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Swayamtrupta Panda - Understanding the general scheme of FeII emission in active galaxies

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Quasar main sequence, analogous to the stellar main sequence , explains the connection between the wide variety of active galactic sources and their evolution. Based on *Principal Component Analysis* (PCA), the sequence can be explained by correlations between the observed spectral properties (Boroson & Green, 1992). Among those quantities, it was observed that the bulk of the correlation is driven by anti-correlation between two dominant terms - the measure of the Keplerian velocity of the Hβ profile (the full-width at half maximum) and the parameter $\mathbf{R}_{\mathrm{FeII}}$ (which is the FeII emission in the optical band between 4434-4684 Å, normalised to the broad Hβ emission). Due to its complexity resulting in numerous emission lines that span from the infrared to the ultraviolet regime, this resemblance to a continuum makes FeII difficult to extract useful information lest the spectra have a sufficiently high signal-to-noise. We utilize the current state of the art photoionisation modelling code, **CLOUDY** (Ferland et al. 2017), to estimate the net optical FeII emission (incorporating a 371 level FeII model with 68,535 transitions) emanating from the dense, ionized broad-line region (BLR) clouds. (a) With the two main physical observables - the black hole mass and accretion rate, and incorporating the distribution of viewing angle, we explain the dependence of the $\mathrm{R}_{\mathrm{FeII}}$ sequence on Eddington ratio ($\mathrm{L}_{\mathrm{bol}}/\mathrm{L}_{\mathrm{Edd}}$) and on the related observational trends. This dependence is shown as a function of the SED shape, cloud density and composition, verified from prior observations; and (b) We explain the high accretors from the theoretical relation between ionization parameter (U), the mean cloud density (n_H) and $\mathrm{R}_{\mathrm{FeII}}$. We incorporate the departure coefficient in standard radius-luminosity relation (Martínez-Aldama et al. 2019) and the fundamental plane relation (which is a bivariate relation between the Eddington ratio, $\mathrm{R}_{\mathrm{FeII}}$ and $\mathrm{D}_{\mathrm{H}\beta}$ i.e., the shape of the broad emission profile for Hβ) for the BLR (Du et al. 2016) in this relation to constrain the physical parameter space for these high-Eddington sources.

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