Astron. Astrophys. 320, 13–18 (1997)

ASTRONOMY
AND
ASTROPHYSICS

The morphology-density relationship for clusters of galaxies revisited

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Received 31 July 1996 / Accepted 25 September 1996

Abstract. Back in 1990 Schombert and West (ApJ 363, 331) reported the discovery of a morphology-density relation for clusters of galaxies analogous to the well established dependence of galaxy types on local galaxy density. Based on a sample of 206 Abell clusters they concluded that Rood-Sastry (RS) C and I types (round and irregular) were much more prevalent in low-density regions while L and F (linear and flattened) occurred predominantly in rich supercluster environments; they did not find any similar correlation either for RS cD and B types or for Bautz-Morgan types. Using a much more extended sample (541 Abell clusters) we show that there is no evidence of SW's claimed correlation so that, on the basis of our analysis, we can conclude that the shape of clusters of galaxies is not determined by the local large-scale structure.

Key words: galaxies: clusters – large scale structure of the Universe

1. Introduction

The study of the relationship between the morphology of (extra)galactic systems and their environment is one first and very important step in the path of understanding the clues to the origin and evolution of this morphology and of the systems themselves. Concerning galaxies, the relationship between morphology and environment has become a very well established fact and a cornerstone of our knowledge of galaxies and clusters. Hubble & Humason (1931) first showed that the relative proportions of different morphological types were different in clusters and in the field and later on Oemler (1974) evidenced this very same fact among clusters of different richness. Dressler's (1980) seminal work went a step forward: it established a very well defined relationship betwen morphological fractions and local projected number density. The interpretation of this observational evidence (i.e. how morphology correlates with true local number density) is not without some controversy (see for instance Salvador-Solé et al. 1989) but in any case it is one major fact to be taken into account for any theory of large-scale formation. Later on (Bhavsar 1981, de Souza et al. 1982, Postman & Geller 1984) it was shown that this relationship holds for a wide variety of density ranges from loose to compact groups. All in all these observational facts are central points in the ongoing nature versus nurture debate, as far as galactic morphology is concerned.

The relationship between the morphology of clusters of galaxies and its environment is not so well established and the very same definition of morphology has much to do with this fact. Galactic morphology is, since Hubble and de Vaucouleurs, a very well established parameter for galaxies and it is inextricably tied to the very existence of galaxies themselves. This is not so for clusters of galaxies. Though the existence and significance of clusters themselves is out of the question, its identity as different from the groups and/or the supercluster environment, is a matter of ongoing investigation (see for instance Andersen & Owen 1994). Therefore it is not surprising that the morphological classification of clusters does not have a Hubble-like scheme. Abell's (1958) first taxonomical classification of clusters into regular and irregular was followed by Zwicky et al.'s (1961) dividing clusters into compact, medium compact and open. But two more elaborate schemes are those which have survived as far as cluster morphological classification is concerned: Bautz & Morgan (BM) (1970) and Rood & Sastry (RS)(1971)

RS's scheme is based on the projected distribution of the brightest galaxies in the cluster. Six types, cD, B, C, L, F and I are interpreted as corresponding to a sequence of cluster evolution (Struble & Rood 1982, 1984). cD and B types would correspond to the more evolved stages, with giant galaxies in the center of the cluster as a final product of mergers. C and L types would correspond to regular structures appearing in the process of dynamical evolution, while F and I types, with more amorphous appearance and the presence of many substructures, would correspond to the early stages of the cluster formation. Struble & Rood (1982,1984) have pointed out several difficulties in telling one class from the others though finally they argue that a level of confidence of 90% can be assigned to all currently available RS classifications.

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