АСТРОФИЗИКА

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AN ATTEMPT TO TEST AMBARTSUMIAN'S IDEA OF GALAXY ORIGIN. II. LOCATION OF GALAXIES WITHIN CLUSTERS AND GALAXY POSITION ANGLES

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The location of galaxies in 377 rich Abell galaxy clusters is discussed. We compared the distributions of galaxies in the sample containing all galaxies with the sample compiled from the 20 brightest objects. Counts in circular sectors with angle width equal to 30° show isotrop Only in the case of BM I clusters and the coordinate system related to the cluster major ax we found anisotropic distributions. We investigated also the distributions of galaxy position angl within clusters exhibiting isotropy. The structure position angles for both samples have bee studied as well. They appeared to be different. The difference in location of galaxies in the case of cD clusters, as well as more elliptical shape and different position angles of sample containing bright galaxies is observed.

Key words: *galaxy structures:distribution:origin*

1. *Introduction*. The origin of galaxies is one of the greatest unsolved problems in astrophysics. In our first paper [1] we shortly described theories of galaxy origin calling attention to the idea developed by Ambartsumian [2-5], that galaxy structures can be regarded as the result of ejection of galaxies from the primordial galactic nuclei. Contrary to classic scenarios of galaxy origin in this case there are neither calculations nor numerical simulations describing the formation and subsequent evolution of galaxy structures. Therefore, the comparison of observations with the theory or physical picture based on the general paradigm very often meets difficulties. In fact, theoretical predictions which can be used for examination of Ambartsumian's idea result from the intuitive analysis of the idea itself.

Actually the main idea of Ambartsumian on the galaxy formation is bei referred rarely and many researchers consider it as something of historical i ... only. Sometimes it is referred in connection with the quasi - stead ... cosmological models of the cyclic Universe [6]. In the latter scenario first ge ... objects are appeared to be QSOs. Later on QSO explosions had generated fronts and shells, fragmentation of which lead to galaxy origin [7].

We study here some distribution properties of galaxies in the whole of 377 Abell clusters (sample A) and the same properties of the san containing only the brightest 20 members [1]. In the first paper we perfc me the analysis of cluster shapes finding that the distributions of ellipticities in sample A and B are different, which in some respect might be interpreted as a fingerprint of an ejection mechanism according Ambartsumian's idea. The most essential assumption, which follows from physical consideration, is one formulating that the first galaxies in any cluster separated from the initial maternal body due to ejection process should be more massive in average and more luminous compared with posteriors. Moreover, less massive galaxies could be ejected not only by the maternal object but also by previously ejected second generation galaxies. So, even if the maternal object had outthrown the second generation galaxies in preferable directions the next generation of galaxies ejected by first ones would destroy this structural order making the distribution comparatively more isotropic.

In the present paper we compare again the distributional properties of galaxies in the mentioned two samples. The studied properties are: the location of galaxies within the parent cluster and the distribution of the galaxy position angles.

Section 2 presents observational data and the manner in which analysed parameters had been obtained, while Section 3 and 4 deal with the results of the analyses of the galaxy location within clusters and galaxy position angles respectively. Conclusions are given in the last Section 5.

2. ***Observational data and determination of investigated parameters***. Our basic sample of galaxy clusters is the same, we have described in the paper [1]. In sake of completeness we repeat here that all Abell clusters [8] with galactic latitude $|b|>40°$, richness class ≥ 1 and redshift $z<0.2$ [9] were selected for the present analysis. Around the centre of each selected in this manner cluster, an area covering 2×2 Mpc ($h=0.75$, $q_0=0.5$) was extracted from DSS [10]. Applying FOCAS package to DSS we obtained catalogues of galaxies in 377 clusters. For each galaxy in the cluster both its equatorial and rectangular x, y coordinates on the photographic plate, instrumental magnitude m, area of the galaxy image, its ellipticity as well as position angle of the major axis were determined.

The cluster shape was calculated using standard covariance ellipse method [11] for all galaxies located in the cluster region and within the magnitude range m_3, m_3+3^m, where m_3 is the magnitude of the third brightest galaxy. The first five moments of the observed two-dimensional point distribution allow one to determine the contour of the ellipse and its position angle θ, computed as (see, [11]): ellipticity $e=1-b/a$ where a and b are the major and minor axes of the galaxy image, while $\mathrm{tg}2\theta = 2M_{11}/(M_{20}-M_{02})$.

We compiled two basic cluster samples. The first one denoted as A contained all the galaxies belonging to the given cluster within the investigated magnitude range, while the sample B included only the twenty brightest galaxies of the same cluster. For both samples ellipticity and position angle of each cluster have been determined independently. Moreover, galaxy clusters' ellipticity was estimated at several distances from the cluster centre, changing the radius of analysis with the pace of 0.25 Mpc from 0.5 Mpc up to 2 Mpc.

3. *The analysis of galaxy location within clusters.* In order to study the location of galaxies within the parent cluster the latter was divided into circular sectors of central angle amounting to 30° and the number of galaxies in each sector was counted. Such analysis was performed changing the orientation of the cluster ellipse. The first counts were performed using x and y rectangular coordinates for sector borders, afterwards the cluster major axis was adopted as basic line for sections.

In the case of Cartesian (x, y) coordinate system the determined distributions were random ones in both samples A and B. When the coordinate system connected with cluster major axis is applied the distributions appeared to be isotropic too. Only in the case of BM type I clusters, containing a cD galaxy in the centre a statistically significant excess of counts in the sectors covering angles between 285° and 345°, as well as in bins covering angles from 105° to 165° occurred (counting anticlockwise). For the B sample of brighter galaxies only one maximum in the former sector was noted (Fig.1).

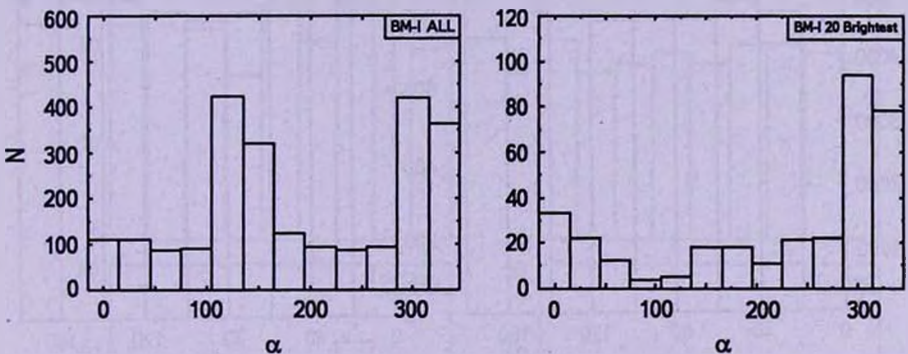

Fig.1. The distribution of galaxies in BM type I clusters of samples A and B counted in the coordinate system connected with the galaxy cluster major axes.

Although not completely comprehended, such a result points out the connection of the galaxy location with the cluster properties. It does mean that the clusters containing in their centre a huge cD galaxy try to locate galaxies in such manner to originate an anisotropic structure. The anisotropy detected in the case of this cluster type and in this coordinate system can be regarded as an argument in favour of the special evolutionary scenario and significance of cD galaxies in clusters. These unique galaxies remain mysterious as they have been since the beginning of their discovery. The key question concerns their distinctness - are these galaxies quite distinct from normal giant elliptical galaxies or they are the natural end of the luminosity function. In both cases various evolution mechanisms could be suggested for the origination of these galaxies.

4. *The position angle analysis.* At the first step of our studies we checked the isotropy of the position angles of major axes for all the galaxies involved. Relevant analyses have been made for both samples separately - for the distribution of position angles of all galaxies (sample A) and of the 20 brightest galaxies (sample B).

In order to verify the randomness of the investigated distributions the Kolmogorov - Smirnov test was applied. Both distributions presented in the Fig.2 appeared to be isotropic. We investigated also the distributions of galaxy clusters major axes' position angles for the different distances from the centre in the manner described above. No any anisotropy has been found again in the calculated distributions. The greatest deviations from the expected mean value were at the most, rather rarely, less than 2σ. We studied also the distributions of galaxy position angles in samples A and B at the distances between 0.75 Mpc and 1.5 Mpc. All the distributions appeared to be isotropic.

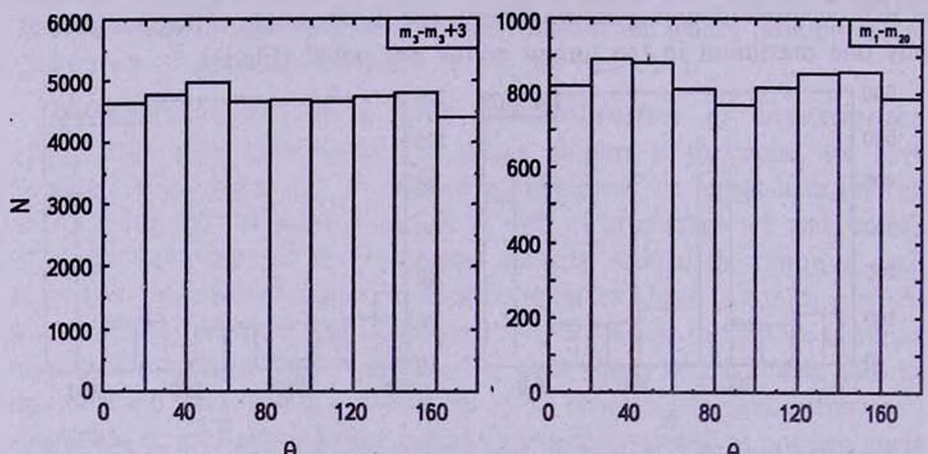

Fig.2. The distributions of the position angle of all galaxies (left panel) and of the 20 brightest galaxies (right panel).

We also determined the position angles of 377 cluster structures in the both cases of sample A and sample B using the coordinate system connected with the photographic plate. Moreover, the division according to the distances from the cluster centres has been considered. The position angles were determined, considering galaxy samples inside the distances of 0.5 Mpc, 0.75 Mpc, 1.0 Mpc, 1.25 Mpc, 1.5 Mpc, 1.75 Mpc respectively. It appeared that in the case of sample A the deviations for the isotropic sample are smaller than 2σ (using Poisson error $\sigma = \sqrt{N}$, where N is the number of objects expected in the random distribution) (see Fig.3a). In the case of the sample B we have a completely different picture. It exhibits statistically significant excess of cluster (major axes) position angles in the range of angles between 120° and 160°. This excess is manifested most significantly when the position angle is calculated for the distance range of 0-0.75 Mpc. It is diminishing up to the distance 0-1.75 Mpc but even in this case it exceeds the 3σ level (Fig.3b).

Fig.3a. The distributions of structure position angles at various distances from the cluster centres considering all galaxies within the structure.

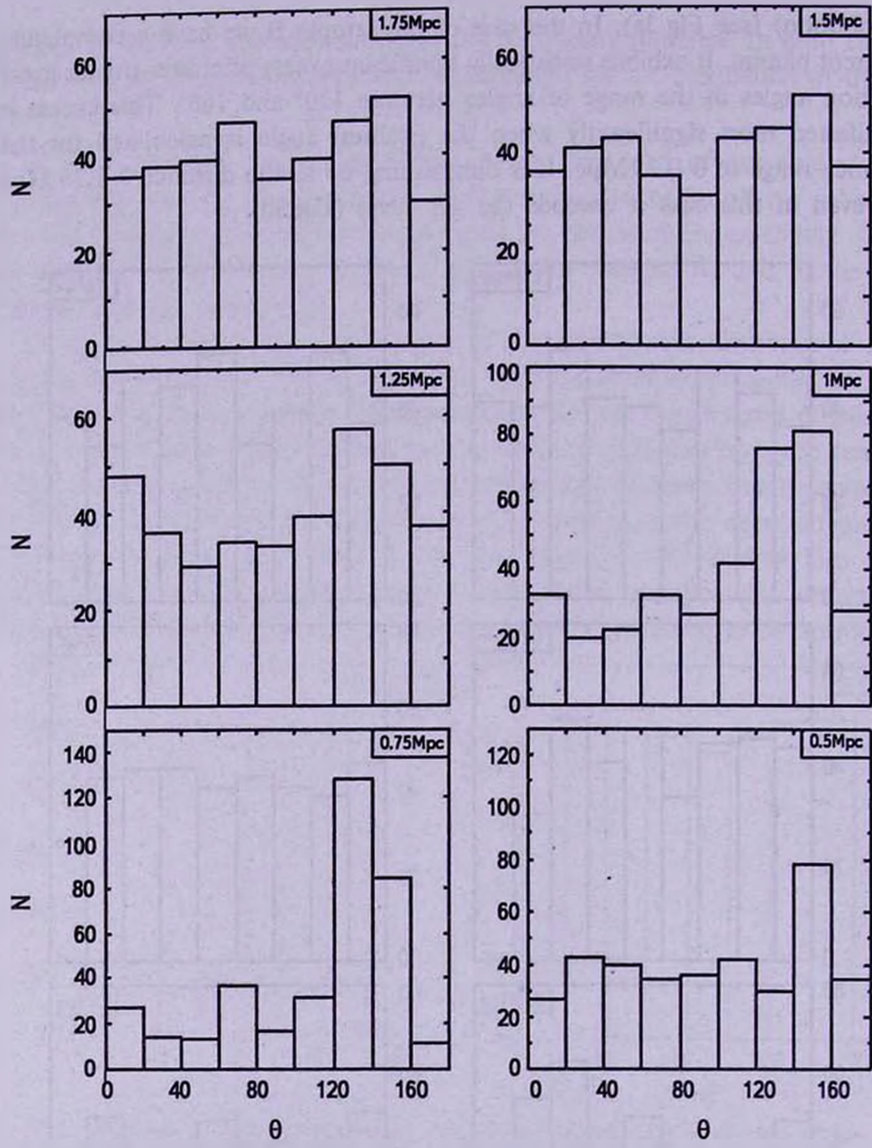

Fig.3b. The distributions of structure position angles at various distances from the cluster centres considering 20 brightest galaxies within the structure.

5. *Conclusions*. For finding any fingerprints of a physical mechanism where galaxy formation is connected with ejection processes one should analyze many features of clusters of galaxies. In the frame of the considered here paradigm the cD galaxies play a special role serving as generators of all the cluster galaxies and any structural features giving a hint in favour (or against) of this idea should be considered carefully [12]. From this point of view the separation of BM type I clusters containing cD galaxy in their centre seems to have a key significance. Of course, it should be considered together with

other observational facts in detail to arrive at a strict conclusion. However at a glance one may suggest from the physical reason that first ejected protogalaxies statistically should be more massive and could originate rather luminous galaxies. On the other hand, even nowadays ejections have strongly anisotropic character and therefore they could form initially elongated structures. Most probably the second generation objects ejected from the central brightest cD galaxies consequently gave birth in hierarchical manner to the next generation of galaxies along with the next ejections of the maternal cD galaxy. Such a mechanism could destroy the initial anisotropy and make the cluster structure more isotropic and having spherical shape. This is the picture we observe here. Moreover, the studied structures of 6188 galaxies show that more numerous structures are more spherical [13]. The difference in structure position angle distributions for samples A and B can be interpreted in the same way.

Our result seems to be consistent with predictions of Ambartsumian's paradigm on the galaxy formation at a glance, but it can be explained also in the frame of other scenarios of galaxy origin. In order to make more conclusive testing of the Ambartsumian's idea the suitable predictions from the theory are necessary, as well as application of more sophisticated statistical tools, as e.g. that which are used in study the ejection of galaxies from quasars are required.

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ПОПЫТКА ПРОВЕРКИ ИДЕИ АМБАРЦУМЯНА О ПРОИСХОЖДЕНИИ ГАЛАКТИК. II. РАСПРЕДЕЛЕНИЕ ГАЛАКТИК В СКОПЛЕНИЯХ И ПОЗИЦИОННЫХ УГЛОВ ГАЛАКТИК

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Рассматривается распределение галактик в 377 богатых скоплениях Эйбела. Мы сравниваем особенности распределения галактик в двух выборках, первая из которых состоит из всех галактик, а вторая - из 20 ярчайших объектов. Подсчеты в секторах с центральным углом в 30 градусов показывают изотропию распределения. Лишь в случае скоплений первого типа по классификации Бауца-Моргана наблюдается анизотропия распределения. Рассмотрены также распределения позиционных углов больших осей галактик в скоплениях, которые также показывают изотропию. Исследованы позиционные углы больших осей самих скоплений. Оказалось, что они отличаются для двух выборок. По-разному распределены галактики в случае cD скоплений, в которых вдобавок распределение ярчайших галактик имеет более вытянутую форму, а также большие оси их совокупности показывают другое преимущественное направление.

Ключевые слова: *строение галактик:распределение:происхождение*

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