

Correlation space of narrow-line Seyfert 1 galaxies

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Abstract. Narrow-line Seyfert 1 (NLS1) galaxies, as active galactic nuclei with low-mass black holes and high accretion rates, are important targets when addressing questions related to black hole growth and accretion physics. We have studied the correlations among the optical emission-line and continuum properties of a sample of NLS1 galaxies, in comparison with a sample of broad-line Seyfert 1 galaxies. We have shown that the density of the narrow-line region is a key component of Eigenvector 1 space. Density turned out to be as important as the Eddington ratio L/L_{Edd} . This result therefore establishes a close link between central engine and host properties, and places new constraints on host - black hole co-evolution.

Keywords. Galaxies: active – galaxies: ISM – galaxies: Seyfert – quasars: emission lines

1. Introduction

Narrow-line Seyfert 1 (NLS1) galaxies are a peculiar subclass of active galactic nuclei (AGNs). They are characterized by small widths of their broad Balmer lines, strong FeII emission and weak [OIII] emission, and are placed at one extreme end of the Eigenvector 1 (EV1) parameter space (e.g., Boroson & Green 1992). Results hint at low black hole masses and high accretion rates in NLS1 galaxies. As such, they constrain models of black hole growth and evolution (see Komossa 2008 for a review on NLS1 galaxies). Of particular interest is to increase the correlation space of NLS1 galaxies, and to identify the physics that drive the correlations.

We have therefore homogeneously analyzed an independent, large sample of NLS1 galaxies, accompanied by a comparison sample of broad-line Seyfert 1 (BLS1) galaxies, in order to identify the correlations across our AGN sample, and the underlying physical drivers.

2. The sample

Our sample of NLS1 galaxies was selected from the catalog of Véron-Cetty & Véron (2003), while the comparison sample of BLS1 galaxies was drawn from Boroson (2003). All galaxies have redshift $z < 0.3$ and well detectable low-ionization emission lines (in particular, [SII] $\lambda\lambda 6716, 6731$, always has $S/N > 5$). The data analyses were based on the the *Sloan Digital Sky Survey* (SDSS) (DR3; Abazajian *et al.* 2005) spectra. The detailed sample selection and data analysis methods were presented in Xu *et al.* (2007).

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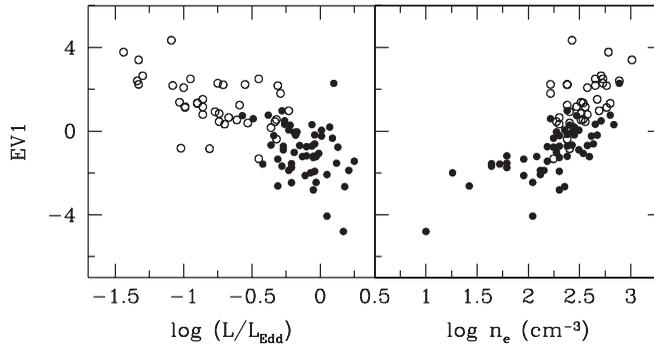


Figure 1. Correlations of EV1 with L/L_{Edd} and n_e . NLS1 galaxies are shown as filled circles and BLS1 galaxies as open circles.

3. Correlation analysis

We have carried out two types of correlation analyses. First, we performed a Spearman rank order correlation analysis between the key parameters measured for our sample, including emission-line widths of [SII] and the broad component of $H\beta$ ($\text{FWHM}([\text{SII}])$ and $\text{FWHM}(H\beta_b)$), emission-line ratios (the strength of the [OIII] line R5007, the strength of the FeII complex R4570 and the sulphur emission-line ratio $R_{[\text{SII}]}$, and the inferred density of the narrow-line region (NLR)), and the parameters λL_{5100} , M_{BH} and L/L_{Edd} . The full Spearman rank order correlation analysis was presented in Xu *et al.* (2012).

Second, we performed a principle component analysis (PCA; Boroson & Green 1992), in order to uncover the underlying drivers of the correlation space. For the first time, the NLR density was included in the PCA. We found EV1 is strongly related to R4570, $\text{FWHM}(H\beta_b)$, $R_{[\text{SII}]}$, $\text{FWHM}([\text{SII}])$ and [OIII] outflow velocity. A correlation analysis further indicates that EV1 of our sample is significantly affected by the NLR density, in addition to the Eddington ratio L/L_{Edd} (Figure 1).

4. Conclusions

For the first time, we have added the NLR density to correlation analyses. The density turned out to be a key component in EV1 space, and as important as the Eddington ratio L/L_{Edd} . This result suggests a close link between the properties of the central engine and those of the host galaxy.

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