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The AGN–host galaxy relation

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We report preliminary results on the relation between the active galactic nuclei and their host galaxies based on a sample of 265 active galaxies within a narrow range around redshift $z = 0.05$. We used parameters of the nucleus, like black hole mass and emission line fluxes. With reference to the host galaxy, the size, colour index and bulge relative importance, are assessed. For the individual Seyfert types, the distributions of the host galaxy parameters are studied. Relations between the parameters of the nucleus and the host galaxy are explored. Weak trends are found in some of the relations. The results are discussed in the context of the Unified Model.

Keywords: Galaxies: fundamental parameters – galaxies: Seyfert

1 Introduction

The Active Galactic Nucleus (AGN) model involves an accretion disk around a black hole, surrounded by a torus. According to the Unified Model, the various types of AGNs, like Seyfert (Sy) types 1/2 nuclei are essentially identical, depending on the viewing angle. However, there have been reported correlations between Sy type and galaxy characteristics, like Hubble stage or local environment. For instance, Sy 1 AGNs were found to reside in earlier type host galaxies compared to Sy 2 ones (e.g., Hunt and Malkan 1999). The Hubble sequence, for its part, is a sequence of various galaxy parameters, as bulge-to-disk ratio, spiral arm winding, etc. The proper definition of the galaxy samples used is essential for resolving this issue.

2 Aim and sample selection

The aim of this study is to explore the relation between the parameters of the AGNs and of their host galaxies on the basis of a relatively large and uniformly drawn sample. The latter is compiled out of optically selected AGNs from the SDSS DR7

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database (Abazajian et al. 2009) by Mullaney et al. (2013) with the extra constraints of a narrow range in redshift ($z = 0.048 - 0.052$), ellipticity of the host galaxy smaller than 0.7, and Galactic latitude $|b| > 35°$; Narrow Line Sy 1 nuclei have been excluded. In this way we got a total of 265 active galaxies. Below we report our preliminary results.

3 Parameters

We used the following AGN parameters, based on parameters determined by Mullaney et al. (2013):

- Luminosity of the [O III] $\lambda 5007$ Å line, $L_{[\mathrm{O\ III}]}$. It is considered a proxy for the bolometric AGN luminosity.
- The flux ratio $F_{[\mathrm{O\ III}]}/F_{\mathrm{H}\beta}$ if the broad Hβ component is present. It underlies the Sy type classification that we made.
- The black hole mass, $\mathcal{M}_{\mathrm{BH}}$, was estimated using the relation with the bulge velocity dispersion, σ_* (Gültekin et al. 2009):

$$\log(\mathcal{M}_{\mathrm{BH}}/\mathcal{M}_{\odot}) = 8.12 + 4.24\ \log(\sigma_*/200\,\mathrm{km\,s^{-1}}).$$

  We used the [O III] $\lambda 5007$ Å line width as a surrogate of σ_* after Salviander and Shields (2013).

The galaxy parameters we used involve estimates from the SDSS DR7:

- $(g-i)_{\mathrm{h}}$ is the host galaxy colour index (CI). It is calculated using magnitudes in the g and i band within 3.00 arcsec and 7.43 arcsec aperture radii.
- $fracDeV_i$ is the relative importance of the de Vaucouleurs term in the image fit, measured in the i-band.
- $R_{25,g}$ is the 25 g mag arcsec^{-2} isophotal semi-major axis.

4 Results and discussion

We classified the AGNs after the criteria of Whittle (1992). This resulted in 91 Sy 1–1.5 and 174 Sy 1.8–2 type nuclei.

Figure 1 reveals the distribution of the host galaxy parameters. According to the Kolmogorov–Smirnov test, the Sy 1 and Sy 2 subsamples are drawn from the same underlying population, regarding all parameters. This result is in agreement with the Unified Model. In particular, the galaxy CI and bulge relative importance ($fracDeV_i$) are related to the Hubble stage. Their distribution can be interpreted as independence of the Sy type from the Hubble stage of the host galaxy in accordance with, for example, Schmitt et al. (2001) and Koss et al. (2011) and at variance with, for example, Hunt and Malkan (1999) and Koulouridis et al. (2006).

We studied the relation between the AGNs and their host galaxies. The correlation coefficients between the individual parameters are listed in Table 1. We found weak trends in some of the relations. A part of them, viz. $\mathcal{M}_{\mathrm{BH}}$ vs. $(g-i)_{\mathrm{h}}$ and

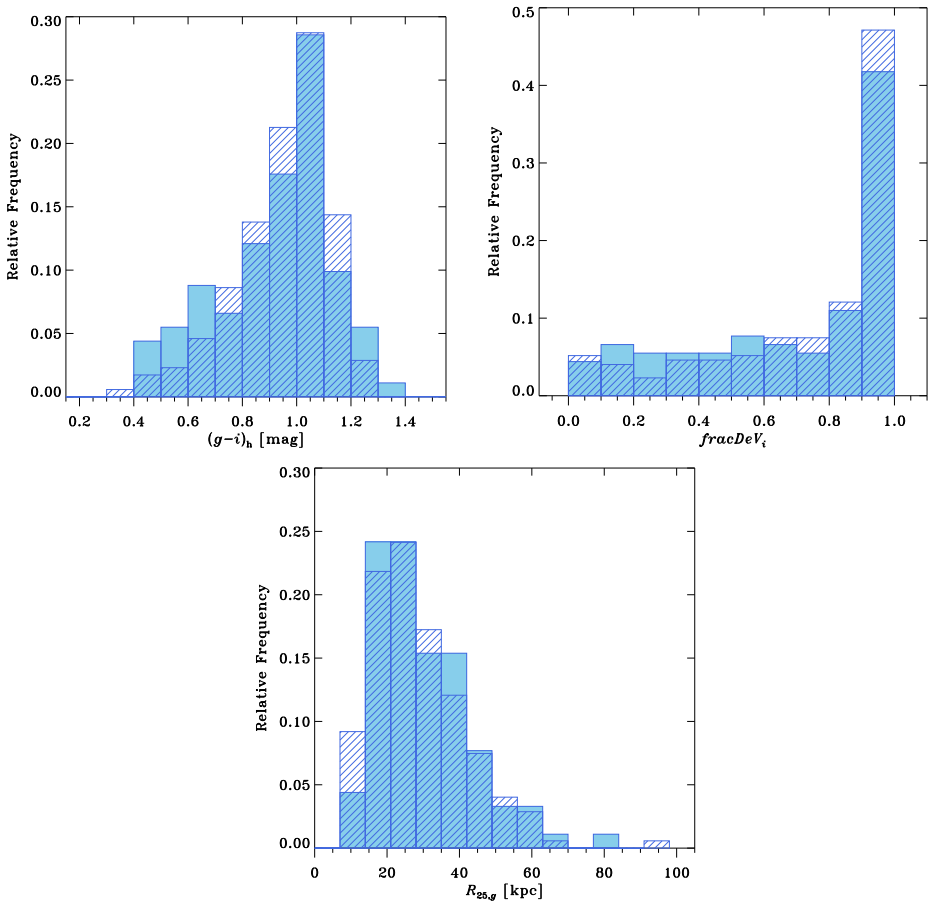

Figure 1 Distribution of the host galaxy parameters for Sy 1 (filled) and Sy 2 (hatched) nuclei.

Table 1 Linear correlation coefficients between the parameters of the AGNs and of the host galaxies.

	$(g-i)_{\rm h}$	$fracDeV_i$	$R_{25,g}$
$\log(L_{[\rm O\ III]})$	0.24	0.27	0.34
$\log(\mathcal{M}_{\rm BH}/\mathcal{M}_\odot)$	0.26	0.17	0.34

$L_{[\rm O\ III]}$ vs. $R_{25,g}$ are shown in Fig. 2. A weak tendency to brighter and more massive central sources generally to reside in larger and redder hosts could be found. Prior to interpreting the relations, however, we should explore the possible AGN influence on the host galaxy parameters (e.g., $fracDeV_i$) and the ways to account for it. Nevertheless, the set of parameters used in this study has the advantage of being estimable in a homogeneous and straightforward way for large samples.

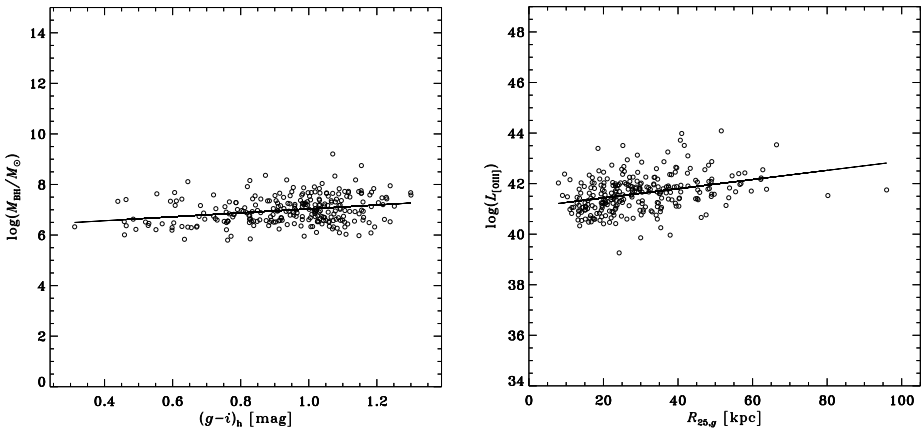

Figure 2 AGN vs. host galaxy parameters relations. A linear fit to the data points is overplotted.

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