Outskirts of Galaxy Clusters: Intense Life in the Suburbs
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Environmental effects in the structural parameters of Coma galaxies

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Abstract. We have studied the quantitative morphology of the galaxies of the Coma cluster brighter than $m_r = 17$. The surface brightness profiles of all galaxies were decomposed into the structural components: bulge and disc. We found a correlation between the scale length of the discs and the location in the cluster. Galaxies located at small projected distances show smaller discs than those located in the outermost regions of the cluster. We have also investigated the correlation betwenn the B−r color of the galaxies and their environment. For late-type galaxies there is a correlation between the color and the position in the cluster. The bluest galaxies are located in the outermost regions of the cluster and show the largest discs. These results can be explained in terms of galaxy harassment.

1. Introduction

Galaxy clusters are ideal to study the influence of environment on the evolution of galaxies. Galaxies in clusters can quickly evolve due to many physical processes, such as: harassment or pre-processing.

The harassment scenario (Moore et al. 1996) proposes that galaxies in clusters evolve, on short time-scales, due to the tidal interactions between them and with the global gravitational potential of the cluster. This mechanism is very efficient at transforming late-type galaxies in S0s, and it will also reduce the size of the discs. Similar to harassment, but more efficient in rich galaxy clusters, is the pre-processing, which consists of recent arrivals in the cluster being pre-processed in group or subcluster environments (Kodama & Smail 2001). The study of the quantitative morphology of galaxies can provide useful constrains to these theories.†

2. Structural parameters and color distribution

We have fitted the isophotal surface brightness profiles of the galaxies with two components: bulge and disc. The surface brightness profiles of the bulges were modeled by a Sersic law, and for the discs we used an exponential profile. The fitting algorithm was developed by Trujillo et al. (2001), and uses a Levenberg-Marquard nonlinear fitting routine. Monte Carlo simulations were carried out in order to determine the uncertainties of the recovered structural parameters. The galaxies were classified according to the bulge-to-total luminosity ratio (B/T) (see Aguerri et al. 2004). We found that there is no trend

† The results presented here correspond to the Coma galaxy cluster. We have observed 1 square degree of Coma cluster. The images were obtained using the Sloan-Gunn r filter of the WFC (see Iglesias-Páramo et al. 2002). The B band magnitudes of the galaxies were obtained from the Godwin et al. (1983) catalogue of Coma cluster galaxies. We have assumed that Coma members are those with 4000 km s^{-1} $< cz <$ 10000. The radial velocities were taken from NED.

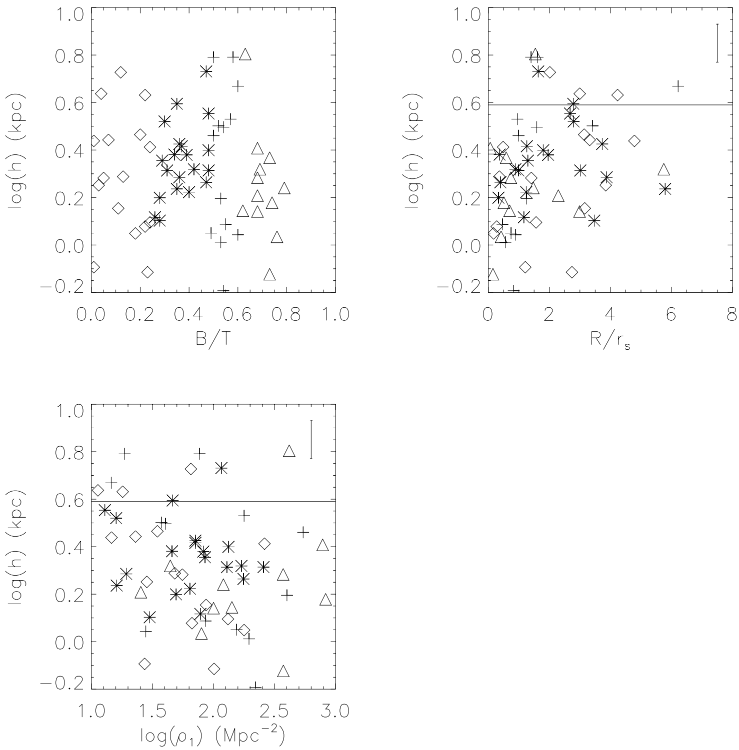

Figure 1. Scale length of the discs vs B/T (top-left), projected distance to the cluster center (top-right), and projected density (bottom-left). The horizontal dashed line shows the scale of the discs of field galaxies. The symbols represent: E with disc (triangles), S0 (crosses), early-type spirals (asterisks) and late-type spirals (diamonds).

between the scale of the discs and the morphological type of the galaxies, similarly to what is found for local field samples. The mean value of the scale of the discs for Coma galaxies is $\log h = 0.33$, which is smaller than the value for field galaxies with similar luminosities ($\log h = 0.59$; Graham 2001). There is also a correlation between the scale of the discs and the position in the cluster. No large discs are located at the center of the cluster (see Fig. 1).

We have investigated the B−r color distribution of the galaxies in Coma. The fraction of blue galaxies (as defined by Butcher-Oemler 1984) is 0.07, taking into account all galaxies brighter than $m_r = 17$. These blue objects have bigger velocity dispersions than the red ones (Colless & Dunn 1996). The color of E and S0 galaxies is constant independently of their position in the cluster. For spirals, the bluest galaxies are located in the outermost regions of the cluster. This trend is more important for late-type galaxies (see Fig. 2).

3. Discussion and conclusions

Galaxies in clusters are affected by their environment, which can be responsible for the morphological transformations between different types. Galaxy harassment is the tidally induced evolution brought about by multiple high speed encounters with other galaxies and with the cluster gravitational potential. This mechanism and the pre-processing can explain the small scale h observed in the stellar discs of the galaxies in Coma. The tidal interactions induced by the harassment can also enhance the star formation rate (SFR)

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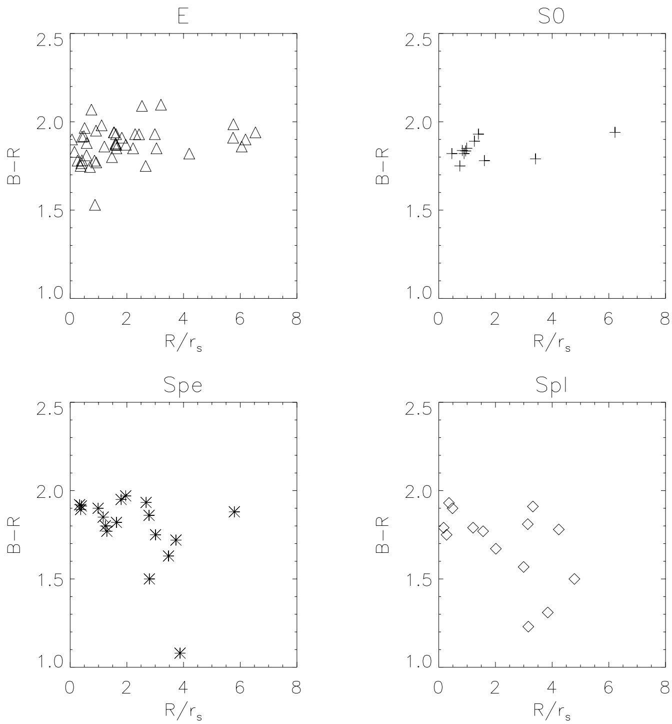

Figure 2. B−r color of the different type of galaxies vs the projected distance to the center of the cluster.

of the galaxies. If the SFR is enhanced by the tidal interactions with the cluster potential, then the bluest galaxies should be located in the center of the cluster. If the SFR is due to galaxy-galaxy encounters then the bluest galaxies are located in the outermost region of the cluster (Fujita 1998). This can explain the distribution of colors observed in the Coma spiral galaxies. The bluest galaxies are those which are falling into the cluster and they are suffering the harassment for the first time.

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