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X-RAY SPECTRAL VARIABILITY OF THE BL LAC OBJECT PKS2155-304 IN 1983-85

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ABSTRACT

PKS2155-304 was observed with EXOSAT in 1983-85 at 9 epochs for a total of 80 hours. Large variability was detected on both short (hours) and medium (weeks) time scales. The dependence of the spectral shape with the intensity in complex.

PKS2155-304 is one of the brightest BL Lac object in the X-ray band. At a redshift $z = 0.117$ (Bowyer et al. 1984), its luminosity is also large, exceeding 10^{46} erg cm^{-2} s^{-1}. It has been extensively studied at all wavelength from radio to X-rays (see e.g. Urry 1984).

A series of observations of PKS2155-304 was carried out with the European X-ray Satellite EXOSAT from 1983 to 1985 as part of a multifrequency monitoring of this source. Results about time variability in 1983 and 1984 are presented in Morini et al. (1986). In particular, an increase of the source luminosity by a factor of 4 in 4 hours was observed, with evidence of spectral

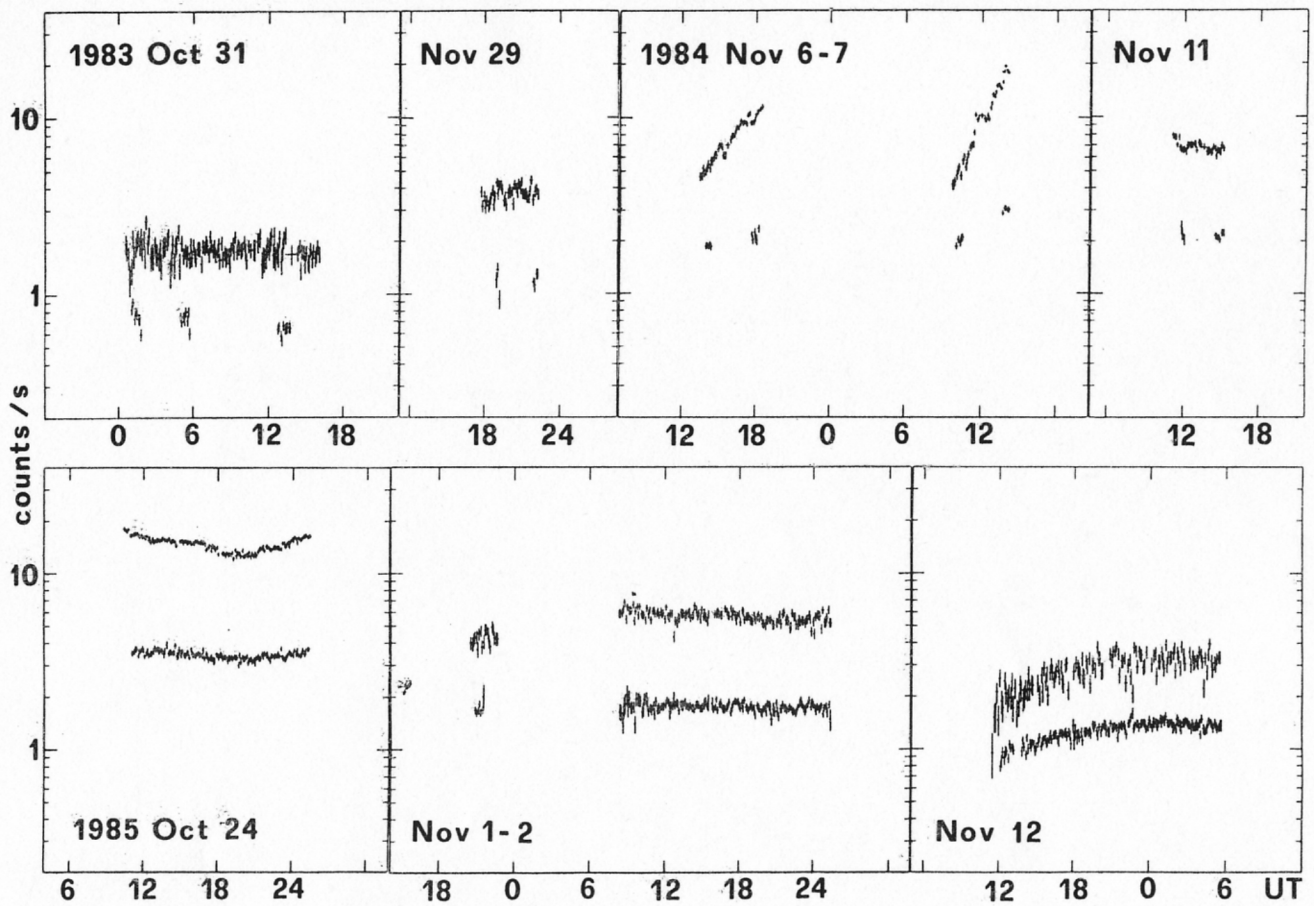
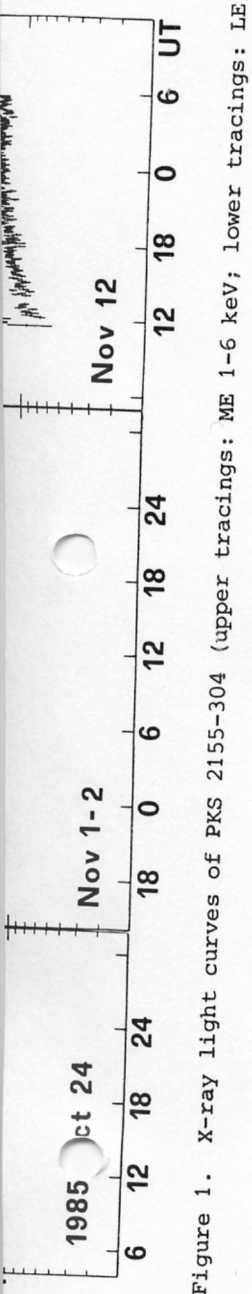


Figure 1. X-ray light curves of PKS 2155-304 (upper tracings: ME 1-6 keV; lower tracings: LE)



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hardening. During 1985 October and November we obtained further four EXOSAT observations of this source. Variability on time scales of hours was detected, although less extreme than that observed previously.

Light curves for the complete set of observations are shown in Figure 1, where the count rates in the Medium Energy (ME, 1-6 keV) and Low Energy (LE + 3000 Å Lexan filter, 0.05-2 keV) bands are reported. Comparison of the ME and LE light curves gives direct information about spectral variability. This is shown in Figure 2, where the LE flux is plotted vs the ME one. It appears that when the source was in a low state (< 5 ME counts s^{-1}) there was a rather well defined LE/ME linear relation, which accomodates points referring to different epochs, independently of the fact that the source was in a quiet or variable state. At higher intensities the LE/ME dependence is not unique. However a common feature of all the high state observations (> 5 ME counts s^{-1}) is that the ME count rates increase more than the LE ones, implying a hardening with increasing intensity.

The X-ray data averaged for each epoch have been fitted with a power law corrected for low energy absorption. The results of the fits, considering separately the proportinal counter (ME) data and their combination with the LE data, are given in Table I. For both fits typical values of the photon spectral index are $2.5 < \alpha < 3.0$. The column densities deduced from the LE+ME fit agree well with those obtained from 21 cm observations ($N_H = 1.8 \pm 0.7 \times 10^{20}$ cm^{-2}, Stark et al. 1986). The ME fit, however, yields much larger column densities, with mean value $N_H = 2.6 \pm 0.4 \times 10^{21}$ cm^{-2}. Relatively high column densities were derived also from EINSTEIN SSS observations (Urry et al. 1986). This disagreement is significant, as we consider it indicative of the inadequacy of the adopted model, as mentioned in Morini et al. (1986). More complex fits, including absorption features by a highly ionized gas (see Canizares and Kruper 1984) are being considered and will be discussed elsewhere.

References

Bowyer, S., Brodie, J., Clarke, J., and Henry, P. 1984, Ap.J.(Letters), 278, L103.

Canizares, C. R., and Kruper, J. 1984, Ap.J.(Letters), 278, L99.

Table I. EXOSAT observations of PKS2155-304

Date	Length hours	ME		ME + LE	
		Spectr.ind.[a]	N_H 10^{20} cm^{-2}	Spectr.ind.[a]	N_H 10^{20} cm^{-2}
1983 Oct 31	14	2.72 ± 0.24	6 ± 37	2.594 ± 0.056	1.06 ± 0.21
1983 Nov 29	5	2.84 ± 0.33	64 ± 57	2.577 ± 0.063	1.37 ± 0.28
1984 Nov 6	5	2.50 ± 0.07	25 ± 13	2.425 ± 0.019	1.23 ± 0.17
1984 Nov 7	4	2.58 ± 0.05	36 ± 10	2.464 ± 0.015	1.55 ± 0.19
1984 Nov 11	4	2.93 ± 0.08	55 ± 14	2.687 ± 0.029	1.91 ± 0.25
1985 Oct 24	13	2.69 ± 0.03	18 ± 06	2.629 ± 0.010	2.37 ± 0.27
1985 Nov 1	2	2.99 ± 0.29	24 ± 35	2.795 ± 0.082	1.98 ± 0.42
1985 Nov 2	18	2.78 ± 0.06	27 ± 11	2.675 ± 0.018	1.74 ± 0.20
1985 Nov 12	17	2.95 ± 0.10	21 ± 14	2.824 ± 0.028	1.86 ± 0.23

- 1 sigma errors
- a) photon spectral index α, $dN/dE = k\ E^{-\alpha}$

Morini, M., Chiappetti, L., Maccagni, D., Maraschi, L., Molteni, D., Tanzi, E. G., Treves, A., and Wolter, A. 1986, Ap.J.(Letters), 306, L71.

Stark, A. A., Heiles, C., Bally, J., and Linke, R. 1986, in preparation.

Urry, C.M. 1984, Ph.D. Thesis, NASA Tech.Mem. 86103.

Urry, C.M., Mushotzky, R.F., and Holt, S.S. 1986, Ap.J., 305, 369.

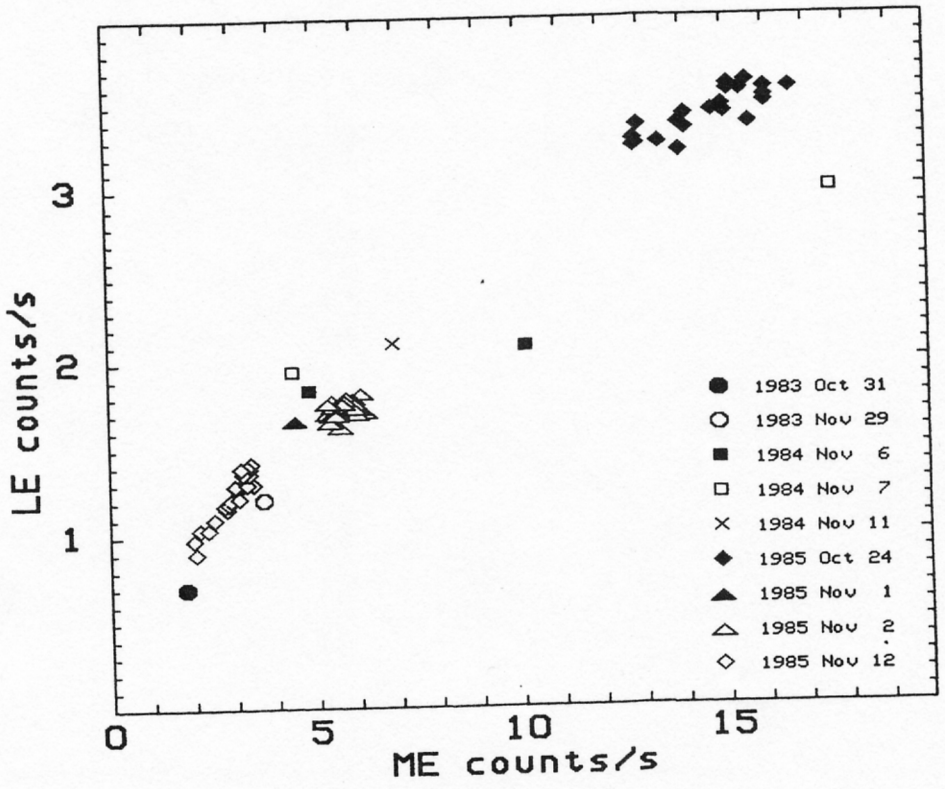

Figure 2. LE count rates as a function of the ME (1-6 keV) ones in temporal bins of 2,400 s. On the 1984 Nov 6-7 epochs when rapid variability was observed, the LE data were taken at the start and end of each observation period, when the source was at the minimum and maximum flux, respectively: the corresponding data are represented by the two pairs of points connected by dashed lines.

- 1 sigma errors
- a) photon spec.]l index α, $dN/dE = k\ E^{-\alpha}$