THE DIVERSE SOFT X-RAY SLOPES OF QSOS

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ABSTRACT. We present _Einstein_ spectra for 30 QSOs which indicate a large diversity in their soft x-ray slopes, unlike the uniform slopes found for AGN higher x-ray energies. The slope is related to radio properties, x-ray luminosity or possibly redshift, but we cannot definitively distinguish these possibilities.

The recent calibration of the _Einstein_ Imaging Proportional Counter (IPC) (Harnden and Fabricant 1985) allows the investigation of faint x-ray source spectra. This provides a unique sample with which to study the soft (0.2-3.5 keV) x-ray spectra of QSOs. The sample now includes 30 QSOs with well constrained x-ray slopes ($\Delta\alpha \lesssim \pm0.5$).

A histogram of the best fit power-law slopes α($F_\nu \propto \nu^{-\alpha}$) for these 30 QSOs clearly shows a large range from 0.4 to 2.2 (Figure 1). This is in sharp contrast to previous results for active galaxies which showed a strikingly uniform slope, of α=0.7 (Mushotsky 1984). We believe (Elvis et al. 1986) that this contrast is mainly due to the IPC sensitivity which allows it to detect QSO's selected by uv-excess or radio emission rather than only the brightest 30 hard x-ray sources in the sky.

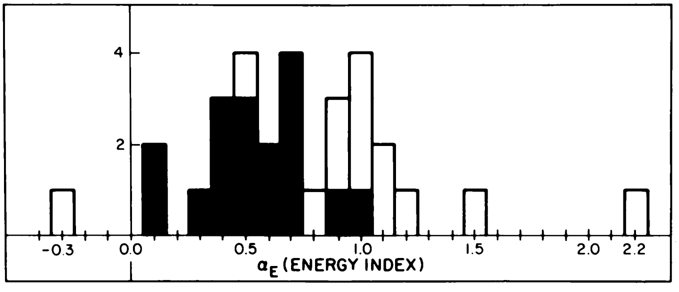

Figure 1: The distribution of α_e in our sample. RL QSOs are shaded RQ open.

Figure 1 divides the sample into radio-loud (RL) and radio-quiet (RQ) QSOs on the basis of their radio to optical slope (α_{ro}>0.35 is RL, Zamorani et al. 1981). Although the errors (typically ±0.2) introduce some scatter. There is clearly a strong tendency for RL objects to have flatter slopes than RQ. The 17 RL QSOs have a mean α = 0.54±0.06, whereas the 13 RQ have α = 1.00±0.16. A KS test shows this difference to be 99% significant. This result is readily

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interpretable if RL QSOs have a strong Inverse Compton component missing in RQ QSOs.

The RL QSOs in our sample, however, are more x-ray luminous than the RQ with little overlap in L_x, so the RL/RQ distinction may instead be a luminosity effect. A division of the sample at $L_x = 10^{44}$ erg s^{-1} yields a marginally significant (95%) difference in x-ray slope. Also AGN x-ray spectra may steepen at low energies. (This could explain part of the difference between our result and earlier, hard x-ray, measurements.) This steepening would be more easily observed in low redshift QSOs, since in them we observe a lower intrinsic energy range. Division of the sample at z = 0.2 yields a steeper mean slope for low-redshift QSOs at 95% confidence. Since z and L_x are highly correlated in our sample we cannot distinguish these two dependencies. From this data alone it is not immediately clear which parameter determines the x-ray slope. The study of Worrall et al. (this meeting) suggests that radio emission may be the key factor.

Spectral fits to the x-ray data allow us to determine the total line of sight absorbing column to each QSO. We find (Figure 2) that the column density of cold material is, on average, smaller than that due to our Galaxy as based on 21 cm data (Stark et al. 1985).

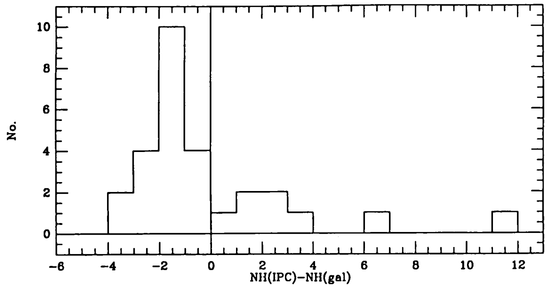

Figure 2:
The differences in N_H measured by the IPC and radio (21 cm).

A two-component x-ray spectrum which steepened at low energy, could produce this discrepancy. However ΔN_H does not correlate with redshift, α_e or radio properties so this is unlikely. It would also be surprising if the ΔN_H values produced this way were always just a few $\times 10^{20}$ atom cm^{-2}. Possibly, the radio measurements of the Galactic column (which are based on a large beam survey) may systematically overestimate the column although it is not clear how this could happen.

This first survey shows that x-ray spectra are clearly a rich subject with great potential for understanding the quasar phenomenon.

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