The Carbon Stars Adventure

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Introduction

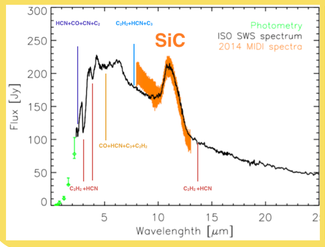
We study of a set of C-rich AGB stars to improve our understanding of the dynamic processes happening in their atmospheres. For the first time we compare in a systematic way spectrometric, photometric and interferometric measurements with different types of model atmospheres: 1) hydrostatic models+MOD-dusty added a posteriori; 2) self-consistent Dynamic Model Atmospheres (DMA) that allow to interpret coherently the dynamic behavior of gas and dust.

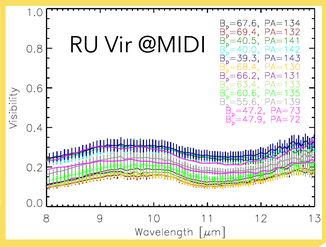
Data

Photometry → SAAO, ESO, ASAS, AAVSO

Spectroscopy → ISO-SWS/IRAS/IRTF

Interferometry → VLTI/MIDI data

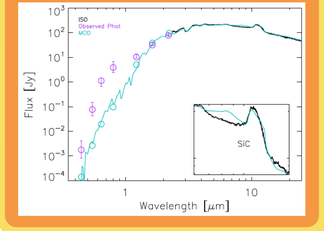




Methodology

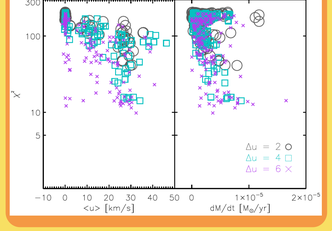
Hydrostatic[1]+MOD[2]

- Fit of hydrostatic atmosphere spectra for the effective temperature
- Use standard C-star dust mix (90% amC + 10% SiC)
- Fit SED & visibilities simultaneously
- Obtaining the MOD output parameters: T_{cond}, L, τ, p



DMA[3]

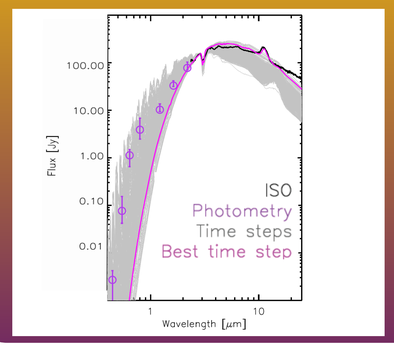
- Fit of the whole grid of 540 Models (~140000 pulsation snap-shots)
- Parameters to fit: L, T_{eff}, C/O, piston amplitude, P
- Independent fit of SED and visibilities

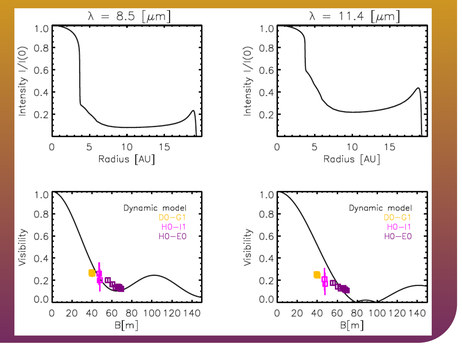


BEST FIT MODELS

RU Vir[5]

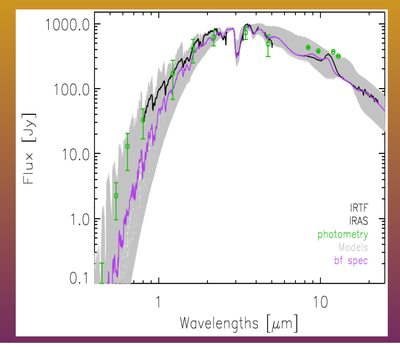
T_{eff} = 2800 K
C/O = 2.38
L = 10000 $L_\odot$
dM/dt = 3.7 10^{-6} M_{sun} /yr
P = 525 d

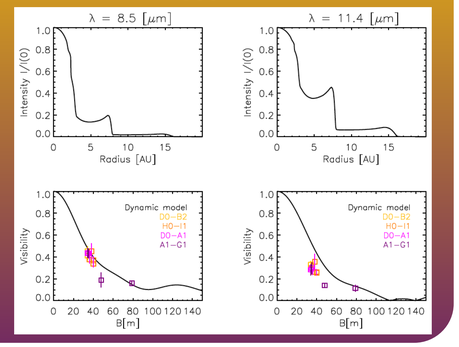




R Lep

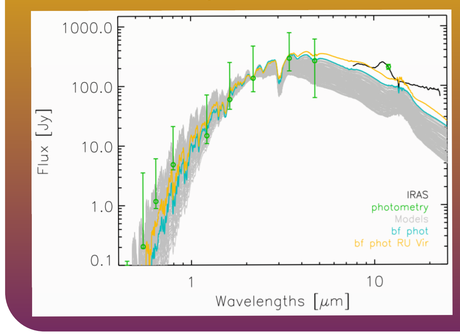
T_{eff} = 3000 K
C/O = 1.69
L = 7000 $L_\odot$
dM/dt = 2.5 10^{-6} M_{sun} / yr
P = 390

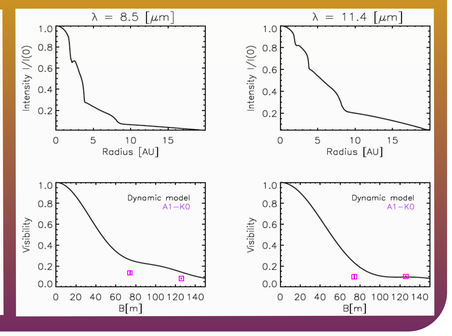




R Vol

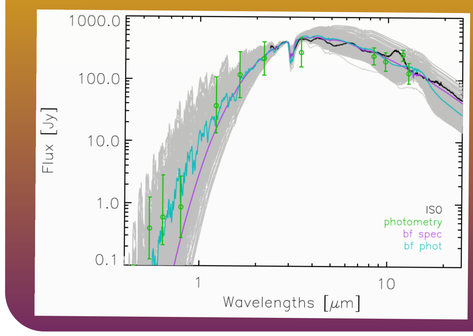
T_{eff} = 2800 K
C/O = 1.69
L = 7000 $L_\odot$
dM/dt = 1.89 10^{-6} M_{sun} /yr
P = 454 d

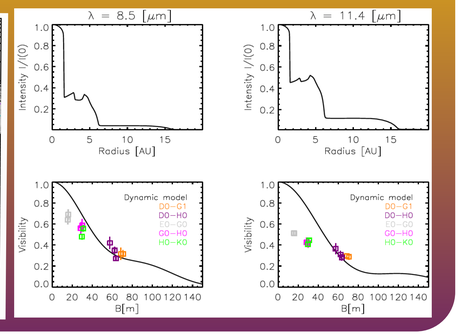




R For

T_{eff} = 2800 K
C/O = 2.38
L = 10000 $L_\odot$
dM/dt = 3.7 10^{-6} M_{sun} /yr
P = 389 d





Conclusions

- Combination of different types of observables (phot+spec+interf) is crucial for constraining the models.
- RU Vir: SED well reproduced between 2-10 μm.
- R Lep, R Vol, R For: better fit to the photometry.
- All Stars: **differences** → SED —> intra-inter-cycle variation?
  → Visib —> different opacity distribution?
- Future: MATISSE & CRIRES & METIS!

References

[1] Aringer, B., Girardi, L., Nowotny, W., Marigo, P., 2009, A&A, 503, 913
[2] Groenewegen, M. A. T. 2012, A&A, 543, 36
[3] Mattsson, L., Wahlin, R., & Höfner, S. 2010, A&A, 509, A14
[4] Eriksson, K.; Nowotny, W.; Höfner, S. 2014, A&A, 566, A95
[5] Rau et al., subm. - arXiv link

Questions?

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