Dwarf Galaxies: From the Deep Universe to the Present
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What are the implications of stellar chemical abundances in dwarf galaxies?

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Abstract. We analyse the chemical abundances of stars in the local group dwarf galaxies using the SAGA database. The inspection of the relationship between Eu and Ba abundances confirms an anomalously Ba-rich population in Fornax, which indicates a pre-enrichment of interstellar gas with *r*-process elements.

Keywords. astronomical data bases: miscellaneous, stars: abundances, stars: evolution

1. Introduction

Chemical abundances of stars provide us with rich information on the star formation history and the chemical evolution of the universe. Thanks to the many efforts to derive the abundances of individual stars in dwarf galaxies, it is possible not only to compare them with those in the Milky Way but to compare among dwarf galaxies in the local group (Frebel & Norris 2015). We have constructed a database of stellar abundances in the local group dwarf galaxies by extending the SAGA database (Suda *et al.* 2008, 2011, 2017 Yamada *et al.* 2013). We analyzed the data in the extended database, which contains more than 6000 stars in 25 dwarf galaxies together with more than 4500 stars in the Milky Way (MW). The large dataset of stellar abundances enables us to explore the characteristics of dwarf galaxies with various approaches. In this paper, we focus on neutron-capture elements to look for similarities and differences in the chemical enrichment history of the interstellar medium (ISM) between MW and dwarf galaxies.

2. Ba enrichment in Fornax

Fig. 1 represents the major source of neutron-capture elements in dwarf galaxies, whether the origin of Ba and Eu is ascribed to the r-process or the s-process (Suda *et al.* 2011). Most of the galaxies are dominated by the *r*-process, meaning that CEMP-*s* population, in other words, the group of stars influenced by binary mass transfer from the former AGB companion, is rarely identified by the present observations. This makes

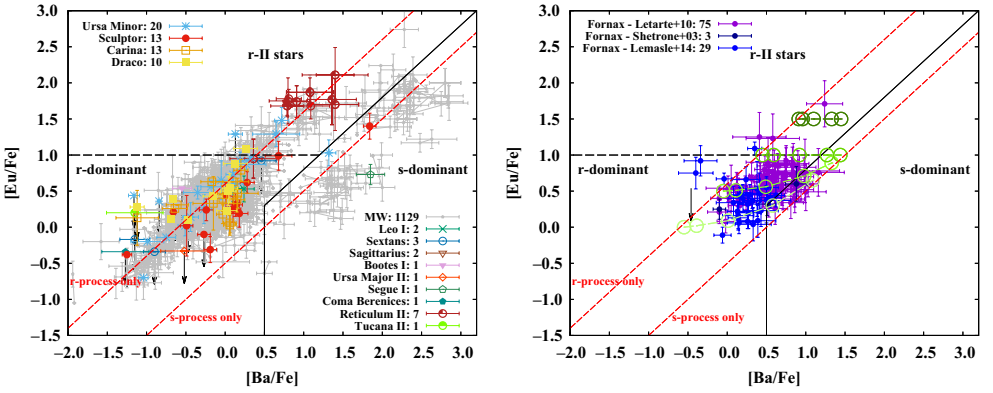

Figure 1. [Eu/Fe] vs. [Ba/Fe] to separate stars with the abundances whether the source of neutron-capture elements is dominated by the *s*- or *r*-process.

a sharp contrast with the MW halo stars in which we have detected unusually large fraction of CEMP-*s* stars (Komiya *et al.* 2007, Suda *et al.* 2013).

There are striking difference between MW stars and Fornax stars. We clearly see Fornax stars around the boundary of the *r*/*s*- dominant region with enhanced Ba and Eu abundance. To explore the possible origin of this anomalous population, we make a simple model of chemical enrichment. Let us suppose that the ISM in Fornax consists only of *r*-process ejecta for neutron-capture elements below [Fe/H] $= -1$. Then, we assume that AGB ejecta have pure *s*-process abundance patterns and that they mix with the ISM. The final [Eu/Ba] values are estimated from the initial enrichment of Eu. We find that the ISM in Fornax must have been pre-enriched by [Eu/Fe] > 0.5 before the *s*-process contamination of ISM until [Fe/H] ~ -1.

3. Final Remarks

Chemical abundances of stars enable us to explore the characteristics of dwarf galaxies with various approaches. Previous work (Suda *et al.* 2017) discussed many aspects of stellar archaeology such as chemical evolution, astrometry, nucleosynthesis in stars, and comparison with the stars in the Galactic globular clusters. Abundance data can be applied to other events and phenomena; chemodynamical evolution of galaxies (Hirai *et al.* 2018), comparisons with stellar yields from rotating first stars (Takahashi *et al.* 2018), abundances in globular clusters in the local group (Larsen *et al.* 2018) comparisons with the simulations of Λ CDM universe (Yves & Pascale), and so on.

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