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THE CLUSTER OF GALAXIES SC2008-57 (A3667)

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RESUMO. Apresentamos os principais resultados de um estudo fotométrico e dinâmico do aglomerado SC2008-57 (A3667). Argumentamos que este aglomerado não está globalmente virializado, estando ainda na fase de colapso.

ABSTRACT. We present the main results of a photometric and dynamical study of the cluster SC2008-57 (A3667). We argue that this cluster is not globally virialized, being still in a collapsing stage.

Key words: GALAXIES-CLUSTERS OF

I. INTRODUCTION

The dynamical state of a galaxy cluster is determined by its age, interactions with other neighbor structures, and by the underlying dark matter distribution. Then, the study of galaxy clusters can yield important clues about the formation and evolution of the large scale structures.

Here we present some results of a study of the galaxy cluster SC2008-57, named A3667 in the Southern extension of the Abell catalogue (Abell, Corwin and Olowin 1989). The details of this work will be published elsewhere.

The cluster redshift is z=0.054. It is an important X-ray source, being among the brightest clusters detected in this spectral range (Bahcall 1977).

II. THE DATA

The observations of the galaxy cluster SC2008-57 were obtained by one of us (JES) at the Cerro Tololo Curtis-Schmidt telescope in September 1983 in the B_J band, with an emulsion IIIa-J and a filter GG385. Plates with the same emulsion/filter combination were exposed to known intensities with the Weston sensitometer at Cerro Tololo to provide the sensitometric spots needed for intensity calibration.

This photographic material was digitized with the PDS microdensitometer of Observatorio Nacional, at Rio de Janeiro. The digitized region (5cm x 5cm) is centered on the brightest cluster galaxy and corresponds to about 1.8 square degrees on the sky. We have used a 20 μm pixel (≃1.93 arcsec), resulting in a 2500 x 2500 10-bit pixel digital image.

This image was analyzed with a detection and classification software developed at IAG and INPE. The resulting catalogue has 368 galaxies brighter than b_{25}=19 and is

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complete up to b_{25}=18.2. The photometric calibration was obtained from photoelectric magnitudes of 6 galaxies published by Melnick and Quintana (1984).

Radial velocities for SC2008-57 are available from two distinct sources: Melnick and Quintana (1981) and Proust et al. (1988), resulting in 48 velocities for the galaxies of our catalogue, from which only two are obvious field galaxies.

III. RESULTS

Figure 1 shows the distribution of the galaxies of our catalogue. The cluster can be classified as L (line) type in the Rood-Sastry system, since its brightest galaxies appear aligned. It shows a central condensation around the brightest member (a cD galaxy) and, apparently, a substructure associated with the second brightest galaxy (a D galaxy). The overall projected galaxy distribution is quite elliptical, with the major axis near to the line defined by the brightest galaxies. In figure 2 we present an isodensity map where the surface density was computed from the projected distance to the 6th neighbor, according to the prescription of Casertano and Hut (1985). Although the substructure associated to the second brightest galaxy is proeminent in this plot, it does not appear in the cluster X-ray image obtained with the HEAO-2. The X-ray emission is elliptical, regular, and centered near the position of the brightest cluster galaxy. This seems to indicate that this substructure, if real, is not yet virialized.

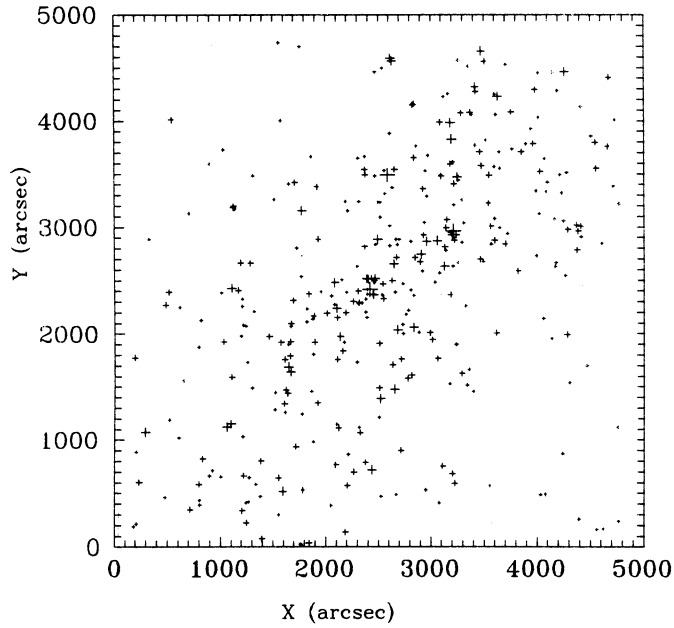

Fig. 1. Distribution of the galaxies of the catalogue. The cross dimensions are nearly proportional to galaxy luminosities. The brightest cluster galaxy is at the center of the figure (N top, E left).

The Schechter function parameters that best fit the cluster luminosity function were obtained by least-squares fitting (Lugger 1986). When one considers and M^* as free parameters, $\alpha \simeq -0.85$, indicating that the luminosity function appears to be flater at faint magnitudes than usually is found in other clusters of galaxies.

We have also searched for luminosity segregation in SC2008-57. Galaxies were grouped into one magnitude bins and their relative degree of concentration was analyzed with

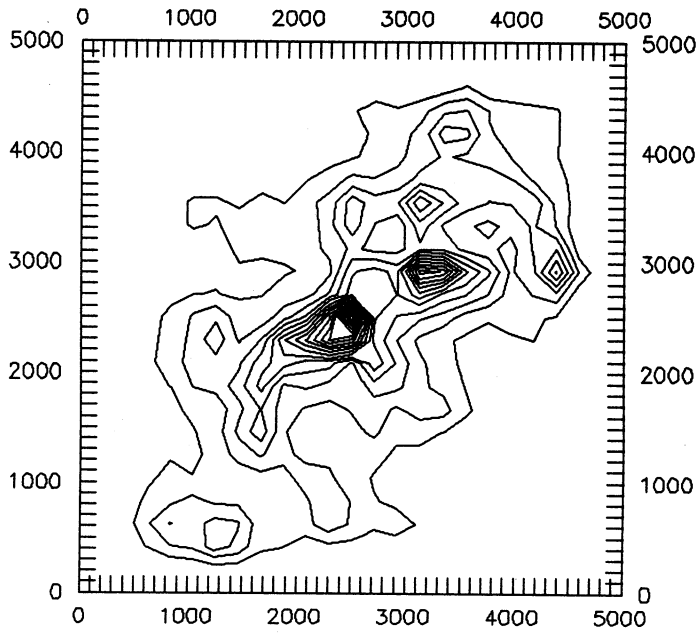

Fig. 2. Isodensity map of the galaxies of the catalogue.

the $\lambda_{\pm 1}$-means (Capelato et al. 1980) and the mean galaxy surface density. This last quantity is plotted against magnitude in figure 3. This plot indicates that the luminosity segregation extends over all the considered magnitude intervals.

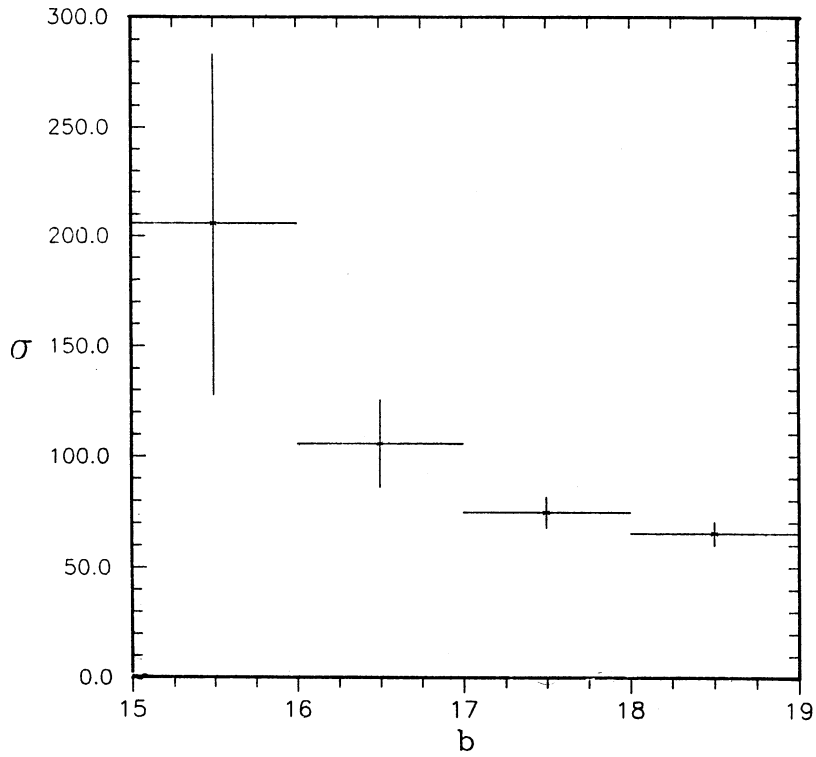

Fig. 3. Luminosity segregation-mean surface density (Mpc^{-2}) versus apparent b_{25} magnitudes.

The velocity dispersion of SC2008-57 is very high, $\sigma_{cor}=1498^{+187}_{-137}$ Km s^{-1}, and the resulting mass to luminosity ratio, $M/L_B \simeq 1700\ h_{100}\ M_\odot/L_\odot$, is quite above the values usually found in other clusters.

We have applied a test suggested by Chapman et al. (1987) to look for some evidence of rotation in the cluster. We have verified that the velocity distribution perpendicular to the line defined by the brightest galaxies is marginally different ($P_{ks}=0.06$) for galaxies bellow and above this line (figure 4), suggesting some amount of systematic motions along the direction of the minor axis of the projected galaxy distribution. Although the number of galaxies with known velocities is small, precluding any definitive conclusion, figure 4 shows that the semi-amplitude of the "rotation curve", $\Delta V \simeq 1600$ Km s^{-1}, is of the same order as the observed velocity dispersion, suggesting that an important fraction of the cluster kinetic energy could be, for instance, in systematic motions. Rotation is probably excluded because if one considers that it is produced by tidal interactions, the time scale needed to produce this rotational energy would be much larger than the age of the universe.

The most likely interpretation of this result is that SC2008-57 is a collapsing pancake with its plane nearly edge-on, slightly inclined with respect to the line of sight in order to explain the observed flattening. The expected velocity field along the normal to the collapsing pancake plane would look very similar to that shown in figure 4.

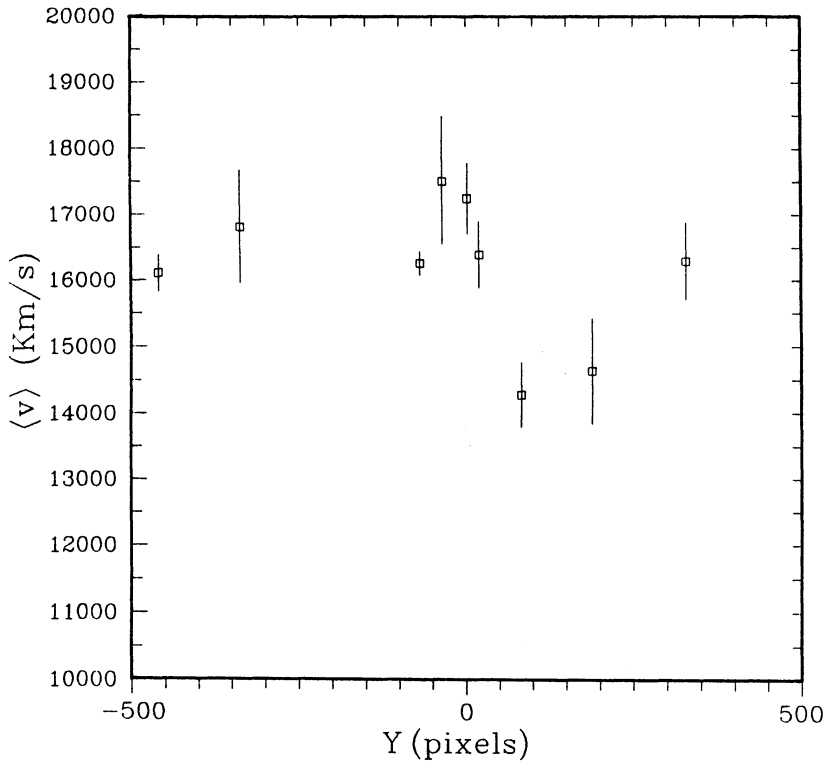

Fig. 4. Mean radial velocities (5 galaxies per point) along an axis pointing from SW to NE. The origin is at the position of the brightest cluster galaxy.

IV. DISCUSSION

The dynamical evolutionary stage of SC2008-57 is not clear. The high velocity dispersion and the substructure associated with the second brightest galaxy seems to indicate that the cluster is not globally virialized. On the other hand, the observed luminosity

segregation, if produced by two-body relaxation, could be considered as an evidence for th opposite side. An atractive scenario to explain several observed features of this cluste would be to consider it as a virialized cluster core near the center of a still collapsin flat, pancake-like, galaxy distribution. Only more data, however, mainly new radia velocities, will permit clarify its dynamical state.

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