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Dependences between the magnitude gap of groups and the morphology of two brightest galaxies

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Abstract

In the present study, the dependencies of the morphological types of the first and second ranked group galaxies on the magnitude gap were studied.

It is shown that there is no increase in the relative number of elliptical galaxies among the first and second ranked group galaxies with large magnitude gaps (in comparison with the expectation, by assuming that the morphological type of these galaxies does not depend on the magnitude gap). This result contradicts the merger hypothesis. The hypothesis proposed by Ambartsumian does not contradict this result.

1. Introduction

Works relating to groups of galaxies are inclined to prove that in these groups the main mechanism of evolution of galaxies is associated with the merging of galaxies.

It should be noted that there is another hypothesis proposed by V. Ambartsumian in the Byurakan Observatory, in which the evolution of galaxies is interpreted in a diametrically opposite way (V. A. Ambartsumian 1956; 1964).

Many observational facts can be explained by both mechanisms, but the dependences of the characteristics of galaxies from the magnitude gap of the groups might enable us to understand which of these two opposite mechanisms, in fact, makes a big contribution to the evolution of galaxies.

As the first characteristic, we can take the observed morphological type of galaxies. According to the merging scenario, the mass (or luminosity) of the central galaxy of the group must grow with the time, and the central galaxy must take an elliptical form. According to Ambartsumian's version

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of the evolution of galaxies, no assumption is made about the morphology of the central galaxy.

Thus, from the point of view of the adherents of the merging hypothesis, a large magnitude gap of group means a long dynamical evolution. From the point of view of the formation of galaxies from protogroup matter through disintegration, this gap is either not related to the dynamical evolution of the groups or there must be an inverse relationship, i. e., a large gap m_{12} means a short dynamic age.

In this paper we consider the dependence between magnitude gap and the morphological types of the first and second ranked galaxies of groups.

2. Sample

We have used the list of groups of galaxies suggested by Mahtessian & Movsessian (2010). The study area is limited to the following: $1000km/s \leq V \leq 15000km/s$, $|bII| \geq 20^o$.

2.1. Completeness of the sample

The CfA2 survey is complete up to $m = 15.5$ (Mahtessian 2011). In this paper, the completeness of the samples of galaxies with measured morphological types has also been studied and it is shown that the completeness does not depend on the morphological types. The identification of the groups was carried out independently of the morphological types of galaxies (see Mahtessian & Movsessian 2010). On the other hand, initially, the definition of morphological types of galaxies is completely independent of their belonging to groups or from the magnitude gap m_{12}. Therefore, our sample can be considered as representative for studying this problem.

3. Results

Let us estimate the dependence of the morphological type of a first ranked galaxy on the magnitude gap m_{12}. The results are shown in Table 1. In the table, the galaxies are grouped according to the morphological types of the first ranked galaxies, as follows:

E,L ($T = -7 \div -1$) – elliptical and lenticular galaxies,

S,I ($T = 0 \div 20$) – spiral and irregular galaxies.

In the table, for a given subsample of galaxies, the observed number and the expected number (in parentheses, based on the assumption that there is no correlation between the morphological type of the first ranked galaxy and the magnitude gap) are given, and the frequency of appearance of m_{12}

is given below. In the last row, regardless of the morphological type, the distributions of the number and the relative number of gaps m_{12} are given.

In the case of elliptical and lenticular galaxies, the statistical significance of the difference between the distributions of the observed and expected numbers is 0.15 by the χ^2 method. In the case of spiral and irregular galaxies, this is ~ 0.4. This means that between these distributions there is no significant statistical difference.

Thus, we can state that the relative number of brightest elliptical galaxy in groups does not increase with increasing magnitude gap m_{12}.

The continuation of Table 1 shows that this applies to extremely larger gaps also.

This casts doubt on the mechanism of merging.

Table 2 shows the distribution of the magnitude gap m_{12} in groups, depending on the morphological type of the second ranked galaxy. It can be seen from the table that in the transition from groups with small gap to groups with large gap, the number of elliptical and lenticular galaxies decreases with respect to the expected number. The statistical significance of the above, based on the χ^2 criterion, is higher (< 0.01).

This applies to extremely larger gaps also (see continuation of Table 2).

This fact cannot be explained by the mechanism of merging.

Let us consider the same question by dividing the sample by m_{12} into two parts. Table 3 gives the corresponding data for the brightest galaxy for $m_{12} < 2.0$ and $m_{12} \geq 2.0$.

Table 3 shows that the relative number of elliptical and lenticular galaxies among a first ranked galaxy groups with $m_{12} \geq 2.0$ is even smaller than the expected number (but its statistical significance is small, ≈ 0.3, estimated by a method $\chi 2$, as well as with using a normal approximation).

Table 4 gives the corresponding data for second ranked galaxies for the cases $m_{12} < 2.0$ and $m_{12} \geq 2.0$. From the table, it can be seen that in the groups with the magnitude gaps $m_{12} \geq 2.0$ among the second ranked galaxies there is no observed large relative number of elliptical and lenticular galaxies in comparison with the expected one. It seems that the opposite phenomenon is observed, but its statistical significance is small ($\alpha \approx 0.2$).

A similar result was obtained when in Tables 1-4 instead of $S, I(T = 0 \div 20)$ galaxies only spiral galaxies $S(T = 0 \div 9)$ were considered.

Thus, it can be confidently asserted that the relative number of elliptical and lenticular galaxies among the first and second ranked galaxies does not increase with respect to the expected when the gap m_{12} increases (when it is assumed that there is no connection between the morphological types the first and second ranked galaxies and the magnitude gap m_{12}). This contradicts the merger hypothesis. As concerning the hypothesis proposed by Ambartsumian about the origin of galaxies due to the division of superdense proto-stellar matter, there is no contradiction here. However, more research is needed. The followings are possible topics for further investiga-

Table 1. Distributions of magnitude gap in groups, depending on the first ranked galaxy morphology type

m_{12}	$0 \div 0.5$	$0.5 \div 1.0$	$1.0 \div 1.5$	≥ 1.5	All_{gap}
E, L	217(230.9)	146(125.7)	71(69.1)	41(49.3)	475
	0.45	0.31	0.15	0.09	
S, I	472(458.0)	229(249.3)	135(136.9)	106(97.7)	942
	0.50	0.24	0.14	0.11	
All_{Type}	689	375	206	147	1417
	0.49	0.26	0.15	0.10	
continued					
m_{12}	≥ 2.0	≥ 2.5	≥ 3.0		
E, L	17(21.5)	10(10.7)	4(5.0)		
	0.036	0.021	0.008		
S, I	47(42.5)	22(21.3)	11(10.0)		
	0.050	0.023	0.012		
All_{Type}	64	32	15		
	0.045	0.023	0.011		

tion: a detailed morphological study of the first and second ranked galaxies, the study of dynamical conditions in groups, the study of X-ray, infrared, radio emission of groups and these galaxies, star formation, etc. We will carry out this research in the future.

Table 2. Distributions of magnitude gap in groups, depending on the second ranked galaxy morphology type.

m_{12}	$0 \div 0.5$	$0.5 \div 1.0$	$1.0 \div 1.5$	≥ 1.5	All_{gap}
E, L	173(149.9)	66(67.7)	25(34.1)	12(24.3)	276
	0.63	0.24	0.09	0.04	
S, I	420(443.1)	202(200.3)	110(100.9)	84(71.7)	816
	0.51	0.25	0.13	0.10	
All_{Type}	593	268	135	96	1092
	0.54	0.25	0.12	0.09	
continued					
m_{12}	≥ 2.0	≥ 2.5	≥ 3.0		
E, L	7(11.1)	2(5.6)	1(2.5)		
	0.025	0.007	0.004		
S, I	37(32.9)	20(16.4)	9(7.5)		
	0.045	0.025	0.011		
All_{Type}	44	22	10		
	0.040	0.020	0.009		

Table 3. The same as table 1 for $m_{12} < 2.0$ and $m_{12} \geq 2.0$

m_{12}	$0 \div 2.0$	≥ 2.0	All_{gap}
E, L	458(453.5)	17(21.5)	475
	0.964	0.036	
S, I	895(899.5)	47(42.5)	942
	0.950	0.050	
All_{Type}	1353	64	1417
	0.955	0.045	

Table 4. The same as table 2 for $m_{12} < 2.0$ and $m_{12} \geq 2.0$

m_{12}	$0 \div 2.0$	≥ 2.0	All_{gap}
E, L	269(264.9)	7(11.1)	276
	0.975	0.025	
S, I	779(783.1)	37(32.9)	816
	0.955	0.045	
All_{Type}	1048	44	1092
	0.960	0.040	

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