APOGEE Abundance Anomalies in the low-mass bulge Globular Cluster NGC 6522: Spectroscopic Evidence for Multiple Stellar Populations

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1. Abstract

Recently, Schiavon et al. (2017a) claimed to have found evidence for multiple stellar populations in the low-mass bulge globular cluster NGC 6522. Here we report on the detection of three new giant stars with second-generation abundance patterns towards the innermost regions of the cluster in H-band spectra using observations from the SDSS-III Apache Point Observatory Galactic Evolution Experiment (APOGEE) survey and find the basic pattern of depletion in C, and Mg simultaneous with enrichment in N, and Al. Our results provide new evidence for the presence of multiple generations of stars in NGC 6522 where multiple bursts of star formation occurred. This finding could provide crucial observational support to the intriguing possibility that NGC 6522 is a fossil relic that contributed to generating the N-rich population and the anomalies patterns recently discovery towards the Milky Way bulge.

2. Introduction

Schiavon et al. (2017a) have recently provided useful chemical ”tags” in several elemental abundances for most, perhaps all, Milky Way bulge globular clusters surveyed in APOGEE for identifying stars with polluted chemistry—i.e., they have found the distinctive chemical patterns characterising multiple stellar populations, with comparable chemical behaviour to what is reported in extensive spectroscopic survey of GCs (for a recent review, see Carretta et al. 2007, 2009a,b). The APOGEE survey has revealed that several bulge GCs exhibits significant star-to-star abundance variations in their light element content (see Schiavon et al. 2017a; Tang et al. 2017), with the usual anti-correlations between pairs of light elements, such as C-N, Na-N, and Al-N. This behaviour pinpoints that the CNO, NeNa, and MgAl cycles took place in many of these GCs (see e.g., Meszaros et al. 2015; Pancino & the GES collaboration 2017).

In this work, we turn our attention to the low-mass bulge globular cluster NGC 6522, which has been little studied in the literature. Here we carry out a detailed re-analysis of the NGC 6522 field to search for abundance anomalies through the line-by-line spectrum synthesis calculations for the full set of (atomic and molecular) lines (particularly CN, OH, CO, Al, Mg, and Si) in the re-reduced APOGEE DR13 spectra. If star-to-star light element abundance variations are found, we might confirm that NGC 6522 is the same kind of stellar objects that host multiple stellar populations such as those claimed by Schiavon et al. (2017a); Recio-Blanco et al. (2017), as well as provide crucial observational evidence that NGC 6522 could be the fossil relic of one of the structures that contributed to generate the N-rich population towards the Milky Way bulge (Schiavon et al. 2017b) and/or re- inforces the link between GCs and the chemical anomalies (second-generation field stars) recently found toward the galactic bulge field (e.g., Fernandez-Trincado et al. 2017), as well as the N-rich moderately metal-poor halo stars, mimicking the chemical abundance patterns of the second-generation population of globular clusters (see Matell et al. 2016, Fernandez-Trincado et al. 2016b).

3. CHEMICAL ABUNDANCE

In Figure 1, the behaviour of the average [Al/Fe], [Mg/Fe], and [N/Fe] abundance ratios of our synthesis analysis (red and blue filled symbols) compared with DR13 abundances (when available) marked with red and blue empty symbols, and overplotted with APOGEE DR13 determinations for the first- (green filled triangles) and second-populations (green empty triangles) in GCs, M5, M71, and M107 (Meszaros et al. 2015). Hexagons are chemically anomalous stars in NGC 6522 from the Gaia-ESO survey presented in Recio-Blanco et al. (2017).

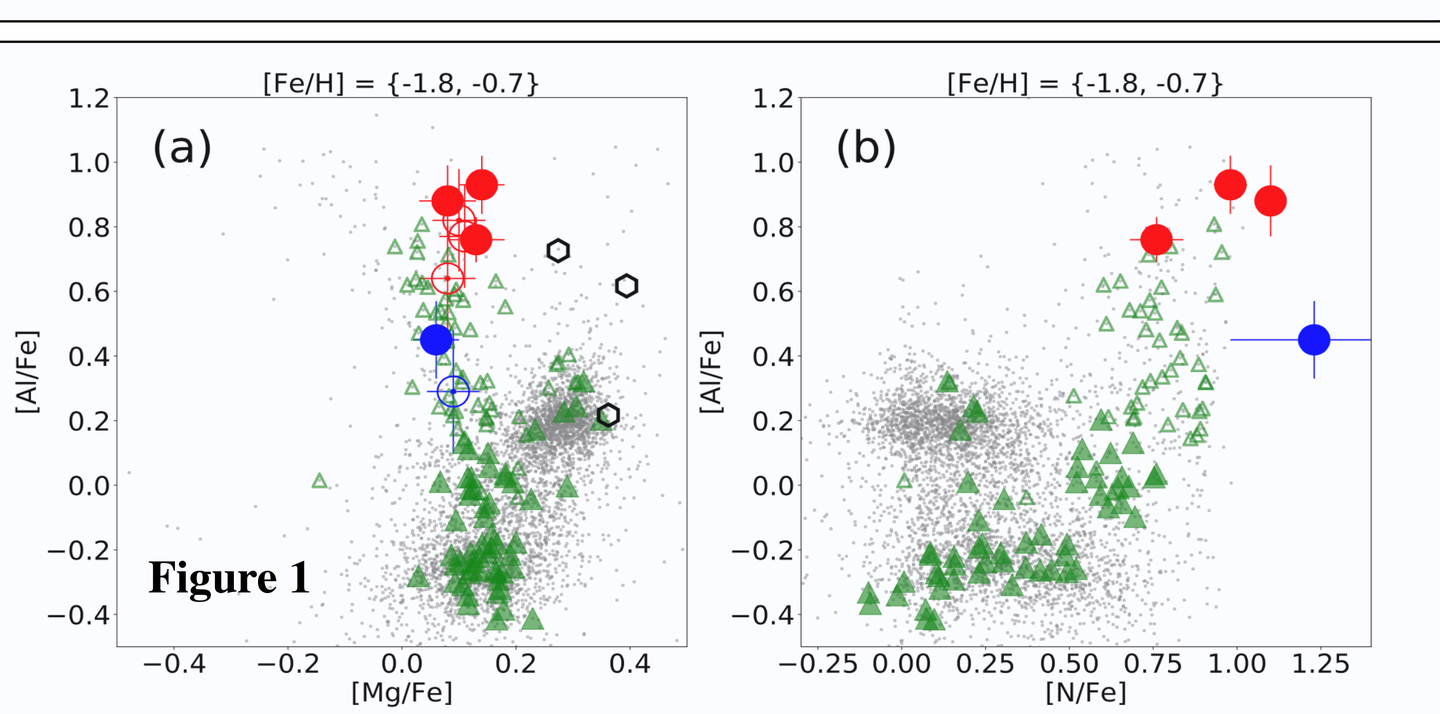

Figure 1

4. Spatial distribution of targets in NGC 6522

In Figure 2, we plot the spatial distribution of our new potential cluster members (red open circles), which clearly lie on or near the cluster centre (all our candidate members fall within a relatively small radius, ∼ 2.5 arcmin) as illustrated in the same figure. The inner plus symbol is the centre of the cluster and the black dotted line marks r_t = 7.1(+6.1/-3.7) arcmin. Field stars from the APOGEE survey are plotted using small gray symbols. Cyan squares, empty squares, orange triangles and the blue empty circle, are cluster members analysed in Ness et al. (2014), Barbuy et al. (2014), Recio-Blanco et al. (2017), and Schiavon et al. (2017a), respectively.

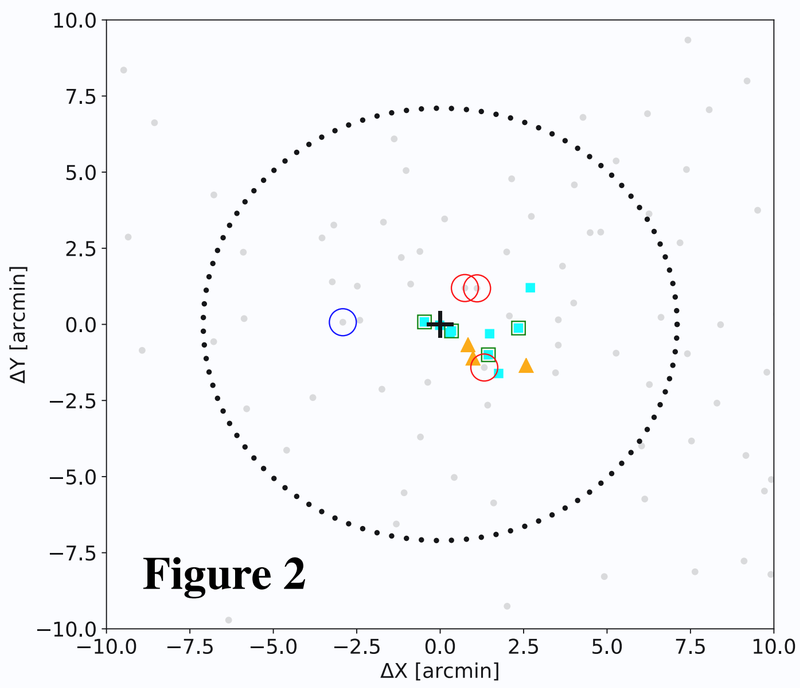

Figure 2

5. Concluding Remarks

The main results of the light-element abundance analysis from high-resolution APOGEE spectra in NGC 6522 can be summarised as follows:

- We report the identification of three new potential stellar members of NGC 6522 in the Apache Point Observatory Galactic Evolution Experiment (APOGEE) survey (Majewski et al. 2017). The spectra analyzed in this work have a signal-to-noise ratios larger that 60, showing very similar line strengths (namely CN bands, Al I and Mg I lines) to that of 2M18032356-3001588 (see Schiavon et al. 2017b), making also them ideal to line- to-line spectrum synthesis calculations on clear selected features. These spectral properties suggest that this group of stars share a common formation history, and spatial relationship on the sky, and therefore gravitationally bound to NGC 6522.
- We measure for the first time significant N and Al overabundances, with Carbon-depletion ([Mg/Fe]<+0.15 dex) in NGC 6522 members, suggesting that the distinctive chemical patterns characterising multiple stellar populations is present within NGC 6522, it reinforces the recent claims in the literature (Schiavon et al. 2017a; Recio-Blanco et al. 2017).

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