Galaxy Populations in the Cluster Abell 209 at $z = 0.2$

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Studying spectral properties of galaxy populations in rich clusters allows us to understand the effects of cluster dynamics on star formation histories. Episodes of star formation in galaxy clusters can be driven either by accretion of field galaxies into the cluster or by cluster-cluster merging. To get insight into this problem, it is crucial to relate the star-formation history of cluster galaxies to the global properties of clusters, such as mass and dynamical state.

We investigated the nature of galaxy populations in the cluster Abell 209 at $z = 0.2$ (Fig. 1), through the study of photometric and spectroscopic properties of 102 bright member galaxies ($R < 20.0$), using ESO NTT-EMMI MOS data (Mercurio et al., 2004, A&A in press, astro-ph/0405543).

We define five different spectral classes:

I) passive evolving galaxies (P), which exhibit red colours and no emission lines;
II) emission line galaxies (ELG), which are blue and have prominent emission lines;
III-IV) H$_d$-strong galaxies, that are characterized by the presence of strong H$_d$ absorption lines and can be divided, according to their colours, into blue (HDS$_{blue}$) and red (HDS$_{red}$) H$_d$-strong galaxies;
V) anemic spirals (Ab-spirals), that have the same spectral properties of passive evolving galaxies, but are disk-dominated systems ($n < 2$).

Passively evolving galaxies represent 74% of the sample. This population formed early during the initial collapse of the cluster (at $z > 3$). They lie mainly in high density regions (Fig. 2) and have a velocity dispersion fully consistent with that of the whole cluster.

HDS$_{red}$ galaxies are distributed along the SE-NW elongation of the cluster, mainly in intermediate density regions (red triangles, Fig. 2) and have a very low velocity dispersion, suggesting that this population could be the remnant of an infalling group.

HDS$_{blue}$ galaxies are found in intermediate density regions (blue triangles, Fig. 2), in a direction perpendicular to the cluster elongation, and have high velocity dispersion.

ELGs lie in low density regions (blue stars, Fig. 2) and have high line-of-sight velocity dispersion, as for the HDS$_{blue}$ galaxies. Both the spatial distributions and the velocity dispersions suggest that these two populations of galaxies have recently fallen into the cluster from the field.

Galaxies are classified according to the equivalent widths of OII, H$_d$, OIII, H$_a$, the strength of 4000 Å break, and the Sersic index $n$.

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Through a comparison with stellar population synthesis models, we find that: • passive evolving galaxies have mean stellar ages greater than 4 Gyr; • HDS$_{red}$ galaxies are observed 1-2 Gyr after a short starburst, while • HDS$_{blue}$ galaxies after 0.5 Gyr; and • ELGs are observed few Myrs after the truncation of star formation.

All these results are understandable in terms of cosmological models of structure formation, in which galaxies form early in the high density regions, corresponding to the cores of rich clusters, while galaxies in the cluster periphery are accreted later. The HDS$_{red}$ galaxies could be the remnant of the core of an infalling group, that have experimented an instantaneous burst of star-formation.