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STRUCTURAL PARAMETERS OF M81 COMPACT STAR CLUSTERS

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RESUMEN

Estudiamos las propiedades estructurales de la población de cúmulos estelares compactos en M81 utilizando imágenes del *HST/ACS* en los filtros F435W, F606W and F814W y cubriendo totalmente el disco óptico de la galaxia. La población contiene 263 cúmulos estelares jóvenes así como 172 cúmulos globulares. En este trabajo analizamos la distribución de tamaños de los cúmulos estelares jóvenes y cúmulos globulares en M81 y comparamos esta última población con la distribución de tamaños de los cúmulos globulares de la Vía Láctea.

ABSTRACT

We study the structural properties of the compact stellar cluster population in M81 using the *HST/ACS* images in the filters F435W, F606W and F814W, that cover the entire optical extent of the galaxy. This population contains 263 young compact clusters as well as 172 old globular clusters. In this work, we analyzed the size distribution of the young compact star clusters and globular clusters in M81 and compared the latter with that of the Milky Way.

Key Words: catalogs — galaxies: individual (M81) — galaxies: spiral — galaxies: star clusters

1. INTRODUCTION

From the studies of sizes and structural parameters of globular clusters (GCs) in different galaxies, it has become clear that these properties correlate with the properties of their host galaxies (Brodie & Strader 2006). Also size measurements of young star clusters are on the other hand valuable tools to put constrains on the formation and early dynamical evolution of star clusters (Mackey & Gilmore 2003). Also, the similarity between the compactness and mass of the compact star clusters (CSCs) and that of the GCs is a reason to think of an evolutionary connection between them. But there are only few galaxies where the star cluster systems are rich in number and cover a wide age range (Mackey & Gilmore 2003) where you have the opportunity of studying the evolution history, with M81 being one of such galaxies.

M81 (NGC 3031) is a large Sab spiral galaxy, very similar to M31 in appearance and roughly as massive as the Milky Way (MW). M81 at a distance of 3.63 Mpc [$m - M = 27.8 \pm 0.2$; Freedman et al. 1994] is the biggest member of the M81 Group. The mass, age and metallicity of population of GCs in M81 has been studied in the past by several groups (Perelmuter et al. 1995; Chandar et al. 2001), and some of these GCs has been classified as bonafide after studying their spectra (Schroder et al. 2002; Nantais & Huchra 2010). However, the structural parameters of only a small sample of CSCs in this galaxy have been studied by Chandar et al. (2001). Now we have the opportunity of study the structural parameters of a full sample of M81 CSCs that cover a wide range in age and relate these properties with the evolutionary stage of the star clusters and their location in the galaxy.

2. COMPACT STAR CLUSTER SAMPLE

Previously we detected 435 CSCs in 29 HST/ACS (Hubble Space Telescope/ Advanced Camera for Surveys) fields in M81 (Santiago-Cortés et al. 2010). The observations covering a field of view of $\sim$340 arcmin^2, with a sampling of $0.05''$ pix^{-1} (0.88 pc pix^{-1}). For each field, observations were carried out in the F435W, F606W and F814W filters (B, V and I filters, respectively). The reduction of these images was carried out by the Hubble Heritage Team (Mutchler et al. 2007).

We used the automatic detection code SExtractor to create an unbiased sample of cluster candidates (Bertin & Arnouts 1996). The B band was used for the detection of candidates, and we carried out aperture photometry of all the detected sources in each of the B, V and I images for each of the 29 fields. Then we used some photometric and physical parameters provided by SExtractor and applied a colour-based criterion to select a sample of CSCs, which is discussed in detail in Santiago-Cortés et al. (2010). Only clusters with FWHM $\leq$10 pix (8.8 pc) are selected.

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3. SIZE DISTRIBUTION

For the star clusters size measurements we use the ISHAPE program (Larsen 1999). ISHAPE convolves analytic profiles with the surface brightness distribution of a cluster with different effective radii with the Point-Spread Function (PSF) and then fits these to each source in the data. The best fitting R_{eff} is determined by minimizing the χ^2 in an interactive process. This method is able to obtain reliable R_{eff} for $R_{\mathrm{eff}} \geq 0.02$ pc, as determined using field stars in the images. In this case, we fit a King model with a concentration index $c = 30$. The characteristic PSF used by ISHAPE was derived selecting isolated stars uniformly distributed over the entire field that contains the star cluster, in total 29 fields in the B filter. At this stage, we used the photometry routine IRAF/DAOPHOT (Stetson 1987), with aperture size of 5 pix, meanwhile the local background was measured in an annulus with an inner radius of 10 pix and 5 pix wide.

The effective radii (R_{eff}, the radius which contains half of the integrated light) distributions of M81 CSCs are showed in the top of Figure 1. It can be seen that there are important differences in the size distributions of young and globular clusters. The young cluster size distribution shows that there are a large number of very compact clusters with $R_{\mathrm{eff}} < 0.5$ pc dropping down at bigger values, whereas the globular cluster distribution is flatter. Young clusters are typically around 7 times smaller that the globular clusters, with the former having a median $R_{\mathrm{eff}} = 0.26$ pc, and the latter with median $R_{\mathrm{eff}} = 1.9$ pc. The range of young cluster sizes is similar to the range found in other galaxies like LMC and M51 (Mackey & Gilmore 2003; Scheepmaker et al. 2007).

In lower panel of Figure 1, we show the size distribution of M81 and MW globular clusters. We have 120 objects in M81 and 130 in the MW (van den Bergh 1996). Comparing the two distributions we can see that are similar between $1.0 < R_{\mathrm{eff}} < 8.5$ pc. M81 has an excess of very compact ($R_{\mathrm{eff}} < 1.0$ pc) globular clusters. The median value of M81 globular clusters $R_{\mathrm{eff}} = 1.9$ pc is marginally smaller than the MW median size $R_{\mathrm{eff}} \sim 2.6$ pc, the latter for Galactic globular clusters with $R_{\mathrm{eff}} < 8.5$ pc.

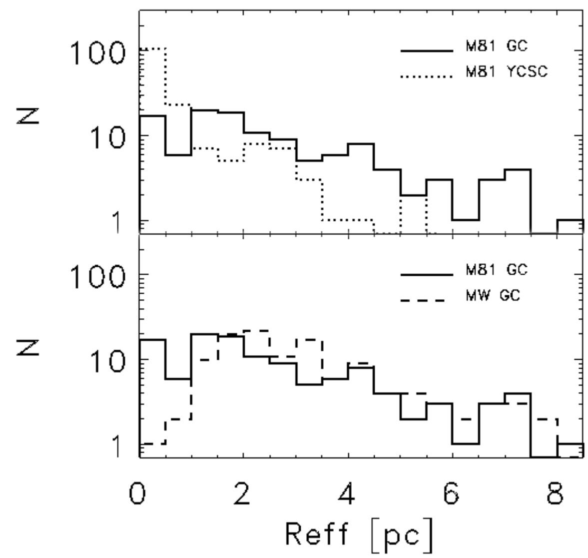

Fig. 1. Effective radii R_{eff} distributions of compact star clusters. M81 young star cluster (Dotted line), M81 globular cluster (continuous line) and Milky Way globular cluster distribution (dashed line).

4. CONCLUSIONS

We present the size distributions of M81 compact star clusters, obtained using the ISHAPE routine. We find that there are differences in the size distribution between young compact star clusters and globular clusters. The globular cluster distribution is flatter and wider than the one for young clusters. The sizes of young star clusters are similar to that found in the LMC and M51, whereas the size distribution of M81 globular clusters is very similar to that of the Milky Way.

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