GALAXY INTERACTIONS AND STAR FORMATION: RESULTS OF A SURVEY OF GLOBAL Hα EMISSION IN SPIRAL GALAXIES IN 8 CLUSTERS

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Kennicutt & Kent (1983) have shown that the global Hα emission from a spiral galaxy is an indicator of the formation rate of massive stars. Moss, Whittle & Irwin (1988) have surveyed two clusters (Abell 347 and 1367) for galaxies with Hα emission using a high dispersion objective prism technique. The purpose of the survey is to investigate environmental effects on star formation in spiral galaxies, and in particular to ascertain whether star formation is enhanced in cluster spirals. Approximately 20 % of CGCG galaxies were detected in emission. Two plates of excellent quality were obtained for each of the two clusters, and galaxies were only identified to have emission if this was detected on both plates of a plate pair. In this way, plate flaws and other spurious identifications of emission could be rejected, and weak emission confirmed.

The results of this survey have been discussed by Moss (1987). The detected galaxies are of types S0–a and later. The frequency with which galaxies are detected in emission increases towards later morphological type as expected (cf. Kennicutt & Kent 1983). There is no evidence of any dependence of the frequency of detected emission on the absolute magnitude of the galaxy (cf. Moss & Whittle 1990), but there is a strong correlation between a disturbed morphological appearance of the galaxy and the detection of emission. Furthermore it is found that the emission is more centrally concentrated in those galaxies which show a disturbed morphology. It may be noted that the objective prism plate gives a spectrum of a 400 Å region around rest wavelength Hα, but superposed on this is the Hα emission from the galaxy which, because the light is essentially monochromatic, results in a true two-dimensional image of the Hα distribution. The visual appearance of the emission on the prism plates was classified according to its diffuseness on a 5 point scale ('very diffuse', 'diffuse', 'intermediate', 'compact' and 'very compact'). In Table 1 the relation is shown between this classification and a morphologically disturbed appearance for the galaxy. Galaxies have been divided into ones with *compact* emission (classification of 'intermediate', 'compact' and 'very compact' on the scale discussed above), and ones with *diffuse* emission (classification of 'diffuse' and 'very diffuse'). There is a noticeable tendency for morphologically disturbed galaxies to have

TABLE 1

Relation of tidally disturbed galaxy morphology and the compactness of global Hα emission for CGCG galaxies in Abell 347 and 1367

	Emission-line galaxies	
	Tidally disturbed	Other
Compact emission	14	6
Diffuse emission	4	12

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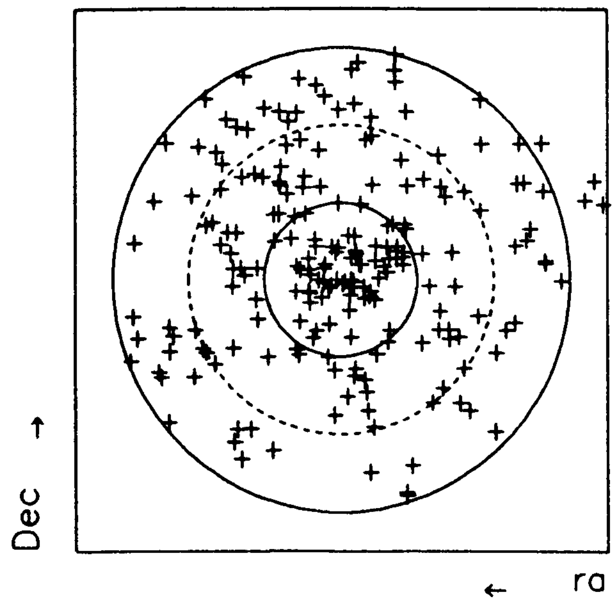

FIGURE 1

The distribution of the sample of galaxies, types Sa and later, surveyed for Hα emission. The sample comprises UGC galaxies in 8 clusters (Abell 262, 347, 400, 426, 569, 779, 1367 and 1656) and additional CGCG galaxies in Abell 347 and 1367. The distributions for the individual clusters have been scaled according to the value of the Abell radius for each cluster and then superposed. The three circles are of radii 0.5, 1.0 and 1.5 Abell radii respectively.

more compact emission. This correlation has been demonstrated independently in the case of radio emission from spirals by Hummel (1980, 1981), Condon *et al.* (1982) and Urbanik, Grave & Klein (1985), and in the case of Hα emission from tidally interacting galaxies by Bushouse (1987) and by Kennicutt *et al.* (1987).

The objective prism Hα survey has been extended to include UGC galaxies in eight clusters (Abell 262, 347, 400, 426, 569, 779, 1367 and 1656). The galaxies surveyed were of types Sa and later and are within 1.5 Abell radii of the cluster centres. The combined distribution of these galaxies together with the other CGCG spirals of types Sa and later surveyed in Abell 347 and 1367, is shown in Figure 1. As is seen there is a noticeable, but not very strong, density increase towards the cluster centre. As expected this effect is strongest for the earliest spiral types.

In Figures 2 and 3 are shown the distribution of detected emission-line galaxies. In Figure 2 is shown the distribution of galaxies with *compact* emission and in Figure 3 is shown the distribution of galaxies with *diffuse* emission. A Mann-Whitney U test was used to compare the radial distributions of the various galaxy samples. Galaxies with compact emission have a radial distribution which is more strongly concentrated towards the cluster centre than the radial distribution of other galaxies in the total sample. This effect is significant at the 3.0 sigma level, and is the more striking since the proportion of

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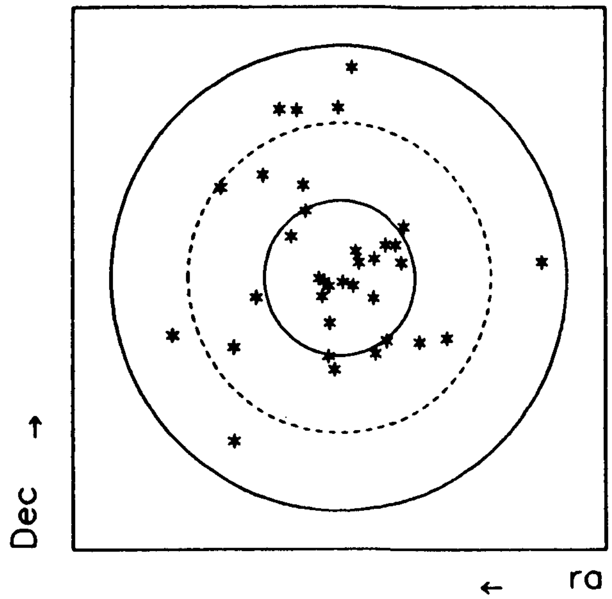

FIGURE 2

As Figure 1, showing the distribution of galaxies with *compact* emission.

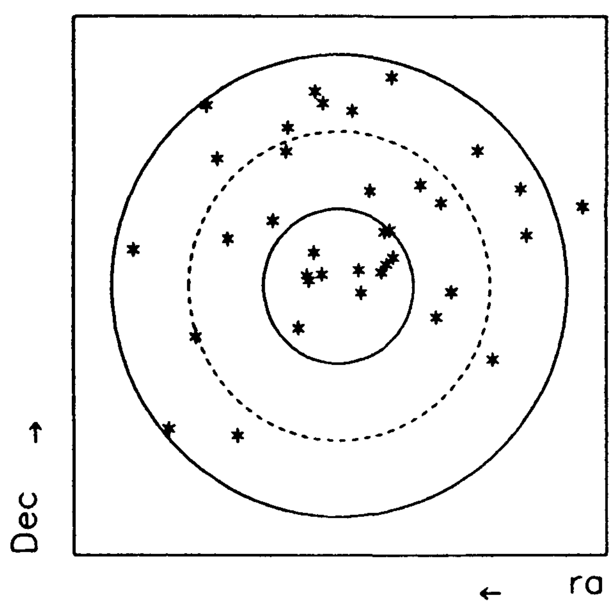

FIGURE 3

As Figure 3, showing the distribution of galaxies with *diffuse* emission.

early type spirals increases towards the cluster centre, and these galaxies are *less* likely to have emission. By contrast, the radial distribution of galaxies with diffuse emission is less concentrated towards the cluster centre than the radial distribution of other galaxies in the total sample, although the difference in these distributions is hardly statistically significant.

There is a simple explanation for the above data. Since compact emission is known to correlate with disturbed morphology, we can explain the centrally concentrated distribution of galaxies with compact emission as due to induced star formation in galaxies undergoing tidal interactions within approximately 0.5 Abell radii of the cluster centres. It would seem likely that these are galaxy–galaxy interactions. A potential difficulty is the high velocity dispersion in clusters which would not allow such tidal interaction to become significant. However Moss (1987) has shown that for two clusters studied in detail, disturbed, peculiar and interacting galaxies can be easily separated into pairs or small groups with low velocity dispersion, although the velocity dispersion of the whole sample is very high. By contrast the galaxies with diffuse emission are likely to be spirals with more normal star formation. The tendency for the percentage of these detected in emission to be less towards the cluster centre can be explained as the combination of two possible effects: the increasing proportion of early type galaxies towards the cluster centre which are less likely to be detected in emission, and possible HI deficiency in cluster spirals close to the cluster centre which is also likely to reduce star formation.

Finally it may be noted that the enhancement of star formation in spirals towards the cluster centre is due to galaxies with compact emission. This emission is strongly correlated with a disturbed morphology of the galaxy. This is an argument against the attribution of enhanced star formation in cluster spirals to ram-pressure effects of the intracluster gas as suggested by Gavazzi & Jaffe (1985) since this would affect the outer halo of the HI gas of the galaxy, but not the morphological appearance of the stellar component.

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