An X-ray Baldwin Effect for narrow Fe Kα lines

University of Leicester
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Kim Page[a], Paul O'Brien[a], James Reeves[b] and Martin Turner[a]

[a] University of Leicester, UK [b] NASA Goddard Space Flight Center, USA

We find a Baldwin Effect for the narrow Fe 6.4 Kα emission line commonly seen in Type 1 active galactic nuclei (AGN). Possible origins for the line include a molecular torus, the broad-line region (BLR) or the outer accretion disc. The observations imply a variation in emission-line region properties with luminosity.

The **Baldwin Effect** is the decrease in line equivalent width (EW) with increasing luminosity and was first identified for the C IV (λ1549) line (Baldwin 1977), although many other optical/UV emission lines show this same effect. This relation is of interest as it may indicate a systematic variation in the properties of the emission-line regions with luminosity. Observation of a Baldwin type relation for the 6.4 keV Fe Kα line may similarly provide information on the origin, geometry and orientation of the line emitting region(s). Using XMM-Newton observations, we find a narrow Fe line is common in type-1 AGN. Figure 1 demonstrates that the EW of the narrow Fe Kα line decreases as the luminosity over 2-10 keV (in the rest frame) becomes higher (Page et al. 2004). Fitting a power-law to the data implies that **$EW \propto L^{-0.17}$**.

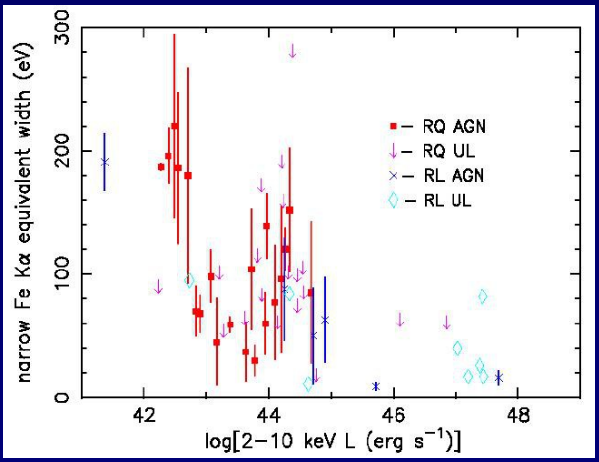

FIG. 1. The Fe Kα EW decreases as the luminosity increases.

High luminosity AGN are often radio-loud and the X-ray emission from such objects is typically ~3x higher than that from radio-quiet AGN; e.g., Zamorani et al. (1981). However, Figure 2 shows that the observed EW decrease is not simply due to dilution from beaming effects. There is also a weak correlation between the power-law slope over the rest frame 2-10 keV energy band and the Fe Kα EW (Figure 3).

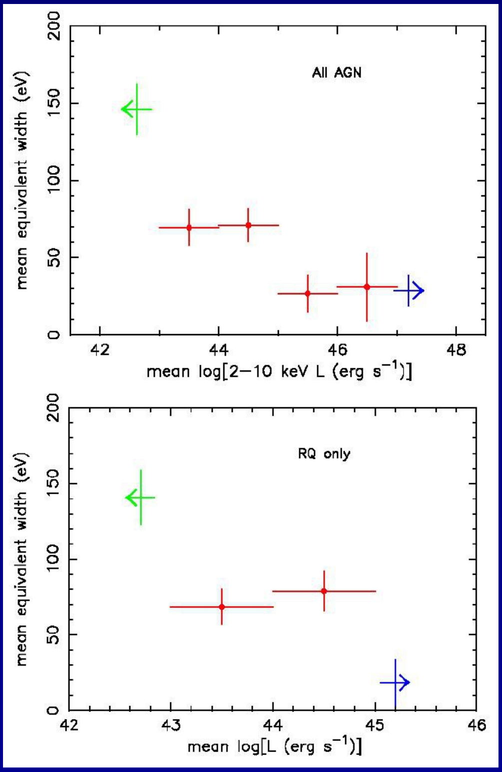

FIG. 2. Averaging the EWs within luminosity bins shows the Baldwin Effect clearly, even when radio-loud objects are excluded (bottom).

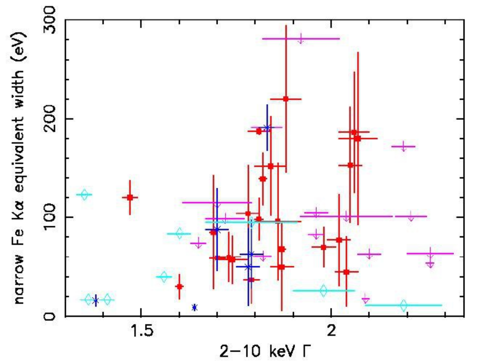

FIG. 3. As the 2-10 keV power law slope becomes steeper, there is a slight trend for the narrow Fe Kα line to become stronger. The Fe Kα EW does not correlate well with the BLR properties (line strengths or widths) for either high or low ionization optical/UV lines.

The origin of the Fe Kα line is not well determined, although the narrow component may arise from the putative giant molecular torus, invoked in AGN unification schemes, the broad line region and/or the outer accretion disc. Whatever the exact origin, the observed Baldwin Effect for the narrow component shows that the properties of the source region(s) vary with luminosity. One possible explanation is that the covering factor of the molecular torus and/or the BLR decreases as the AGN luminosity increases. This could occur for the torus due to increased radiation pressure. See Page et al. (2004) for more details.

References:
Baldwin, J., 1977, ApJ, 214, 679
Page, K. et al., 2004, MNRAS, 347, 316
Zamorani, G. et al., 1981, ApJ, 245, 357