Is there a scaling law for the size of the BELR in AGNs?

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ABSTRACT. The spectra of active galactic nuclei (AGNs) are characterised by broad permitted emission lines. The relative intensities of these lines are roughly similar in spectra of galaxies of very different continuum luminosities. The most likely source of energy for the line emitting gas is photoionization by an energetic (non-stellar) radiation field.

There are no clear density or temperature indicators for the gas which emits these broad lines and detailed photoionization models are necessary to study this gas. These models require the radius of the broad emission line region(BELR) to be greater than 0.1 pc in low luminosity AGNs and 1.0 pc in high luminosity AGNs. These models provide a simple and obvious explanation for the similar line ratios observed in the spectra of AGNs of very different continuum luminosities– the radius of a BELR increases with increasing luminosity of a galaxy to maintain constant ionizing conditions in the line emitting region.

Analysis of spectra of quasars observed more than once with IUE indicates that in the spectra of a number of quasars the emission lines (Lyα +NV and CIV) change over a very short time (Gondhalekar 1988). These data provide upper limits of the radii of BELRs in these quasars. These upper limits, plotted against the flux of ionizing radiation emitted by the quasars, are shown in in Fig.1. The flux of ionizing radiation was inferred from the observed intensity of Lyα. Also shown in Fig.1 are the radii of BELRs in low luminosity AGNs, these radii are more accurate as they have been obtained from more frequent observations.

The radii of BELRs required to model the spectra of these AGNs are also shown in Fig.1. The observed radii of BELRs are considerably smaller

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than those required to model the spectra of these galaxies, and furthermore the observed radii do not scale with the luminosity of ionizing radiation, as required by the models.

The results presented here shake our belief in our current understanding of emission of permitted lines in AGNs. The absence of luminosity scaling law for the size of BELR suggests that the current models of line emitting region in AGNs may be conceptually wrong.

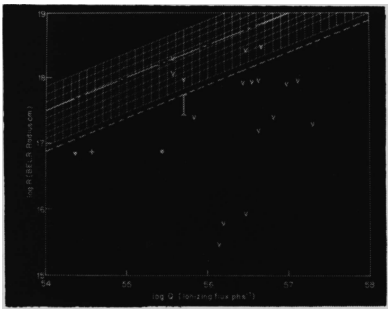

FIGURE.1. The radii of BELRs (if spherical) plotted against the flux of ionizing radiation emitted by AGNs.

NGC4151(∇)[1], NGC5548($\bullet$)[2], Ark120(+)[3], Fairall9(I)[4] and the quasars in this sample(V). The hatched area, the most optimistic choice of parameters for the "standard model"(eg Kwan & Krolik 1981); dashed line, model of Netzer(1985); dot-dash line, model of Collin-Souffrin et al(1988).

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