FLARING BLAZARS WITH BEPPOSAX

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ABSTRACT We observed three blazars in an active state with *Beppo*SAX. For ON 231 and BL Lac, we detected simultaneously both the synchrotron and the Compton component. Fast time variability was present in both sources, **only** for the synchrotron component. PKS 2005-489 was observed in a very high state and the 0.1-200 keV X-ray spectrum is well accounted for by the sole synchrotron emission. No fast time variability was detected. The SED of the three sources are well described by pure SSC models.

KEYWORDS: BL Lacertae objects: individual: ON 231, PKS 2005-489, BL Lac; X-rays: general

1. INTRODUCTION

The overall Spectral Energy Distribution (SED) of blazars shows two broad emission peaks, believed to be produced by the synchrotron and inverse Compton processes respectively. The position of the synchrotron peak is used to define different classes of blazars, i.e. HBL and LBL (high- and low-energy peak BL Lacs). The good *Beppo*SAX sensitivity and spectral resolution over a wide X–ray energy range (0.1–200 keV) are ideal to constrain existing models for the X–ray emission of blazars.

We successfully used the *Beppo*SAX satellite to perform observations of blazars that were known to be in a high state from other observations both in the X–ray

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and other bands (mainly optical and TeV). Here we present the preliminary analysis of the *Beppo*SAX observations of the three Blazars observed in an active state in 1998-99: ON 231, PKS 2005-489 and BL Lac.

2. THE DATA

2.1. ON 231 (W Com, B2 1219+28, $z = 0.102$)

It had an exceptional optical outburst in April–May 1998, reaching the most luminous state since the beginning of the century, and showed a continuing flaring activity. ON 231 has a SED that peaks in the optical, representing an intermediate object between HBL and LBL. It was observed in a high X-ray state by *Beppo*SAX in May and June, 1998, and was detected up to 100 keV. In both cases a single power law model plus absorption does not fit the data, while a broken power law model provides a good fit, with the second spectral index much flatter than the first one resulting in a concave shape (see Table 1)..

We therefore conclude that in both observations **both the synchrotron and the Compton component were detcted**. In May rapid X–ray variability of about a factor of three in few hours was clearly detected, but only at energies smaller than 3-4 keV, corresponding to the synchrotron component (Tagliaferri et al. 1999).

2.2. PKS 2005-489 ($z = 0.071$)

It is a bright BL Lac object with a SED that peaks in the UV-soft X-ray, typical of an HBL source. It has already been observed by *Beppo*SAX in September, 1996 (Padovani et al. 1998). Multiwavelength campaigns were organized in September and October, 1998 including *Rossi*XTE monitoring (Perlman et al. 1999). At the end of October, 1998, a flare alert was issued by the *Rossi*XTE team (Remillard 1998). This triggered also our *Beppo*SAX ToO observation and PKS2005-489 was observed by *Beppo*SAX on November 1-2, 1998.

We detected the source in a high state, up to 100-200 keV (see Fig. 1, left panel). Few days later the source was observed in an even higher state with the *Rossi*XTE satellite (Perlman et al. 1999). A single power law can not fit the 0.1-200 keV spectrum, while a broken power law provides a good fit. The spectrum is found to be convex, the spectral index increasing with energy by a small but significant amount with the break below 2 keV (see Table 1). This is consistent with the *Rossi*XTE results. No flux variability was detected during our observation.

As shown by the SED (see Fig. 1, left panel), for this HBL we see only the synchrotron component, that fits the X-ray data in the full 0.1-200 keV band. Recent *Beppo*SAX observations of MKN 501 and 1ES 2344+514 have shown that the peak of the synchrotron emission can move to very high energies during strong flares (Pian et al. 1998, Giommi et al. 1999). This does not seem to be the case for PKS 2005-489 where it definitely remained below few keV.

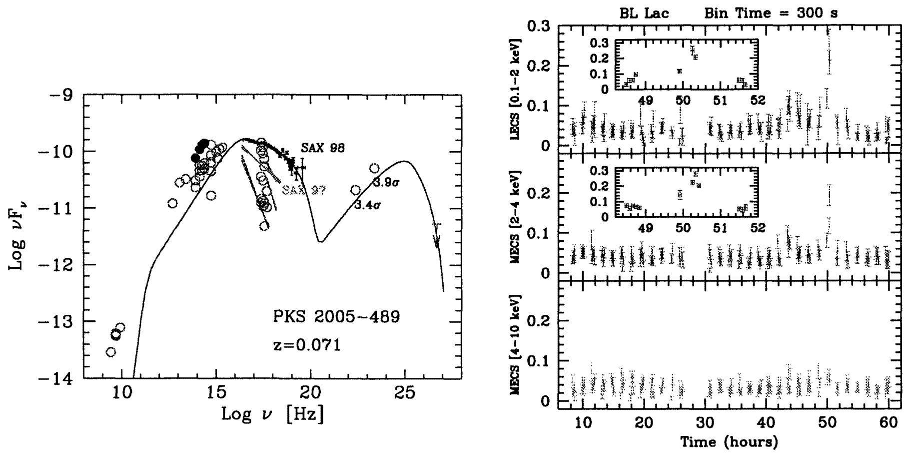

FIGURE 1. Left panel:The SED of PKS 2005-489, together with the SSC model used to fit the X–ray data. Right panel: MECS 2–10 keV (bottom panels) and LECS 0.1–2 keV (top panel) light curves of BL Lac during the June 1999 *Beppo*SAX observation. Note the clear flare detected at the end of the observations and better shown in the insert.

2.3. BL Lac ($z = 0.069$)

Its SED peaks in the optical-infrared band, i.e. it is typical of an LBL source. Also this source was already observed by *Beppo*SAX, in November 1997, in a high state with a 2-10 keV flux of $\sim 2 \times 10^{-11}$ erg s^{-1} cm^{-2} (Padovani et al. in preparation). This is comparable to the level observed by *Rossi*XTE during the 1997, July outburst. The X-ray spectrum of this object is quite hard with an energy spectral index of $\alpha = 0.4 - 0.9$, as measured by ASCA, *Rossi*XTE and *Beppo*SAX (Sambruna et al. 1999; Madejski et al. 1999; Padovani et al. in preparation).

On May, 1999, the source was again in an optically bright state, thus we triggered our *Beppo*SAX ToO and BL Lac was observed the 5-7 of June, 1999. The source was about a factor of two weaker than the first *Beppo*SAX observation. The 0.1-100 keV X-ray spectra is not fitted by a single power law. A broken power law gives a better fit with a concave shape (see Table 1). Thus, also for BL Lac we detected both the synchrotron and the Compton component.

During this observation we also find very short time variability, with the 0.1-10 keV flux increasing by a factor of two in about 20 minutes. As in the case of ON 231, this variability was detected only in the synchrotron part of the spectrum. In fact, the variability is seen by both the LECS and the MECS detectors only below the break (~ 4 keV) (see Fig. 1, rigth panel).

3. CONCLUSIONS

ON 231: the source was observed in a high state and we detected both the synchrotron and the Compton component in the 0.1-200 keV X-ray range. We detect

TABLE 1. Fit results for a broken power law model

source	date	Γ_1[a]	Γ_2	break keV	χ^2_r (d.o.f.)	$F_{[2-10\ \mathrm{keV}]}$ erg cm^{-2} s^{-1}
ON 231	11-12/05/98	$2.60^{-0.08}_{+0.07}$	$1.13^{-0.20}_{+0.30}$	$4.0^{-0.70}_{+0.55}$	0.92 (63)	4.4×10^{-12}
	11-12/06/98	$2.68^{-0.12}_{+0.11}$	$1.49^{-0.26}_{+0.25}$	$2.6^{-0.60}_{+0.50}$	0.88 (47)	3.2×10^{-12}
PKS 2005	01-02/11/98	$2.02^{-0.04}_{+0.03}$	$2.21^{-0.02}_{+0.02}$	$1.87^{-0.35}_{+0.40}$	0.90 (212)	1.8×10^{-10}
BL Lac	5 - 7/06/99	$2.18^{-0.09}_{+0.08}$	$1.74^{-0.43}_{+0.22}$	$4.0^{-1.25}_{+2.35}$	1.17 (113)	6.5×10^{-11}

[a] photon spectral index; errors at 90% confidence level for 3 parameters of interest.

fast time variability, but only for the synchrotron component.
PKS 2005-489: the source was in a very high state. The 0.1-200 keV X-ray spectrum steepens with increasing energy and is accounted for by the synchrotron emission only. The synchrotron peak did not reach the hard X-rays as in the case of Mkn 501. No fast time variability was detected.
BL Lac: the source was not very bright during our observation. However, as for ON 231, we detected both the synchrotron and the Compton component and very fast time variability, again only for the synchrotron component.

We are able to explain the SEDs of the three sources with a pure homogeneous SSC model. The intrinsic luminosities that we derived are between $0.3 - 3 \times 10^{42}$ erg s^{-1}, the magnetic field B is between 0.7-1.5 Gauss, the size R of an assumed spherical region is between $7 - 10 \times 10^{15}$ cm, while the Doppler factor δ is 14-16. In Fig. 1, left panel, we show as an example the SED of PKS 2005-489 together with the SSC model used to fit the X-ray data.

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