Stellar winds and circumstellar environments

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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)
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)