DEATHSTAR: Nearby AGB stars with the Atacama Compact Array (ACA)

CO envelope sizes and asymmetries

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DEATHSTAR
alma investigation of cool giants

Context

What is the DEATHSTAR project ?

DEtermining Accurate mass-loss rates (MLRs) of THermally pulsing AGB stars [1] .

How ?

CO line observations + radiative transfer modelling give the average MLR that created the circumstellar envelope (CSE) probed by the CO line.

The sizes of the CO line-emitting CSE are poorly constrained.

Step 1 (this work)

Directly measure the size of the **CO-line-emitting CSE** through interferometry.

Conclusions

- About 2/3 of the CSEs of our 52 sources are consistent with a spherically symmetric CSE.
- Below $5 \times 10^{-8} \mathrm{M_\odot\,s\,km^{-1}\,yr^{-1}}$, C-type CSEs are larger than S-types, which are larger than M-types due to their CO abundances.
- C-type CSEs are larger than predicted, M-type are smaller.
- S-type CSEs are larger than C-types for the same density above $5 \times 10^{-8} \mathrm{M_\odot\,s\,km^{-1}\,yr^{-1}}$.

Step 2 : radiative transfer modelling, stay tuned!

https://www.astro.uu.se/deathstar

Methods

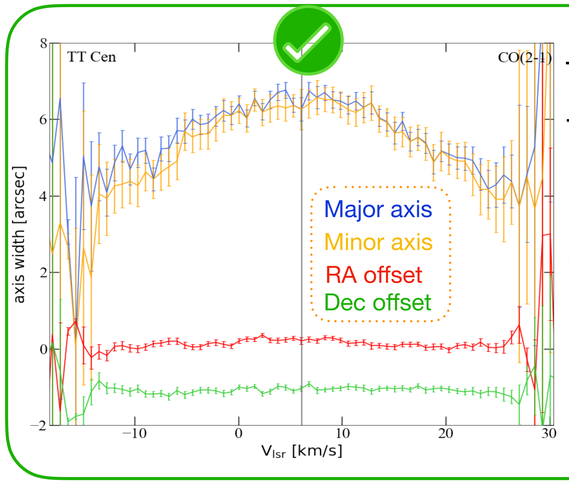
- ALMA ACA observations of the CO(2-1) line toward the CSEs of a sample of nearby AGB stars of the three chemical types.

- Fit a *Gaussian model* to the visibility data [2].

Major axis → Diameter of the CSE

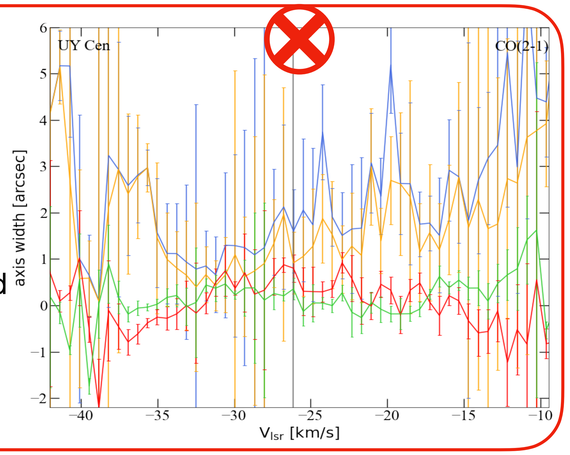
Major/minor axes + Line profile, Image → Signs of asymmetries

Fitting results

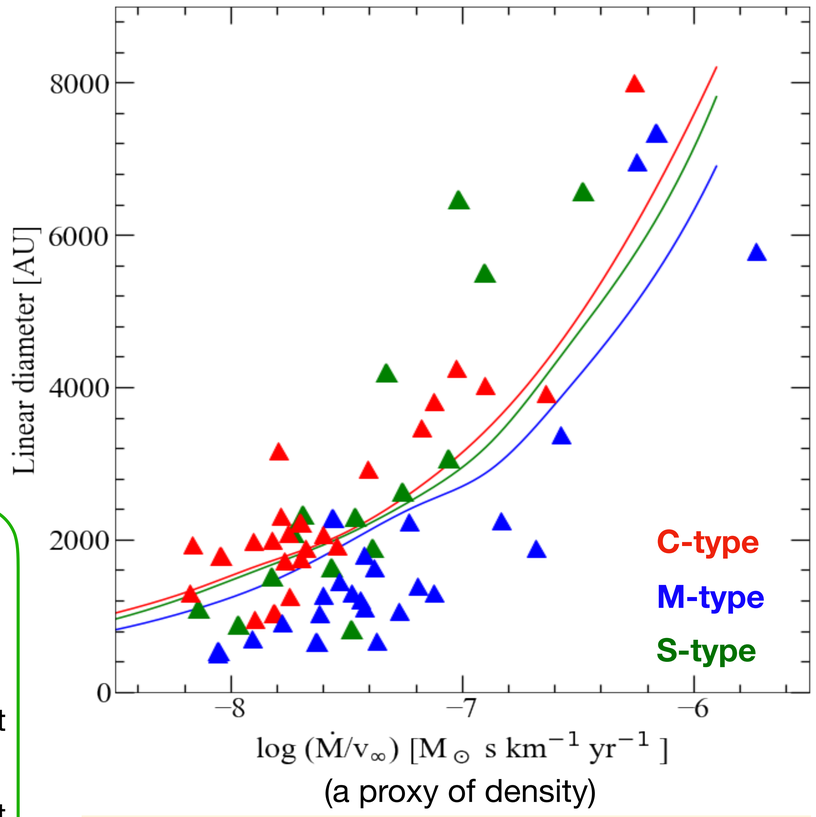


- Monotonic
- Major ~ minor axis
- Size: major axis at central velocity
- Good fit: consistent with a spherically symmetric outflow

- Unpredictable
- Shift in position
- Noisy data
- Size underestimated
- Possibly aspherical
- Need better data



Main result



(a proxy of density)

Legend

▲ Data points

— Expected size of CO(2-1)-emitting CSE

References

[1] Ramstedt, S., Vlemmings, W. H. T., Doan, L., et al. 2020, A&A, 640, A133

[2] Martí-Vidal, I., Vlemmings, W. H. T., Muller, S., & Casey, S. 2014, A&A, 563, A136

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