THE LOCAL ENVIRONMENT OF HII GALAXIES

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Abstract

We address the question of whether violent star formation in HII galaxies is induced by low mass companions by describing statistically their local environment as estimated by the correlation function. We argue that even if low mass companions were mainly intergalactic HI clouds, their optical counterparts should be detectable at faint limits of the Automatic Plate Measuring Machine scans. We then cross-correlate a large sample of HII galaxies with the APM faint field galaxy catalogue. The preliminary results are all consistent with HII galaxies being a randomly selected sample of normal faint field galaxy with no extra clustering. This suggests that at least in these dwarf starburst galaxies star formation is not triggered by tidal interactions and may have a different origin.

1 Introduction

HII galaxies are dwarf galaxies in a bursting phase of star formation of low luminosity (mass), low heavy element abundance and low dust content where the triggering mechanism of the present episode of violent star formation is not so obvious [18].

HII galaxies are less clustered than normal bright galaxies and tend to populate regions of low galactic density [1 2 4 11 12 18 20]. They are not associated with giant galaxies, therefore, HII galaxies are not tidal debris of strongly interacting systems.

A possible and appealing alternative that other dwarfs or intergalactic HI clouds could be the triggerers [18] was followed up by Taylor and collaborators [14 15 16]. They have used
the VLA 21 cm maps to search for HI companions around HII galaxies. The main VLA results can be summarized as follows: (i) 12 out of 21 HII galaxies have HI companions; (ii) 13 out of 17 Low Surface Brightness Galaxies (LSBG) from a control sample of quiescent galaxies do not have HI companions. As also pointed out by these authors, some questions remain intriguing from this: Why are these 9 out of the 21 HII galaxies with no companions violent forming stars now ("bursting")? Why are these 4 out of the 17 LSBGs with companions not "bursting"?

Since most of the detected clouds in HI surveys have optical counterparts at faint levels (c.f. Hoffman and Zwaan at this meeting), we have carried out a further investigation of the galaxy environments of a unbiased sample of over 160 low redshift HII galaxies by cross-correlating their accurate position in the sky, also derived from the APM scans, to faint field galaxies (15 < $b_J$ < 20) galaxies in the APM galaxy catalogue. The HII galaxy sample used in this work is taken from the Spectrophotometric Catalogue of HII Galaxies [19]. Our sample of faint field galaxies was selected from the APM Galaxy Survey, which is described in detail in [7]. The galaxy sample selected from the survey data at a magnitude limit of $b_J = 20.5$ has a completeness $\sim 90$–95%, stellar contamination $\sim 5\%$ [8].

2 The angular cross-correlation function $w_{hg}(\theta)$

The angular cross-correlation function $w_{hg}(\theta)$ is estimated by comparing the number of galaxies $N_{HG}$ as a function of angular radius $\theta$ from the central HII galaxy with the number $N_{HR}$ counted for a catalogue of uniform random positions with the same surface density:

$$w_{hg}(\theta) = \frac{N_{HG}(\theta)}{N_{HR}(\theta)} - 1$$

(1)

We also used the simpler direct estimate using the mean surface density of field galaxies. This gave essentially indistinguishable results.

The main results are shown in Figure 1. The filled points show $w$ from equation (1) and the open points from the direct estimator. It can be seen that $w_{hg}$ is significantly positive for angles $\theta \lesssim 10'$, and this corresponds to an excess of galaxies near the HII galaxy positions over a uniform distribution. The lines in Figure 1 show the predicted cross-correlation between the faint
Figure 2: The observed projected cross-correlation between the HII galaxies and the faint APM field galaxies, $\Xi_{hg}(\sigma)/\sigma$.

APM sample and a field galaxy sample with the same redshift distribution as the HII galaxy sample. To predict this, we used the measured APM $w(\theta)$ [8], and calculated scaling factors by numerically integrating Limbers equation [10] with the HII galaxy redshift distribution and the APM redshift distribution as given by [8]. Figure 1 shows that the estimated $w_{hg}(\theta)$ for HII galaxies (points) follows the prediction (lines) for what we would expect if HII galaxies were clustered in the same way as normal faint field galaxies. There is a marginal excess over the prediction, but this is not significant compared to the expected errors, and we conclude that HII galaxies have the same number of companions as faint field galaxies.

3 The projected cross-correlation function $\Xi_{hg}(\sigma)$

Since we know the redshift to each HII galaxy, we can estimate the correlation function using physical separation in kpc. The resulting projected cross-correlation function is an integral over the spatial correlation function $\xi_{hg}$, and traditionally denoted by $\Xi_{hg}(\sigma)$, where $\sigma$ is the projected separation. For a simple power law correlation function, $\Xi_{hg}(\sigma)/\sigma = \xi_{hg}(\sigma)\Gamma(\frac{1}{2})\Gamma(\frac{\gamma-1}{2})\Gamma(\frac{\gamma+1}{2})$. We defer the formal analysis to a forthcoming paper and present our preliminary results in Figure 2.

It can be seen that the measured $\Xi_{hg}$ is positive for $\sigma \lesssim 1\,Mpc$. We have also calculated the expected clustering, $\Xi_{hg}(\sigma)/\sigma$, on the assumption that HII galaxies are clustered in the same way as normal galaxies on small scales, $\xi_{hg}(r) = (r/5.7h^{-1})^{-1.8}$ [8]. Note that the different distance to each HII galaxy means that relation between $\sigma$ and $\theta$ is different for each centre, and also the $1/n(x)$ leads to a different weighting of the pair count from each centre. This means that $\Xi_{hg}$ is not simply a rescaling of $w_{hg}$. As in the case of the angular cross-correlation, the measured value here is consistent with the prediction.

Assuming that all of the excess galaxies compared to a random distribution, $\sigma < 1\,Mpc$, are at the redshift of the central galaxy, the magnitude distribution of the excess directly gives the luminosity function (LF) of the neighbouring galaxies [13]. Comparison with the LF of faint field galaxies estimated from the Stromlo/APM survey [14] shows that the galaxies near to HII galaxies have an absolute magnitude distribution consistent with normal galaxies.
4 Conclusion

1. Both the angular and projected correlation functions are significantly above zero, so HII galaxies are significantly clustered. This is what you expect to find for any sample of galaxies.

2. Both the angular and projected measurements are consistent with the predictions expected for a sample of normally clustered galaxies, showing that HII galaxies are no more or less clustered than normal faint field galaxies.

3. The LF from the extra galaxies within 1 Mpc compared to a random distribution shows that the galaxies near to HII galaxies have an absolute magnitude distribution consistent with normal faint field galaxies. This result will be shown in a forthcoming paper.

In summary, HII are less clustered than bright galaxies, but our present results are all consistent with HII galaxies being a randomly selected sample of normal faint field galaxies. This suggests that at least in these dwarf galaxies (or in most of them) star formation is not triggered by tidal interactions and may have a different origin.

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