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Stellar populations in CL0048-2942: a galaxy cluster at z ∼ 0.64

M. Serote Roos[1], C. Lobo[2], F. Durret[3], A. Iovino[4] and I. Márquez[5]

[1]Centro de Astronomia e Astrofísica da Universidade de Lisboa, Tapada da Ajuda, 1349-018 Lisboa, Portugal email: serote@oal.ul.pt
[2]Centro de Astrofísica & Departamento de Matemática Aplicada, Universidade do Porto, 4150-762 Porto, Portugal email: lobo@astro.up.pt
[3]Institut d'Astrophysique de Paris, 98bis Bd. Arago, 75014 Paris, France email: durret@iap.fr
[4]Osservatorio Astronomico di Brera, via Brera 28, 20121 Milano, Italy email: iovino@brera.mi.astro.it
[5]Instituto de Astrofísica de Andalucía (CSIC), Camino Bajo de Huétor 24, 18008 Granada, Spain email: isabel@iaa.es

Abstract. We present and discuss results concerning a study of stellar populations in the galaxies belonging to CL 0048-2942, a cluster at intermediate redshift (z = 0.64), and to the field. This study gives insight on the evolutionary stage of the cluster galaxies at different radial distances from the cluster centre. We find a population gradient within the cluster: centre galaxies host older stars whereas galaxies located towards the cluster outskirts are predominantly made of less evolved stars. This effect is even more pronounced as we move outside the cluster, into the field. This is interpreted as star formation being more intense in the field, or rather, suppressed within the cluster, particulary as we move towards its centre.

1. Introduction

Cluster candidate CL 0048-2942 was first identified in the ESO Imaging Survey dataset (EIS; Nonino et al. 1999) by a matched filter-like detection algorithm (Lobo et al. 2000). It was later followed-up in BVRI photometry at the ESO 3.6m telescope, which allowed to select some galaxies for targeted spectroscopy. Spectroscopy was performed with the VLT FORS1 and FORS2 instruments at ESO, in the spectral range 4450-8650 Å, with a resolution of R ∼ 500. Reliable redshifts were thus obtained for 54 objects and within these 22 were found to belong to the cluster with a redshift $0.6165 < z < 0.6565$.

2. Population Synthesis

We have analysed the stellar populations of the 54 galaxies with reliable redshifts, both belonging to the cluster and to the field. The population synthesis analysis gives us an idea of the stellar content (or evolutionary stage) of the cluster galaxies at different radial distances from the cluster centre. Galaxies of the field sample, analysed in the same way, provide the term of comparison in order to deduce the impact of environmental effects and dynamical interactions typical of clusters on the evolution of their member galaxies in what concerns, in particular, their stellar populations.

We use a synthetic population algorithm (Pelat 1997) with a powerful mathematical method that is able to provide a unique solution. The particular stellar content of each galaxy - various spectral type stars with different luminosities and metallicities - imposes its own signature in a galaxy spectrum, affecting the continuum and equivalent widths (EW) of all absorption features. These can be matched, as closely as possible, by the algorithm that adjusts a combination of stars, taken from a stellar library (we have

compiled 39 stars taken from Pickles 1998), to the galaxy spectrum; also the internal reddening is a free parameter derived from the fit in an indirect way. Fits are done with a least squares method, the accuracy being estimated through means of a parameter that computes the sum, for all absorption features, of the differences between the observed and the synthetic EW (between 19 and 42 EW were used). Residuals estimated over the continuum further help to verify the accuracy of the solution.

3. Results

The populations found have, in a general way, three main components: a main sequence old population component, an intermediate giant component and a young population of supergiant stars, that traces recent star formation. The populations are generally weak in metals and no dust seems to be present (except in three cases, no internal reddening was necessary to account for the observed spectra). Probing in more detail, a population gradient is found in the cluster: centre galaxies host older stars whereas galaxies located towards the cluster outskirts are predominantly made of less evolved stars, i.e. supergiant stars.

The populations obtained for the 24 back/foreground galaxies - with redshifts ranging from 0.22 to 0.82 - are, in a general way, less evolved than the ones found in the cluster galaxies. In terms of ages, young supergiants dominate the field galaxies spectra whereas cluster galaxies host a dominant number of old and intermediate age stars. In fact, comparing the population found in the field galaxies and the one found in the cluster as a whole, the cluster centre and the cluster outskirts, we note that the supergiant population is clearly decreasing as we move from the field into the cluster and then to its centre. The old main sequence stars dominate the cluster centre with respect to the outskirts and to the field galaxies, whereas the intermediate giant population is predominantly present in the cluster. This result points to the fact that star formation is more intense in the field, or rather, is suppressed within the cluster, particulary as we move towards the centre.

4. Conclusions

Though dealing with very low number statistics, these trends are clear and could be interpreted in the framework of hierarchical cluster evolution combined with galaxy transformations triggered by interactions with the cluster environment. In such a scenario, the star formation of galaxies within the cluster is suppressed relatively to their field counterparts. This effect seems to be even stronger as we move from the outskirts to the centre. Detailed results are presented in Serote Roos et al. (2004).

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