THE ROLE OF ENVIRONMENT IN THE ORIGIN OF RADIO EMISSION FROM GALAXIES

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ABSTRACT. The influence of the environment on the origin of radio radiation from galaxies is studied by compairing the occurence of radio emission in galaxies in compact high density groups of Hickson (1982) with that in field galaxies of similar types. The study shows that the fractional luminosity functions of elliptical and spiral galaxies in compact groups are similar in shape to that of field galaxies but the probability of a compact group galaxy being a radio source is 5 to 10 times greater than that of an isolated galaxy of the same type. Radio Loud group ellipticals tend to be the optically brightest galaxy in the group independent of their absolute luminosity.

1. INTRODUCTION

The influence of local galaxy density on the occurence of radio emission from galaxies has been the subject of a number of investigations in the recent past (Auriemma et al (1977), Stock (1978), Adams et al (1980), Hummel (1980), Condon et al (1982), Altschuler and Pantoja (1984), Fanti (1984), Heckman et al (1985), Gioia et al (1981), Altschuler et al (1984)). The results of these investigations have been inconclusive with some investigators concluding that higher local galaxy density decreases the probability of a galaxy becoming a radio source while others derived an increase in the probability under conditions of higher density. The main reason for these contradictory results appears to be the influence of selection effects in the choice of the samples which made the comparison with isolated galaxies difficult. In order to study this question in a systematic manner we need to have two samples of galaxies with a high constrast in local galaxy density. The compact group sample of Hickson (1982) has local space densities ranging from a hundred to a million galaxies per cubic megaparsec. The radio properties of a subsample of the above sample are compared with that of comparision samples of isolated galaxies from Hummel (1980, 1981). Some of the main conclusions from such a study are reported in this paper.

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2. OBSERVATION AND DATA ANALYSIS

A survey of the 86 groups north of Dec=-19° from Hickson's (1982) sample was made with the Very Large Array of the National Radio Astronomy Observatory in the C-configuration at 1635 MHz. The sample consisted of 95E, 65L and 228S galaxies based on the classification from deep CCD pictures by Hickson and Kindel (1986). Subsequent additional observations were made for some groups in the B and A configurations also. The details of the observations and analysis are presented elsewhere (Menon and Hickson (1985), Menon and Hickson (1986)). The detection limit for the undetected sources was estimated to be 1.5 mJy. The optical positions of the member galaxies were determined from the POSS prints using the Mann measuring engine at the VLA. The positions of the E and L galaxies could be determined with an accuracy of 1 arc sec while the centres of symmetry of spiral galaxies could be in error by 4 arc sec in some cases. A comparison of the radio positions of the detected sources within galaxies shows that in the case of ellipticals and lenticulars the radio and optical positions agreed with a dispersion of 1.5 arc sec while for spiral galaxies the dispersion was about 3.3 arc sec.

3. RESULTS AND DISCUSSION

Of the 388 galaxies in the sample 86 galaxies were detected as radio sources above 1.5 mJy. It may be possible to marginally improve the upper detection limit and hence the number of detections with further editing and processing of the data. Except for one head tail source all the detected sources have dimensions less than the optical dimensions of the galaxy. The statistics of the detections are given in Table 1. The

Table 1
Number of Detected Galaxies

Galaxy Type	Optical Luminosity Class			
	a	b	c	d
E	14(47)	5(28)	1(6)	1(7)
L	3(42)	1(8)	0	0
S	20(41)	22(39)	16(29)	3(6)

numbers in parantheses are the percentages of the total sample in each category which were detected as radio sources in the survey.

Of the 21 radio loud (RL) ellipticals 20 are optically the brightest of their type in their groups. A similar effect was pointed out by Thomassian and Shakhbazyan (1982) for galaxies in the Turner-Gott groups. However their analysis did not make any distinction among the different types of galaxies. However as is seen from Table 1, this strong tendency of a radio source to occur in only the optically brightest elliptical in a group is in sharp contrast to the optical rank distribution of RL spirals which appear to be more or less uniformly distributed among the top three luminosity classes. Furthermore out of the 31 groups containing two or more ellipticals none contained more than one RL elliptical while out of 73 groups containing two or more spirals 14 had two or more RL spirals. I have looked for possible differences in the parameters and properties of the galaxies and groups in order to find a possible explanation of the above characteristic of the elliptical radio sources. The absolute magnitude distributions of the RL and RQ ellipticals are only marginally different and do not appear to be a primary factor in producing the conspicuous ranking effect. However the volume density of galaxies for the groups containing the RL ellipticals is significantly higher than those containing the RQ ellipticals. On the other hand such a difference in volume densities is not seen in the case of the RL and RQ spirals. Similarly the location of the RL ellipticals within the groups is not statistically different from those of the others. Hence it would appear that the cause of the activity in the nuclei of these ellipticals is not a simple conequence of interactions during the evolution of the groups. None of the many scenarios suggested for the occurrence of nuclear activity in galaxies can account for the ranking effect in the case of the ellipticals. Spectroscopic studies of the RQ and RL ellipticals in thses groups might give some insight into the nature of the physical differences between these two classes.

Deep CCD pictures of the galaxies in the groups obtained by Hickson (1986) show considerable evidence of interaction among the spirals in these groups. Hence it is not surprising that many groups contain more than one RL spiral. The paucity of radio sources among the lenticular galaxies confirms from the much larger present sample under different density conditions a well known result. The four detected lenticulars are the brightest intheir groups and show a ranking effect similar to the ellipticals.

One of the methods used to study the emission properties of two samples is by compairing the Fractional Luminosity Functions (FLF) or the Fractional Ratio Functions (FRF) of the two samples where the ratio of the radio to optical luminosity R is used as the relevant parameter. Both methods have been used by Hummel (1980) and his third method of computing the fractional functions was used in our study. For the purpose of comparison in the case of ellipticals we have used the "Local Sample" of 40 ellipticals of Hummel (1980) and for spirals we have used Hummel's (1980) isolated sample of 95 spirals. The details of the samples and the procedures are given elsewhere (Menon and Hickson (1986)). These comparisons show that the FLF and FRF of the compact galaxy groups and the comparison samples have very similar shapes but in the range of values of log R between 0.5 and 2 the compact group galaxies are about 5 to 10 times more powerful than the isolated galaxies of the same type and absolute magnitude range. Detailed studies of the structure of the detected sources and their relationship to the optical features seen in deep CCD pictures of all the galaxies, obtained by Hickson, is in progress.

4. CONCLUSIONS

The Fractional Radio Luminosity Functions of E and S galaxies in high density groups show that these galaxies are significantly more luminous than isolated galaxies of the same type. The radio loud ellipticals in the groups show in addition an unusual dependence on the optical ranking within a group independent of the absolute magnitude distribution of the sample. It would appear that the triggering of the nuclear activity in elliptical and spiral galaxies may be due to two different physical processes.

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