X-Shooter spectroscopy of dwarf elliptical galaxies in the Centaurus Cluster

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Introduction

Dwarf galaxies (M \(_{d} \gtrsim -16\)) are recognized to be the objects that are most susceptible to the physical processes involved in their interaction with the surrounding environment, because of their shallow gravitational potential. In particular, it is believed that some early-type dwarfs may bear little resemblance to their progenitors (Moore et al. 1998), as a consequence of tidal stripping (harassment) and/or ram pressure stripping events. However, because of their low luminosity, dwarfs are seen only in a limited look-back time range, and the clues of their complex evolutionary histories must be searched in the fossil properties of their stellar populations. To set tight constraints on their formation and evolution, the intrinsic properties of each family of objects must be precisely outlined.

In this study we aim to characterise the dynamical and stellar population properties of a first set of dwarf elliptical galaxies (M \(_{d} \approx -15\)) in the Centaurus Cluster (Abell 3526 – R.A.: 12° 48′ 51.8″; Dec: -41° 18′ 21″). For this purpose we employed the X-Shooter spectrograph at ESO-VLT UT2. The depth of vision provided by the 8 m mirror, coupled with the unique combination of the medium resolution (R = 3000 – 11000) and the extended wavelength coverage (0.35 – 2.2 μm) of the instrument, provides an excellent mean of studying the broadening and strength of the absorption features in the galaxies’ spectra.

Observations & data reduction

We observed six faint elliptical galaxies in the Centaurus Cluster selected from the catalogues of Jerjen & Durrell (1997; CCC) and Chiboucas & Mateo (2007; CM07). Data reduction was performed with the X-Shooter instrument pipeline, while for data analysis the UlySS (Koleva et al. 2009, http://ulys.ia.unicamp.br/) spectral fitting package was employed. UlySS fits a linear combination of components with non-linear parameters broadened by the LOSVD (line of sight velocity distribution) to the observed spectrum.

Stellar kinematics

We derived the X-Shooter instrumental broadening using the spectrum of a non-rotating star (HD111486), and inserted it into the theoretical models, to analyse the VIS arm spectra.

Ages & metallicities

Stellar population parameters (mainly age and metallicity) were analysed in the UVB arm of the spectrograph. The single stellar populations (SSPs) were produced using population synthesis programs. A sample fit is displayed below, with residuals in the bottom panel. We initially fit a single SSP component to derive the luminosity-weighted age and metallicity, which are plotted in the Fig. 4.

RESULTS: We find that luminosity-weighted ages and metallicities of Centaurus dEs are compatible with those measured in dwarfs from other clusters. Compact ellipticals in our sample display an older age and higher metallicity compared to their dE counterparts.

Star formation histories

We extended our analysis to the star formation histories (SFHs) of the galaxies, by carrying out multiple-component fits to the measured spectra: we employed 15 SSPs with fixed age and free metallicity. The plot on the right shows two sample fits, one for a dE (CCC-61) and one for a dE (CM07-1214).

RESULTS: The SFH of dEs appears dominated by an old (13 Gyr) burst of metal rich stars. The properties of dEs instead can be accounted for by a second episode of star formation (at ~5 Gyr).

Summary and conclusions

We have begun a spectroscopic study (the first of its kind) of dwarf elliptical galaxies in the Centaurus Cluster:

- Age and metallicity measurements, performed via full spectrum fitting, reveal for all the galaxies an early star formation (\(\gtrsim 10\) Gyr).
- Dwarf ellipticals, however, consistently show evidence for a more extended SFH.
- The measured ages and metallicities of dEs are consistent with a formation scenario involving more massive progenitors which have been stripped of their outer stellar population (Chilingarian et al., 2009).
- In the future, we plan to better constrain the environmental dependence of the galaxy properties, e.g. by studying their variation in relation to the nearest neighbors. We will also consider the combined with measurements on the NIR part of the spectrum. Finally, we are currently planning to increase our sample size (proposal submitted) to strengthen the statistics of our conclusions.

References

Chilingarian, I. et al., 2009, Science, 326, 1379

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