The globular cluster system of the galaxy NGC 4546: clues about the origin of S0 galaxies.

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INTRODUCTION

We present here the first photometric and spectroscopic characterization of the globular cluster system (GCS) of the lenticular galaxy NGC 4546. Located in a low density environment, this galaxy poses a challenge in understanding the origin and evolution of this kind of galaxies. We also present the age and metallicity of the ultra compact dwarf (UCD) associated with the galaxy.

OBSERVATIONS

The photometric study is based on a mosaic of three deep fields obtained using GMOS (**Hook et al. 2004**), and comprises 4x100s exposures in the g',r',i' filters and 4x290s exposures in the z' filter (**Fukugita et al. 1996**). The images were taken under excellent seeing conditions (0.46 - 0.71 arcsec), as part of Gemini programs **GS-2011A-Q-13** and **GS-2014A-Q-30**. We have also obtained spectroscopic data for one GMOS mask (**GS-2013A-Q-26**) centered in NGC 4546. A total of 12 exposures of 1850s were taken. The B1200 grating was used, and the spectra of the NGC4546-UCD was obtained through a 0.5 arcsec wide slit, and 1.5 arcsec wide slit for the GC candidates.

PHOTOMETRY

At the assumed distance to NGC 4546 ((m-M)=31.27±0.36, NED), GCs are expected to be identified as unresolved objects. The detection and classification of the candidates (**black filled circles in Figure 1**) was performed following **Faifer et al. (2011)**, based on colour ranges (g'-i'), (g'-r'), (r'-i'), (r'-z') and (i'-z'), magnitudes and also considering the stellarity index of Sextractor (**Bertin & Arnouts 1996**). The low brightness end of our sample was defined by the 80% completeness, and the high brightness end was chosen to include all GC candidates with absolute magnitude M_V>-11 (**Mieske et al. 2006**). This last limit was adopted to separate "normal" GCs from supermassive or young GCs, or UCD candidates.

Figure 1

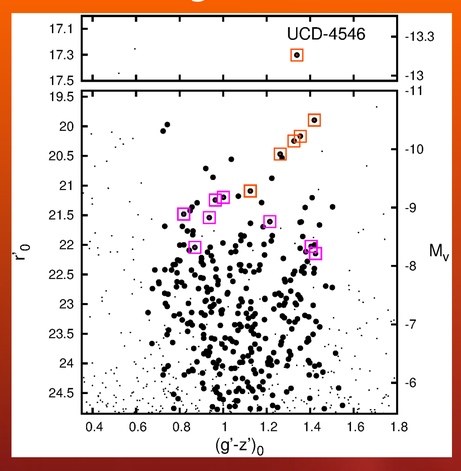


Figure 2

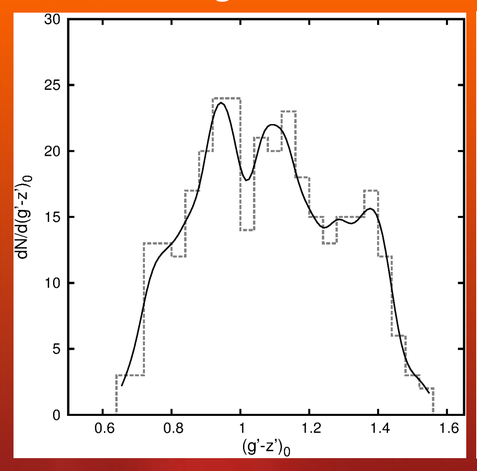
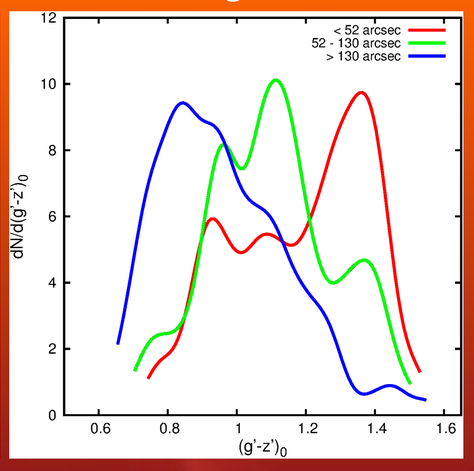


Figure 3



COLOUR DISTRIBUTION AND POSITIONS

In **Figure 2**, we show (g'-z') colour histogram for all the GC candidates. It reveals a trimodal integrated colour distribution. This trimodality in colours can be interpreted as indicative of the presence of, at least, three subpopulations of GCs, which have different characteristics, such as metallicity and spatial distribution, among others. We split the sample of GC candidates into three radial bins with approximately 110 objects in each of them (R_{gal}<52, 52-130 and >130 arcsec), obtaining again the colour distribution (**Figure 3**). The fit of three Gaussian distributions performed with GMM (**Muratov & Gnedin 2010**) software, gave the peaks for the blue ((g'-z')=0.91), intermediate (green; (g'-z')=1.11) and red subpopulations ((g'-z')=1.33). **Figure 4a**, show the spatial distribution of the red ((g'-z')>1.23), green (1.01<(g'-z')<1.23), and blue ((g'-z')<1.01) GC candidates. **Figure 4b, c and d** show the same candidates, but separated by colours. It can be seen that the red subpopulation presents a stronger spatial concentration towards the galaxy than the blue ones, while green candidates are clustered mostly to the south of it.

Using the GC luminosity function, and integrating the projected density profile for the entire sample of GC candidates, we get a total population of 560±50 GCs.

Figure 4a

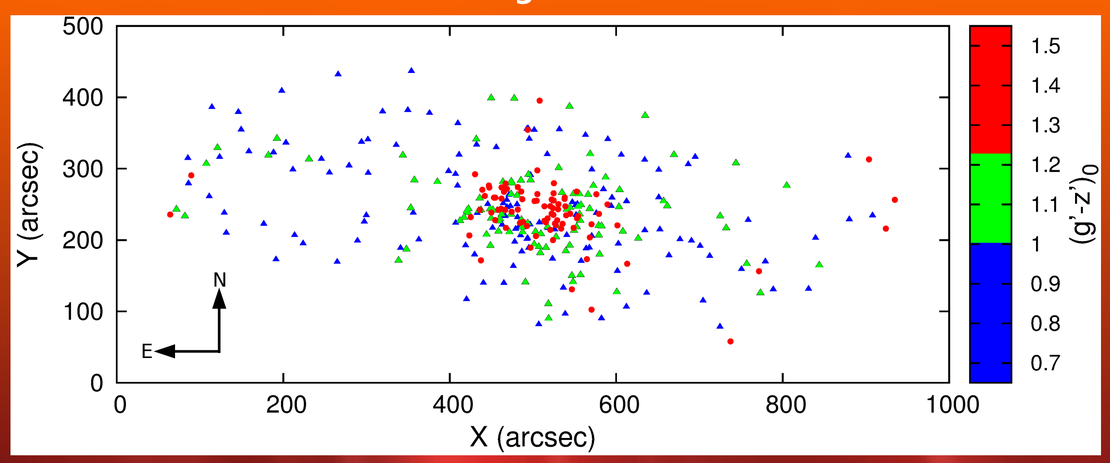


Figure 4b

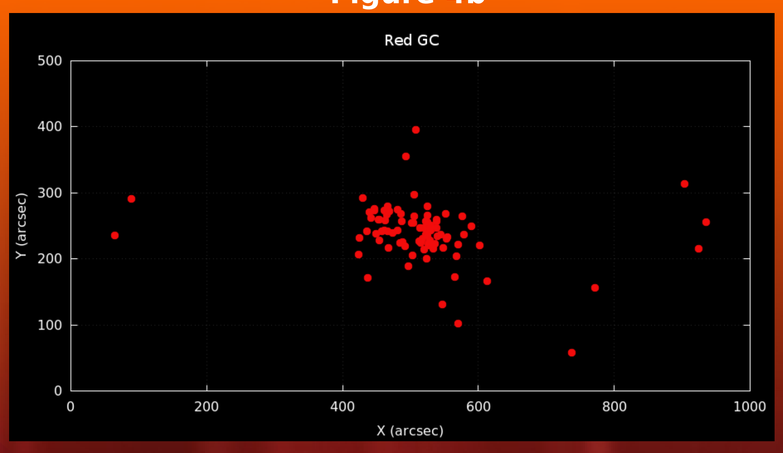


Figure 4c

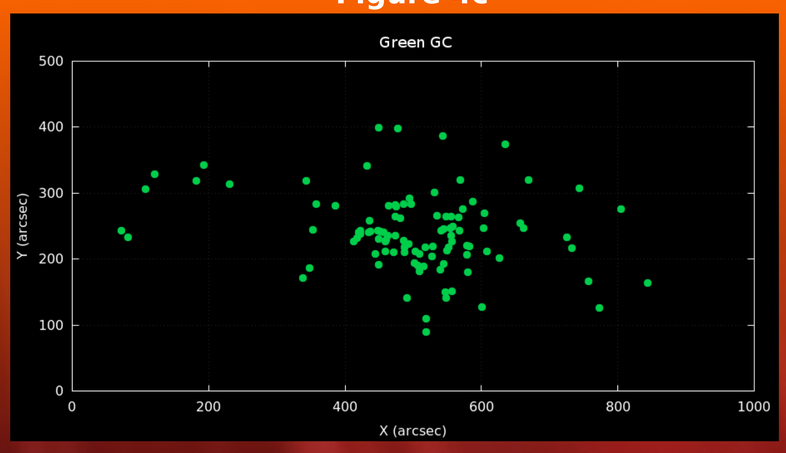
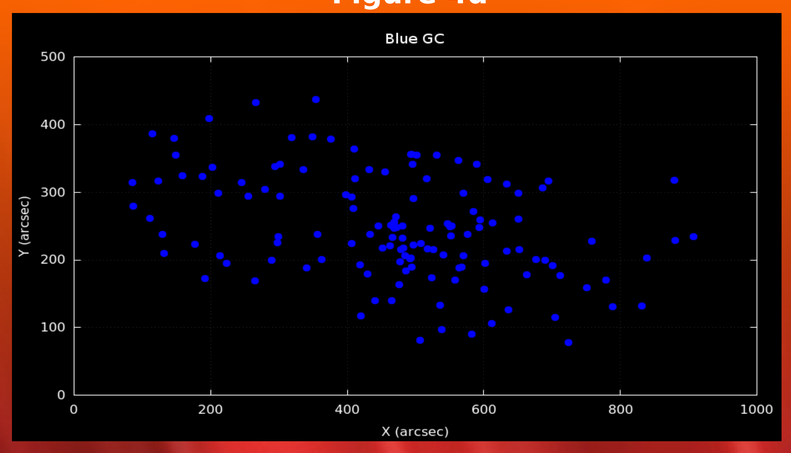


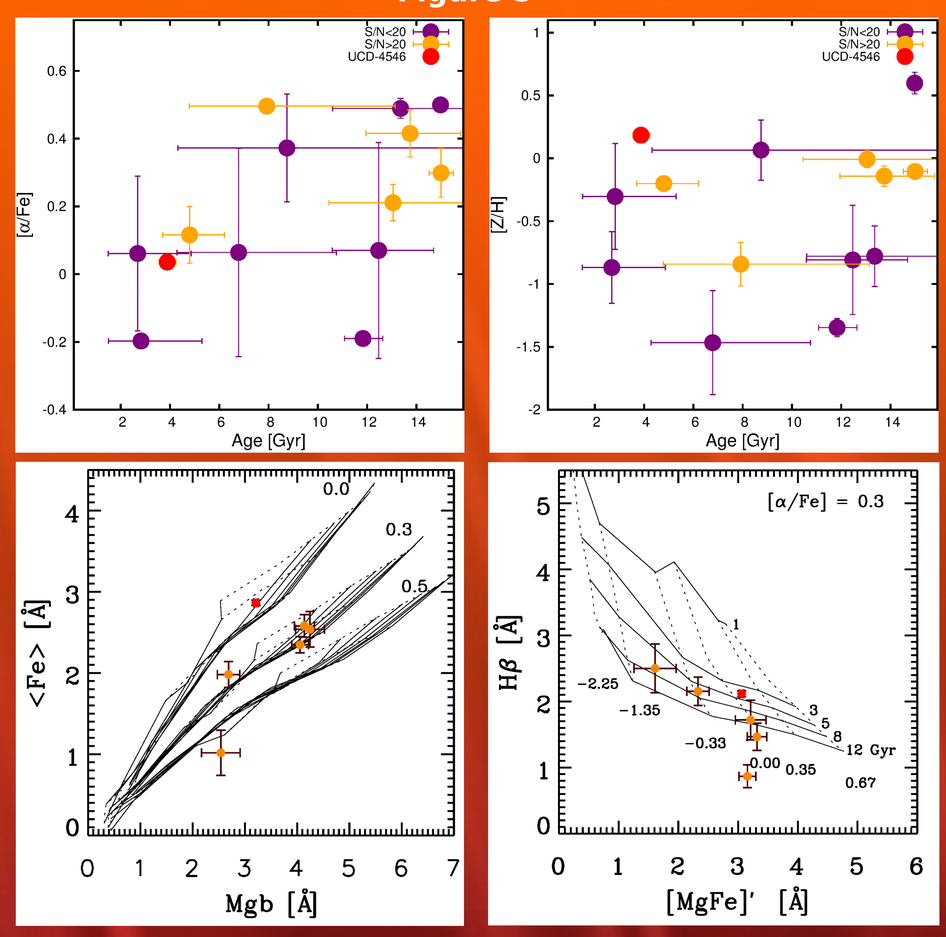
Figure 4d



SPECTROSCOPY

We have confirmed and analyzed 14 spectra corresponding to GCs and the mentioned UCD, present in the system of NGC 4546. We use the penalised pixel fitting code pPXF (**Capellari & Emsellem 2004**) to measure the objects kinematics, employing the stellar population synthesis models of **Maraston & Strömbäck (2011)** as template spectra. We present ages, metallicities ([Z/H]) and α-element abundances ([α/Fe]) derived through χ^2 fitting of the measured Lick indices with the stellar population models. Due to the low S/N in some spectra (**magenta squares and filled circles in Figure 1 and Figure 5, respectively**), we were not able to get reliable Lick indices for 8 GCs, therefore in the diagnostic plots (**lower panels in Figure 5**) we included only those objects with S/N>20 (**orange squares and filled circles in Figure 1 and Figure 5, respectively**). As can be seen in the plots, the GCs have metallicities ranging from -1.5 to +0.5, and appear to have a wide range of α-element abundance ratios. The luminosity-weighted values obtained for UCD (**red filled circle in Figure 5**) were: age=$3.99^{+0.93}_{-0.75}$ Gyr, [Z/H]=0.18±0.06 dex and [α/Fe]=0.05±0.05 dex. **Norris et al. (2015)** confirm that NGC4546-UCD was forming stars from the earliest epochs until at least 1-2 Gyr ago, being this object the remnant nucleus of a galaxy tidally disrupted by NGC 4546.

Figure 5



PRELIMINARY CONCLUSIONS

The photometric study shows a trimodal colour distribution for the GCs in NGC 4546. This feature, also observed in other galaxies (**Escudero et al. 2015**), may be an evidence of a past interaction or merger where new GCs were formed. The spatial distribution of the red and blue GC candidates, is consistent with that expected in GC systems. However, the green subpopulation is mostly located towards the south of NGC 4546 and there are very few red candidates outside 10 kpc of R_{gal}. According their radial velocities, we have confirmed the first 13 GCs belonging to the lenticular galaxy NGC 4546. We have measured ages, metallicities and [α/Fe] ratios for them, obtaining that most GC have old ages, with the exception of at least one cluster (S/N>20), which has an intermediate age of 5 Gyr. In contrast, **Kuntschner et al. (2010)** have found that the best SSP models for the diffuse light of NGC 4546 give an age of $11.7^{+1.1}_{-1.0}$ Gyr. Regarding the UCD, we have found that it is a relatively young and metal rich object which was forming stars during several Gyrs. We speculate that process which gave origin to this young UCD, could be the responsible of the third GCs subpopulation detected in this galaxy.

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