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Multiple light-element populations in globular clusters: the case of NGC 6362

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Abstract. We present the results of a project aimed at characterizing the spectro-photometric properties of the Galactic globular cluster NGC 6362. Our study reveals the presence of two distinct populations, making NGC 6362 the least massive globular ($M_{tot} \sim 5 \cdot 10^4 M_{\odot}$) where both photometric and spectroscopic signatures of multiple populations have been found. Also, we observe that in this system the first and second generation stars share the same radial distribution across the entire cluster extension. At variance with the other Galactic globular clusters (dominated by second generation stars), NGC 6362 is composed of a mixture of the two populations in a similar proportion.

Key words. Stars: abundances – globular clusters: individual (NGC 6362) – Techniques: photometric – Techniques: spectroscopic

1. Introduction

All the old and massive globular clusters studied so far show evidence of star-to-star variations in the light element abundances (i.e. C, N, O, Na, Mg, Al). These chemical anomalies have been detected both from high-resolution spectroscopy (see e.g. Carretta et al., 2009; Mucciarelli et al., 2009) and from photometry, when appropriate filters (like the U filter) are used (see e.g. Piotto et al., 2007; Marino et al., 2008; Dalessandro et al., 2011). These multiple populations are generally explained within the framework of a self-enrichment process occurring in the early stage of life of globulars; however, a coherent scenario able to explain all the observational evidence is still lacking. Here we present the results of a spectro-photometric study of the loose Galactic globular cluster NGC 6362.

2. Photometric results

We used optical and near-UV Hubble Space Telescope and ground-based photometry to characterize photometrically the evolutionary sequences of NGC 6362 (Dalessandro et al., 2014). We found that both the sub giant and the

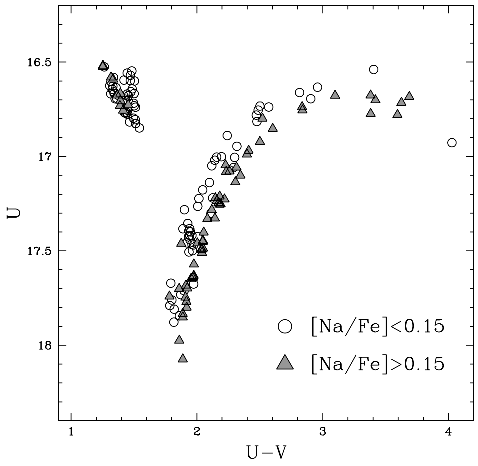

Fig. 1. (U, U-V) color-magnitude diagram of the spectroscopic targets studied in NGC 6362, divided according to their [Na/Fe] abundance, assuming [Na/Fe]=0.15 dex as the boundary between Na-poor (open circles) and Na-rich (solid triangles) stars.

red giant branches are split in two sequences in all color-magnitude diagrams whenever the F336W (or U) filter is used. The populations share the same radial distribution across the cluster extension. NGC 6362 is the first system where first and second generation stars are found to be completely spatially mixed. Also, this cluster is the least massive globular cluster ($M \sim 510^4 M_{\odot}$) where multiple populations have been detected so far. Based on N-body simulations of multiple stellar populations, we argue that to reproduce these findings NGC 6362 should have lost up to ∼80% of its original mass due to long-term dynamical evolution (Vesperini et al., 2013).

3. Spectroscopic results

We measured [Fe/H] and [Na/Fe] abundances in 160 member stars of NGC 6362 by using FLAMES@VLT spectra (Mucciarelli et al., 2016). We provided the first measure of the metallicity of this cluster based on high-resolution spectra: its iron content is [Fe/H]=−1.09 ± 0.01 dex, without evidence of intrinsic spread. The [Na/Fe] distribution of RGB stars is clearly bimodal: the two samples, selected according to their [Na/Fe] abundance, are equally populated (47% are Na-poor and 53% Na-rich), at variance with the other GCs, where the stellar content is dominated by the Na-rich population (see, e.g., Carretta et al., 2009). Also, we find that the [Na/Fe] distribution of the red HB stars is dominated by Na-poor stars, accounting for 82% of the sample.

Fig. 1 shows that there is a clearcut correspondence between the [Na/Fe] content and the two RGBs detected in the color-magnitude diagram built by using the U filter: the Na-poor stars populate the bluest RGB and the Na-rich stars align along the reddest RGB (in agreement with the theoretical expectations).

We performed a differential comparison between the [Na/Fe] distribution NGC 6362 and that obtained for M4, a globular cluster with comparable mass and metallicity. The comparison reveals that both these clusters have a broad and bimodal [Na/Fe] distribution, but the ratios of Na-poor and Na-rich stars are different, with the Na-rich population being dominant in the case of M4 (∼73%).

Until now, NGC 6362 is the least massive globular cluster where both the photometric and spectroscopic signatures of multiple populations have been detected.

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