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ROSAT OBSERVATIONS OF HIGH REDSHIFT QUASARS

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ABSTRACT We present some results of the analysis of 4 ROSAT PSPC observations of high redshift radio-loud quasars: S5 0014+81 (z=3.39), Q0420-388 (z=3.12), PKS0438-436 (z=2.85) and PKS2126-158 (z=3.27). The quasars have mean energy spectral index of 0.8 ± 0.1, similar to that of low z, radio-loud quasars in the same emitted energy band. PKS0438-436 and PKS2126-158 show evidence of absorption above the Galactic value at $> 99.7\%$ confidence level.

INTRODUCTION

In the strong evolution shown by quasars must lie important physics for understanding what these objects are and how they form. Quasars at $z \geq 1$ have been so far studied in detail only in the optical and radio bands. However, quasars emit a large fraction of their bolometric luminosity, possibly the largest part, at energies $\gtrsim 1$ keV. Furthermore, X-ray flux variations are faster than at any other wavelength, suggesting that X-rays allow one to probe the immediate neighbourhood of the 'central engine'. So, to understand quasar evolution, it is essential to study high z objects in X-rays. ROSAT, with its high sensitivity, enables us to measure the spectra of high z quasars for the first time. The rest energy range observed by the PSPC at Z=3 is 0.5-10 keV. Previous studies of quasars in this energy range, performed with *Einstein*, EXOSAT and *Ginga*, were limited to luminosities $\lesssim 10^{46}$ erg s^{-1} and $z \lesssim 1$. Our ROSAT results extend this kind of investigation by a factor ~ 100 in luminosity and to $z \lesssim 4$. We will search for evolutionary effects by comparing ROSAT spectra of high z quasar with those of objects of low z already measured. In this paper we present some results about the 4 quasars at $z > 2.8$ for which > 250 counts were obtained.

NO CHANGE IN X-RAY SLOPE WITH LUMINOSITY OR REDSHIFT

The energy spectral indices α_E for the four quasars are plotted as a function of z and of the 2-10 keV Luminosity L_{2-10} in Fig. 1a, b. L_{2-10} is in the range $5 \times 10^{46} - 10^{48}$ erg s^{-1}. To extend this range we include the data of low z quasars and of four broad line radio galaxies (from EXOSAT and *Ginga*, see Elvis et al. 1992 for details). All α_E were obtained in approximately the same rest frame energy range (1-10 keV). The mean α_E for the 4 high z radio-loud quasars is 0.81 ± 0.10, well within the 90 % confidence range of Williams et al. (1992) and consistent with the spectral indices found in radio galaxies. We have nearly doubled the logarithmic range of L_{2-10} and extended the look back time to $\sim 10^{10}$ yr and still no $\Delta\alpha \geq 0.3$ is detected (at the 95 % confidence level).

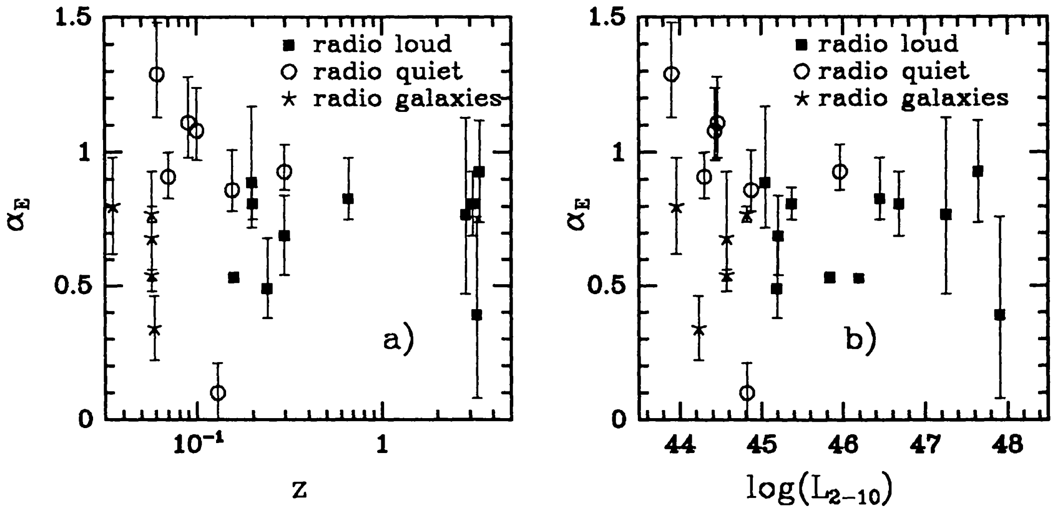

Fig. 1. The variation of α_E with z and L_{2-10}.

HIGH Z X-RAY ABSORPTION

A very unexpected result of our analysis is the discovery of significant absorption in the spectra of PKS0438-436 and PKS2126-158. If these absorbers are at the redshift of the quasars then they correspond to $N_H \sim 10^{22}$ cm^{-2}. Wilkes et al. (1992) suggested that the absorbing gas may be located within the radio emitting jet, but while PKS0438-436 has a flat spectrum core dominated radio emission, suggesting that it is beamed towards us, PKS2126-156 is a Gigahertz Peaked Source (O'Dea et al. 1991) and beaming should not be important in this source. The radio spectrum of PKS2126-156 suggests another intriguing possibility for the origin of the absorption. The pressure needed to produce the low-frequency radio cut-off due to free free absorption is $\approx 10^8$ cm^{-3} K, similar to typical pressures in X-ray cooling flows (Fabian and Crawford 1990). Recently White et al. (1991) detected X-ray absorption from material in cooling flows and therefore the X-ray absorption found in PKS2126-156 and PKS0438-436 could represent the detection of intracluster material at z$\sim$ 3.

REFERENCES

Elvis, M., et. al. 1992, in preparation.
Fabian, A.C. and Crawford, C.S. 1990, *M.N.R.A.S.*, **247**, 439.
O'Dea, C.P., Baum, S.A., and Stanghellini, C. 1991, *Ap. J.*, **380**, 66.
White, D.A. et al. 1991, *M.N.R.A.S.*, **252**, 72.
Wilkes, B. et al. 1992, *Ap. J. (Letters)*, **393**, L1.
Williams, O.R. et al. 1992, *Ap. J.*, **389**, 157.