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APOGEE Chemical Anomalies discovered everywhere in the Milky Way: Giant stars with GC-like abundance patterns

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Abstract. We report the discovery by APOGEE of five mildly metal-poor ([Fe/H] > -1) anomalous giant stars in the halo/disk/bulge Galaxy with abundances of C, N, and Al that are typically found in globular cluster stars (GCs, see e.g. Carretta *et al.* 2009a; Mészáros *et al.* 2015; Pancino *et al.* 2017; Schiavon *et al.* 2017a; Tang *et al.* 2017) and in the inner Galaxy (e.g., Schiavon *et al.* 2017b; Recio-Blanco *et al.* 2017) simultaneously with atypical abundances of Mg (Mg-poor: [Mg/Fe] < 0) never before seen in Milky Way (MW) GCs, dwarf galaxies (see Hasselquist *et al.* 2017) neither in MW field stars. Additionally, four new moderately metal-poor ([Fe/H] < -1) anomalous giant stars (i.e., N-rich, Al-rich and C-poor) with trustly GCs second-generation like chemical patterns were identified within the Galactic bulge, halo and disk field.

Keywords. Galaxy: structure – stars: abundances – stars: Population II – globular clusters: general

1. Relevant results

A number of independent studies from many different surveys argue that all Galactic GCs lost mass through the escape of individual stars (Schaerer & Charbonnel 2011; Anguiano *et al.* 2016; Fernández-Trincado *et al.* 2013, 2015a, 2015b, 2016a, 2016b; and references therein). The high-resolution ($R \sim 22,500$) H-band spectra (Albareti *et al.* 2017) provided by the APOGEE instrument (see Wilson *et al.* in prep) and its ability to produce accurate stellar abundances can be used to identify the escaped members of GCs. We have made a detailed spectrum synthesis analysis of $\sim$ 4,000 sources, which has led to the discovery of anomalous field giant stars possibly born in GCs. Such is the case of TYC 5619-109-1, which is heavily enriched in light-elements (Al and N) and also enhanced in the s-process elements (Nd, Ce, Ba, La: Hasselquist *et al.* 2016; Pereira *et al.* 2017; Cunha *et al.* 2017), both chemical and orbital arguments render it plausible that TYC 5619-109-1 born in the anomalous GC ω Cen (see Fernández-Trincado *et al.* 2016a; Pereira *et al.* 2017). More recently, a new group of moderately metal-poor stars ([Fe/H] $<$ -1) with enhanced N and Al abundances were recently discovery by Fernández-Trincado *et al.* (2017) along the disk, bulge and halo – in other words, the newly discovered stars present the same levels of enrichment in light elements as that of second generation stars in metal-poor GCs. However, in the same study, Fernández-Trincado *et al.* (2017) claimed to have discovered for the first time a new group of mildly metal-poor stars ([Fe/H]> -1), with high levels of enrichment in light elements (N-rich and Al-rich stars), and low values of [Mg/Fe]. The detection is clearly illustrated in Fig. 1 where each of these Mg-poor stars are plotted against MW stars with similar metallicities. Such values of ^{14}N and ^{27}Al enhancements and ^{24}Mg depletions have never been seen in MW GCs

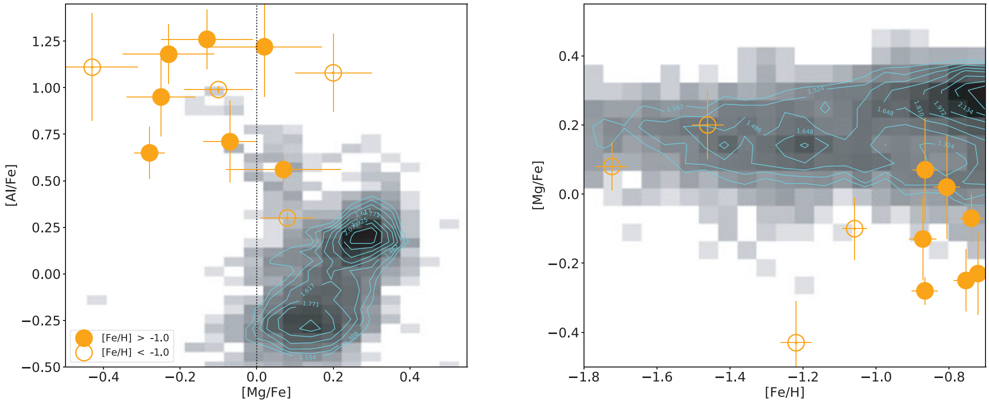

Figure 1. The distribution of the Mg-poor/N-rich stars (orange symbols) from Fernández-Trincado *et al.* (2017) in the [Al/Fe]-[Mg/Fe] plane (left panel) and [Mg/Fe]-[Fe/H] plane (right panel). The logarithmic contours show the number density of the APOGEE DR 13 metal-poor stars ($-1.8 < \text{[Fe/H]} < -0.7$) surviving the quality cuts discussed in Fernández-Trincado *et al.* (2017). The black dotted line mark the Solar abundance ratio.

environments at the same metallicity (see Mészarós *et al.* 2015; Pancino *et al.* 2017). The complex chemistry and orbtial properties of these MW Mg-poor stars suggest that these may be of an extragalactic origin (see Mucciarelli *et al.* 2012). This discovery opens a new route of investigation into nucleosynthesis and stellar evolution of chemically anomalous stars and brings very interesting constraints on the subject of Multiple Stellar Populations in GCs.

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References

Anguiano, B., De Silva, G. M., Freeman, K., Da Costa, G. S. *et al.*, 2016, *MNRAS*, 457, 2078
Carretta, E., Bragaglia, A., Gratton, R., & Lucatello, S. 2009a, *A&A*, 505, 139
Cunha, K., Verne, V. S., Hasselquist, S., *et al.*, 2017, *ApJ*, 844, 145
Fernández Trincado, J. G., Vivas, A. K., Mateu, C. E., & Zinn, R. 2013, *MemSAI*, 84, 265
Fernández-Trincado, J. G., Vivas, A. K., Mateu, C. E., *et al.* 2015a, *A&A*, 574, A15
Fernández-Trincado, J. G., Robin, A. C., Vieira, K., *et al.* 2015b, *A&A*, 583, A76
Fernández-Trincado, J. G., Robin, A. C., Moreno, E., *et al.* 2016a, *ApJ*, 833, 132
Fernández-Trincado, J. G., Robin, A. C., Reylé, C., *et al.* 2016b, *MNRAS*, 461, 1404
Fernández-Trincado, J. G., Zamora, O., Garcia-Hernandez, D. A., *et al.* 2017, *ArXiv e-prints, arXiv:1707.03108*
Hasselquist, S., Shetrone, M., Cunha, K., *et al.* 2016, *ApJ*, 833, 81
Hasselquist, S., Shetrone, M., Smith, V., *et al.* 2017, *ArXive-prints, arXiv:1707.03456*
Mucciarelli, A., Bellazzini, M., Ibata, R., *et al.* 2012, *MNRAS*, 426, 2889
Pancino, E., Romano, D., Tang, B., *et al.* 2017, *A&A*, 601, A112
Pereira, C. B., Smith, V. V., Drake, N. A., *et al.* 2017, *MNRAS*, 469, 774
Recio-Blanco, A., Rojas-Arriagada, A., de Laverny, P. *et al.* 2017, *A&A*, 602, L14

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Schaerer, D. & Charbonnel, C. 2011, *MNRAS*, 413, 2297

Schiavon, R. P., Johnson, J. A., Frinchaboy, P. M., *et al.* 2017a, *MNRAS*, 466, 1010

Schiavon, R. P., Zamora, O., Carrera, R., *et al.* 2017b, *MNRAS*, 465, 501

SDSS Collaboration, Albareti, F. D., Allende Prieto, C., *et al.* 2016, *ArXiv e-prints, arXiv:1608.02013*

Tang, B., Cohen, R. E., Geisler, D., *et al.* 2017, *MNRAS*, 465, 19