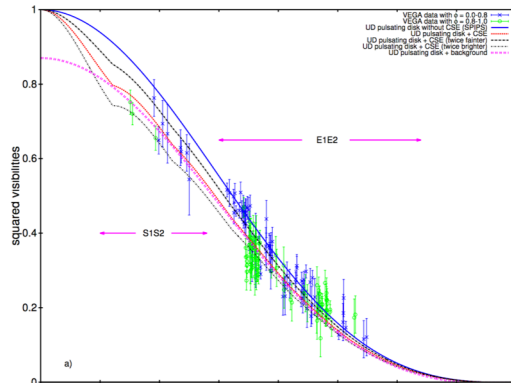# Stellar winds and circumstellar environments

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ESO

Winds and CSE across the HR diagram

Stars across the HR diagram are affected by winds and circumstellar environments, for example: Young stellar objects, Debris discs - possibly surviving the MS, hot evolved stars (Be stars), Cepheids, del Sct stars, red giant winds, AGB stars, RSGs, BSG, post-AGB
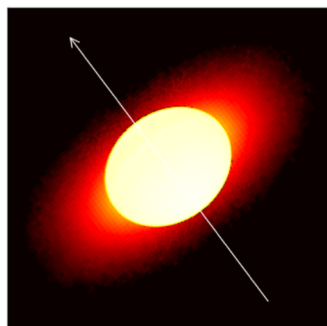

CSE of 7% in the visible around the Cepheid δ Cep (Nardetto et al. 2016)
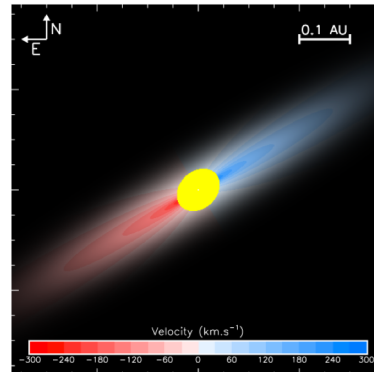
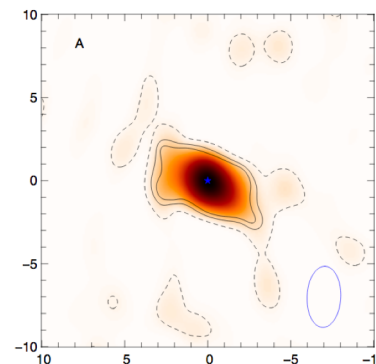

Fast-rotator 51 Oph (Jamialahmadi et al. 2015)
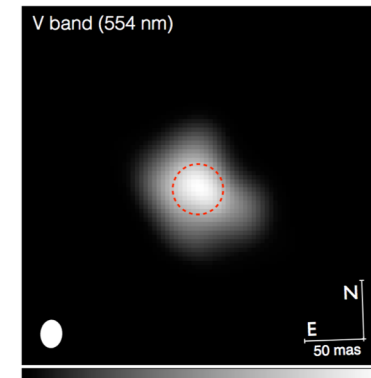
The RSG Betelgeuse (Kervella et al. 2016)


Achernar dust model (Dalla Vedova et al. (2017)

B[e] star MWC 158 (Kluska et al. (2016)

SPICA observations

- **SPICA in LR mode will be little affected much by line-forming regions**

- **SPICA in MR mode may see CSE geometries in lines (e.g., Hα, Hβ, HeI, forbidden lines)**

- **SPICA will see winds and CSEs as an additional geometrical component in addition to the stellar disk**

  - ➢ LD disk plus
    - (2D) Gaussian component, disc,
    - more complex geometries (clumps)
  - ➢ CSE with different flux contribution from

    little obscuration to complete obscuration of the stellar disk
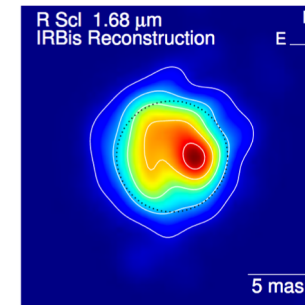
Carbon AGB star
R Scl
(Wittkowski et al. (2016)
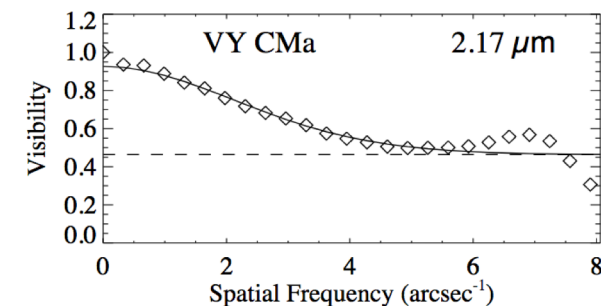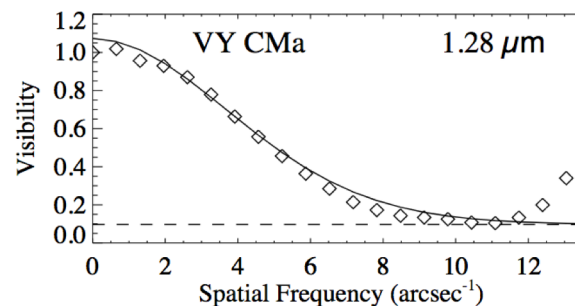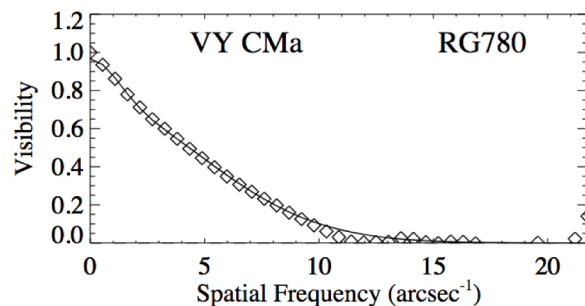
Speckle interferometry of the RSG VY CMa simultaneously at ~0.8µm, 1.28µm, 2.17µm, where the central star contributes with 0.00%, 0.09%, 0.50%, respectively (Wittkowski et al. 1998)

Interpretation

■ Winds start at the stellar surface

  ➤ Radiatively-driven winds (mostly) for hot stars

  ➤ Pulsation/convection-driven winds for cool evolved stars

  ➤ Both processes not yet well understood

■ Strong links to other processes discussed at this meeting:

  ➤ Radiation

  ➤ Convection/Pulsation

  ➤ Spots

  ➤ Magnetic fields

  ➤ Rotation

  ➤ Multiplicity

Advantage of SPICA: Statistical analysis of many stars

■ For example, contribution and geometry of CSE as a function of

> ➢ Luminosity
> ➢ Effective temperature
> ➢ Multiplicity
> ➢ Magnetic field strength
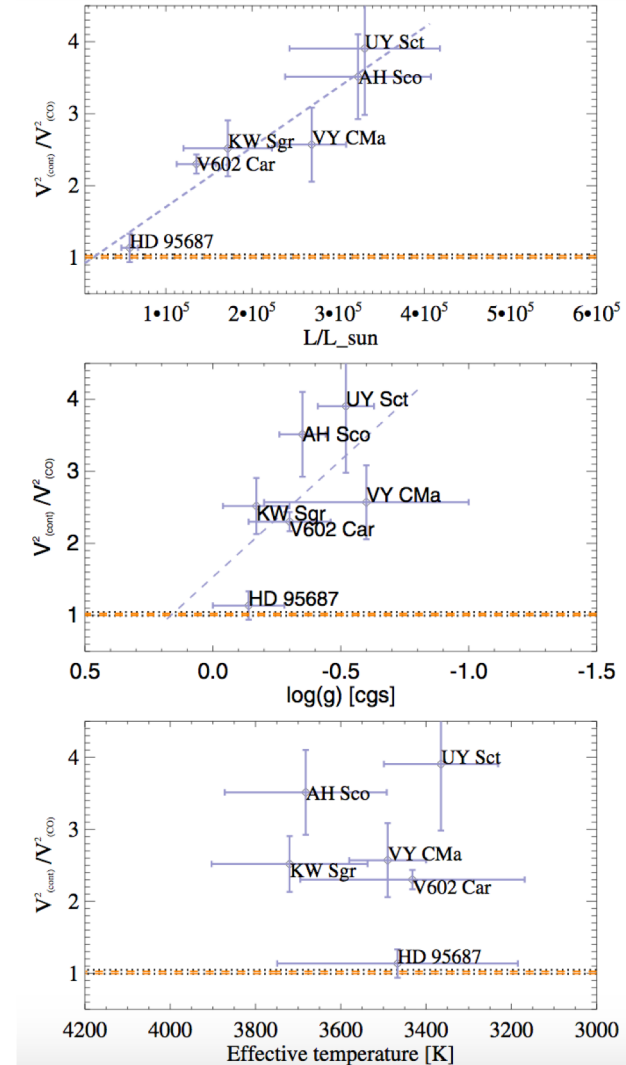
Example (Arroyo-Torres et al. 2015)