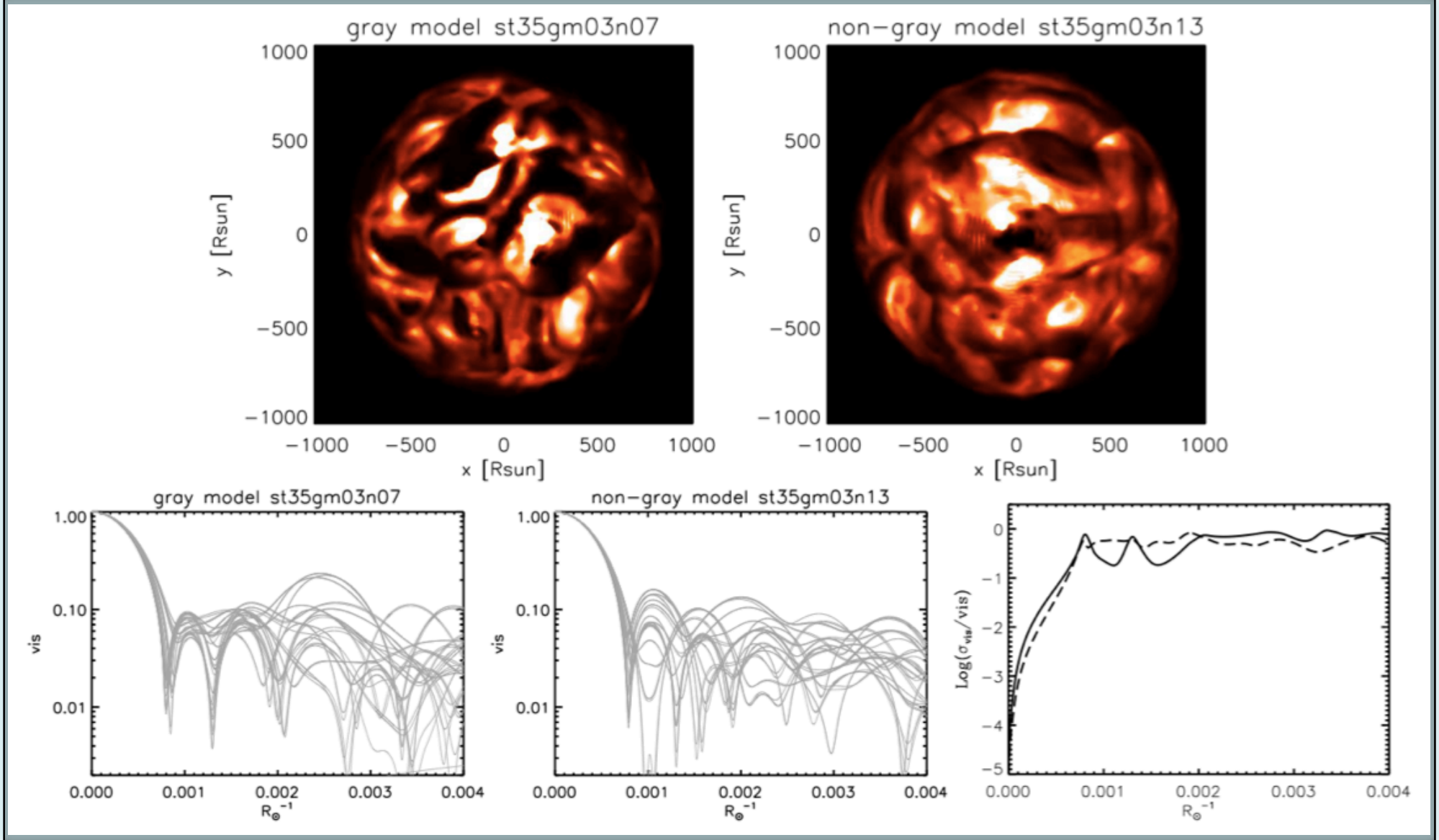


Preliminary 2012 image

VEGAS on Betelgeuse: Convection in 3D



- We don't necessarily need images
- The spatial power spectrum of the convective structures is an appropriate observable
- Convective velocity v=5-30 km/s (c/v~20000) for Betelgeuse: R~50000 would be good to probe velocities
- Visibility(lambda) up to very small spatial scales (~1 mas) would provide key constraints for 3D convection models
- RSGs are difficult (=good) tests for 3D convection

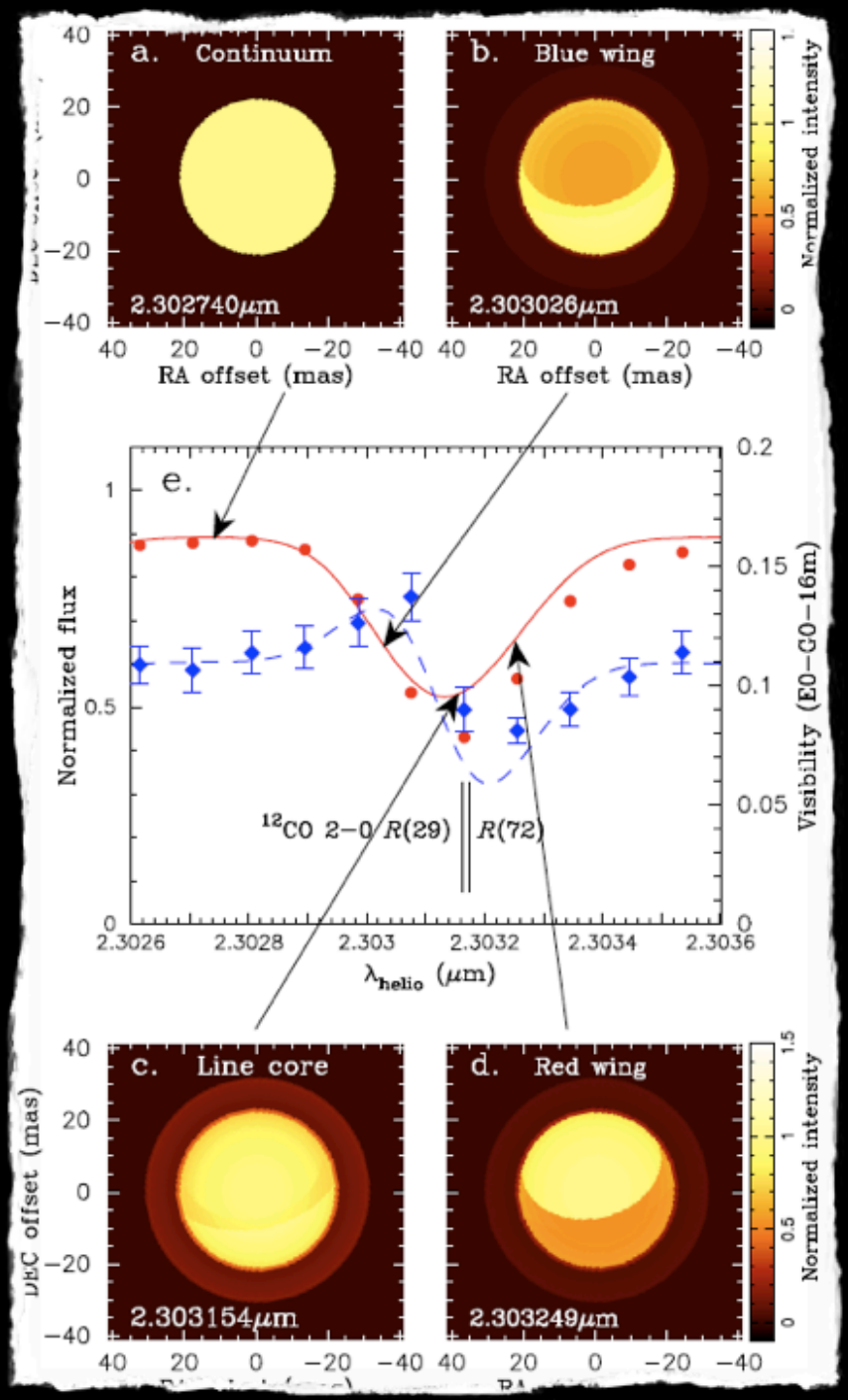


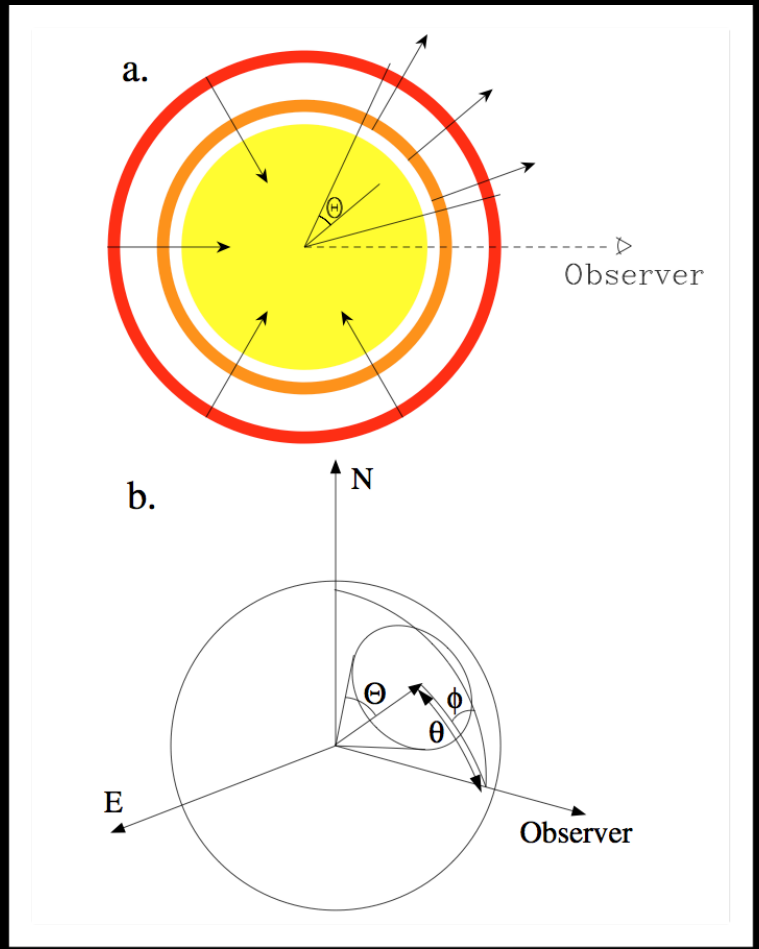
Chiavassa et al. (2011)

VEGAS observing Betelgeuse

- Low visibilities, but not very low up to high spatial frequencies
- Very high brightness (R~0)
- Variability: observations over several months or years to get statistics
- Calibration difficult, although no need for very high precision

CO gas in motion

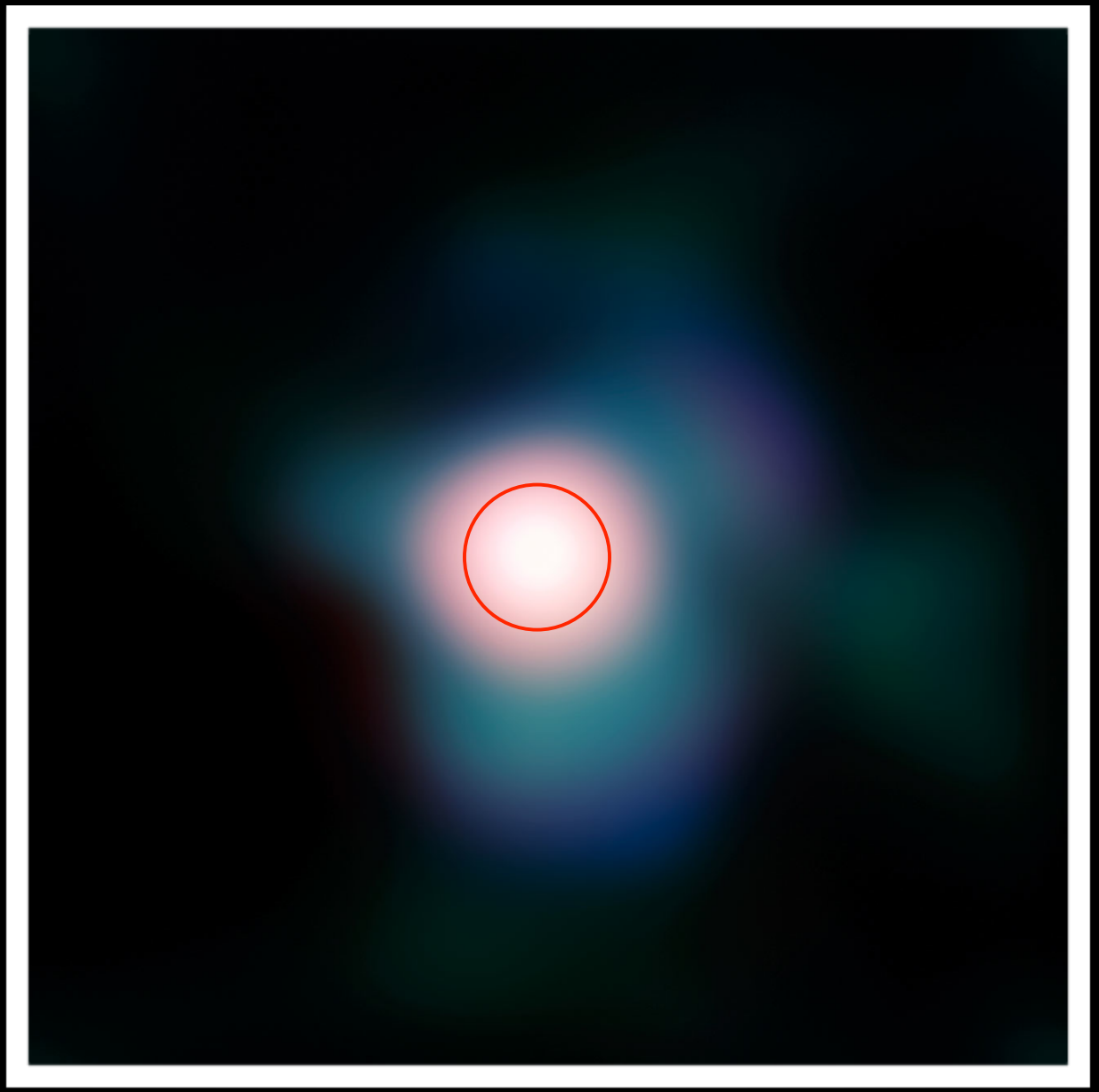




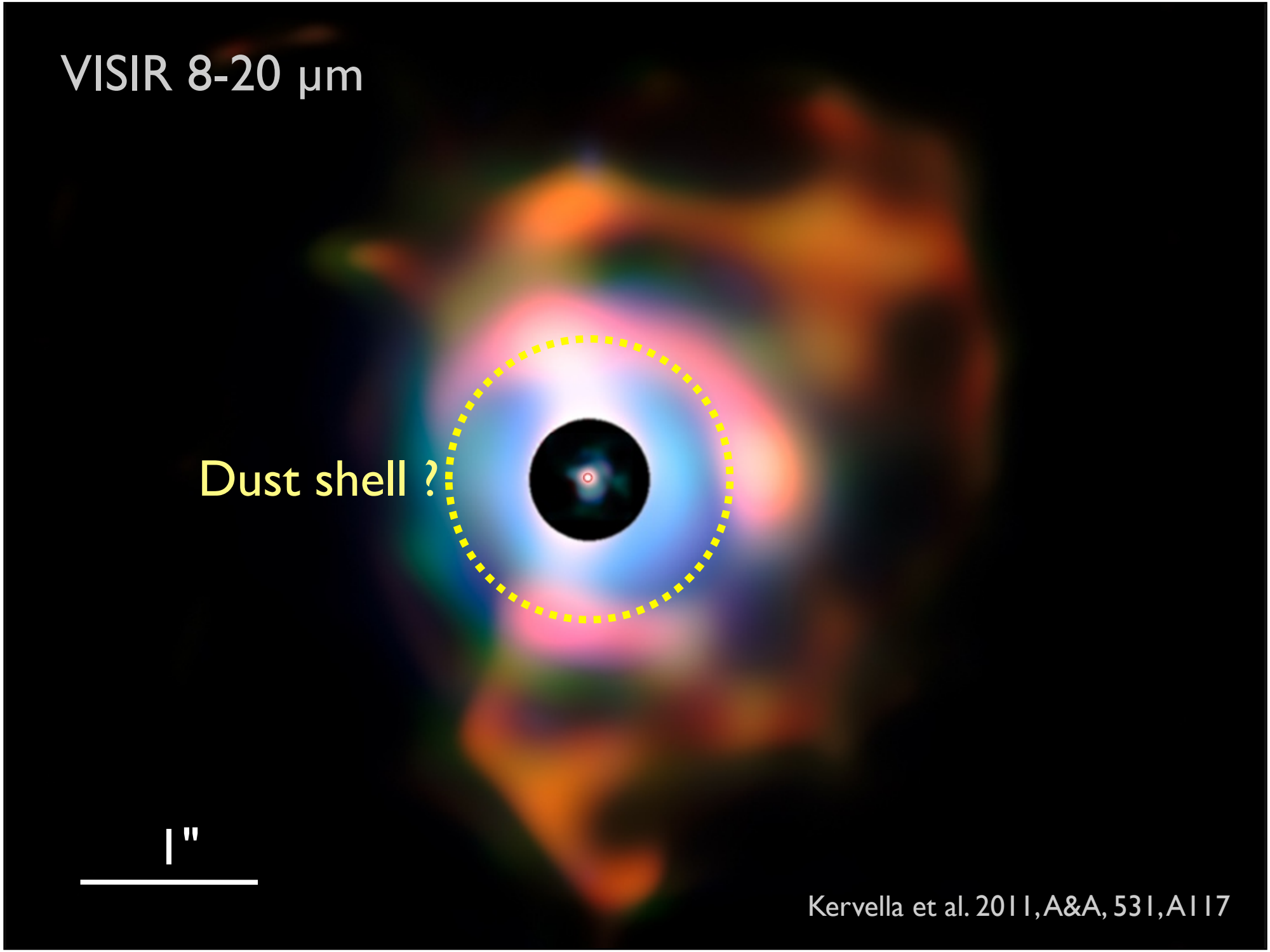
Ohnaka et al. 2009, A&A, 503, 183

The internal envelope

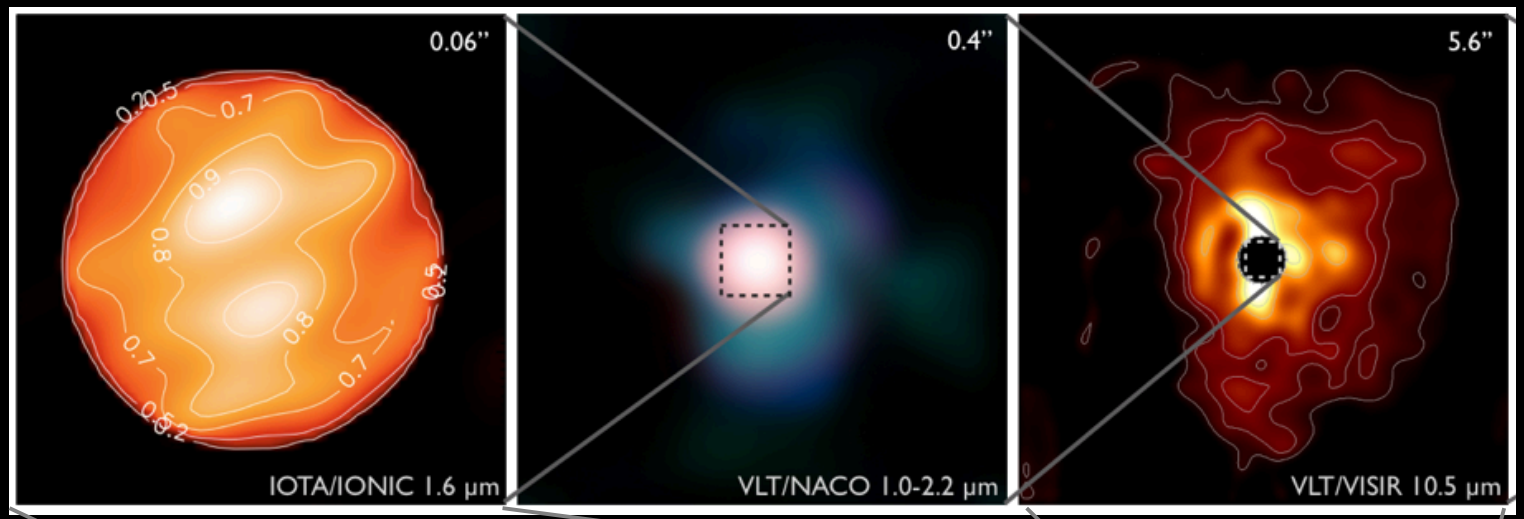
- Close environment of the star, above the photosphere up to ~ 10 R*
- Large ground based telescopes can resolve the internal envelope (θ~50-100 mas) in the near infrared
- Presence of molecules («MOLsphere»)
- Observations also in the radio domain

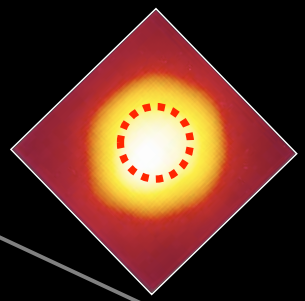


Kervella et al. 2009, A&A, 504, 115

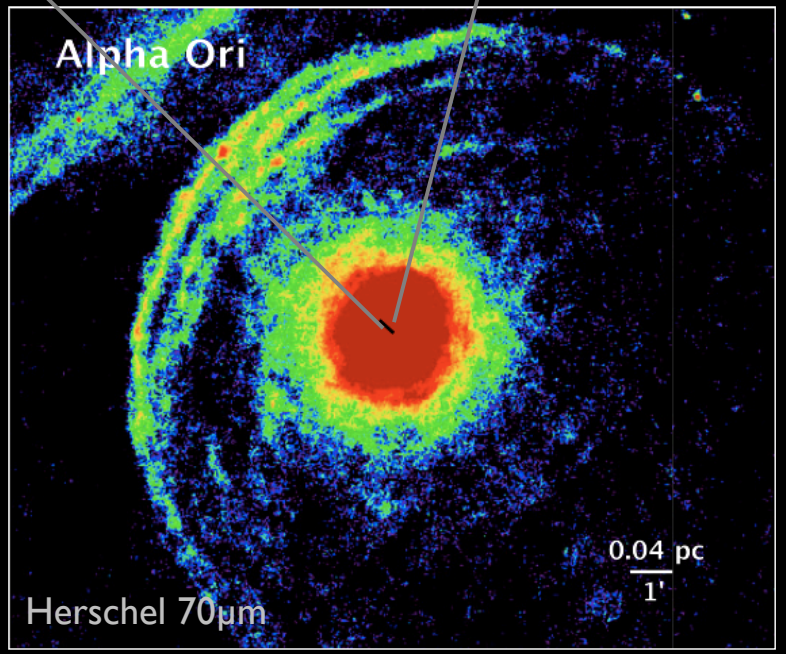

VISIR 8-20 µm
Dust shell ?
1"
Kervella et al. 2011, A&A, 531, A117

Overview





HST/STIS 275nm



Conclusion

- Many observing programs are in progress and converge towards a comprehensive view of Betelgeuse
- The convection at the surface is most probably at the basis of the mass loss
- Thanks to the very large convective cells (5-10 mas) VEGAS will provide constraints comparable to what we have from the solar surface convection (~1")