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# The TGAS HR diagram of barium stars

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**Abstract.** Barium stars are formed via binary interaction with a former AGB companion. Observations are needed to constrain theoretical models and better understand their evolution and surface composition. We present the HR diagram of Ba and related stars, using the recently released TGAS parallaxes, and the mass distribution of the Ba giants that we derived from it.

**Keywords.** stars: binaries, stars: evolution, Hertzsprung-Russell diagram

## 1. Introduction

Barium (Ba) stars (Bidelman & Keenan 1951), are chemically peculiar giants which show overabundances of elements produced by the slow neutron-capture (s-) process of nucleosynthesis. They got polluted by a former AGB companion in a low- or intermediate-mass binary system (e.g., McClure 1984; Boffin & Jorissen 1988). Binary evolution models fail to reproduce their observed chemical and orbital properties. Observations are essential to constrain interaction physics in these binary systems, which will lead to a better understanding of their formation.

We present a Hertzsprung-Russell diagram (HRD) of Ba and CH (low metallicity equivalents) stars making use of the Tycho-Gaia Astrometic Solution (TGAS, Lindegren *et al.* 2016). We also show the mass distribution of the Ba giants. This work is part of our research to combine the results of our dedicated observational programme with our state-of-the-art binary evolution models produced with BINSTAR (Siess *et al.* 2013) to explore all aspects of the evolution of Ba stars.

## 2. Methods

Atmospheric parameters of a sample of 437 Ba and CH stars were derived by modelling their spectral energy distribution (SED). We used photometry available in the literature and looked for the best-fitting MARCS model atmosphere (Gustafsson *et al.* 2008) in a parameter-grid search. The temperature ($T_{\rm eff}$) was assigned from the best-fitting model, and the luminosity ($L$) was obtained by integrating the SED over all wavelengths and

† This work has made use of data from the European Space Agency (ESA) mission *Gaia* (https://www.cosmos.esa.int/gaia), processed by the *Gaia* Data Processing and Analysis Consortium (DPAC, https://www.cosmos.esa.int/web/gaia/dpac/consortium). Funding for the DPAC has been provided by national institutions, in particular the institutions participating in the *Gaia* Multilateral Agreement.

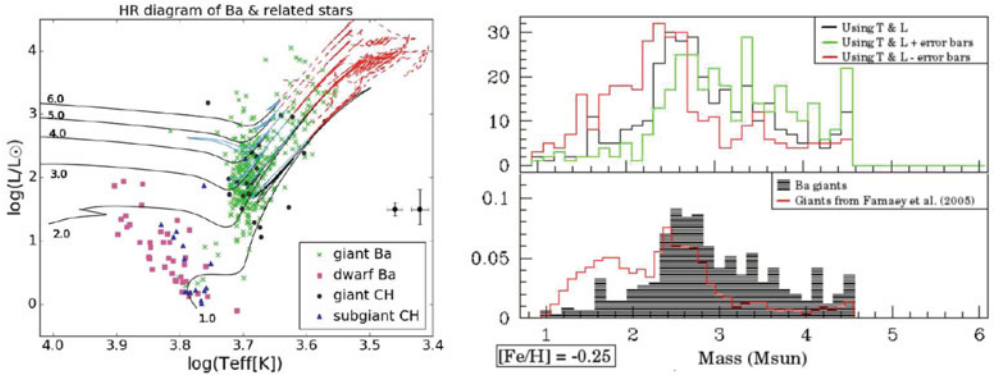


**Figure 1.** HRD of Ba and CH stars, and mass distribution of Ba and normal K and M giants.

applying the distance modulus derived from the TGAS parallax. Hipparcos parallaxes (ESA 1997) were used when the source was too bright to be part of TGAS. We fixed the metallicity of the atmospheric models to [Fe/H] = -0.25 because the distribution of spectroscopically determined metallicities for Ba stars peaks at this value.

The location of stars on the HRD provides information about their masses and evolutionary status. We derived the mass distribution of the Ba giants interpolating between our STAREVOL (Siess 2006) evolutionary tracks computed also with [Fe/H] = -0.25.

## 3. Results and discussion

Figure 1 shows the HRD of Ba and CH stars, including the average and maximum error bars, and the mass distribution of Ba giants, which peaks at about 2.6 $M_{\odot}$. The latter is compared with a sample of K and M giants (Famaey *et al.* 2005). The Ba giants concentrate on the red clump, which suggests that they behave like other red giants.

Metallicity influences our result. It affects the stellar lifetime as well as the location of the stars on the HRD through the atmospheric model used to compute $T_{\rm eff}$ and $L$. This effect will be studied by Escorza *et al.* 2017 (in prep.). Spectroscopically determined metallicities are a key ingredient to obtain information about individual masses.

The HRD presented in this publication will be used by Escorza *et al.* 2017 (in prep.) to compare the evolutionary stage of Ba stars with their orbital parameters. Any correlation found could give us clues about the evolution and interaction history of these binaries.

## References

Bidelman, W. P. & Keenan, P. C. 1951, *ApJ*, 114, 473
Boffin, H. M. J. & Jorissen, A. 1988, *A&A*, 205, 155-163
ESA 1997, *ESA Special Publication*, 1200
Famaey, *et al.* 2005, *A&A*, 430, 165-186
Gustafsson, *et al.* 2008, *A&A*, 486, 951-970
Lindegren, L., *et al.* 2016, *A&A*, 595, A4
McClure, R. D. 1984, *PASP*, 96, 117-127
Siess, L. 2006, *A&A*, 448, 717-729
Siess, L. *et al.* 2013, *A&A*, 550, A100

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