Formation of Barium Stars constrained by *Gaia* parallaxes

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Barium stars

White dwarf companion

Chemically peculiar star polluted by a former AGB companion.

Prototypical post binary interaction binary system.

Formation of barium stars

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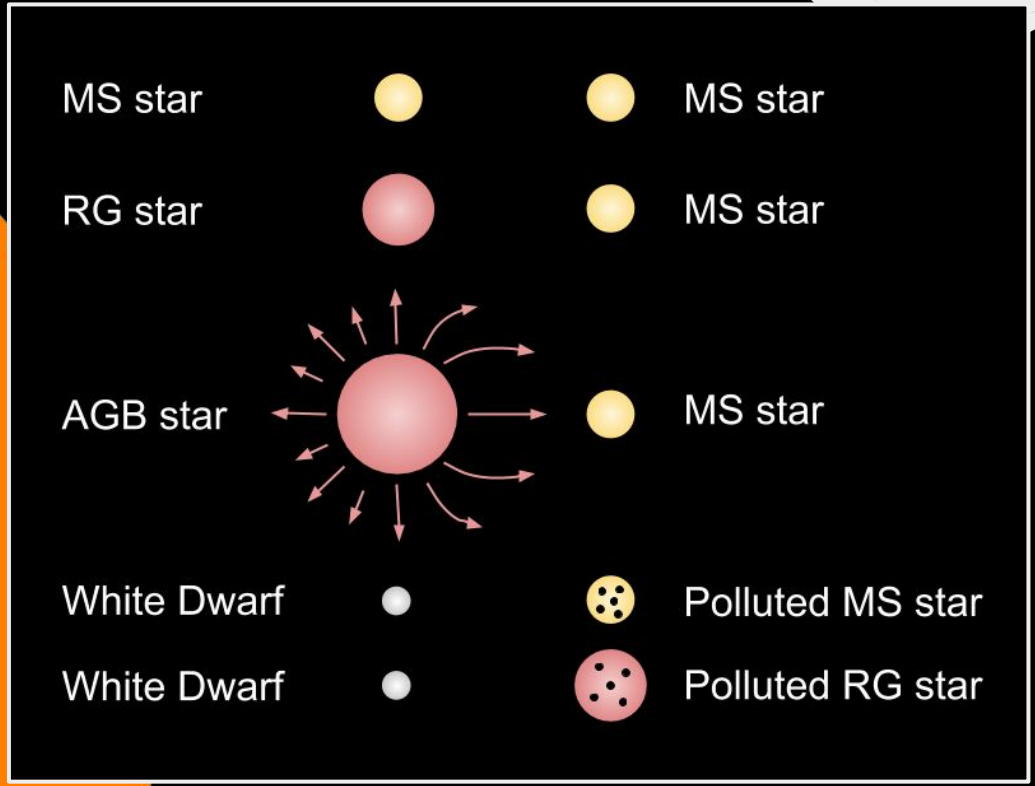

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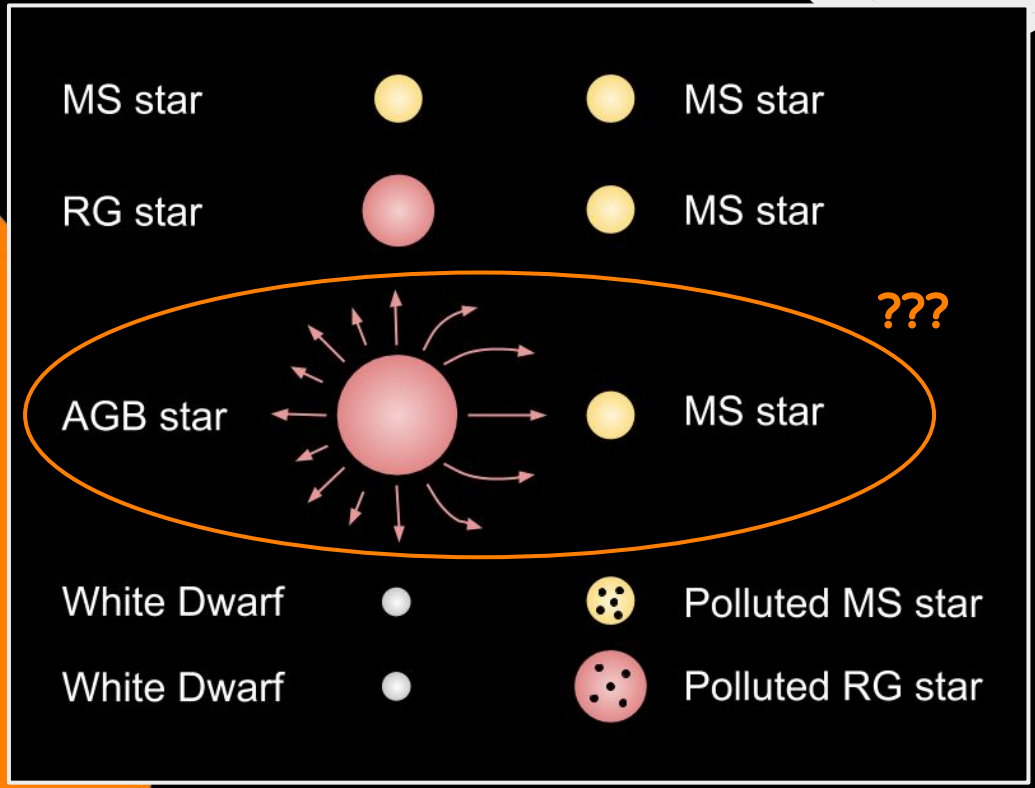

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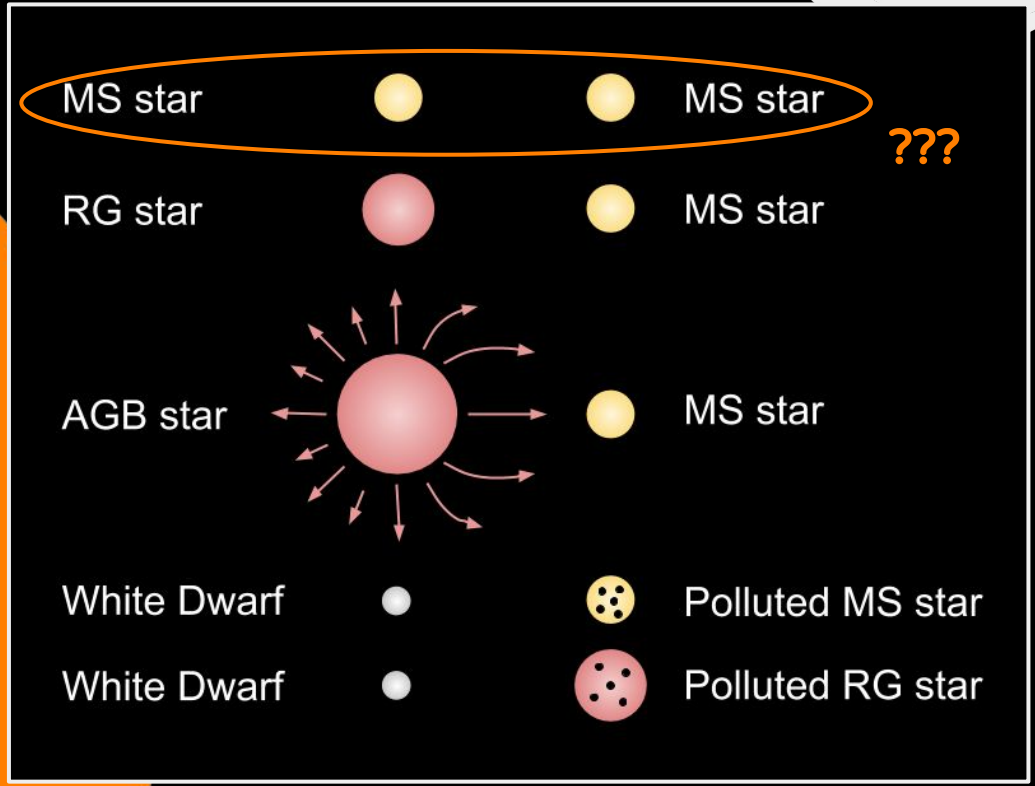

Observational properties of Ba stars can teach us binary interaction physics

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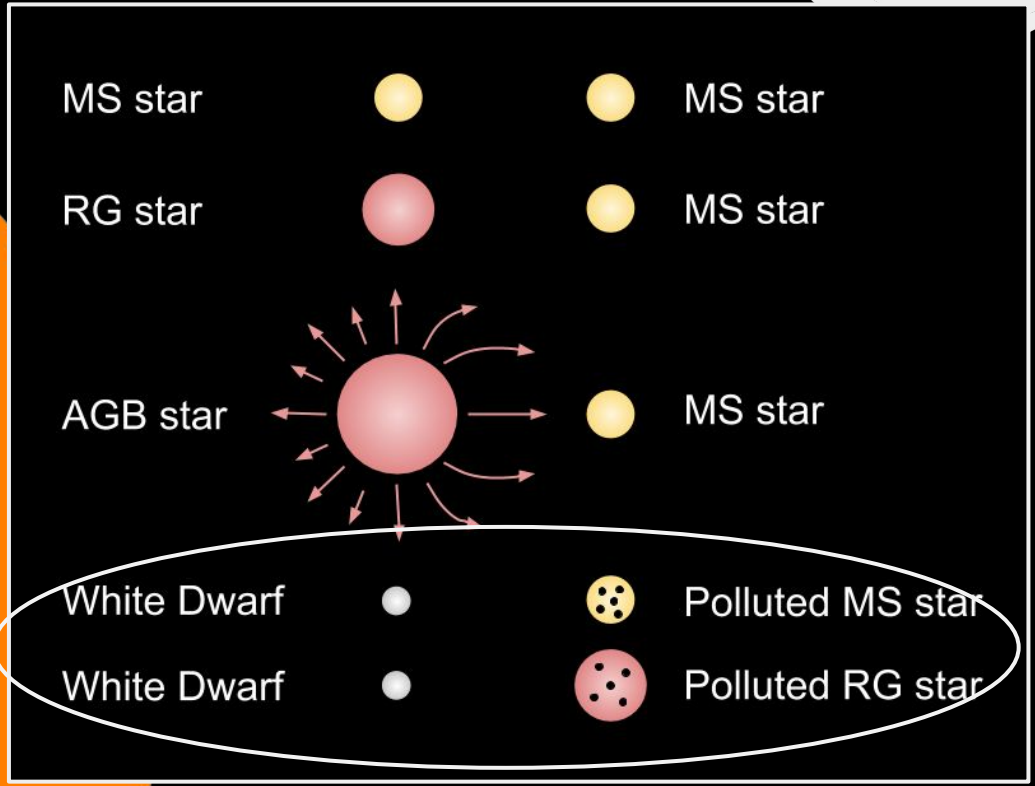
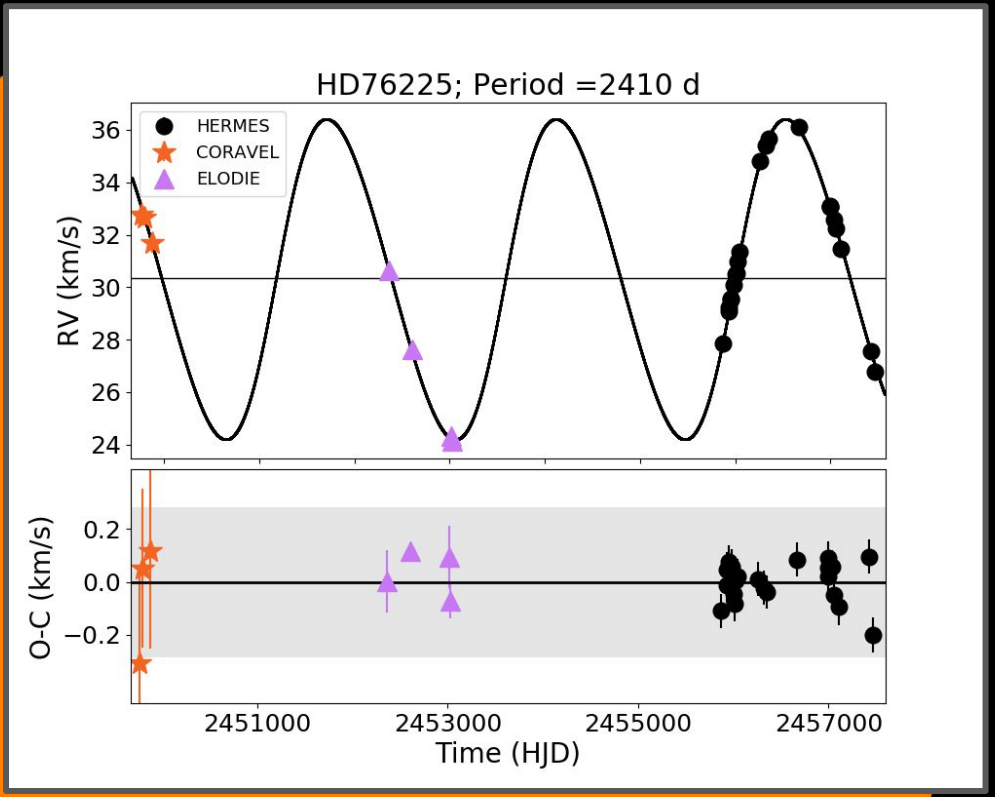


Orbital properties of Ba stars

Orbital properties

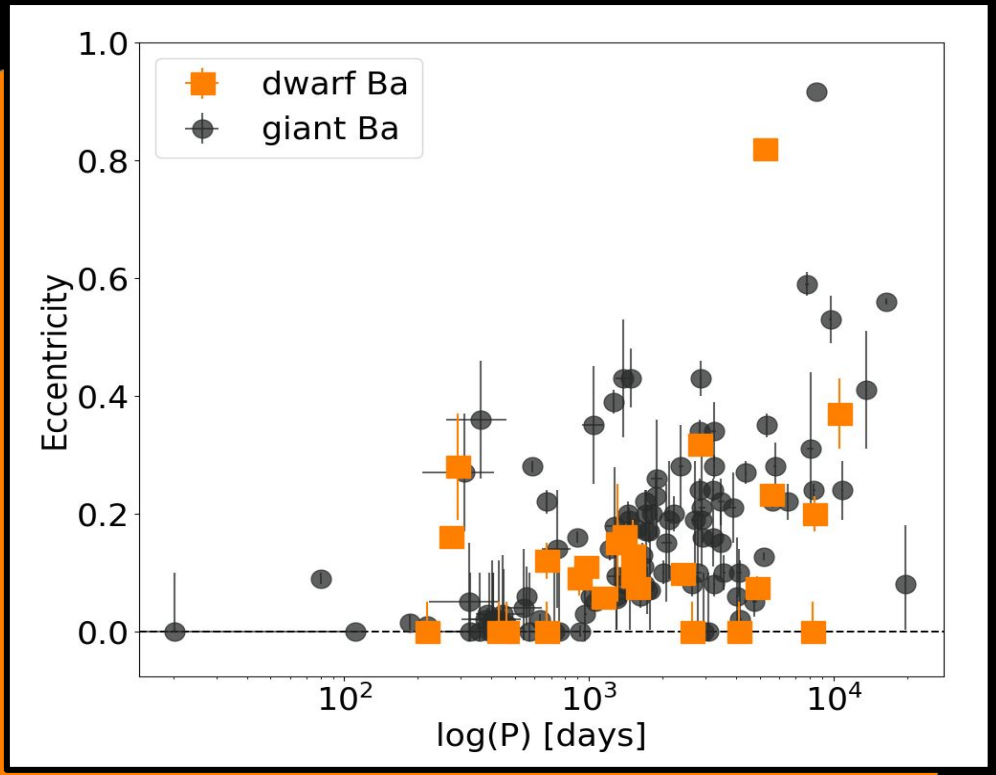


CORAVEL and other ESO
radial velocity data
+
HERMES
radial velocity monitoring
+
HRS@SALT spectra

~130 systems

White Dwarf
White Dwarf
Polluted MS star
Polluted RG star

The eccentricity-period diagram



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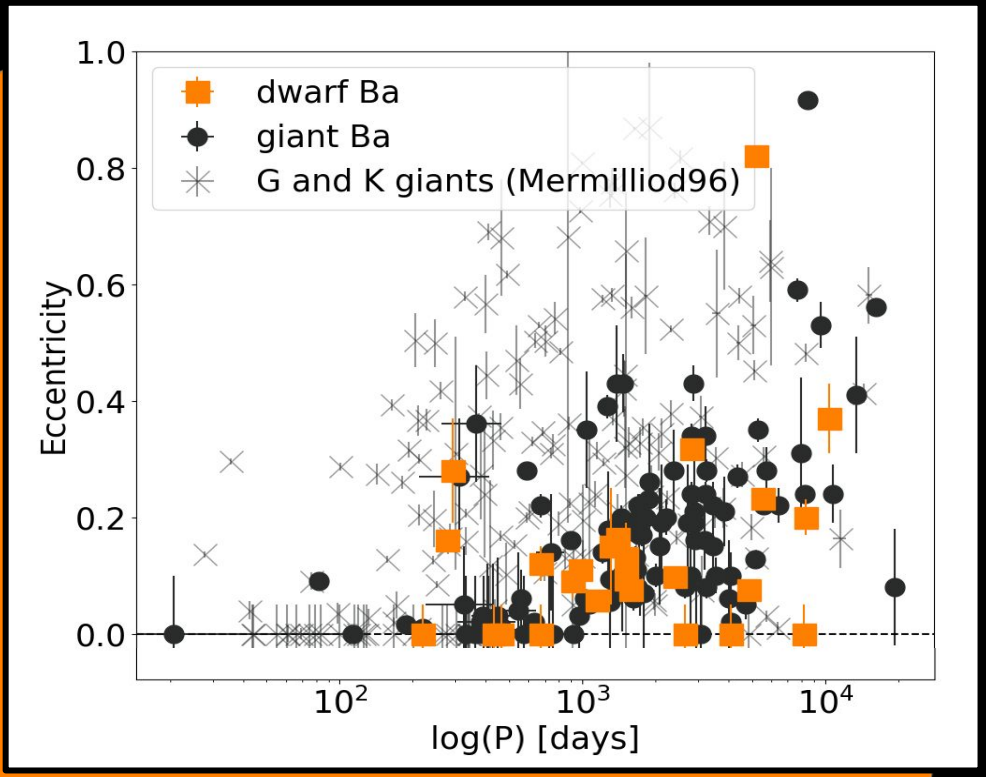

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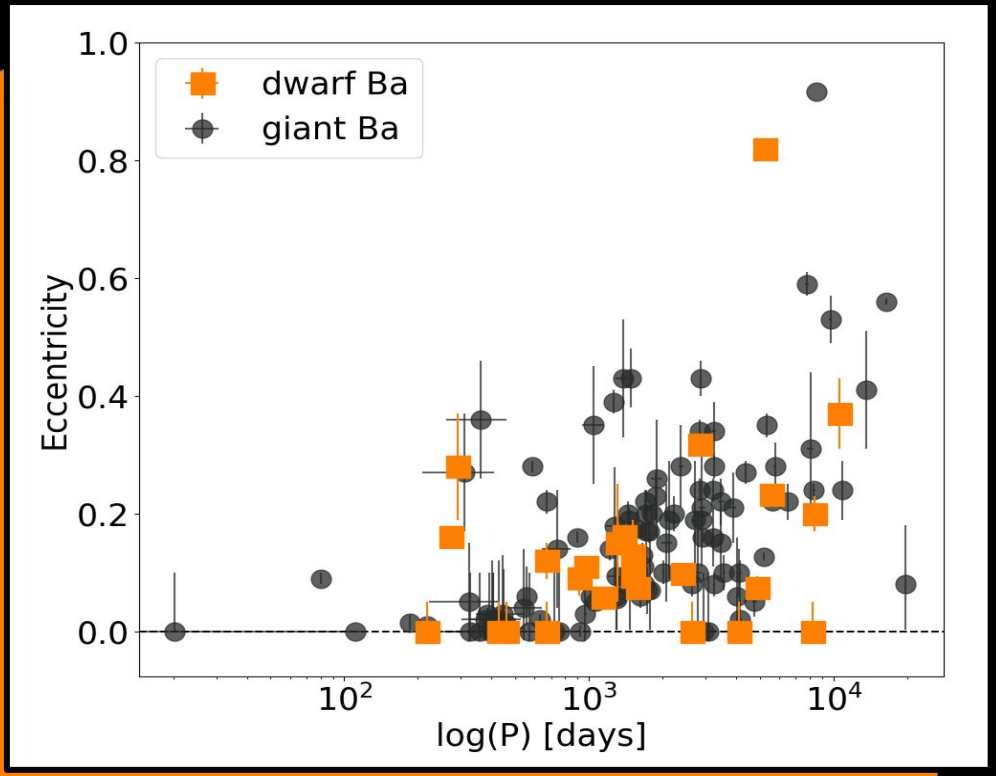
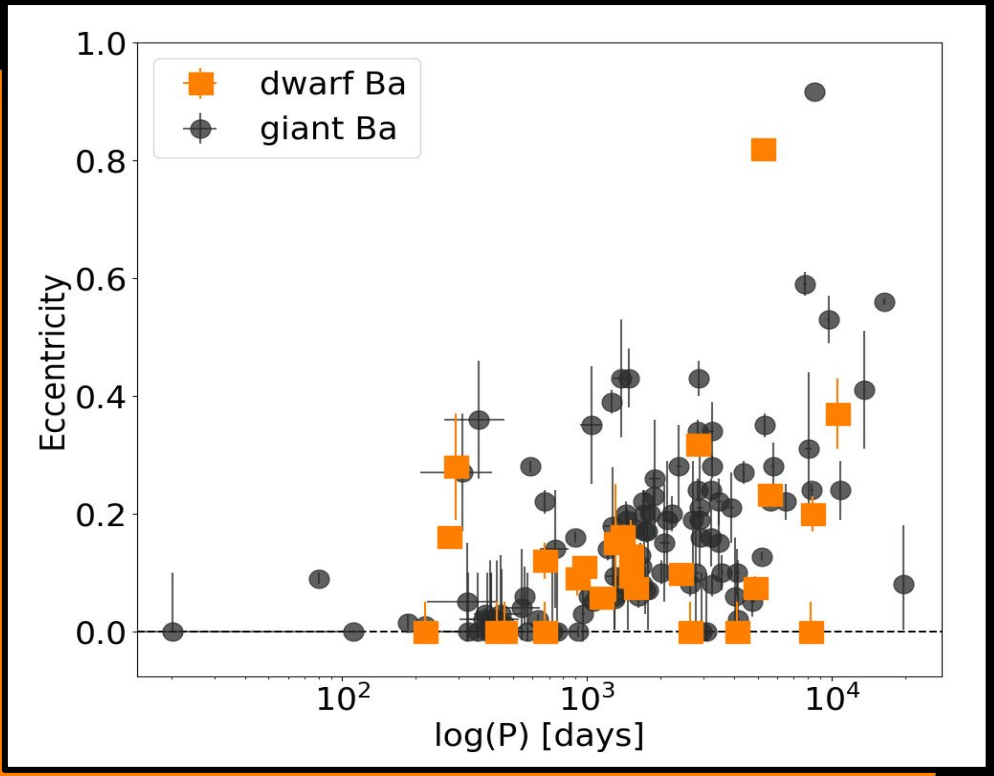


Ba dwarfs and Ba giants occupy the same region in the e-logP diagram.

The mass function



$$f(m) = \frac{m_2^3}{(m_1 + m_2)^2} \sin^3 i$$

$$= 1.0361 \cdot 10^{-7} \cdot (1 - e^2)^{3/2} K_1^3 P \quad [\mathrm{M}_\odot]$$

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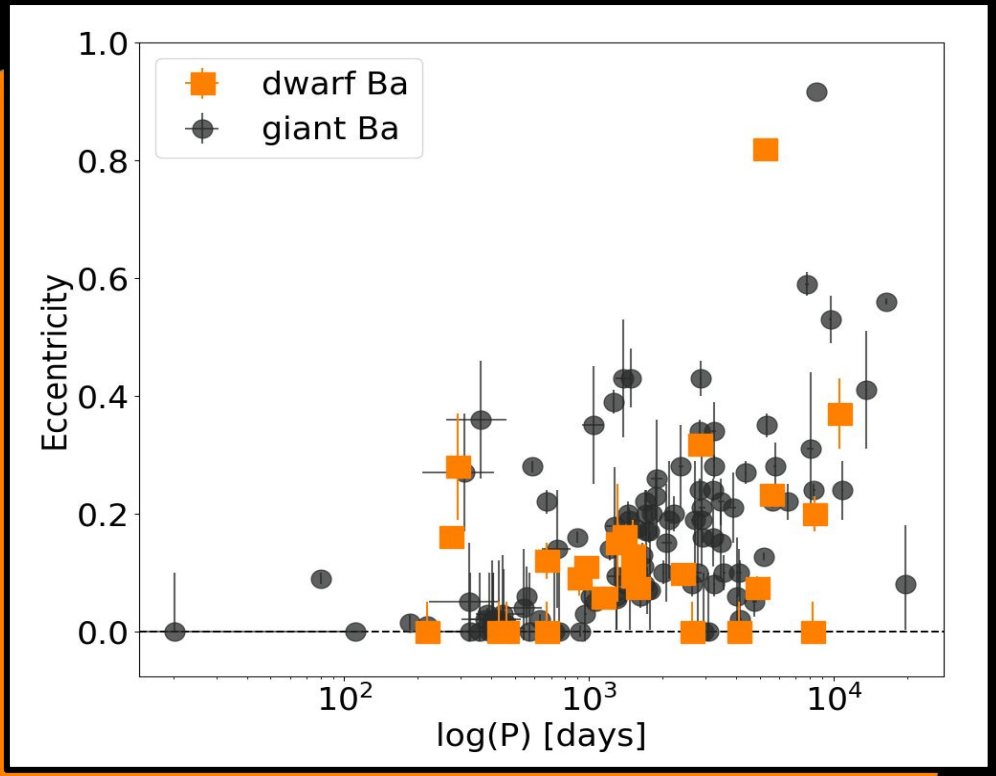

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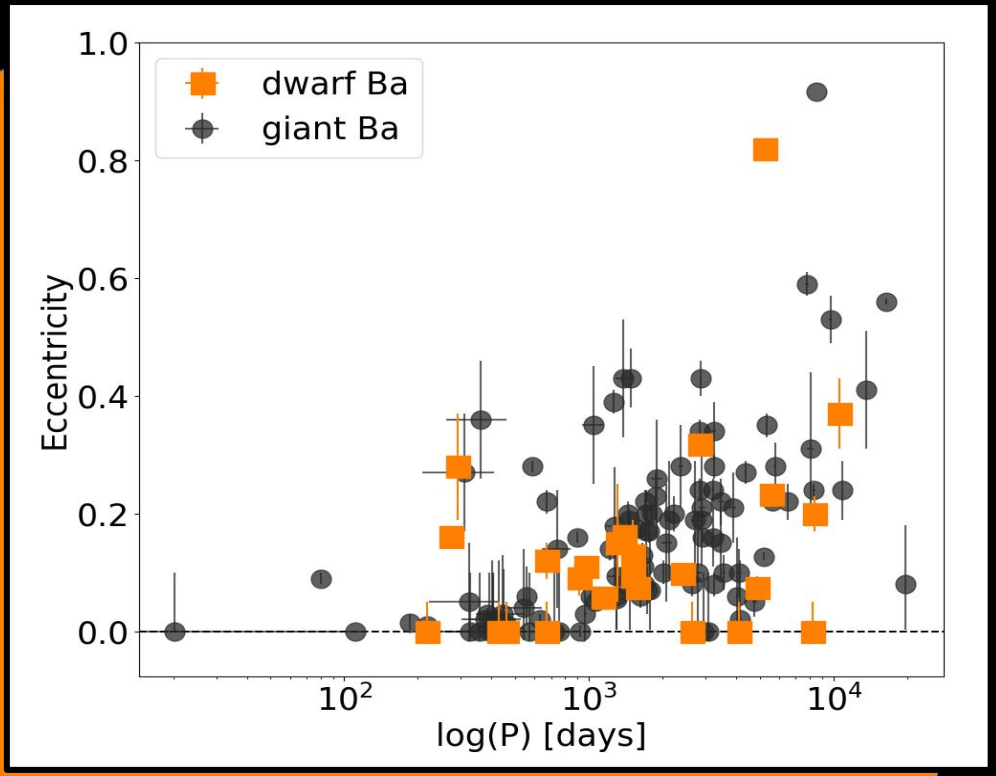

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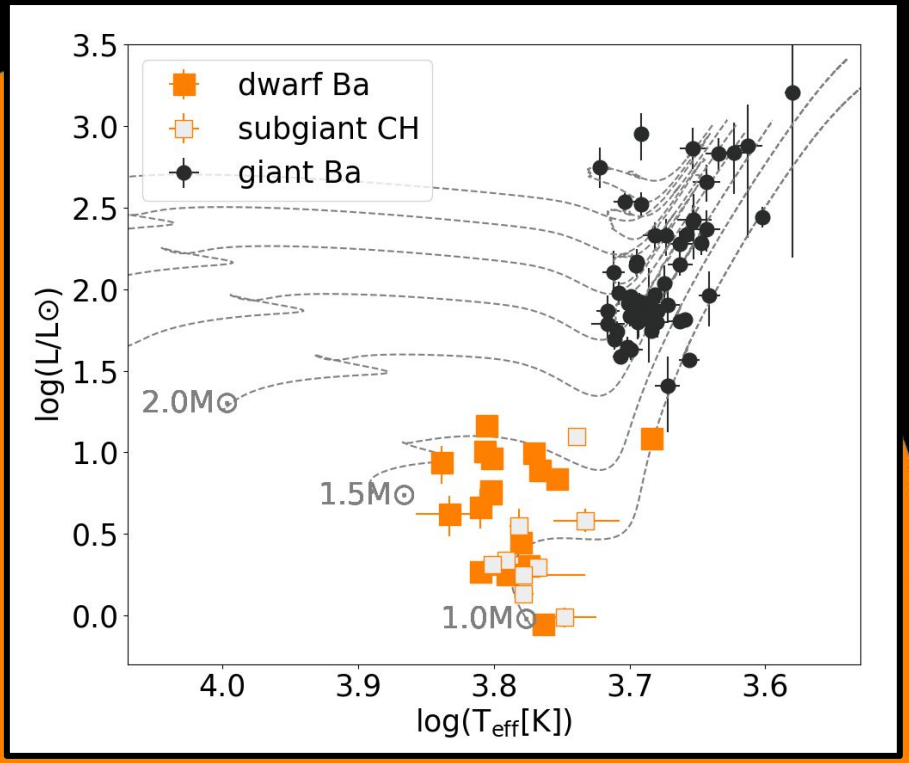
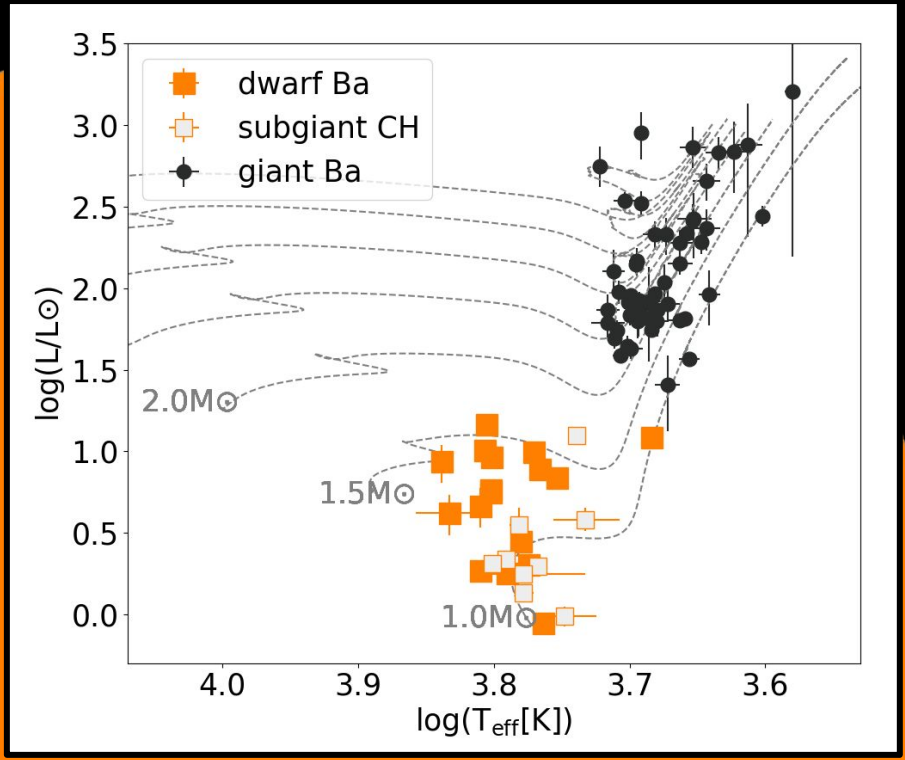
HR diagram and primary Ba stars masses

The Hertzsprung-Russell diagram



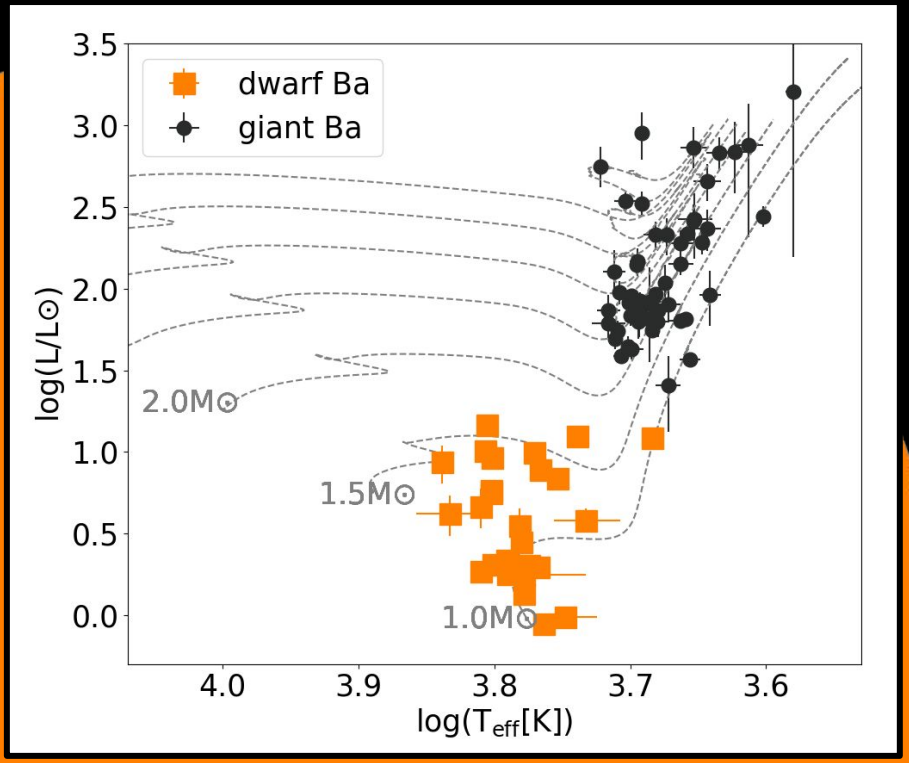
HERMES spectra
+
MARCS model atmospheres
+
Gaia DR2 distances
+
STAREVOL tracks

The Hertzsprung-Russell diagram



Ba dwarfs and CH subgiants share the same region in the HR diagram.

The Hertzsprung-Russell diagram



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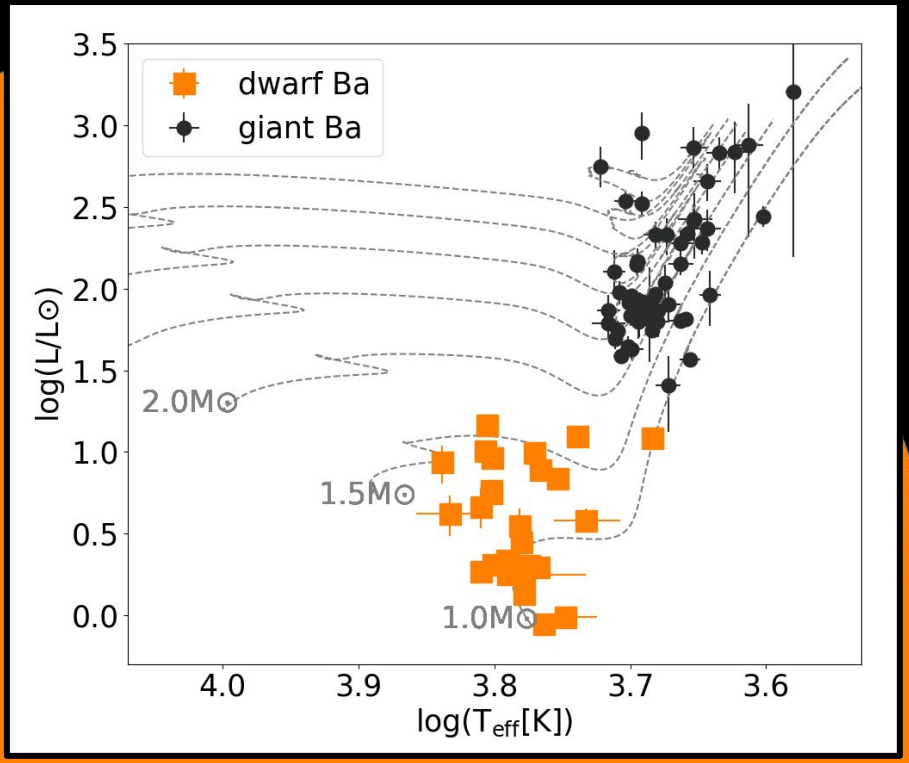

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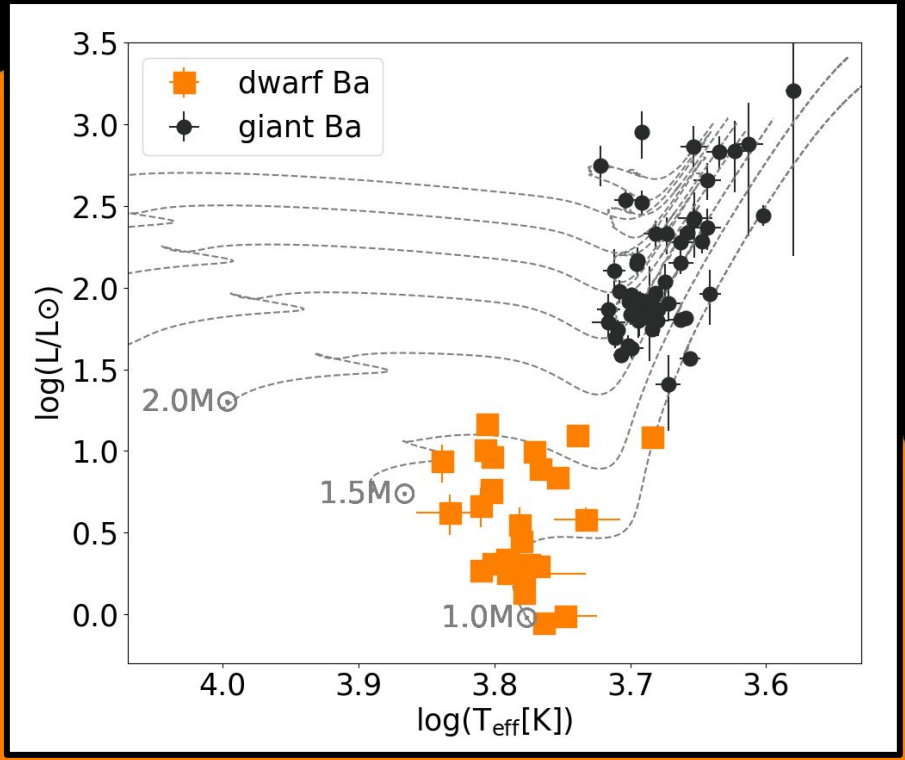
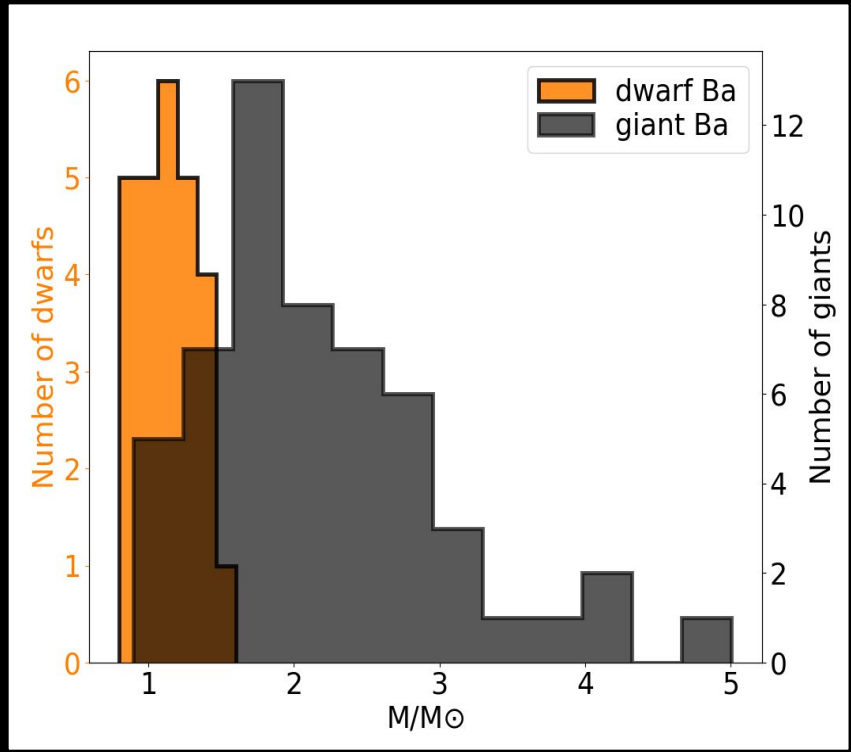
The mass distributions

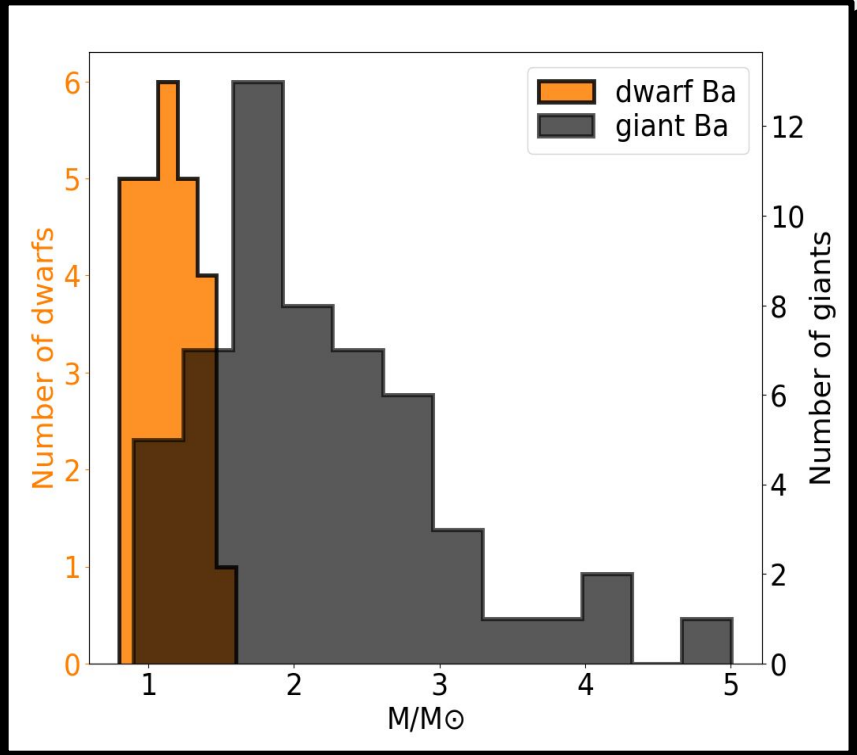




The mass distributions

$$f(m) = \frac{m_2^3}{(m_1 + m_2)^2} \sin^3 i$$

$$= 1.0361 \cdot 10^{-7} \cdot (1 - e^2)^{3/2} K_1^3 P \; [\mathrm{M}_\odot]$$



Mass distribution of the unseen WD companion

Mass distribution of the WD companion

Random distribution of orientations

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Mass distribution of the WD companion

Random distribution of orientations

$$f(m) = \frac{m_2^3}{(m_1 + m_2)^2} \sin^3 i = Q \approx \text{constant}$$

$$= 1.0361 \cdot 10^{-7} \cdot (1 - e^2)^{3/2} K_1^3 P \; [M_\odot]$$

Mass distribution of the WD companion

Random distribution of orientations

$$f(m) = \frac{m_2^3}{(m_1 + m_2)^2} \sin^3 i$$

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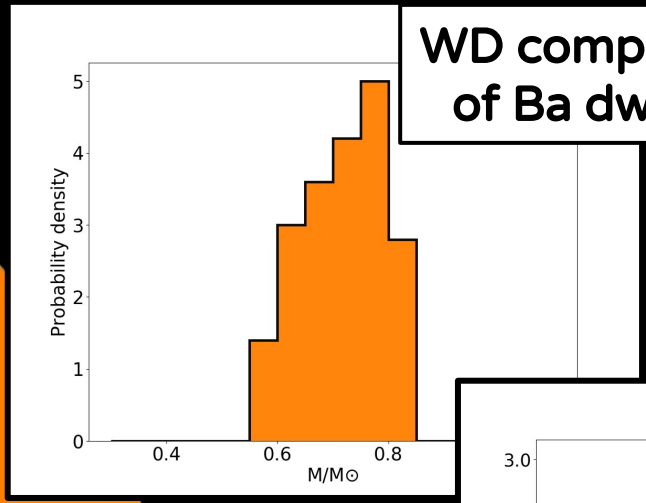
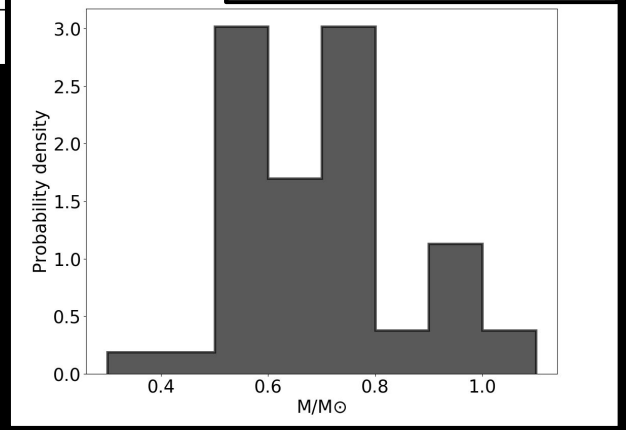
WD companion of Ba dwarfs



WD companion of Ba giants



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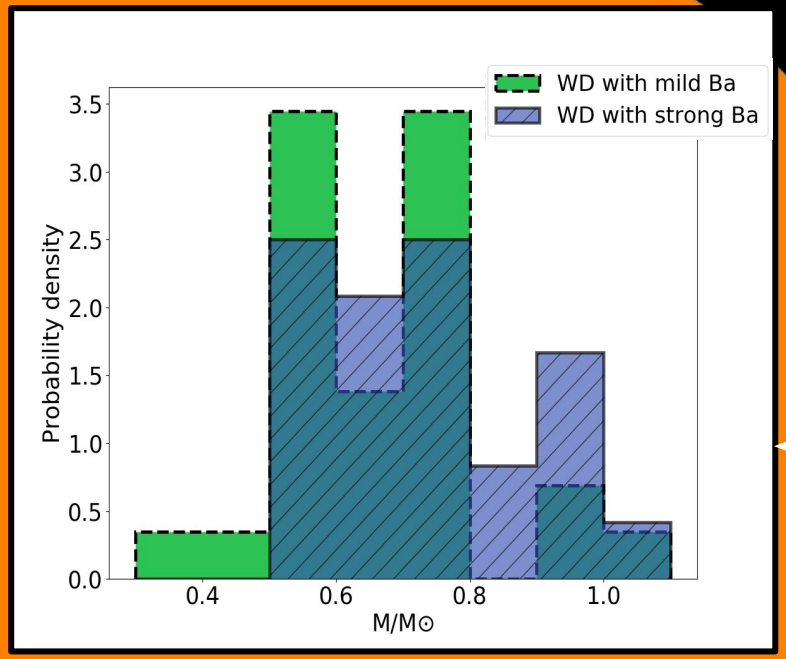

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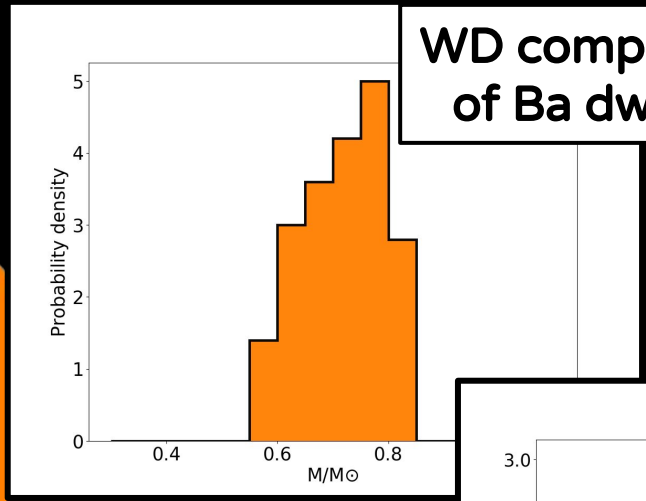

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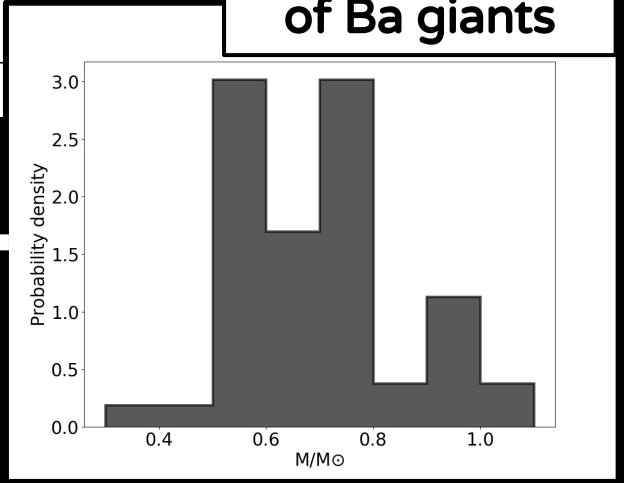

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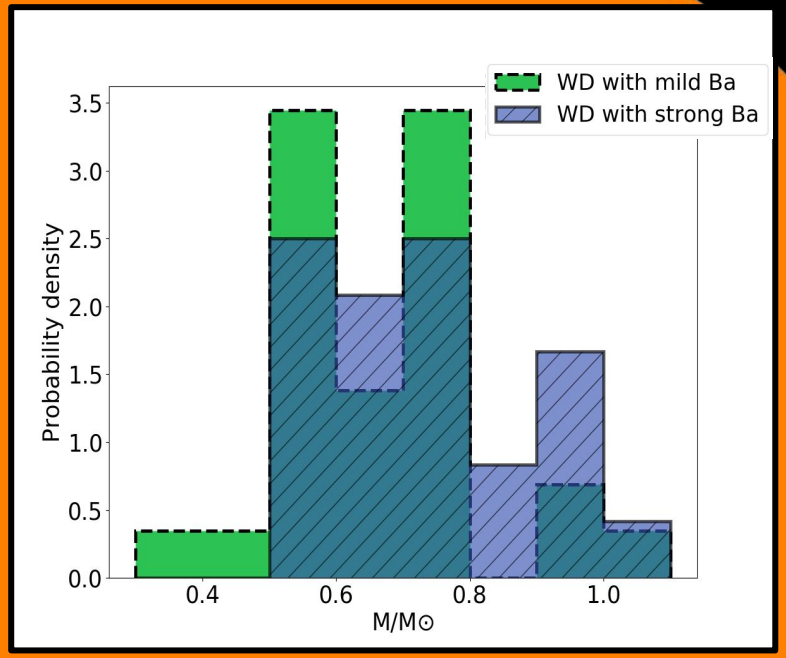

More strongly polluted Ba stars seem to have more massive WD companions.

Future *Gaia* data releases will help us get absolute masses for unseen WDs

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$$= 1.0361 \cdot 10^{-7} \cdot (1 - e^2)^{3/2} K_1^3 P \quad [\mathrm{M}_\odot]$$

Done with Hipparcos data!

ID	ϖ [mas]	Inclination [°]	Companion mass [$\mathrm{M}_\odot$]
HD 34654	21.5 ± 1.0	80 ± 4	0.621 ± 0.018
HD 50264	14.1 ± 1.1	109 ± 5	0.60 ± 0.05
HD 89948	23.9 ± 0.8	102 ± 3	0.54 ± 0.03
HD 123585	9.5 ± 1.7	64 ± 13	0.66 ± 0.11

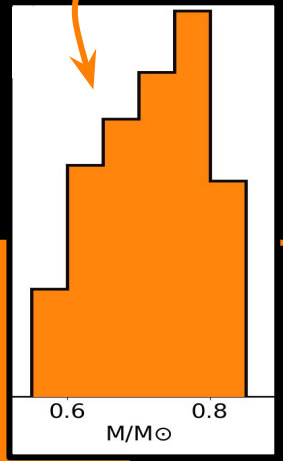
Summary

HR diagram and primary masses from HERMES spectra, MARCS models, Gaia distances and STAREVOL tracks

$$f(m) = \frac{m_2^3}{(m_1 + m_2)^2} \sin^3 i$$

Assumed (for now!)

Long-term orbital monitoring with HERMES and others



For more information:

Escorza et al. (2019) - arXiv:1904.04095

Jorissen et al. (2019) - arXiv:1904.03975

Thank You!

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