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A new diagnostic for multiple populations: NGC 6388 as a test case

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Abstract. Recently, the sample size of stars with detailed, homogeneous abundances in the massive bulge Globular cluster NGC 6388 expanded to 185 giants. We use this wealth of data to present first results on its multiple stellar populations. In particular, *i)* we introduce a new diagnostic plot to survey the occurrence of very high temperature for H-burning in the first-generation polluters, and *ii)* we pinpoint a restricted temperature range reached by polluters at work in NGC 6388.

Keywords. Stars: abundances, globular clusters: general, globular clusters: individual (NGC 2808, NGC 6388)

1. Discussion

In the FLAMES survey of multiple stellar populations in Galactic globular clusters (GCs) (see e.g. Carretta *et al.* 2009a, Carretta *et al.* 2009b), NGC 6388 was one of the clusters with the most limited sample of stars analyzed, mostly due to the heavy field contamination affecting this bulge GC. This problem was bypassed by using data from the ESO archive, as well as newly acquired proprietary data. The improved database now includes 185 giants, all analyzed in the most homogeneous way with respect to the other 24 GCs in our survey. Abundances of O, Na, Mg, Si, and other α- and Fe-group elements are obtained. Derivation of Al abundances for almost all the stars in the sample is currently under way. Here we focus on abundances of Mg, Ca, and Sc. UVES spectra are available for 35 stars, GIRAFFE HR13 spectra for another 150 stars. We use the same procedure (i.e. derivation of atmospheric parameters, abundance analysis, internal error estimate) as for other GCs by our group (Carretta *et al.* 2009a, Carretta *et al.* 2009b). No intrinsic metallicity spread is detected: [Fe/H] = −0.488 dex (rms = 0.040 dex, 150 GIRAFFE stars); [Fe/H] = −0.480 dex (rms = 0.045 dex, 35 UVES stars).

A lower limit for the temperature range of the first-generation polluters was derived in Carretta & Bragaglia (2018) from the presence of leakage on ^{28}Si from the Mg-Al cycle. This becomes possible at about 65 MK (see Arnould *et al.* 1999) and we see an overproduction of Si for temperatures larger than 100 MK (see Prantzos *et al.* 2017).

An upper limit to this range is defined comparing abundances for NGC 6388 with those of NGC 2808 (Carretta 2015) in the new diagnostic plots showing [Sc/H] and [Ca/H] as a function of [Mg/H] (Fig. 1, left and right panel, respectively). Field stars from Gratton *et al.* (2003) are used as reference for first-generation stars with primordial composition. In NGC 2808 there are statistically significant Ca-Mg and Sc-Mg anti-correlations. These are interpreted as the effect of H-burning at very high temperature (T > 150–180 MK, Prantzos *et al.* 2017, Ventura *et al.* 2012). In this fiery burning the production of Al from Mg is bypassed, favouring proton-capture on heavier and heavier nuclei, producing

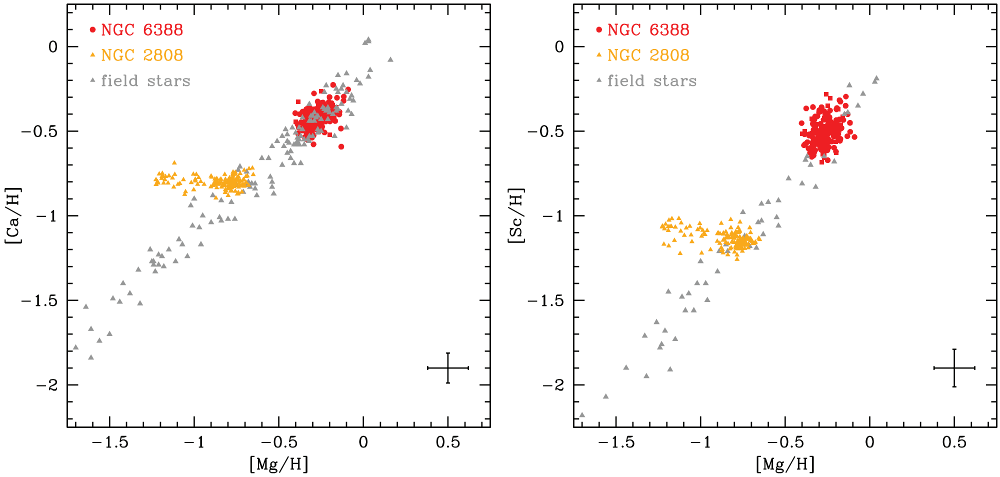

Figure 1. Diagnostic plots for NGC 6388 (in red) compared to NGC 2808 (in orange) from Carretta (2015); field stars from Gratton *et al.* (2003) are indicated in grey.

species like K, not available in NGC 6388, but also Ca and Sc. Conversely, these elements do not seem to be modified in NGC 6388.

In summary, by comparing the chemical pattern of NGC 2808 and NGC 6388 we provide a probable temperature range, T $\geqslant$ 100 MK but $\leqslant$150-180 MK, in (part of) the polluters shaping the multiple population in NGC 6388. In addition, the usual Na-O and Mg-Al anti-correlations found in NGC 6388 (Carretta & Bragaglia 2018) also seem to imply that probably two sources of pollution are required to reproduce the whole pattern. More details and future perspectives are discussed in Carretta & Bragaglia (2019).

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