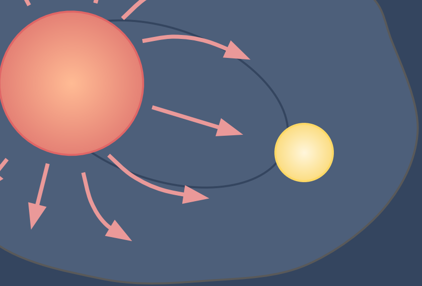
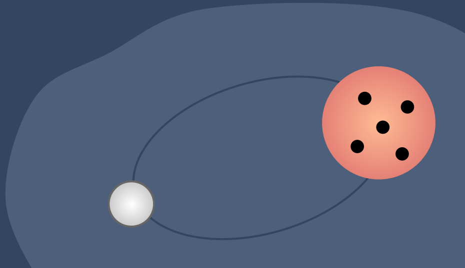


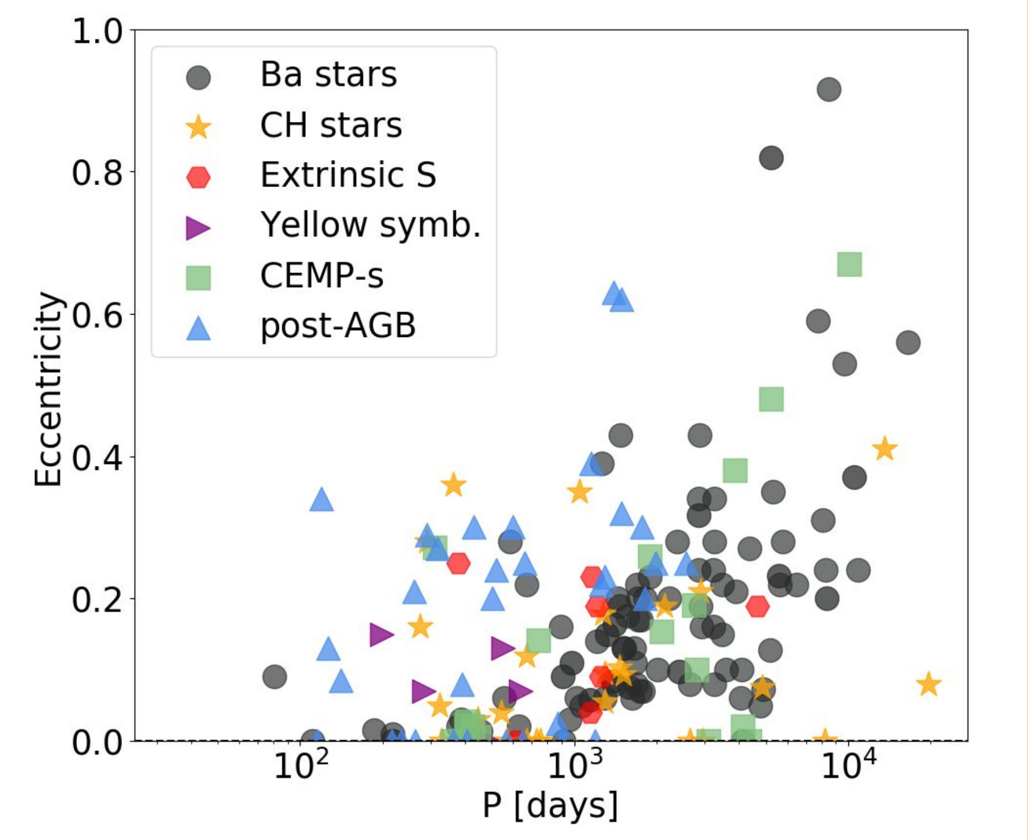
The fundamental role of stellar multiplicity in stellar dynamics and evolution

The eccentric progeny of red giant stars in binary systems



Ana Escorza

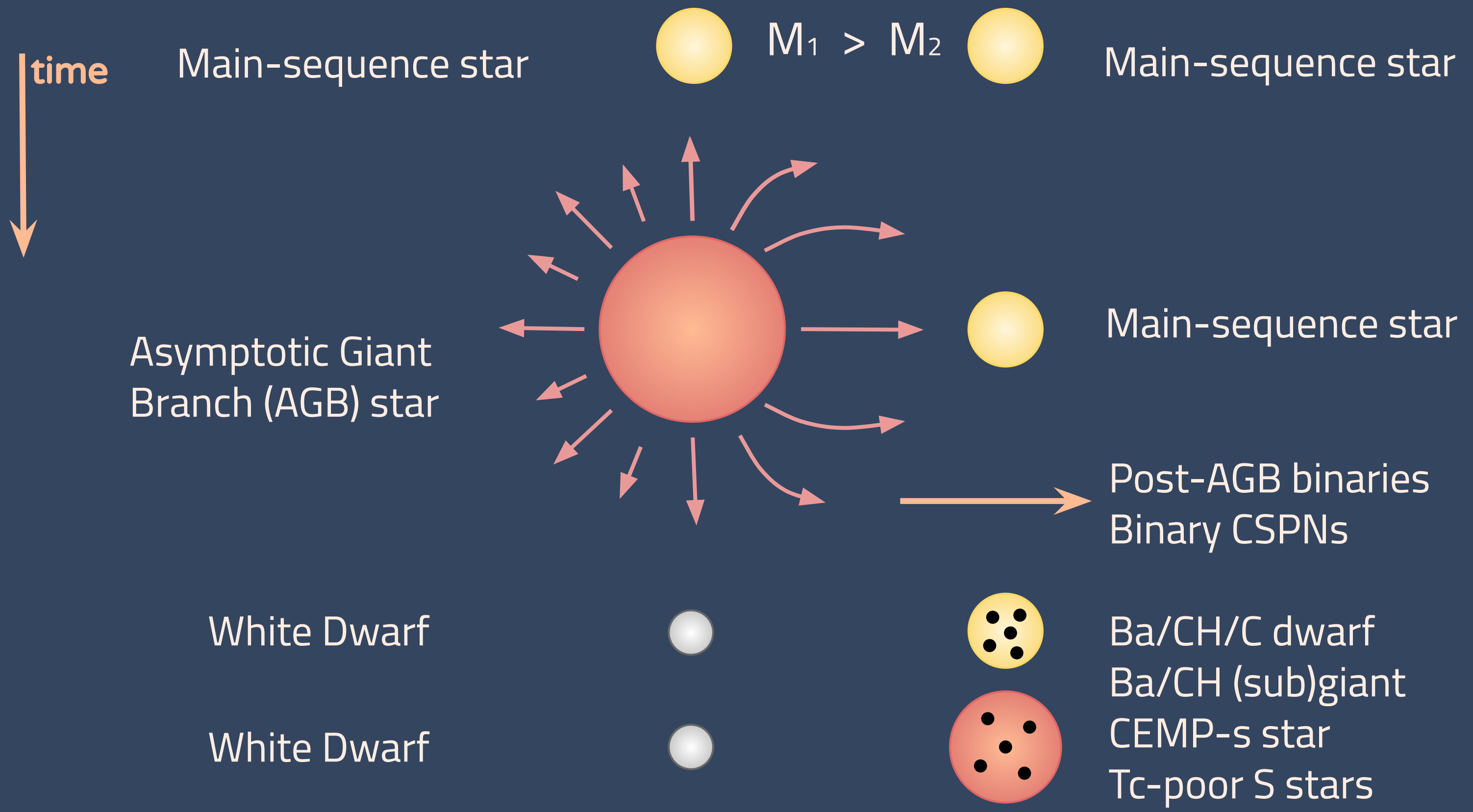
Motivation for this discussion



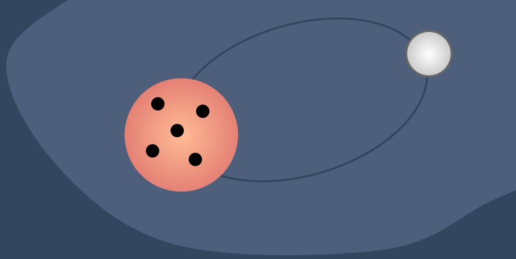
Data from:

Smith+96
Vanture+03
Hansen+16
Jorissen+16
Van der Swaelmen+17
Oomen+18
Jorissen+19
Escorza+19
North+20
...

The eccentric progeny of red giant binaries



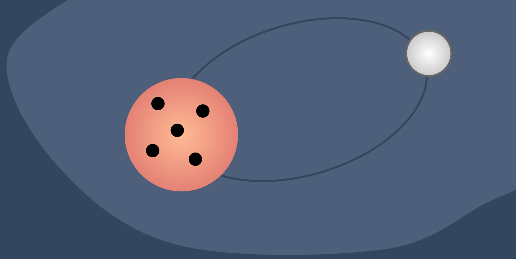
Barium and related stars



	Ba stars	CH stars	CEMP-s stars
Metallicity:	~0.5 Zsun	~0.1 Zsun	< 0.01 Zsun
Multiplicity:	~ 100%	~100%	Likely 100%
RG fraction:	~1%	~2%	6% - 20%

(Onno Pols, ImBaSE 2017)

Barium and related stars



	Ba stars	CH stars	CEMP-s stars
Metallicity:	~0.5 Zsun	~0.1 Zsun	< 0.01 Zsun
Multiplicity:	~ 100%	~100%	
RG fraction:	~		

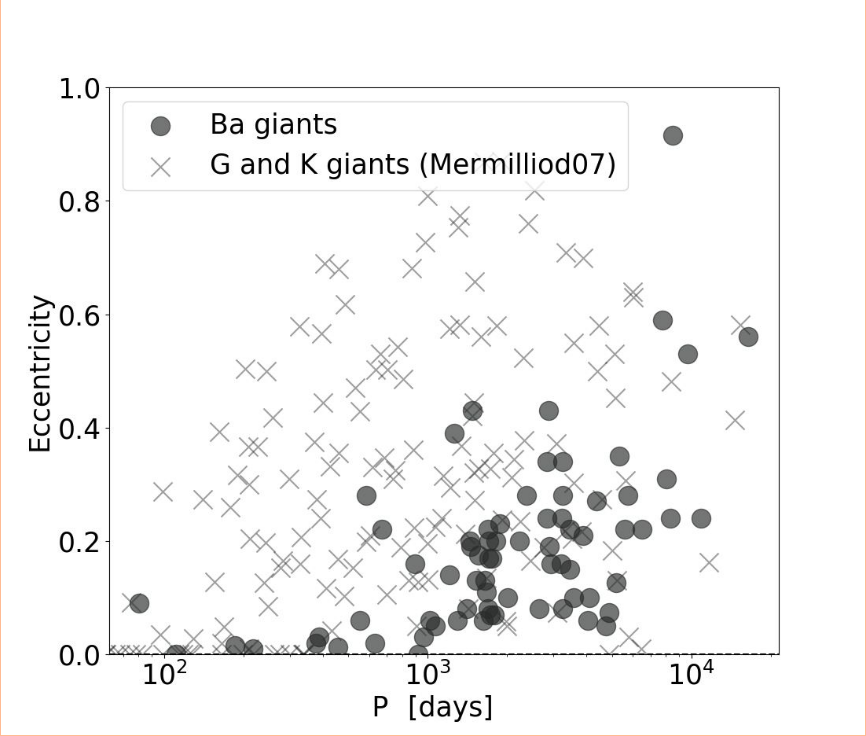
AGB binary evolution models should reproduce the orbital properties of Ba stars.

The stellar and chemical properties of the current components can constrain nucleosynthesis models

White Dwarf — Ba dwarf

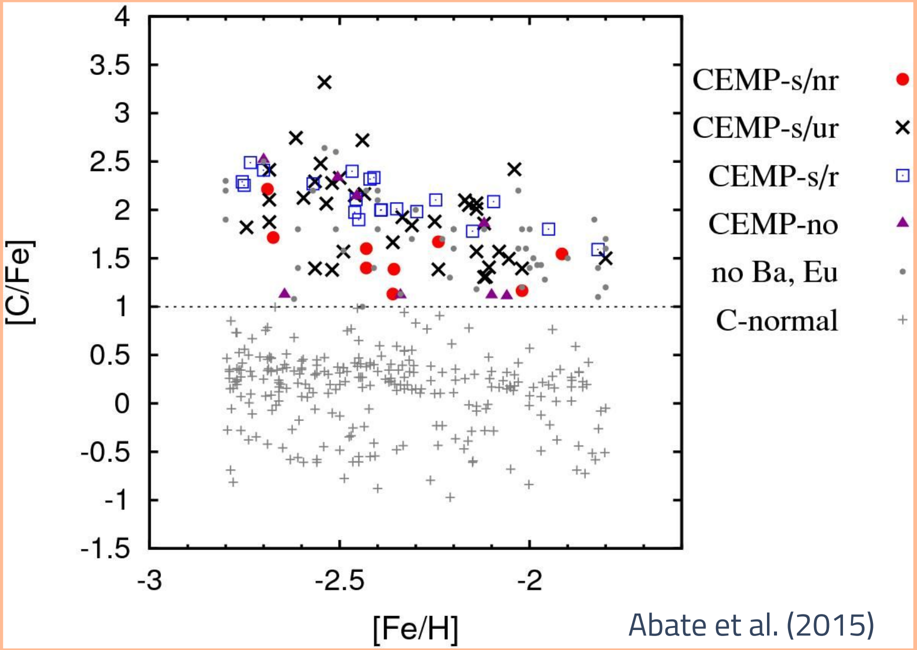
White Dwarf — Ba giant

Barium and related stars



- Intermediate orbital periods.
- Significant eccentricities, but showing signatures of tidal interaction.
- Companion masses consistent with white dwarfs.

Carbon-enhanced metal-poor stars



Abate et al. (2015)

[C/Fe] > +1.0,

CEMP-s: [Ba/Fe] > +1.0, and [Ba/Eu] > +0.5

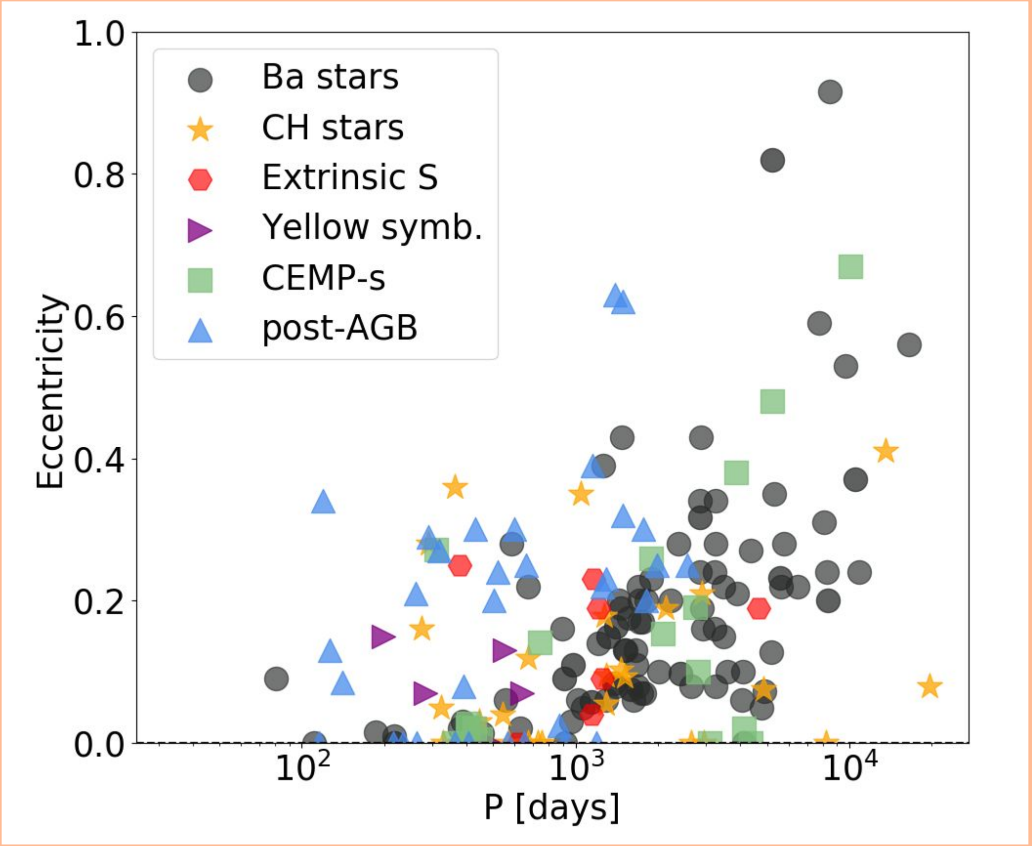
CEMP-r: [Eu/Fe] > +1.0

CEMP-r/s (i?): 0.0 < [Ba/Eu] < +0.5

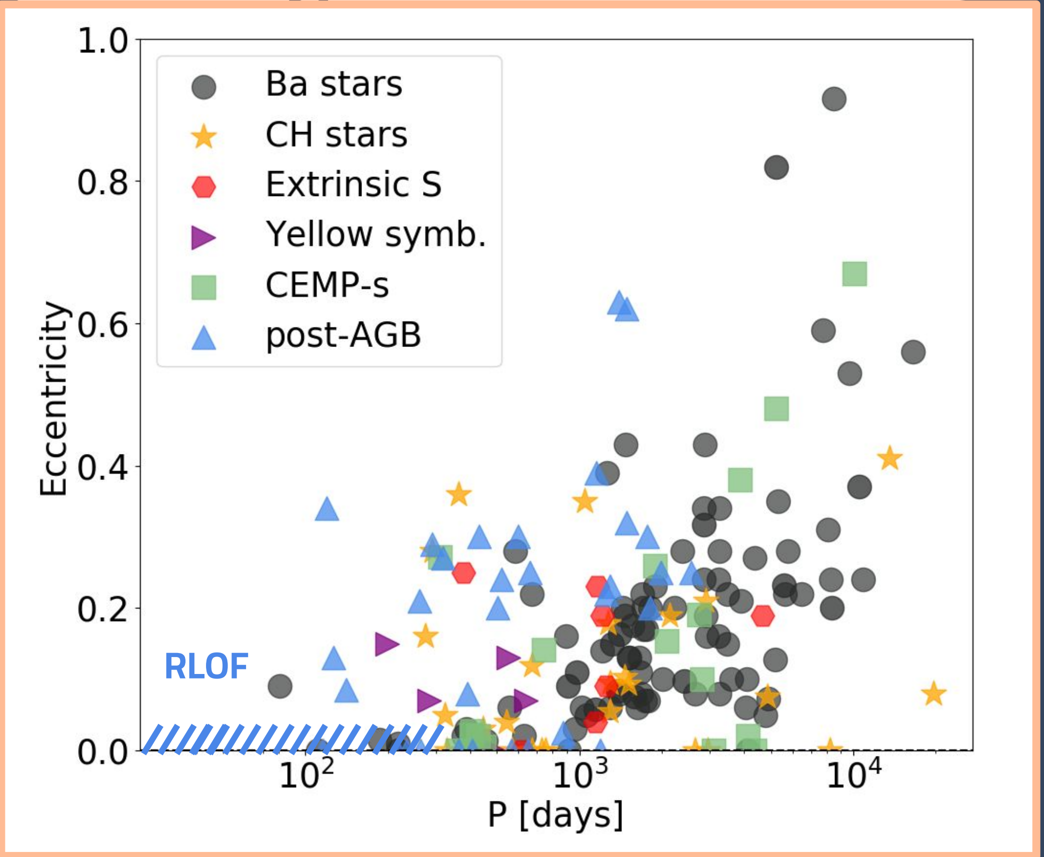
CEMP-no: [Ba/Fe] < 0

Beers & Christlieb (2005), Lucatello et al. (2005), Starkenburg et al. (2014), Hansen et al. (2015, 2016) ...

The eccentric progeny of red giant binaries

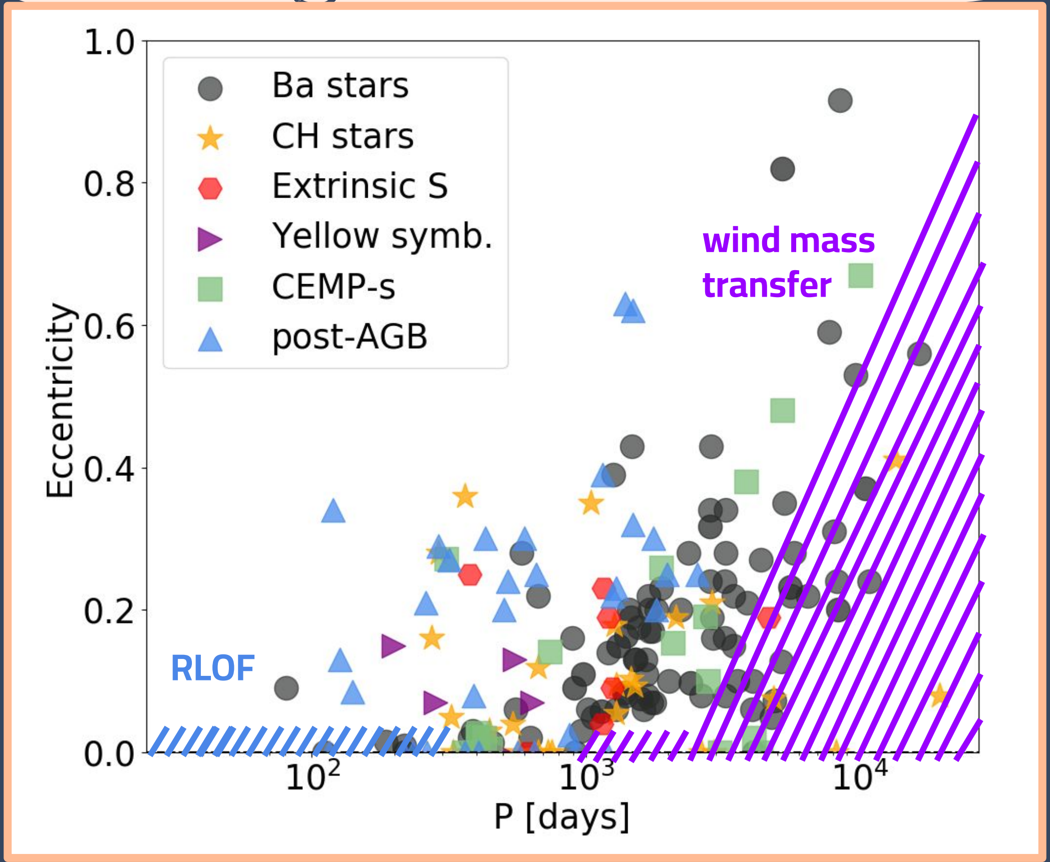


The eccentric progeny of red giant binaries



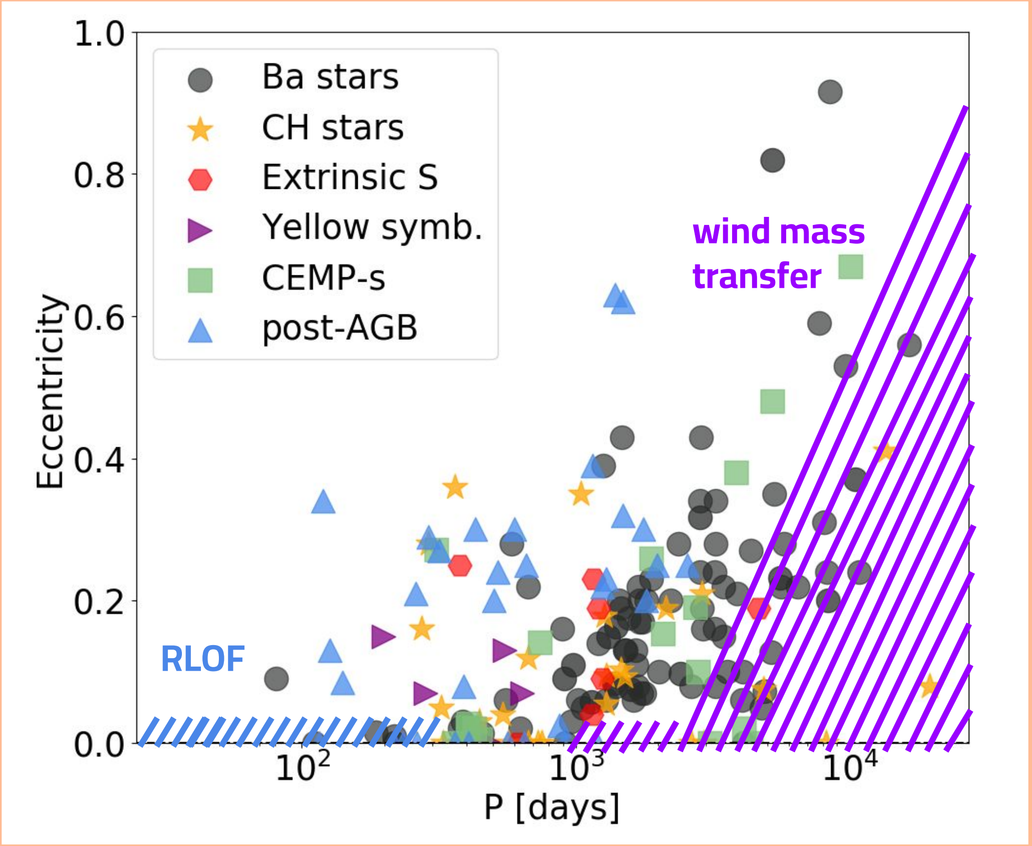
Models drawn from:
Izzard+10

The eccentric progeny of red giant binaries



Models drawn from:
Izzard+10

The eccentric progeny of red giant binaries



- Less efficient tides?
- Eccentricity-pumping mechanism?
- Intermediate mass transfer formalism?
- ... ?

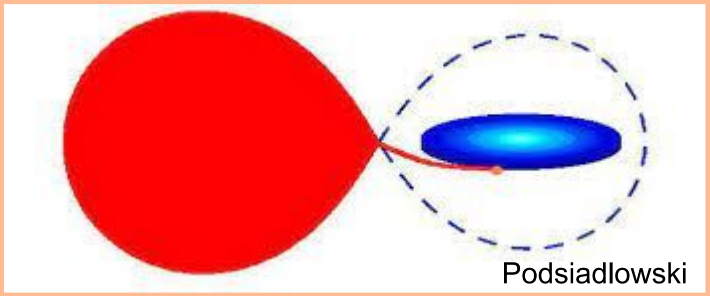
Models drawn from:
Izzard+10

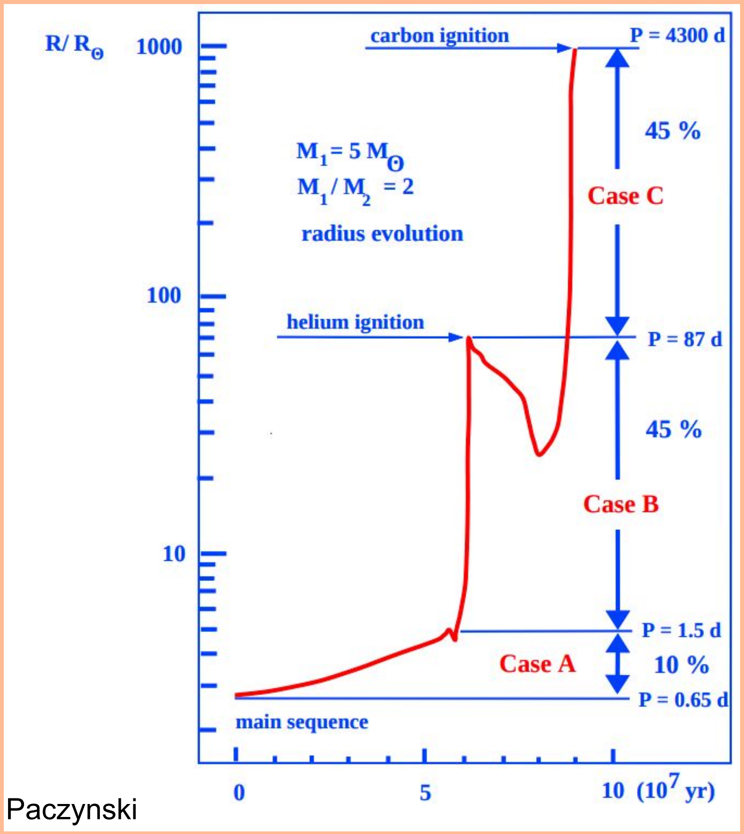
Roche-lobe overflow

~ 25% of low-mass binaries will undergo RLOF.

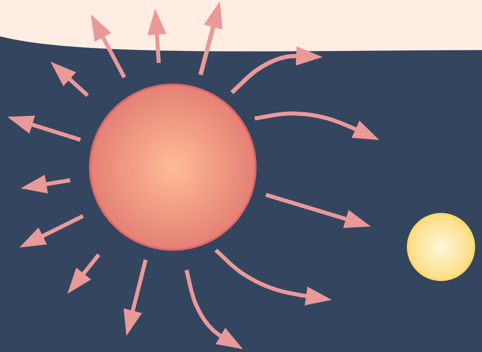
RLOF is usually unstable when a red convective giant is involved.

Strong tidal interaction is expected to lead to close and circular binaries.

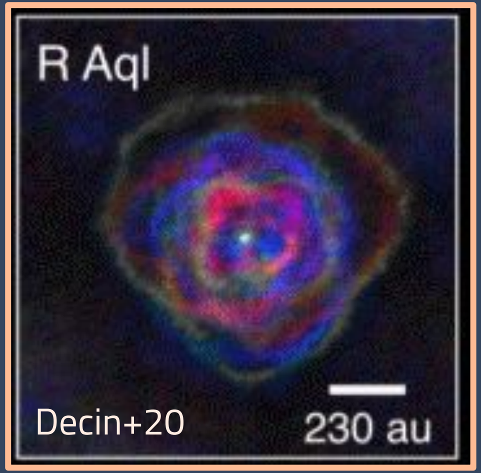




Classical wind-mass transfer



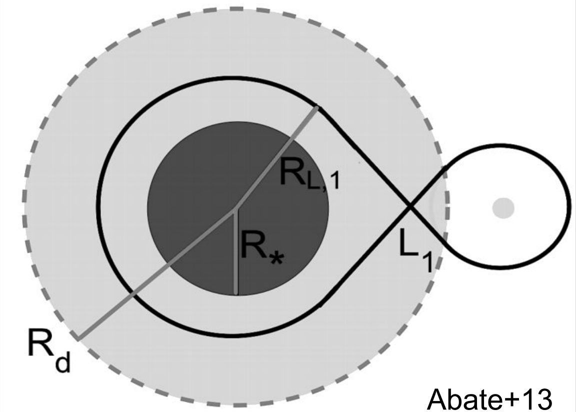
AGB wind - companion interactions can shape the orbits of these systems and be, at the same time, responsible for the pollution.



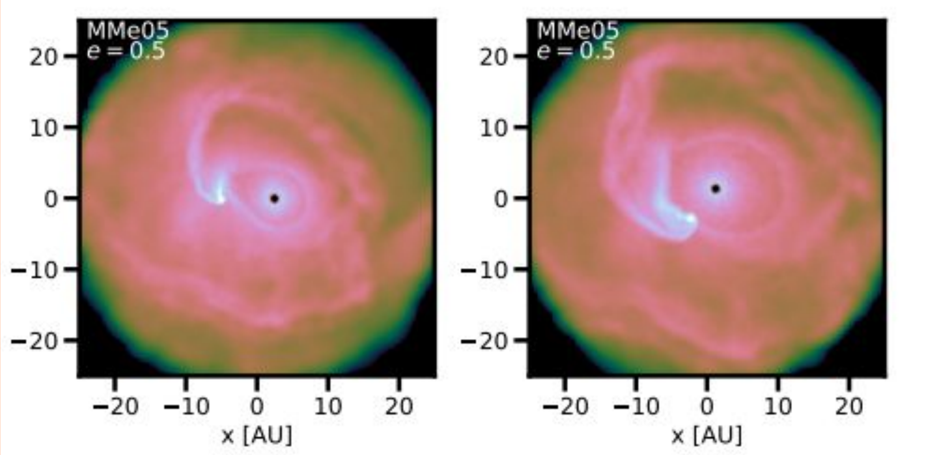
BUT! The Bondi-Hoyle-Lyttleton accretion formalism (isotropic flow, fast wind) does not work.

Wind-RLOF

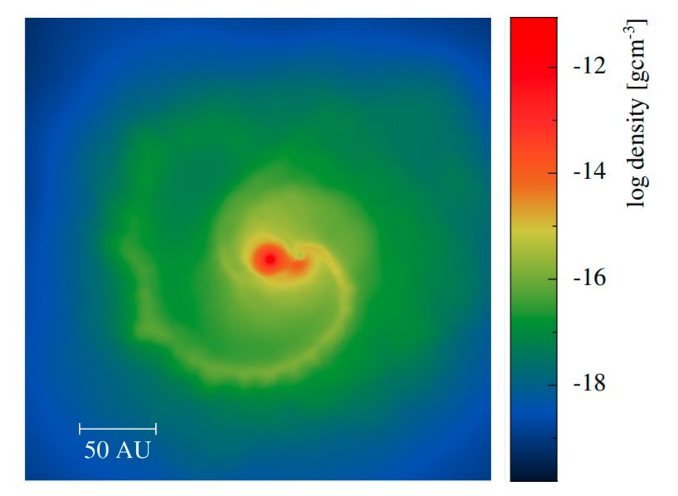
If the wind, instead of the star, fills the Roche lobe, larger accretion efficiencies possibility of orbital shrinkage



Abate+13



Saladino+18,19



Mohamed&Podsiadlowski12

Eccentricity-pumping agents

- Enhanced wind mass loss or RLOF at periastron
  (e.g. Tout&Eggleton88, van Winckel+95, Bonačić Marinović+08, Soker+00...)
- Resonant interactions with a circumbinary disks
  (Artymowicz&Lubow94, Dermine+13, Vos+15, Oomen+20)
- Triples
  (Perets&Kratter12, Gao+22)
- Kicks to the white dwarf at its birth
  (Izzard+10)

- Reduced or updated tidal interaction prescriptions
  (Nie+17, Escorza+20, Preece+22)

Summary and Conclusions

- The eccentric progeny of AGB binaries are excellent tracers of binary evolution and interaction models.

  (The s-process enhanced subset can also help to constrain AGB nucleosynthesis models)

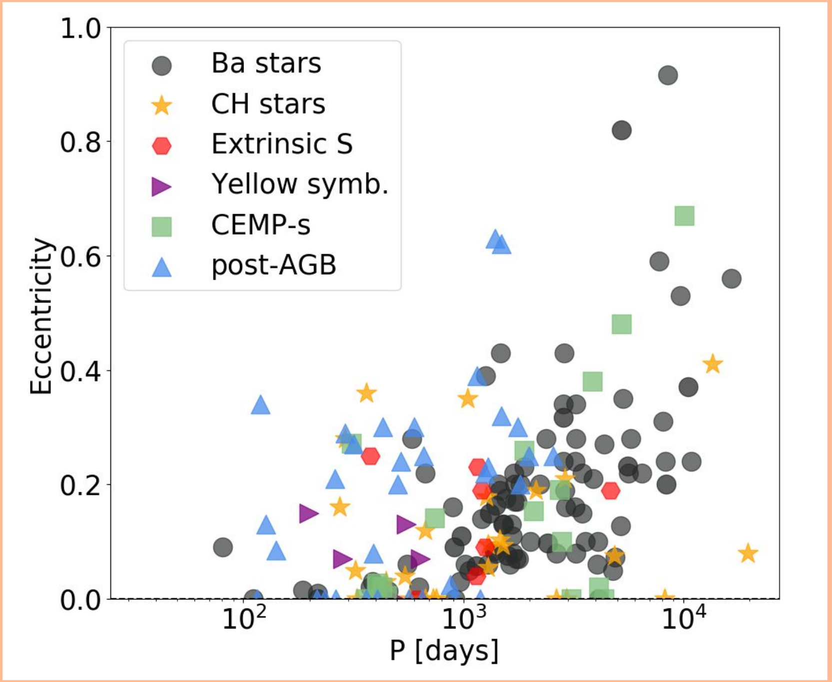
Summary and Conclusions

- The eccentric progeny of AGB binaries are excellent tracers of binary evolution and interaction models.

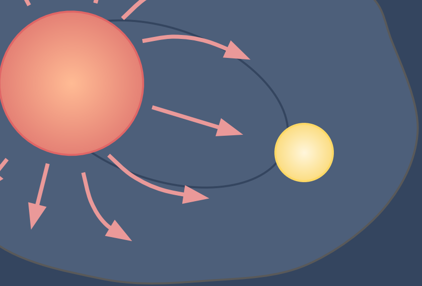
  (The s-process enhanced subset can also help to constrain AGB nucleosynthesis models)

We have strong observational constraints and a great variety of models, but the problem is not yet solved. Where do we go next?

Motivation for this discussion

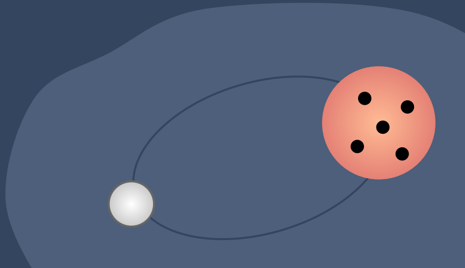


- Where do we go next, observationally?
  - Longer monitoring programs?
  - Larger populations?
  - Different environments?
  - New identification methodologies?
- What's next theoretically?
  - 1D vs. 2D vs. 3D models: possibilities and limitations?
  - W-RLOF? Circumbinary discs? New tidal formalisms? Others?
- Analogue eccentric binaries at higher masses?
- ...



The fundamental role of stellar multiplicity in stellar dynamics and evolution

Thanks!



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