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Are Galactic globular cluster AGB stars rich or poor in Sodium?

Sodium abundance of AGB and RGB stars in NGC 2808

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Abstract. A spectroscopic study comparing the [Na/Fe] distributions of RGB and AGB stars in the Galactic globular cluster (GC) NGC 6752 found that there was no Na-rich, 2nd-generation star along the early-AGB of this cluster. This came as a surprise since in this GC, as well as other Galactic GCs studied so far, 1st- and 2nd-generation stars have usually been found from the main sequence turnoff up to the red giant branch. To investigate whether the failure of a significant fraction of stars to ascend the AGB also happens to other GCs, we studied a sample of AGB and RGB stars in NGC 2808 observed at the ESO/VLT with FLAMES. Contrary to NGC 6752, we find that the AGB and RGB stars we studied in NGC 2808 have comparable [Na/Fe] dispersions.

Keywords. globular cluster, abundances, AGB star

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1. Introduction

Galactic globular clusters (GCs) are now known to have multiple stellar populations. These populations can be identified by their chemical properties, e.g. the O-Na anticorrelation. So far, stars with Na overabundances have been found at different evolutionary stages, from the main sequence turnoff up to the tip of the red giant branch (e.g. Carretta *et al.* 2006). Surprisingly however, in a spectroscopic study comparing the [Na/Fe] distributions of red giant branch (RGB) and asymptotic giant branch (AGB) stars in NGC 6752, Campbell *et al.* (2013) did not find Na-rich AGB stars, so they concluded that the Na-rich 2nd-generation stars cannot enter the AGB phase in this GC. To investigate whether this phenomenon also happens in other GCs, we observed a sample of AGB and RGB stars in the Galactic GC NGC 2808 whose multi-populations have been well studied (Carretta *et al.* 2006). Here we present the results of the chemical analysis of our sample.

2. Observation, data reduction and analysis

The high-resolution spectra of our sample of AGB and RGB stars in NGC 2808 were obtained with FLAMES at ESO/VLT adopting the combined mode of GIRAFFE + UVES. We achieved S/N ratios larger than 100, by combining multiple exposures. Seventy-four

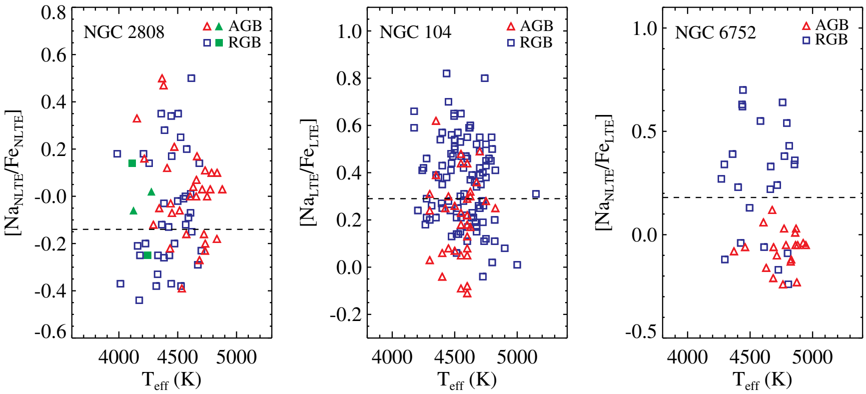

Figure 1. [Na/Fe] distributions of AGB and RGB stars in NGC 2808, NGC 104 and NGC 6752. Left: NGC 2808, our work where the Na and Fe abundances have been corrected for non-LTE effect. Middle: NGC 104, from Johnson *et al.* (2015) for AGB stars and Cordero *et al.* (2014) for RGB stars. Right: NGC 6752, from Campbell *et al.* (2013), with their Na abundances corrected for non-LTE effect. Open symbols represent results derived from GIRAFFE spectra, and solid ones from UVES spectra. The black horizontal dashed lines mark the critical [Na/Fe] ratio adopted to distinguish the 1st- and 2nd- generation stars in each cluster, following the definition in Carretta *et al.* (2009) that $[Na/Fe]_{cri} \sim [Na/Fe]_{min}$ + 0.3 dex.

member stars (34 AGB stars + 40 RGB stars) of NGC 2808 are identified by their radial velocities and metallicities. The stellar parameters (effective temperature T_{eff} , surface gravity log g, metallicity [Fe/H] and microturbulent velocity ξ_t) were determined with an iterative procedure. We synthesized the spectra in the region of the Na doublet at 6154-60Å to determine the Na abundance. NLTE corrections were applied to the Fe I and Na abundances (Bergemann *et al.* 2012; Lind *et al.* 2012; Lind *et al.* 2011). An average [Fe/H] = -1.17 ± 0.05 dex was derived for our sample.

3. Results

The distribution of [Na/Fe] of our sample of NGC 2808 stars is shown in the left panel of Fig. 1. We find that AGB and RGB stars exhibit comparable Na abundance dispersions. The ratios of Na-poor over Na-rich stars are respectively 24:76 for the AGB sample and 43:57 for the RGB sample. For comparison, we also show in Fig. 1 the [Na/Fe] distributions of AGB and RGB stars in NGC 104 (derived by Johnson *et al.* 2015 and Cordero *et al.* 2014, Na-poor:Na-rich = 63:37 for AGB, 45:55 for RGB) and NGC 6752 (derived by Campbell *et al.* 2013, Na-poor:Na-rich = 100:0 for AGB, 30:70 for RGB). Different from NGC 6752, NGC 2808 and NGC 104 both have Na-rich AGB stars. Because the three clusters span quite a range in metallicity (from [Fe/H]=-0.73 to -1.54), our next step will be to add more GCs at different metallicities to further constrain any possible metallicity dependence. Data on new GCs have already been secured.

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