# ABUNDANCE OF ZIRCONIUM IN THE ATMOSPHERES OF RED GIANTS IN GALACTIC GLOBULAR CLUSTER 47 TUC

Edgaras Kolomiecas[1], Vidas Dobrovolskas[1], Arūnas Kučinskas[1]

[1] Institute of Theoretical Physics and Astronomy, Faculty of Physics, Vilnius University, Lithuania
edgaras.kolomiecas@ff.vu.lt

It has been long held that Galactic globular clusters (GGCs) are homogeneous objects consisting of stars that have the same age and chemical composition. However, research done during the past decade has shown that stars in the GGCs do not share the same chemical composition and may have formed during different star formation episodes (see, e.g., [1]). This suggests that GGCs may consist of two (or more) generations of stars, with the second generation born from the material enriched by the ejecta of first-generation stars, with the most plausible candidates being fast-rotating massive stars [2] and asymptotic giant branch (AGB) stars [3], the so called polluters. Unfortunately, our current knowledge about the GGCs does not allow us to discriminate between the possible pollution scenarios.

In order to determine which polluters were most likely to enrich the intracluster medium during the early stages of GGC formation, one may look at the abundances of *s*-process elements. Since AGB stars produce *s*-process elements and fast-rotating massive stars do not, abundance correlations between the light and *s*-process chemical elements would indicate that the polluters were AGB stars. On the other hand, no such correlation would indicate that the polluters were fast-rotating massive stars. One earlier study has suggested a tentative existence of a correlation between the abundances of Na and Ba in the globular cluster 47 Tuc [4]. In order to check if such correlation may also exist in the case of Zr, which, like Ba, is also an *s*-process element, we determined Zr abundance in 327 RGB stars in 47 Tuc. Importantly, the studies of Zr abundance in the GGCs have been very scarce until now and the results were inconclusive, i.e., not only for this but also other GGCs.

Abundance analysis was based on the archival spectra of RGB stars in 47 Tuc that were obtained with GIRAFFE spectrograph mounted on the VLT UT2 telescope (ESO, Chile). Two spectral lines of neutral Zr were used, with their central wavelengths located at 613.4585 nm and 614.3252 nm. Line equivalent widths were measured using IRAF package, by fitting Gaussian profiles to the observed spectral lines. Stellar model atmospheres were computed using the ATLAS9 code and were further employed to derive 1D LTE Zr abundances with the WIDTH9 package.

The mean Zr to Fe abundance ratio that we obtained in a sample of 327 RGB stars in 47 Tuc is [Zr/Fe] = +0.38 ± 0.12 (the error is standard deviation due to star-to-star abundance variation). This is so far the largest sample of RGB stars analyzed in this cluster for Zr abundance. Analysis of Zr and Na abundances shows weak but statistically significant correlation: Pearson correlation coefficient is 0.36 and Student's *t*-test probability is $< 10^{-4}$ (Fig. 1). This suggests that AGB stars played a significant role in the enrichment of the intracluster medium in 47 Tuc.

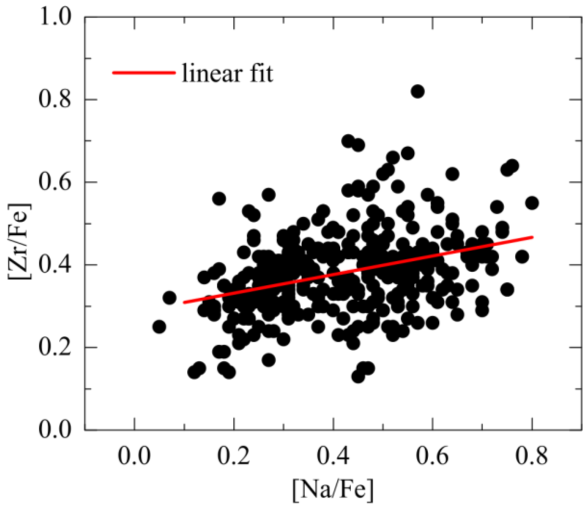


Fig. 1. Abundance of Zr in the RGB stars of 47 Tuc plotted against the sodium-to-iron abundance ratio.

[1] Bastian, N. & Lardo, C. 2018, ARA&A, 56, 83.
[2] Krause, M., Charbonnel, C., Decressin, T., Meynet, G., & Prantzos, N. 2013, A&A, 552, A121.
[3] Ventura P., D'Antona F., Mazzitelli I., Gratton, R., 2001, ApJ, 550, L65.
[4] Gratton, R. G., Lucatello, S., Sollima, A., Carretta, E., Bragaglia, A., Momany, Y., D'Orazi, V., Cassisi, S., Pietrinferni, A., & Salaris, M. 2013, A&A, 549, A41.