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LOW LEVELS OF LUMINOSITY SEGREGATION IN CLUSTERS OF GALAXIES: EVIDENCE FOR THEIR DYNAMICAL YOUTH?

Laerte Sodré Jr(*). and Hugo V. Capelato(*)

Departamento de Astrofísica
Instituto de Pesquisas Espaciais, Brazil

RESUMO. Apresentamos resultados preliminares de um estudo da distribuição projetada de galáxias em uma amostra homogênea de 14 aglomerados ricos com fotometria feita por Colless (1989). Encontramos que mais da metade destes aglomerados estão segregados em luminosidade, ainda que com baixa significância. Comparamos estes resultados com aqueles provenientes de amostras da distribuição das galáxias em grandes escalas e sugerimos que estes aglomerados são dinamicamente jovens.

ABSTRACT. We present preliminary results of a study on the projected galaxy distribution of a homogeneous sample of 14 rich clusters for which the photometry was given by Colless (1989). We find that more than a half of these clusters are luminosity segregated at low levels. We compare our results with those coming from large scale samples to suggest that these clusters are dynamically young.

Key words: CLUSTERS-GALAXIES

. INTRODUCTION

The possibility of ocurrence of luminosity segregation in rich clusters of alaxies has been associated to either, or both, of two processes: i) it may be originated at ery initial epoch of cluster formation, as predicted by some biased galaxy formation cenarios in which the more luminous galaxies collapse and start their clustering evolution arlier than the fainter ones (Dekel and Silk, 1986); ii) it also may be due to the dynamical riction of the cluster dark matter substractum acting on the more massive (and therefore uminous) galaxies, causing them to spiral towards the cluster center (Lecar, 1975), therefore nhancing their central concentration. In this case the phenomena of luminosity segregation in lusters would much more reflect their dynamical aging rather than the initial conditions at ormation. Clearly both processes should be playing a role in real clusters, with the ynamical friction acting towards the enhancement of a primordial luminosity segregation or ven leading to the formation of central giant dominant galaxies.

It is therefore important to try to assess the relative importance of these two rocesses in the observed clusters. One possibility consists of estimating the level of the uminosity segregation displayed by a representative sample of rich clusters of galaxies and hen compare it with similar results coming from the analysis of representative samples of the patial distribution of galaxies at scales larger than cluster scales which we may suppose ave suffered little dynamical evolution leading to luminosity segregation.

*) On leave of absence from Instituto Astronômico e Geofísico da Universidade de São Paulo, Brazil.

II. MEASURING THE LUMINOSITY SEGREGATION

In this work we have analysed the homogeneous sample of 14 southern clusters of galaxies given by Colless (1989) (see table 1). For each cluster the galaxies were grouped in 1 Mag bins, according to their B_J magnitudes and the clustering level in each bin was estimated using three distinct non-parametric estimators: (a) the arithmetic (λ_1) and (b) the harmonic (λ_{-1}) means of the projected separations of pairs of galaxies, as defined by Capelato et al. (1980) in their study of the luminosity segregation in the Coma cluster; (c) The mean ($<\sigma>$) of the local surface density of galaxies in each magnitude bin computed according to the prescription of Casertano and Hut (1985) using the distance to the 6th neighbour. These mean densities were normalised to the mean density of the cluster inside a $1h_{100}$ Mpc circular region centered at the cluster center.

Table 1. The Cluster Sample

Cluster[1]		Type[2]	Redshift	σ_v(km/s)
C02	A2717	I-II	0.04925	547
C03	A2721	II	0.11598	1011
C19	A3126	III	0.08588	1030
C20	DC0329-52	III	0.05938	854
C21	A458	I	0.10560	631
AC1	A3225	II-III	0.05489	1072
C30	A3334	I-II	0.09655	615
C31	A3360	III	0.08450	769
C37	A3705	III	0.08967	927
C39	A3716	III	0.04818	453
C52	A3854	II	0.14922	1180
C64	A2538	II-III	0.08291	821
C65	A2554	I-II	0.11094	797
C67	S1157	I-II	0.05846	726

(1) Colless (1989) catalogue identification and other designations
(2) Bautz-Morgan type (from Colless 1989)

In order to avoid problems with the possible presence of sub-structures inside the clusters, we have restricted our analysis to galaxies within $1h_{100}$ Mpc from the center of the clusters, which was calculated by simply averaging over the galaxy positions. Because of the small total number, galaxies brighter than $M_B = -20$ were all grouped in the same magnitude bin. This magnitude is close to the value of the characteristic M_B^* of the Schechter luminosity function found by Colless (1989) for these clusters.

We found that 8 out of the 14 clusters do exibit some degree of luminosity segregation: C02, AC1, C30, C31, C37, C52, C64, C65. However, the measured luminosity segregation level is weak, that is, with low statistical significance. In figure 1 we present the median profiles of our three measurements for these 8 clusters. This figure shows that the galaxies brighter than M_B^* are essentially the ones that appear to be segregated.

III. DISCUSSION AND CONCLUSIONS

Our analysis of the projected galaxy distribution suggests that more than half of the clusters of Colless's sample show some level of luminosity segregation, although with low statistical significance for the majority of these clusters. These results are consistent with previous analyses (e.g., Quintana 1979, Capelato et al 1980) which have also found some level of luminosity segregation in some clusters.

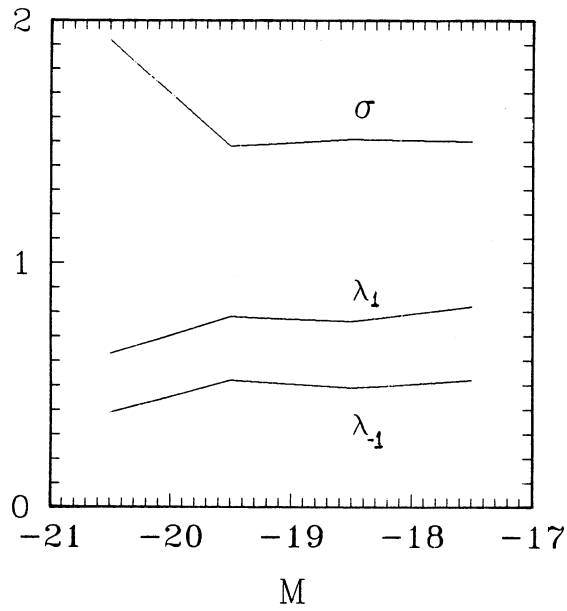

Fig. 1. Median profiles of luminosity segregation measures for 8 clusters

What is, on theoretical grounds, the expected level of luminosity segregation due the dynamical processes (e.g. dynamical friction and two-body relaxation) ocurring inside a ch cluster? The answer to this question depends essentially on the relative contribution to e cluster total mass of galaxies and dark matter. From one side, the analysis of White 977) shows that if all the cluster mass, as estimated by the virial theorem, is attached to laxies, one should observe a strong luminosity segregation. The simulations of Farouki and lpeter (1982) and Farouki, Hoffman and Salpeter (1983, FHS) confirm this point. In fact, in ese simulations, a strong mass segregation is established soon after the cluster collapse. ch an amount of segregation is not observed. On the other side, if the cluster mass is minated by dark matter, the characteristic time scale for orbital decay of a m^* galaxy due dynamical friction (Spitzer 1962) is close to or less than the Hubble time and thus only a ld segregation is expected, more in agreement with the results presented here.

From another side, we should also ask how much of the observed luminosity gregation may be attributed to the initial conditions prevailing at cluster formation epoch. e study of the two-point correlation function of galaxies in "fair samples of the Universe" ows in fact that there is an increase of the correlation length with the luminosity of laxies, at least up to scales of $5\text{-}10h_{100}$ Mpc (Davis et al. 1988, Boerner et al. 1989). though part of this effect may be assigned to dynamically evolved structures with typical ales less than, say $2h_{100}$ Mpc, for the larger scales it seems difficult to see how stellar namical processes could have erased the initial conditions of the distribution of galaxies. direct comparison with our results can be made possible through the mean local surface nsity of galaxies. We find that for the 8 luminosity segregated clusters the median value of > increases about 35% when going from the fainter than $B_j = -20$ galaxies to the brighter es (cf. Figure 1). Exactly the same amount of increase was found by Davis et al.(1989) for e mean of the normalized number of galaxy neighbors within a $6h_{100}$ Mpc sphere (note that the icky magnitudes used by these authors almost coincide with those of Colless). Although the merical coincidence should be regarded as fortuitous, it suggests that the level of the minosity segregation measured in those clusters just reflects the initial conditions of ıster formation. We are lead to conclude that as far as our cluster sample may be considered representative (an open question), the nearby rich clusters of galaxies do not seem to have ffered, in average, much dynamical evolution since their collapse and virialization. wever, in view of all the incertitudes of this kind of analysis, this conclusion must be garded with caution, waiting a more extensive study to be done.

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Hugo V. Capelato, Laerte Sodré Jr.: Departamento de Astrofísica, Instituto de Pesquisas Espaciais, C.P. 515, 12201 São José dos Campos, São Paulo, Brazil.