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Extra-tidal features using Gaia DR2

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Abstract. In recent years, we have gathered enough evidence showing that most of the Galactic globular clusters extend well beyond their King tidal radii and fill their Jacobi radii in the form of "extended stellar haloes". In some cases, because of the interaction with the Milky Way, stars are able to exceed the Jacobi radius, generating tidal tails which may be used to trace the mass distribution in the Galaxy. In this work, we use the precious information provided by the space mission Gaia (photometry, parallaxes and proper motions) to analyze NGC 362 in the search for member stars in its surroundings. Our preliminar results suggest that it is possible to identify member stars and tidal features up to distances of a few degrees from the globular cluster center.

Keywords. (Galaxy): globular clusters: individual: NGC 362 (Galaxy)- halo

1. Introduction

The overall structure of a Galactic globular cluster (GC) is shaped by the tidal stress exerted by our own Galaxy, the Milky Way. Low-mass member stars are lost along the orbit of each of these clusters and are mostly placed between the theoretical King (1962) tidal radius and its Jacobi surface. This process results in the formation of more or less extended tidal tails, which have been succesfully traced for a reduced number of clusters, including Pal 5 and NGC 5466 (Odenkirchen *et al.* 2003; Kuzma *et al.* 2015; Belokurov *et al.* 2006; Grillmair *et al.* 2006). When unbound stars are found within the Jacobi radius, they seem to form an 'extended halo', which seems to be a common feature for many GCs in the outer Galactic halo (Olszewski *et al.* 2009; Correnti *et al.* 2011; Kuzma *et al.* 2016; Carballo-Bello *et al.* 2018).

These extra-tidal structure have been unveiled following different procedures that consider the color-magnitude distribution of the stars belonging to the cluster and those that compose the surrounding populations. A good example of these methods is the matched-filter technique, which has been profusely use to identify the tidal tails of Galactic GCs (and Milky Way satellite galaxies) (e.g. Sollima *et al.* 2011; Navarrete *et al.* 2017; Carballo-Bello *et al.* 2018). On the other hand, the search for extra-tidal structures around GCs and select cluster members for those globulars located in the densest areas of the Galaxy (i.e. disk and bulge) requires a statistical decontamination algorithm (e.g. Bonnatto *et al.* 2007; Carballo-Bello *et al.* 2016).

The second data release (DR2), generated by the European Space Agency Mission *Gaia*, is providing insights on the origin, dynamical evolution and structure of the Milky Way Gaia collaboration (2018). As for the Galactic globulars, the proper motions derived by *Gaia* for relatively bright cluster members together with their mean line-of-sight velocities have allowed us to compute their orbits and study their internal rotation.

In this work, we test a statistical decontamination methodology on a GC using *Gaia* DR2 stellar parameters. The main objective of this work is to evaluate whether this technique is adequate or not for data with the current quality of the information contained in the *Gaia* DR2. Among the nearby Galactic GCs, we focus on NGC 362, a system at $R_{\odot} = 8.5$ kpc (Chen *et al.* 2018). This is an ideal target to test our procedure because it is likely contaminated by Small Magellanic Cloud (SMC) and NGC 104 (47 Tucanae) stars.

A full description of the procedure followed, taking into account the colours, magnitudes, proper motions and heliocentric distances for all the stars in the area of the sky surrounding NGC 362 is found in Carballo-Bello (2019).

2. Results

The density contours shown in Carballo-Bello (2019) with higher significance ($\sigma > 2$) seem to be elongated in the direction of the highly eccentric orbit derived for NGC 362 and beyond r_J. This may indicate that the structure of this GC is affected by its interaction with the Galaxy, thus NGC 362 could have lost stars along its orbit. There are no previous reports of extra-tidal features around this cluster and only some stars outside the King tidal radius have been identified (Grillmair *et al.* 1995; Anguiano *et al.* 2015; de Boer *et al.* 2019).

In the young/old halo GC scheme proposed by Zinn (1993), NGC 362 is classified as a young cluster, thus it is a good candidate to be an extra-Galactic GC, formed in the interior of a dwarf galaxy and later accreted by the Milky Way. Together with other 9 Galactic GCs, it has been proposed as a member of the *Gaia Sausage/Enceladus* GC system (Belokurov *et al.* 2018; Helmi *et al.* 2018; Myeong *et al.* 2018). Interestingly, most of the possibly accreted globulars present extended stellar structures (Kuzma *et al.* 2016; Carballo-Bello *et al.* 2018; Piatti & Carballo-Bello 2019), which may indicate that GC born in less massive galaxies are more prone to suffer from the interaction with the Galaxy.

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