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CLUSTERS OF GALAXIES WITH DOUBLE COMPONENTS

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RESUMEN. Se presentan resultados preliminares de velocidad promedio, dispersión de velocidad y masa dinámica en los cúmulos de galaxias A1750, SC0626-54 y SC0625-536, basados en nuevas observaciones espectroscópicas de más de 150 galaxias. Se analizaron en todos ellos las estructuras ópticas y dinámicas, comprobando que A1750 es un cúmulo con estructura compleja, pero que los otros son de estructura simple, formando entre ellos un supercúmulo.

ABSTRACT. Preliminary results of mean velocities, velocity dispersions and dynamical masses are presented for the galaxy clusters A1750, SC0626-54 and SC0625-536, based on new spectroscopic observations of more than 150 galaxies. Their optical and dynamical structures show that A1750 is dynamically a double cluster, but the other two have single structures, forming together an extended supercluster.

Key words: **CLUSTERS-GALAXIES – GALAXIES-DYNAMICS**

I. INTRODUCTION

The clusters A1750 and SC0626-54 are strong ray-X sources with bimodal structure, while SC0625-536 is located in a confused region covered by HEAO-1, but it appears as a strong source in data from the Einstein Observatory (Jones and Forman, 1984). This is the first detailed study on the dynamics of these double clusters based on new observations of radial velocities. A brief analysis using clustering techniques with multivariate statistical methods was carried out to find substructures. Velocities and positions of galaxy members were considered as variables for this analysis. A1750 shows a double structure, both in its spatial distribution and in its dynamical structure. On the other hand, SC0626-54 and SC0625-536 show no double internal distribution of velocities or densities, though we find they form a supercluster with a group of galaxies situated between them.

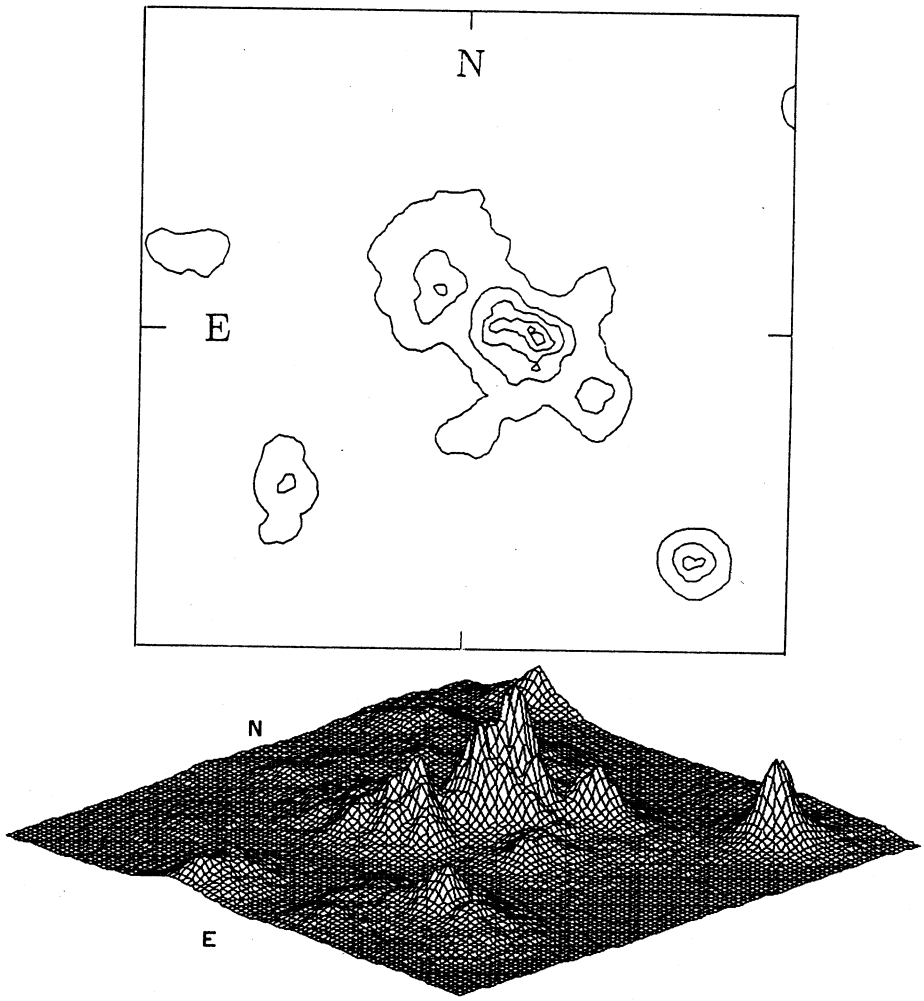
II. OBSERVATIONS AND RESULTS

Most of the observations were carried out between February 1982 and March 1984 using the 100" telescope of Las Campanas Observatory with a Boller & Chivens spectrograph and a grating of 600 lines/mm on the Shectograph detector in the spectral range 3200 to 7000 Å, with a resolution of 1 Å (Shectman 1981). The remainder of the observations were carried out at the 3.6m telescope of La Silla Observatory in March 1985, with the OPTOPUS detector and a Boller & Chivens spectrograph, working in the spectral range 3700 to 5500 Å with 4 Å resolution (Lund 1986). We used IRAF for all data reductions. The individual velocities have a typical error of 30-40 kms^{-1} in the Shectograph data and 60-100 kms^{-1} in the OPTOPUS data. Velocity dispersions, mean velocities and errors were obtained following the precepts given by Danese *et al.* (1980). The dynamical masses were calculated using the mass estimators for equal mass self-gravitating systems defined by Heisler *et al.* (1985). The results are shown in Table I, where MV, MP, MA and MM denote the virial, projected, average and median masses.

TABLE I. Mean velocities, velocity dispersions and dynamical masses (H_o = 100 kms^{-1}Mpc^{-1}).

Parameter	A1750-North	A1750-South	SC0625-536	SC0626-54
N	24	27	85	81
<v>	23850±210	25128±130	15676±181	14919±82
σ_v	931 (174,-111)	609 (105,-69)	1583 (137,-109)	698 (62,-42)
MV[a] (10^{14} $M_\odot$)	5.9±1.9	2.3±0.7	23.4±3.5	3.9±0.6
MP[a] (10^{14} $M_\odot$)	14.7±4.8	4.4±1.4	58.7±8.8	4.5±0.7
MA[a] (10^{14} $M_\odot$)	10.3±3.2	3.4±1.0	38.2±4.6	4.5±0.5
MM[a] (10^{14} $M_\odot$)	3.3±1.6	2.4±1.2	28.4±6.3	4.4±1.0

[a] Based on equal mass bodies calculations, assumes isotropic orbits (Heisler *et al.* 1985).



Figures 1 (a) and (b): Contour and surface maps of A1750 in a total area of 40′ × 40′ from counts down to approximately 17^{mag} galaxies.

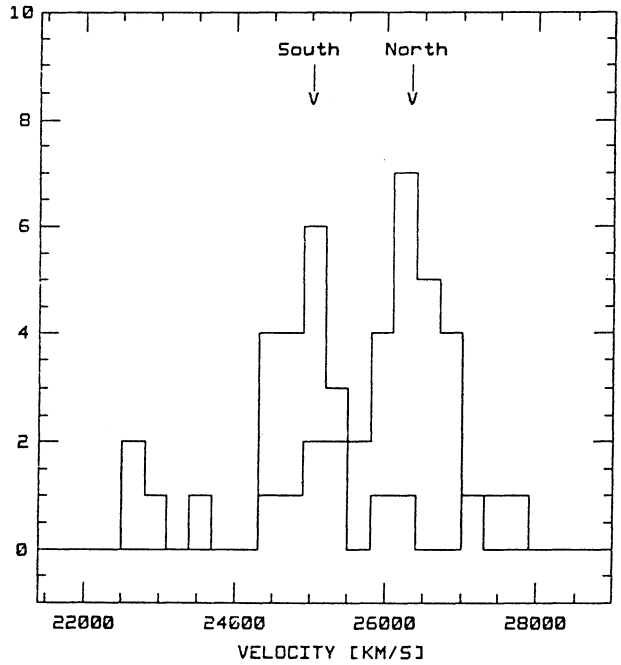


Figure 2. Velocity histogram of 51 galaxies of A1750. The arrows show the peaks of each substructure found in this cluster.

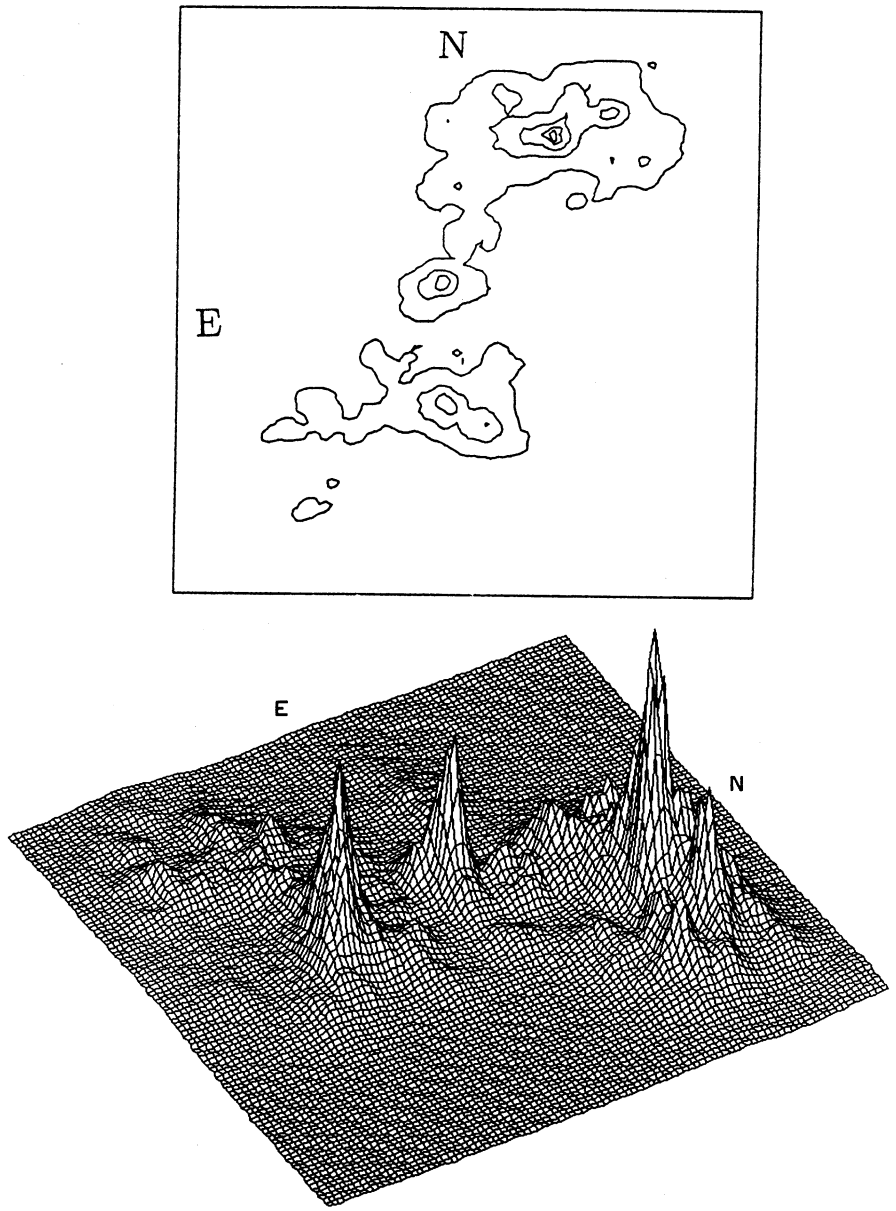
The mean velocity of A1750 as a whole is 24486 ± 150 kms^{-1} and the velocity difference between the North and the South substructures is 1278 ± 247 kms^{-1}. The clusters SC0625-536 and SC0626-54 have 757 ± 199 kms^{-1} velocity difference, forming two clear clusters on the sky. Maps of numerical density were made using position measurement of more than 590 galaxies with a magnitude below ~17 for A1750 and 540 galaxies of magnitude below ~16.5 for SC0625-536 and SC0626-54, covering 40'x40' and 1.5°x1.5°, for A1750 and SC0625-536 and SC0626-54, respectively. These measurements were made on a IIIa-J plate of A1750 obtained in the prime focus of the 4m telescope at Cerro Tololo Inter-American Observatory and a glass copy of the ESO/SRC-J Survey plate for SC0625-536 and SC0626-54. The densities were calculated in 100x100 grids, defined by circles containing 10 galaxies around each point.

Methods of multivariate analysis used to define substructures were applied as follows: a Principal Component Analysis (PCA) was initially applied, using the computational programs installed on MIDAS and extensively described in Murtagh and Heck (1987). Sky positions, radial velocities and numerical densities of each object (galaxies) were considered as variables of analysis. The second step was to apply five hierarchical clustering methods and two non-hierarchical methods, all of them also installed in MIDAS.

II. DISCUSSION

A1750: This cluster shows a clear double structure in the X-ray emission (Forman 1981), in the projected position of its galaxies (Figs. 1(a) and 1(b)) and in the velocity distribution (Fig. 2). These are the first spectroscopic observations of this cluster confirming its double optical and dynamical structure. The dynamical parameters of each substructure are shown in Table I. The velocity data is enough to carry out an analysis for evolution models, work under progress (similar to that applied to A98 by Beers *et al.* 1982). Our next step in the study of this cluster will be the simulation of its structure by N-body codes.

SC0626-54 and SC0625-536: Both clusters form a supercluster, extending for more than 1.5°x1.5° (Fig. 3(a) and 3(b)). The inner substructures of each cluster and the substructure of the supercluster were defined by multivariate analysis. Figure 3(a) shows contour maps of isoplets in the supercluster, where three substructures are clearly seen, but only two are resolved using the clustering methods. This is probably due to the



Figures 3(a) and (b): Contour and surface maps of SC0625-536 (a) and SC0626-54 (b) A1750 in a total area of 1.5° × 1.5°, from counts down to approximately 16.5^{mag} galaxies.

few velocities measured in the region between both clusters. We will be adding in a future work more than 60 velocities obtained in 1988-1989 in the 100" telescope of Las Campanas Observatory with the 2D-Frutti detector now in the final calibration process. Almost all of these velocities are of galaxy members situated in the middle structure seen in the contour map.

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