The environment of Seyferts, Liners and HII galaxies in a complete AGN sample

V. Zitelli\(^1\), B. Kelm\(^2\), P. Focardi\(^2\) and S. Montanaro\(^2\)

\(^1\) INAF-Osservatorio Astronomico di Bologna, via Ranzani 1, 40127 Bologna
\(^2\) Dip. di Astronomia, Università di Bologna, via Ranzani 1, 40127 Bologna, Italy

ABSTRACT
We use a complete AGN sample (Ho et al. 1997) to study the environment of Seyferts, LINERs and HII galaxies. For each AGN we search for companions in the UZC redshift catalogue and compute local as well as large scale neighbour density and distance to the nearest neighbour. We find that on small scale (\(\sim 0.2 h^{-1}\) Mpc) LINERs exhibit denser environments than Seyferts and HII galaxies at 3\(\sigma\) significance level. The same result is not confirmed when densities are computed on large scales. LINERs also exhibit closer nearest neighbours than Seyferts and HII galaxies (at 2\(\sigma\) c.l.). However, when excluding AGNs in early type galaxy hosts, the neighbour density characteristics of LINERs Seyferts and HII galaxies turn out to be similar, a result that confirms that the excess of neighbours around LINERs is most likely due to a morphology-density effect.

1. INTRODUCTION

It is not yet fully understood whether the dynamical effect exerted by interaction with other galaxies is one of the major cause of the efficient gas fueling observed in AGNs. Indeed, the claimed excess of companions in Seyfert galaxies (Dahari 1984, Laurikainen & Salo 1995) is not confirmed (Bushouse 1987; De Robertis et al. 1998) at better than 95\% significance level.

Examination of the frequency of the occurrence of Seyferts in pairs and groups (Kelm et al. 1998) has further shown that Seyferts constitute a \(\sim 2\%\) in all galaxy systems, whereas the fraction of Seyferts in UZC-Compact Groups (CGs) turns out to be 3 times as large as among isolated UZC galaxies (Kelm et al. 2004). Interestingly, no significant differences in dynamical properties are found, when comparing galaxy systems which host, or not, a Seyfert member. For Seyferts, it has also been shown (Malkan et al. 1998) that there is little direct evidence for unusually high rates of interaction; less than 10\% show tidal feature or multiple nuclei. And Seyferts in UZC-CGs do not seem to be more likely than other CG galaxies to display major interaction patterns (or a bar), which is consistent with the results of earlier papers (Keel 1996, Ho et al. 1997) all finding no clear relationship between the presence of AGNs and detailed morphological properties.
Concerning environmental differences between LINERs and Seyferts Kauffmann et al. (2004) have used a complete sample of galaxies drawn from the SDSS to suggest that the fraction of low luminosity AGN (LINERs) depends very little on local density, whereas the fraction of strong AGN in massive galaxies decreases as a function of density. And Schmitt (2001) has shown that LINERs exhibit a higher percentage of companions than Seyferts and HII galaxies, but that differences disappear when considering only galaxies of similar morphological type.

2. THE SAMPLE

The AGN sample we use here is selected from the master list of 503 nearby galactic nuclei by Ho et al. (1997), obtained from the revised version of the Shapley-Ames Catalog of Bright Galaxies (RSA) and Second Reference Catalog of Bright galaxies (RC2). It is a flux limited catalog of galaxies with magnitude $B_T \leq 12.5$. Our AGN subsample includes all AGN with radial velocity in the range $[1500 \div 3000]$ km s$^{-1}$: 48 LINERs (including transition objects), 15 Seyfert galaxies and 52 HII galaxies. For each AGN we have automatically identified neighbours in the UZC catalog (Falco et al. 1999) which is complete for galaxies brighter than $m_{zw} = 15.5$. The local density of each AGN is estimated by counting all neighbours within a cylinder 0.2 $h^{-1}$ Mpc in projected radius and $\pm1000$ km/s in depth. The large scale density is estimated by counting all neighbours within a cylinder 1 $h^{-1}$ Mpc in projected radius and $\pm1000$ km s$^{-1}$ in depth. The distance to the nearest among these neighbours defines the nearest neighbour distance.
3. NEIGHBOUR DENSITY

In fig. 1 we show the distribution of AGNs as a function of the local neighbour density (neighbours within 0.2 $h^{-1}$Mpc) for Seyferts, Liners and HII galaxies respectively. Distributions show some difference by eye. The U-test indicates, at a significance level 3$\sigma$, that the local density distributions of LINERs and Seyferts are drawn from different parent distributions. Significant differences (3$\sigma$) are also found when comparing (U-test) the local density of LINERs and HII galaxies, whereas Seyferts and HII galaxies do not appear to differ significantly.

In fig. 2 we show the distribution of AGNs as a function of the large scale neighbour density (neighbours within 1 $h^{-1}$Mpc). The large scale density distributions of LINERs, Seyferts and HII galaxies appear similar. The U-test indicates that differences between population are not significant.

4. NEAREST NEIGHBOUR DISTANCE

The distribution of LINERs, Seyferts and HII galaxies as a function of the distance to the nearest neighbour is shown in fig. 3. The plot suggests that Liners exhibit nearest neighbours that are closer than those of Seyfert and HII galaxies. The KS indicates, at a 2$\sigma$ significance level, that distributions of LINERs and of Seyfert or HII galaxies are drawn from different parent populations. Conversely, we find no evidence that Seyferts and HII galaxies are drawn from different population.

5. ELLIPTICAL AND SPIRAL HOSTS

There is a tendency for LINERs to be found in richer and more massive Compact Groups than Seyfert galaxies (Kelm et al. 2004). LINERs are further found in galaxies of earlier
Fig. 3. Distribution of AGNs as a function of the distance to the nearest neighbour. LINERs exhibit nearest neighbours that are closer than those of Seyfert and HII galaxies.

Hubble type than Seyferts and HII galaxies, suggesting that the excess of neighbours around LINERs might be due to a morphology density effect (Schmitt 2001). To test whether this effect is responsible for the excess of close companions that we find around LINERs we have excluded from our sample all AGNs located in early-type hosts. This reduces the size of samples to 28 LINERs, 11 Seyfert galaxies and 49 HII galaxies.

Indeed, when comparing the nearest neighbour distribution of late-type galaxy samples we find that differences between LINERs and other AGNs turn out to be non significant. And differences in local density distributions between LINERs and Seyfert or HII galaxies become less significant.

We therefore confirm that the excess of neighbours around LINERs is most likely due to a morphology density effect.

REFERENCES

Bushouse H.A. 1987, ApJ 320, 49
Dahari, O. 1984 AJ 89, 966
De Robertis, M.M., Hayhoe, K., & Yee, H.K.C. 1998, ApJSS 115, 163
Falco, E.E., Kurtz, M.J., Geller, M.J., et al. 1999, PASP, 111, 438
Ho, L.C., Filippenko, A.V., & Sargent, W.L. 1997, ApJS, 112, 315
Kauffmann, G., White, S.D.M., Heckman, T.M. et al. 2004, [astro-ph/0402030]
Keel K. 1996, AJ 111, 696
Kelm, B., Focardi, P., & Palumbo, G.G.C. 1998, A&A 335, 912
Kelm, B., Focardi, P., Zitelli, V. 2004, A&A, 418, 25
Laurikainen E. & Salo H. 1998 A&A 293, 688
Malkan, M.A. Gorjian, V. & Tam, R. 1998, APJS 117, 25
Schmitt, H.R., 2001, AJ, 122, 224