The Interplay among Black Holes, Stars and ISM in Galactic Nuclei
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The optical spectral index vs. luminosity relation in AGN and one of its implications

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Abstract. Spectroscopic optical data (∼4200-6300 Å in the rest-frame) acquired during the monitoring of some QSOs seem to confirm that AGN spectra normally harden at higher luminosities. Focusing only on the global trend (i.e. comparing different objects), the implications in deriving luminosities using optical photometric data (through the K-correction) is briefly outlined here, as well as the result of its parameterization for calculating BH masses through the $M_{BH} \propto L_V^{\gamma}$ (FWHM Hβ)^2 virial relation.

1. Introduction

Since the work of Kaspi et al. (2000, hereafter K00), it became possible (and current) to estimate the mass of AGN supermassive black holes (SMBHs) through simple virial arguments, using some velocity dispersion + optical luminosity data. Despite the *ad hoc* assumption on the constancy of the ionization-to-optical luminosity ratio, it seems now rather established that

$$M_{BH} \propto L_{opt}^{\gamma}(\mathrm{FWHM\ H}\beta)^2 \tag{1.1}$$

with $\gamma = 0.7$† (K00) is the most powerful estimator of galactic BH masses based on single-epoch optical AGN observations.

In Netzer (2003), Bj photometric luminosities are used in BH mass estimates, when analyzing a sample of 1000 LBQS quasars. The author argues that the assumption of a power-law $L_\nu \propto \nu^\alpha$ with a single α (=−0.5) for the whole population can affect the mass estimates. The objective of this brief analysis is to evaluate this effect.

2. Samples, analysis and discussion

The spectroscopic data used here come from a monitoring of 11 nearby QSOs, conducted in Brazil (OPD/LNA) and in Chile (La Silla/ESO). They were selected from a photometric sample of 63 QSOs ($0.15 \leqslant z \leqslant 2.0$), also monitored in Brazil, in the V band, for 7 years. The left panel in Figure 1 shows a combination of all these photometric and spectroscopic data, for observations coincident in time by less than one month, to avoid variability effects. Median optical spectral indexes, derived in each epoch from the object's spectra, were used in the K-correction.

Despite the small number of data points, radio-quiet and radio-loud objects seem to follow the same trend, strengthening the positive correlation between α and L_V, with $P(r_S) \sim 10^{-4}$. The dashed line in this plot represents a linear parameterization, robustly fitted by $\alpha = (-1.07 \pm 0.24) + (0.75 \pm 0.16) \times \log(L_V/10^{10}\ L_\odot)$. The overall trend is still confirmed by the addition of other data samples: a) 55 spectra of QSOs selected from

† Note: $\gamma = 0.5$ is the prediction for a constant ionization parameter U in all AGN population.

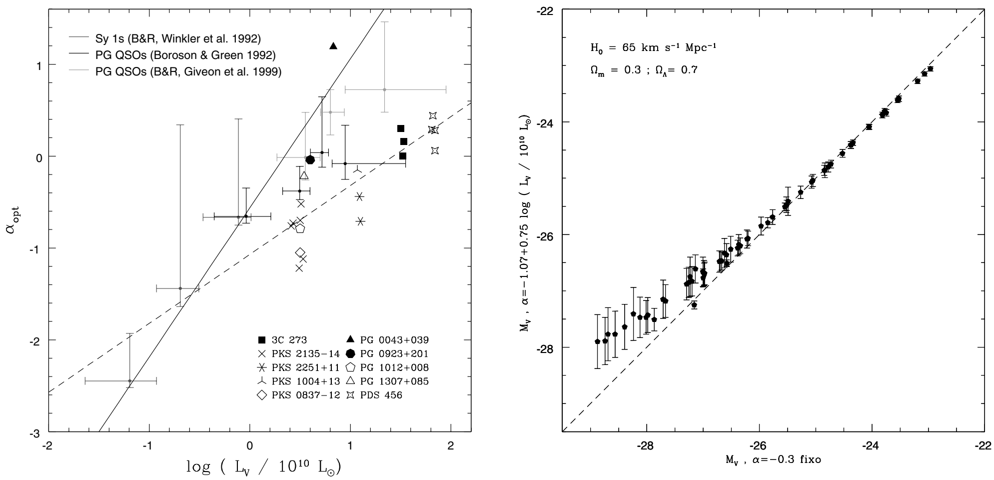

Figure 1. *Left Panel:* the spectral index vs. luminosity correlation for our data (symbols) and other samples. For the latter, the horizontal bars denote the range in luminosities, whereas the vertical ones denote quartiles, for each bin. *Right Panel*: photometric magnitudes calculated with our parameterization and with a fixed spectral index (the dashed line means 1:1 relation).

Boroson & Green (1992) sample; B and R measurements‡ of b) 42 PG QSOs observed in the Wise Observatory (Giveon et al. 1999) and of c) 35 Southern Seyfert galaxies (Winkler et al. 1992). A fit through these data (before binning) is given by the solid line.

The right panel in Figure 1 shows the effect of using a fixed α ($=-0.3$, Francis 1996) or an α dependent on the luminosity (according to the parameterization above) for calculating the absolute magnitudes of the photometric sample. Larger deviations occur for higher redshift objects, and reach a difference of about 1 mag in the most critical case ($z \approx 2$).

The impact of such a difference for estimating BH masses was evaluated calibrating equation (1.1) in terms of reverberation masses and Hβ FWHMs available in the literature, and V band luminosities calculated according to $\alpha(\mathrm{L}_V)$ above. This gives a BH mass about 60% of the one obtained using a fixed α ($=-0.3$), in the worst case. Depending on the exact slope in this $\alpha \times \log \mathrm{L}_V$ relation, it could at least partially help to explain the discrepancy between the observations and the predictions of host galaxy bulges as large as 10^{13} $\mathrm{M}_\odot$ (Netzer 2003). This demands more data analysis to evaluate, for instance, how far back in time (i.e. to which luminosities/redshifts) equation (1.1) still applies.

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‡ The spectral indexes were calculated here using the median colors of each object.

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