Why Galaxies Care About AGB Stars:
A Continuing Challenge through Cosmic Time
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s-process abundances of Primary stars in the Sirius-like Systems: Constraints on pollution from AGB stars

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Abstract. We present the results from the abundance analysis of 21 primary stars in Sirius-like systems with various masses of white dwarf companions and orbital separation to understand the origin and nature of Ba stars. Three new Ba dwarfs are found for which masses are relatively low compared to Ba giants. Large fraction of the sample are found to be non-Ba stars, however, some of them have required WD mass and/or close orbital separation. Observed s-process abundances in Ba dwarfs are in good agreement with AGB models of respective WD companion mass, however, it required different pollution factors.

Keywords. stars: binaries (including multiple): close, stars: abundances, stars: AGB

1. Introduction

Sirius-like systems (SLSs) refer to white dwarfs (WDs) in binary or multiple star systems. They contain at least a less luminous companion of spectral type K or earlier (Holberg *et al.* 2013), which provide direct evidences to understand the origin and nature of Barium II (Ba) stars. Ba stars are G-K type giants and dwarfs that show excess of Ba and other neutron capture elements in their atmosphere. S-process elements are known to be present in the atmospheres of AGB stars, but Ba stars are not evolved enough to be self enriched like them. Therefore, s-process enrichment in Ba stars is proposed due to mass transfer within a binary system from its companion AGB star (now WD). The degree of chemical contamination in Ba stars is suggested to depend on the mass of the WD companion, orbital separation, and metallicity. However, the minimum WD mass limit of $0.51\,M_\odot$ is set to be its progenitor to evolve as AGB star. Other parameters, such as eccentricity, mass-loss mechanism, the efficiency of thermal pulses and dilution factors, also play a role in observed chemical peculiarities of Ba stars (see Kong *et al.* 2018b and references therein). Here, a systematic abundance analysis is performed for 21 FGK primary stars (15 dwarfs and 6 giants) of SLSs selected from Holberg *et al.* (2013).

2. Elemental abundances

Abundances are derived using measured equivalent widths of selected lines in high quality (SNR > 100) high resolution spectra, Kurucz model atmospheres, and ABONTEST8 program supplied by Dr. P. Magain (see Kong *et al.* (2018a) for details). Atmospheric parameters like effective temperature (T_{eff}), surface gravity (log g), metallicity ([Fe/H]) and microturbulence (ξ_t), are determined in standard procedure., e.g. imposing

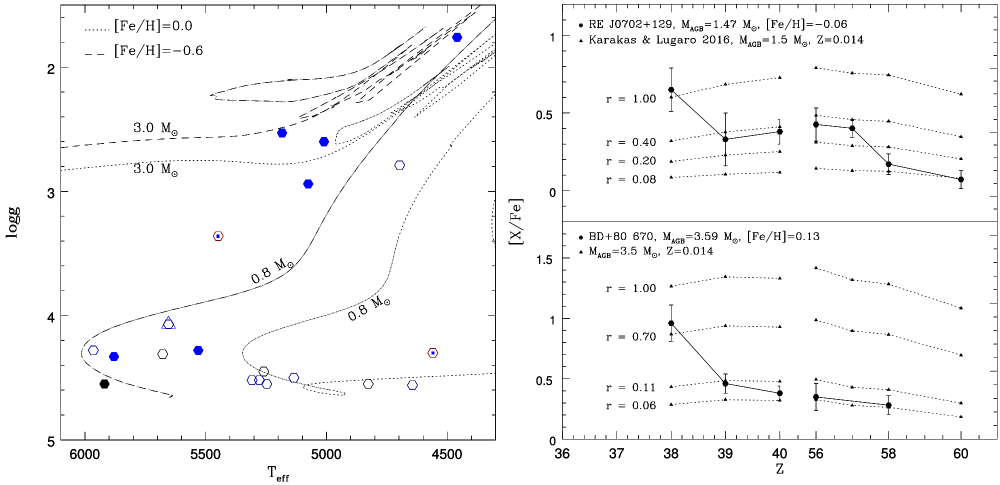

Figure 1. Left: Samples are on the HR-Diagram. Open and closed symbols are Ba ([s/Fe] > 0.25) and non-Ba stars. Red and blue represents WDs with mass less and greater than 0.51 M$_\odot$, respectively. Triangles represent stars with $M_{wd} > 0.51$ and close orbital separation. Right: Observed s-process enrichment of sample Ba dwarfs are compared with AGB models with different pollution factors.

excitation equilibrium from Fe I lines for T_{eff} and ionization equilibrium method from Fe I and Fe II lines for log g. Differential abundances ([X/Fe]) are obtained relative to solar values, derived from solar spectra observed along with programme stars (Kong *et al.* 2018b).

3. Results and Discussion

The abundance analysis for 21 primaries resulted in three new Ba dwarfs, 4 Ba giants, and 14 non-Ba stars. The location of these stars on the HR diagram suggests Ba dwarfs (< 1.0 M$_\odot$) and relatively lower in mass compared to Ba giants (> 1.5 M$_\odot$). Among the sample, two stars with WD mass < 0.51 M$_\odot$ show the absence of s-process enrichment, which confirms the predictions and observations in the literature. Interestingly, 11 stars whose WD masses > 0.51 M$_\odot$ show absence of s-process enrichment, suggesting the WD mass alone can't decide Ba nature. Also, the existence of a non-Ba star whose WD mass > 0.51 M$_\odot$ and with an orbital separation of 58 AU suggests further investigation on pollution and accretion efficiency (Fig. 1, left). The observed s-process abundances for two Ba dwarfs are compared with AGB models (Karakas & Lugaro 2016) of respective companion masses which are estimated from their WD mass including different pollution factors (Kong *et al.* 2018a) (Fig. 1, right). This suggests further understanding of pollution factors which could constrain s-process enrichment.

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