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Globular Clusters at the Centre of the Fornax Cluster: Tracing Interactions Between Galaxies

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Summary. We present the combined results of two investigations: a large-scale study of the globular cluster system (GCS) around NGC 1399, the central galaxy of the Fornax cluster, and a study of the GCSs around NGC 1374, NGC 1379 and NGC 1387, three low-luminosity early-type galaxies located close to the centre of the same cluster. In both cases, the data consist of images from the wide-field MOSAIC Imager of the CTIO 4–m telescope, obtained with Washington *C* and Kron–Cousins *R* filters, which provide good metallicity resolution.

The colour distributions and radial projected densities of the GCSs are analyzed. We focus on the properties of the GCSs that trace possible interaction processes between the galaxies, such as tidal stripping of globular clusters (GCs). For the blue GCs, we find tails between NGC 1399 and neighbouring galaxies in the azimuthal projected distribution, and the three low-luminosity galaxies show low specific frequencies and a low proportion of blue GCs.

1 Introduction

It is widely known that GCs are a useful tool for studying the origin and evolution of galaxies, in the case of isolated galaxies as well as for those within groups or clusters.

In our first wide-field CCD study of the GCS around NGC 1399, at the centre of the Fornax cluster [4], we found that there are GCs out to the very limits of the studied field (Field 3 in Fig. 1), corresponding to a projected galactocentric distance of 100 kpc. In a later run, we obtained images of three adjoining fields, using the same observational set up, which is described in Sect. 2. We added one field to the West (Field 4 in Fig. 1) and two fields to the East of NGC 1399 (Fields 1 and 2 in Fig. 1). As there were several low-luminosity early-type galaxies with their own GCSs in the western field (NGC 1374, NGC 1379 and NGC 1387), we decided to keep this field to study them [1], and we used the eastern fields, where there were no conspicuous galaxies, to study the NGC 1399 GCS over a larger field [2].

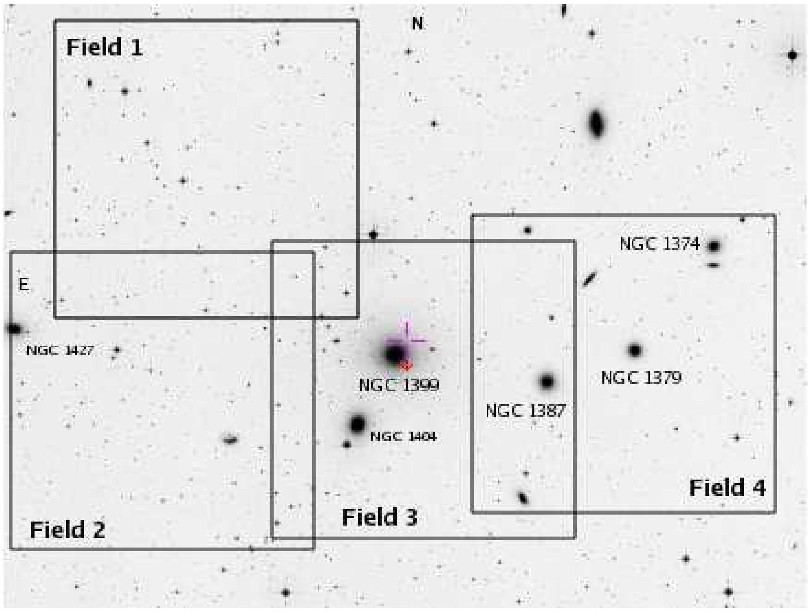

Fig. 1. MOSAIC fields overlaid on a DSS image of the Fornax cluster. North is up and East to the left.

2 Observations and Data Reduction

The observations were performed with the MOSAIC camera and 4–m Blanco telescope at the Cerro Tololo Inter–American Observatory (CTIO). The MOSAIC wide-field camera has a field of view of 36 × 36 arcmin (200 × 200 kpc at the Fornax distance). For more information on the MOSAIC camera we refer to the homepage *http://www.noao.edu/kpno/mosaic/mosaic.html*.

Kron–Cousins R and Washington C filters were used. We remind the reader that R and Washington T_1 magnitudes are very similar, with a very small colour term and zero-point difference [8]. For more details on the point source selection, photometric calibration, and the identification of GC candidates we refer the reader to [1] and [2]. Statistical subtraction of the contamination by the background was performed in all cases.

3 GCSs around NGC 1374, NGC 1379 and NGC 1387

It is shown, for the first time, that the colour distributions of these three low-luminosity galaxies are clearly bimodal, with very similar colours for the blue GC peaks [1]. The red peak in NGC 1387, the galaxy located closer to NGC 1399 (see Fig. 1), is redder than the others and its whole colour distribution is atypical: the red clusters are much more numerous than the blue ones and the separation of the peaks is very pronounced. In fact, the fraction of blue clusters, with respect to the total GC population is low for the three systems, but even lower for NGC 1387 (43%, 45%, and 24% for NGC 1374, NGC 1379 and NGC 1387, respectively).

With regard to the radial distributions, the blue GCs in these systems show flatter distributions than the red ones, while the respective galaxy light profiles follow the density profiles for all GCs.

By means of the luminosity functions we estimate the total GC populations in NGC 1374, NGC 1379 and NGC 1387 between 200 and 400 clusters, and obtain specific frequencies $S_N = 2.4$, 1.4 and 1.8, respectively. These specific frequencies are rather small when compared to the typical value $S_N = 4$ found for elliptical galaxies in dense environments [9].

Figure 2 shows the specific frequencies and fractions of blue clusters versus distance from NGC 1399, including the data for NGC 1404 [6] and NGC 1427 [7] (see Fig. 1). The specific frequencies seem to decrease with decreasing distance from NGC 1399 and a similar trend is present in the fraction of blue clusters. These behaviours support the idea that galaxies closer to NGC 1399, in projected distance, might be losing their blue GCs as a result of some interaction process, like tidal stripping of clusters by the giant elliptical NGC 1399 (e.g. [5], [11], [3], etc.).

4 GCS around NGC 1399

The large-scale study of the projected radial distribution of GCs around NGC 1399 [2] shows that the blue clusters extend up to 250 kpc from the galaxy centre (45 ± 5 arcmin) while the red ones show a steeper radial profile that reaches a radius of 140 kpc (25 ± 5 arcmin). To our knowledge, this is one of the largest GCSs ever studied and, as our limiting magnitude is $T_1 = 23$, we cannot assure that there are no more GCs further out.

The colour distributions at different radial ranges confirm that the red GCs are more centrally concentrated than the blue ones, and show that the blue peak gets bluer with increasing galactocentric radius; a similar gradient was found in the NGC 1427 GCS by [7].

The colour distributions in different magnitude ranges show that the distribution is unimodal for the brightest bin (magnitudes similar to that of ω Cent), as already pointed out by [4]. However, we found no evidence for a

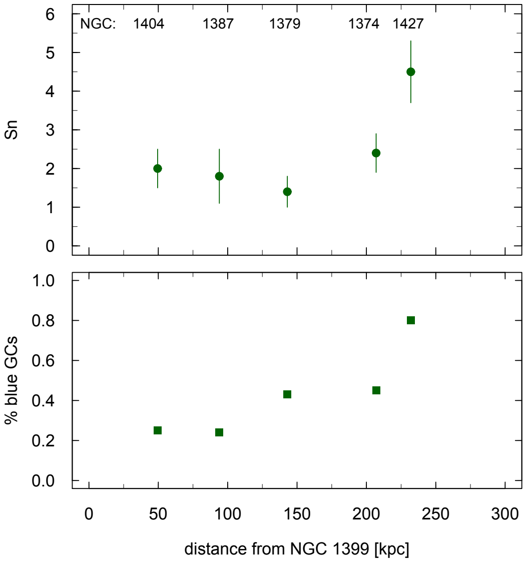

Fig. 2. Specific frequencies (upper panel) and fraction of blue GCs (lower panel) versus projected distance from NGC 1399.

"blue tilt" (e.g. [10]), i.e. the blue peak does not get redder with increasing luminosity.

The azimuthal distribution of the smoothed projected number density of blue clusters around NGC 1399 (Fig. 9 in [2]) shows two tails: one towards NGC 1404 and another towards NGC 1387. In the case of NGC 1404 one might wonder if this is just an overlapping of the two GCSs but it has been proposed, and tested by numerical simulations [3], that its GCs are probably being stripped by NGC 1399. The other tail, towards NGC 1387 cannot be just an overlapping of GCSs due to the small size of the GCS of NGC 1387 (r = 3 arcmin [1]) as compared to the projected distance to NGC 1399 (19 arcmin). Such overdensity of blue GCs may be understood as evidence that blue clusters, the less bound ones, are being lost by NGC 1387 due to some interaction process with the central cluster galaxy, like tidal stripping.

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