# Morphology and life of galaxies in clusters*

Stefano Andreon

*CNRS-URA 285, Observatoire Midi-Pyrénées, Toulouse, France*
*Present address: Istituto di Fisica Cosmica del CNR, Milano, Italy*
*E-mail: andreon@ifctr.mi.cnr.it*

*(Received )*

We present the first results on our study of the Coma cluster, as a part of a larger project centered on the study of the properties of galaxies in different environments. Besides known results, we found that blue spiral galaxies avoid the cluster center more than the whole spiral class. The galaxy group associated to the Rosat secondary clump 50' SW of the cluster center has a morphological composition richer in early-type galaxies than is expected from a random density enhancement suggesting a possible general tool to discriminate fortuitous alignments from real subclustering. The spatial distribution of disky ellipticals is not centered on the cluster center.

## 1. THE CONTEXT

Hubble & Humason (1931) first noted that galaxies having different shapes reside in different environments. Elliptical and lenticular galaxies crowd the inner regions of clusters, while spirals are predominantly found in the outer regions (e.g., Dressler 1980; Sanromà & Salvador-Solé 1990; Whitmore et al. 1993) and in the field (Postman & Geller 84). This segregation is probably less pronounced in distant (young) clusters, for which there is indirect evidence that they are richer in spirals (Butcher-Oemler effect, see Couch et al. (1994) and references therein). Large efforts have been made to explain this segregation and, more generally, the galaxy population properties as a result of galaxy interactions with environment, but the situation remains unsatisfactory. For example, it is not clear if the primary source of the segregation is the distance from the cluster center or the local density of galaxies (see Andreon 1996 for some other examples).

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For this reason we started an observational program of galaxies in clusters.

We have obtained CCD images of about 700 galaxies in different environments in order to investigate the effects of environment on galaxy properties. The samples of galaxies are complete in magnitude, and concern the nearby clusters of Perseus, Coma, Abell 194 and Abell 496, a region in the Coma supercluster and a field control-sample. Some distant clusters have also been studied in order to reveal time-dependent galaxy properties. Most galaxies have been observed in good to excellent seeing conditions at 2 to 4m-class telescopes in order to have a 0.65 Kpc rest frame resolution ($H_0 = 50$ km s$^{-1}$ Mpc$^{-1}$). WFPC-2 HST images are being used for distant clusters, at the same rest frame resolution. We classified the galaxies along a Hubble-like morphological sequence according to the presence of morphological components (disk, bar, arms, etc.). We also derived the galaxy properties (luminosity function, color distribution, spatial distribution of types) and compared the different properties and the different samples among each other to put in evidence the environnement and/or epoch dependence of the galaxy properties of the Hubble types (for examples see Andreon 1994, 1996).

## 2. FIRST RESULTS

We present here some results for a complete magnitude-limited sample of galaxies in the Coma cluster, whose observations have just been completed (Andreon et al. 1996a, 1996b). Because of limited space, we postpone a statistical assessment of these results and a complete discussion to future papers (e.g. Andreon 1996). Fig. 1 (plate xx) shows the spatial distribution of the whole sample (upper-left panel, about 200 galaxies) and of each galaxy population (other panels).

– The upper-center and upper-right panels of Fig. 1 show the spatial distribution of two complementary samples of galaxies selected according to galaxy velocities. Galaxies with a low velocity difference relative to NGC4889 (less than about 300 km/s) (upper-central panel) are more centrally concentrated than all the other galaxies (upper-right panel). The morphological composition of the central part of this velocity selected sample is a bit richer in ellipticals than the sample formed by the other galaxies projected on the same region (E/S0/S=50/40/10 vs. 25/55/20), but the numbers are small. The luminosity distributions of the two samples do not differ substantially, within the (large) statistical errors.

– The spatial distributions of the Hubble types become more and more strongly concentrated as one goes from S to E (second row of Fig. 1), looking similar to the one found in previous studies of this and other clusters (e.g. Melnick & Sargent 1977, Sanromà & Salvador-Solé 1990, Whitmore, Gilmore & Jones 1993). However the spatial distribution of diE (disky ellipticals: elliptical with a luminosity excess on the major axis), shown in the E panel as magenta points, is not centered on the cluster center (the center of each panel), as seems to be the case for the other types, and is displaced eastward. This is a bit surprising because diE are not believed to be special, but just the extension of SA0 with faint disks (Michard 1994, Nieto et al. 1992).

– If the morphological density relation holds everywhere, then a substructure (a local density enhancement) in clusters can be detected as a local change of the morphological composition associated to a local density enhancement. Then, the

morphological segregation could help disentangle fortuitous alignments (due to projection effect, which do not change the local morphological composition) from real density enhancements. Such a possibility has been tested for the galaxies in the NGC4839 group whose X-ray emission confirms its reality, whose position is marked with a cross in the top and middle panels of Figure 1. The morphological composition of the clump (E/S0/S=20/60/20) is richer in S0 and poorer in S than the mean composition of the cluster at the same radius (E/S0/S=21/33/45), giving a positive result to our test.

– The lower panels of Fig. 1 show the spatial distribution of the same sample of about 200 galaxies, split this time into three classes according to the galaxy color. All (but one) blue ($B-R<1.7$) galaxies of our sample are S. Blue galaxies avoid the center and in particular the inner 24' region of the cluster (16 % of the explored region). A similar color segregation, but less pronounced, has already been detected in distant clusters (e.g., Mellier et al. 1988, Garilli et al. 1992) and nearby clusters (Metcalfe et al. 1994). Here the important point is that blue spiral galaxies avoid the inner region much more than S galaxies as a whole (compare the S and $B-R<1.7$ panels). Therefore it seems that stronger star forming galaxies are more segregated than the whole class of spiral galaxies.

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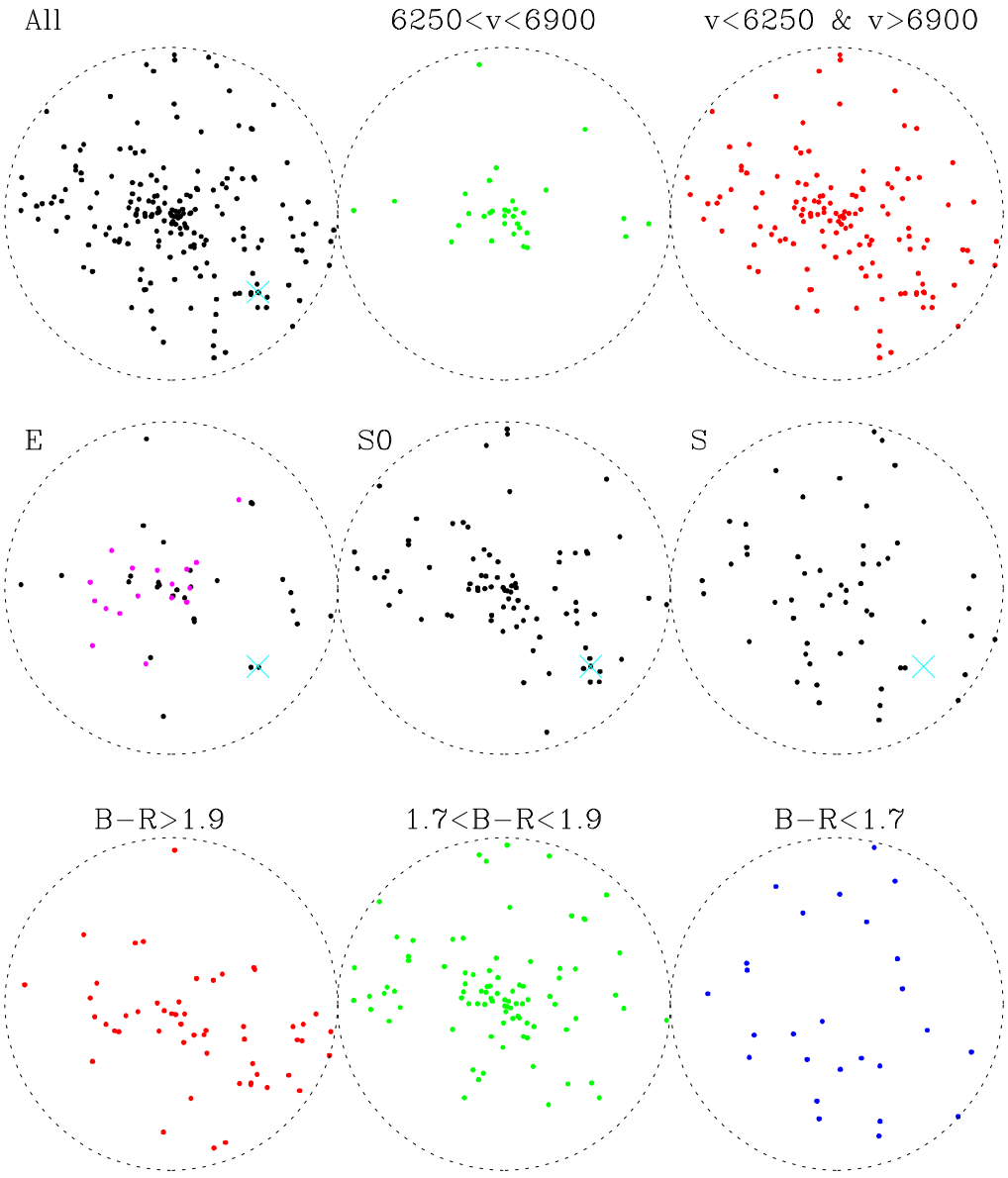


FIGURE 1. Spatial distribution of galaxies in Coma