N91-16874

WHAT IS THE NUMBER OF SPIRAL GALAXIES IN COMPACT GROUPS?

N. A. Tikhonov
Special Astrophysical Observatory
USSR Academy of Sciences
st. Zelenchukskaya, Stavropol Territory
357147, USSR

ABSTRACT. The distribution of morphological types of galaxies in compact groups is studied on plates from the 6 m telescope. In compact groups there are 57% galaxies of late morphological types (S + Irr), 23% lenticulars (SO) and 20% ellipical galaxies. The morphological content of compact groups is very nearly the same as in loose groups. There is no dependence of galaxy morphology on density in all compact groups (and possibly in loose groups). Genuine compact groups form only 60% if Hickson's list.

INTRODUCTION

As numerical calculations show (Ishisawa et al., 1983; Mamon, 1987; Barnes, 1988) the dynamical evolution of small close systems of galaxies must lead to formation of elliptical galaxies after successive merging of all its neighbors to the central galaxy. To test the results of such calculations in observations, the most suitable objects are compact groups of galaxies, a homogeneous list of which is presented by Hickson (1982). There were also earlier lists of compact groups of galaxies compiled by Shakhbasian and her colleagues (1973) and also the list of Roe (1977), but these results could not be used for statistical conclusions, because of the sample being incomplete or group selection criteria being applied incorrectly.

In Hickson's list (1982) the space density of galaxies in the group reaches 10^6 gal/Mpc and interaction effects may be expected to appear must strongly maximally in such groups. If the numerical calculations are correct, and the compact groups are physically related systems with sufficient lifetimes for evolutionary change, the morphological content must systematically differ between compact groups and looser groups of galaxies.

As galaxy classification using plates obtained with a wide-angle telescope leads to significant losses of spiral galaxies (Wirth and Gallagher, 1980) morphology of galaxies in compact groups was determined based on large-scale plates obtained by the author at the 6 m telescope. The first results were obtained studying 40 groups. Addition of twenty more plates did not change the main conclusions of the work (Tikhonov, 1986) but at the same time allowed further specification of the results.

OSBSERVATIONS

Photographic observations were carried out by the author in 1984-85 with the 6 m telescope of the Special Astrophysical Observatory, USSR Academy of Sciences, plates were obtained at the prime 24 m focus of the telescope. The large scale of the plates (8.19"/mm) allowed determination of the galaxy type confidently, using the Hubble classification. Almost all the plates were obtained using IIa0 and 103a0 emulsions in the "B" system.

When obtaining the plates the emphasis was on close groups where morphology is impossible to study using the POSS, on groups possessing a small number of spiral galaxies and groups showing traces of interaction between galaxies. Plates of 60 compact groups with the numbers: 1, 2, 3, 5, 6, 7, 8, 10, 12, 13, 14, 15, 17, 20, 25, 34, 35, 38, 39, 41, 43, 45, 46, 49, 50, 51, 54, 56, 57, 58, 61, 66, 68, 70, 71, 72, 73, 74, 75, 76, 77, 78, 80, 81, 82, 84, 85, 88, 89, 92, 93, 94, 95, 96, 97, 98, 99, and 100 were obtained.

These plates were later used for photometry of galaxies in groups.

Besides photographic observations, at the 6 m telescope spectral observations of about 60 galaxies in various groups and group neighborhoods were carried out. This allowed estimation of dynamic mass of groups, the ratio M_{VT}/L and comparison of compact and loose groups of galaxies more completely. However, this article deals only with morphology of galaxies in groups, considering the results of spectral observations, as well.

CRITICAL REMARKS

The list of compact groups by Hickson (1982) is the most complete and homogeneous of all the existing ones. Unfortunately it also contains errors, mainly associated with the isolation criterion.

Precise position measurement of galaxies on the 6 meter telescope plates has shown that the isolation criterion is broken rather often, i.e., that inside the $3R_G$ circle galaxies brighter than $(m_a - 3)$ are present. Including such galaxies into the group breaks the other group selection criteria, and we cannot thereafter consider such groups compact and isolated. I can give some examples of such groups: 1, 12, 20, 45, 46, 57, 70, 71, 72, 76, 83, 94.

Radial velocity measurements of galaxies in some compact groups and study of other authors' results led us to a new revision of the compact groups list. Some quartets turned into triplets and we should not consider them groups according to Hickson's criteria ($N \geq 4$). They are groups 38, 61, 77, and probably some others. Groups 18 and 54 are single galaxies with HII regions (Williams and van Gorkom, 1988; Arkhipova et al., 1981) and they must also be excluded from the list.

Radial velocities obtained on the 6 meter telescope and also comparison of Hickson's list (1982) with the group lists of other authors showed that some compact groups are central condensations in loose groups and we must not consider them isolated. They are the groups: 8, 10, 35, 44, 58, 60, 61, 68, 79, and 95. Absence of complete data on radial velocities of compact groups of galaxies and neighboring galaxies does not allow me to enlarge the list.

So the initial list of Hickson contains several types of objects: nuclei of loose groups of galaxies, compact groups, double or triple galaxies with background galaxy superposition, single galaxies with HII regions. This should be borne in mind when discussing the morphological composition of compact groups from Hickson's list (1982).

RESULTS AND DISCUSSION

In the 59 groups of galaxies for which direct plates were obtained (excluding group 54) 278 galaxies were classified. The results are presented in Table 1.

TABLE 1

GALAXY CLASSIFICATION IN COMPACT AND LOOSE GROUPS OF GALAXIES

Groups	S	SO	E	The Authors
loose	65	18	10	Bhavsar, 1981
loose	62	20	17	de Souza et al., 1982
loose	64	20	15	de Souza et al., 1982
compact	38	28	34	Hickson (from Williams and Rood, 1987)
compact	46	--	--	Hickson and Kindl, 1988, 60 groups
compact	61	26	13	Williams and Rood, 1987, 60 groups
compact	57	23	20	6 m telescope, 60 groups
compact	61	22	17	the first-ranked galaxies, 6 m telescope, 60 groups

The results of Table 1 show great scatter of the results when the same groups of galaxies are used. This is largely caused by the small apparent size of the galaxies, and in this case the number of galaxies classified as spirals must reduce when passing from near to distant groups. In Figure 1 the relation between spiral-galaxy fraction in the group and the distance to the group, according to Hickson and Kindl (1989) is shown. The decrease in number from ~60% in nearby groups to 20% in distant ones is clearly seen. The decrease begins with Z = 0.04; this is the very limit of distance up to which we can classify galaxies correctly with good imaging.

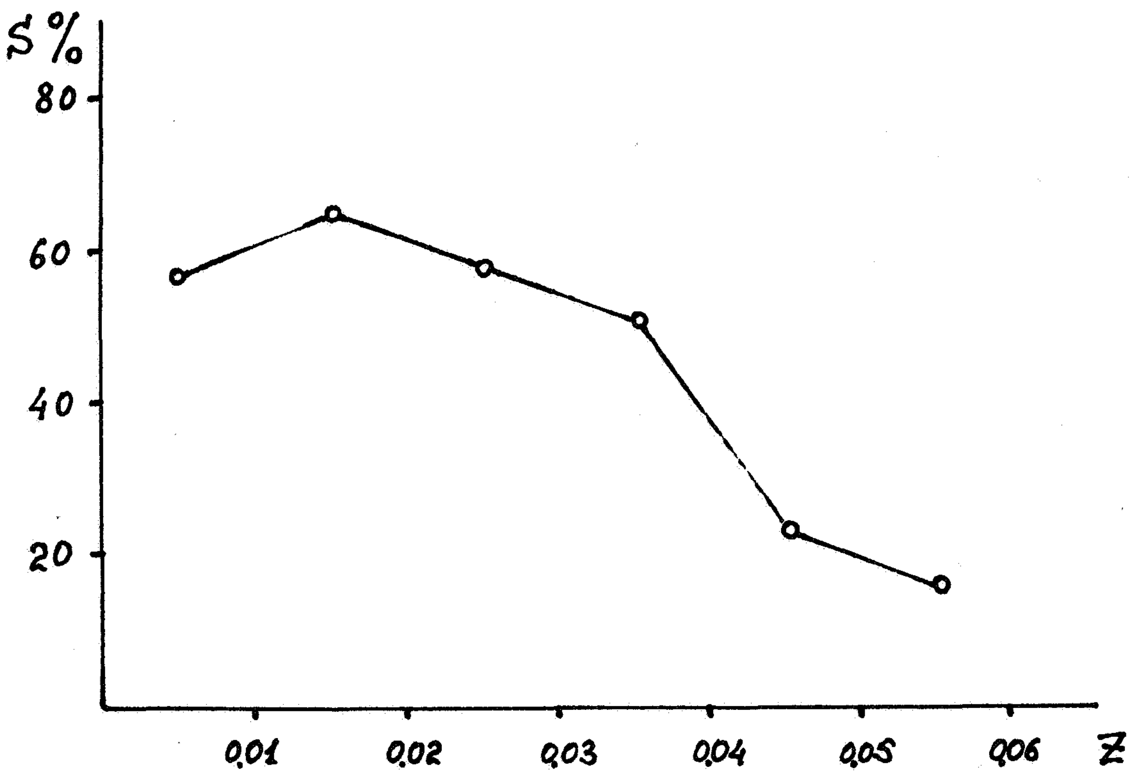

Figure 1. Changing of the number of spiral galaxies in compact groups through distances (from the data of Hickson and Kindl, 1988).

Since loose groups of galaxies are as a rule at close distances, misclassifications are less possible for them. So, the morphological composition of compact groups is only slightly different from the composition of loose groups. Among the brightest galaxies in the compact groups spiral galaxies constitute 61%, which indicates that morphological type is preserved during merging or that merging is rare.

Interacting galaxies are observed in 31 of 59 groups, but these are interactions of pairs of galaxies. In seven groups interaction of three or more galaxies is observed. They are the groups 2, 38, 49, 70B, 80, 92, 95. In only two cases all four galaxies are interacting (groups 49 and 80). As for galaxy merging, it is observed only in Group 8. The processes of galaxy merging are very rare which leads to preservation of morphological composition in the groups.

The similarity between compact and loose groups is seen also from comparing the "Morphology-density" relation. From Dressler (1980) this relation is known for clusters of galaxies. Later it was obtained for smaller groups of galaxies, too (Bhavsar, 1981; de Souza et al., 1982; Postman and Geller, 1984). After radial velocity measurements and determination of space density of the galaxies with the 6 meter telescope it became clear that compact groups do not follow Dressler's "morphology-density" relation. As for compact and loose groups of galaxies the identical morhphological composition and spatial density of compact and loose groups suggest that a continuous "morphology-density" relation must be observed for small groups of any compactness.

In Figure 2 the results after combining the data by several authors are presented. It is seen, that with space densities ~10^2 gal/Mpc^3 a shift from Dressler's relation is outlined, and this shift is present for both compact and loose groups of galaxies. The most probable reason for such a shift is the presence of a relation not only with space density of galaxies, but also with the number of galaxies in the group.

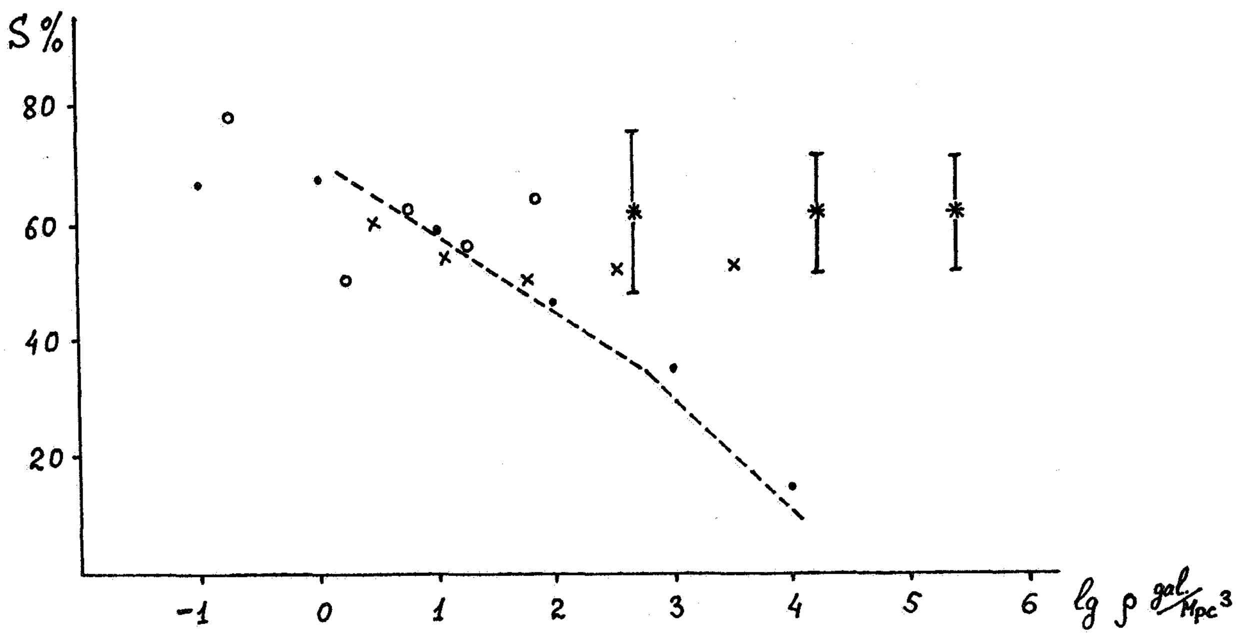

Figure 2. Morphology-density relation for compact and loose groups of galaxies.

x x x - Bhavsar (1981),

o o o - de Souza et al. (1982),

. . . - Postman and Geller (1984),

----- - Dressler (1980),

* * * - Tikhonov, this paper.

CONCLUSIONS

In the list by Hickson (1982) genuine compact groups constitute about 60%.

Compact and loose groups of galaxies possess identical morphological compositions.

Compact (and loose) group do not follow Dressler's "morphology-density" relation.

In compact groups galaxy merging or absorption processes are rather small in number.

REFERENCES

Arkhipova, W. P., et. al. 1981, Astron. Zh., **58**, 490.

Barnes, J. E. 1988, Princeton JASOL, preprint 73.

Bhavsar, S. P. 1981, Astrophys. J. Lett., **246**, L5.

Dressler, A. 1980, Astrophys. J., **236**, 351.

Hickson, P. 1982, Astrophys. J., **255**, 382.

Hickson, P., Kindl, E. 1988, Astrophys. J., **331**, 64.

Ishisawa, T., Matsumoto, R., Tajita, T., Kageyama, H., and Sakai, H. 1983, Publ. Astr. Soc. Japan, **35**, 61.

Mamon, G. A. 1987, Astrophys. J., **321**, 622.

Postman, M., and Geller, M. J. 1984, Astrophys. J., **281**, 95.

Rose, J. A. 1977, Astrophys. J., **211**, 311.

Shakhbasian, R. K. 1973, Astrofizika, **9**, 495.

de Souza, R. E., Capelato, H. V., Arakaki, L., and Logullo, C. 1982, Astrophys. J., **263**, 557.

Tikhonov, N. A. 1986, Soobshch. Spets. Astrofiz. Obs., **52**, 51.

Williams, B. A., and van Gorkom, J. H. 1988, Astron. J., **95**, 352.

Willaims, B. A., and Rood, H. J. 1987, Astrophys. J. Suppl. Ser., **63**, 265.

Wirth, A., and Gallacher, J. S. 1980, Astrophys. J., **242**, 469.