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The Relationship Between the Emission-Line Spectra and X-Ray/UV Continuum [1]

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According to photoionization calculations, the broad emission-line (BEL) spectrum depends not only on the physical conditions of line-emitting gas, but also on the spectral shape of incident ionizing continuum, especially from the UV to X-ray. Analysis of emission-line spectra and their correlations with the continuum, therefore, provide a way of probing the anisotropy of ionizing continuum on the BLR scale, which is predicted by current models. Previous works have concentrated on explaining the Baldwin effect, an inverse correlation between equivalent width and continuum luminosity. In this contribution, we present the results of an analysis of 75 AGNs which have well-determined soft X-ray spectral parameters from *ROSAT* and UV line and continuum measurements.

Table 1. Main Correlations

First Quantity	Second Quantity	R_s	P_r
α_{uvx}	M_{abs}	-0.471	2.0×10^{-5}
α_{uvx}	$w_r(\mathrm{C\,IV})$	0.538	6.3×10^{-7}
α_{uvx}	$w_r(\mathrm{Ly}\alpha)$	0.467	2.4×10^{-5}
α_{uvx}	$\mathrm{C\,IV}/\mathrm{Ly}\alpha$	-0.546	4.0×10^{-7}

The soft X-ray data are either collected from the literature (Wang et al. 1996, Siebert et al. 1994, 1995) or retrieved from the *ROSAT* archive and reduced by using EXSAS. The UV continuum and line fluxes are measured from *IUE* spectra for 67 objects in the sample in an objective way: UV spectra are first corrected for the Galactic reddening, and the continuum at pseudo-line-free windows is then modeled with a single power-law function. Finally, emission lines are fitted with multiple Gaussian functions. The UV data for the remaining eight objects are taken from Laor et al. (1994, 1995). The UV to X-ray spectral index (α_{uvx}) is defined by a power-law ($f_\nu \propto \nu^{-\alpha_{uvx}}$) connecting the soft X-rays at 1 keV and UV flux at 1335 Å. The average value of α_{uvx} for this sample is 1.46. The spectral indices between 1335 Å and 0.2 keV have also been calculated for comparison. Details will be presented elsewhere (Lu et al., in preparation).

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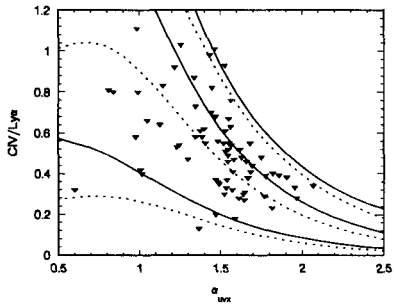

Figure 1. C IV/Lyα flux ratio vs. spectral index α_{uvx}. The triangles represent the observational values of the sources. The theoretical lines from photoionization models are plotted; dotted lines and solid lines correspond to hydrogen densities $10^9\,\mathrm{cm}^{-3}$ and $10^{10}\,\mathrm{cm}^{-3}$, respectively. From lower to upper, the three dotted or solid lines correspond to ionizing parameter $U = 10^{-2.5}$, 0.01 and 0.1, respectively.

The results of a Spearman rank correlation analysis are summarized in Table 1. The C IV/Lyα flux ratio, equivalent widths w_r(C IV), w_r(Lyα), and absolute magnitude M_{abs} are significantly anti-correlated with α_{uvx}. The correlations weaken significantly if the spectral indices between 1335 Å and 0.2 keV are used.

Theoretical emission-line spectra are calculated for column densities $10^9 < n_{\mathrm{H}} < 10^{11}\,\mathrm{cm}^{-3}$, ionization parameters $10^{-2.5} < U < 0.1$, a typical cloud column density $10^{23}\,\mathrm{cm}^{-2}$, and solar abundances. The incident ionizing continua are assumed to be power-laws in UV/X with slopes covering the observed range, but otherwise an average AGN continuum (Mathews & Ferland 1987).

Clearly, the correlation between the C IV/Lyα flux ratio and α_{uvx} can be well explained by photoionization models (Fig. 1). It is obvious that the scatter in the C IV/Lyα ratio for constant α_{uvx} can be explained by models with different BLR parameters. The correlations between the equivalent widths w_r(C IV) and w_r(Lyα) and the spectral index α_{uvx} also can be explained by the model under the assumption that the collective covering factor is in the range 0.1–0.25.

Since these results explain the relationships between the BELs and UV/X continua well, we can conclude that the input ionizing continuum is not very different from the observed continuum, i.e., there is no serious anisotropy of the AGN continuum emission on BLR scales.

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