PROCEEDINGS OF SCIENCE

Multifrequency observations of VLBL objects

Alessandro Maselli[*a], **Enrico Massaro**[a], **Roberto Nesci**[a], **Paolo Giommi**[b] **and Silvia Sclavi**[c]

[a] *Dipartimento di Fisica, Sapienza - Università di Roma*
Piazzale A. Moro 2, I-00185, Roma, Italy
[b] *ASI Science Data Center (ASDC)*
c/o ESRIN, via G.Galilei, I-00040, Frascati, Italy
[c] *Stazione Astronomica di Vallinfreda*
Via del Tramonto, I-00020, Vallinfreda (RM), Italy

E-mail: alessandro.maselli@uniroma1.it, enrico.massaro@uniroma1.it

We present the SED of three BL Lac objects with the peak of their synchrotron emission at very low ($\simeq 10^{13}$ Hz) frequency, using ground-based radio (5 GHz) and optical-NIR data, UV and X-ray data from *Swift* satellite. A log-parabolic fit was applied to the data around the peak region, joined to a power-law in the radio. The sources showed a large flux variability, an increase of the peak frequency and a flattening of the spectral shape at higher fluxes. A comparison of the (log)shifts of the synchrotron peak and flux level of these LBL sources with that of an HBL one (Mrk 421) indicates that the same physical mechanism originates the flux variability of these objects, despite the large difference in peak frequency, and therefore physical parameters of the jets.

Workshop on Blazar Variability across the Electromagnetic Spectrum
April 22-25 2008
Palaiseau, France

*Speaker.

PoS(BLAZARS2008)077

1. Introduction

BL Lacertae objects are a peculiar class of Active Galactic Nuclei. The origin of their Spectral Energy Distribution is believed to be non thermal and presents a double bump shape. The lower frequency bump is attributed to synchrotron radiation, and the second bump would be the signature of inverse Compton scattering by the synchrotron electrons. BL Lacs are usually classified according to the peak frequency ν_p of the synchrotron bump that usually spans the range $10^{13} < \nu_p \leq 10^{18}$ Hz, from the infrared/optical for the Low-energy peaked BL Lacs (LBLs) to the X-ray range for the High-energy peaked BL Lacs (HBLs). This denomination was introduced by Padovani & Giommi (1995) and was motivated by a more physical approach to the classification of these sources, with respect to an initial one based on the survey of selection. Following this habit of naming sources, at the lower and higher end of this range we find VLBLs (Very Low-energy peaked BL Lacs, Antón & Browne 2005) and EHBLs (Extremely High-energy peaked BL Lacs, Costamante et al. 2001).

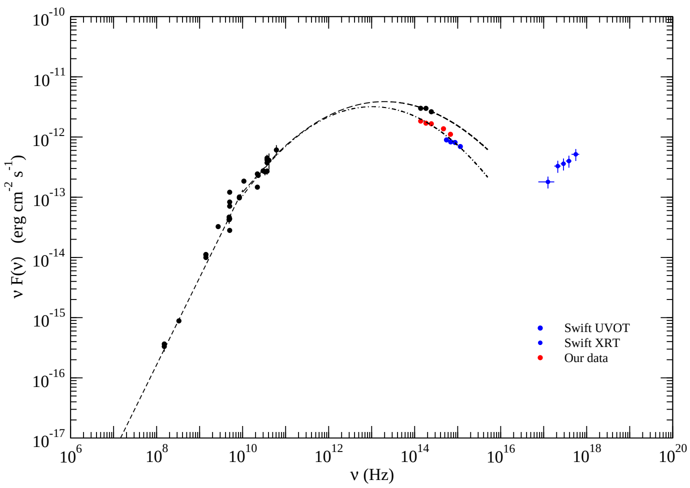

Figure 1: Spectral energy distribution of BZB J0753+5352.

2. VLBL sources

We focus here on some VLBL sources, having ν_p in the poorly explored infrared energy band. We intend to determine with the best accuracy the SED peak frequency and how it changes because of the intrinsic variability of the source. An important subject to address is the origin of such a low ν_p value. Two possible explanations are *i*) an intrinsic low efficiency of electron acceleration in the jet, or *ii*) a low beaming factor δ. VLBL sources are expected to have high flux in the radio and low flux in the optical band, where the synchrotron emission declines; typical values of the radio-optical index α_{ro} for VLBL candidates were found greater than 0.6 (Sclavi et al. 2005, AGN7 Italian Conf.). Using literature data, we selected some VLBL candidates according to:
1) radio flux at 5 GHz higher than 200 mJy; 2) V-band magnitude, corrected for interstellar absorption, fainter than 17.0; 3) spectral index $\alpha_{ro} \geq 0.6$. We started a campaign of photometric

observations in January 2005 until November 2006; sources with high declination were favoured to observe them along the whole year. We used B, V, R and I filters at the telescopes of Loiano (152 cm) and Asiago (182 cm) observatories. In a few nights we could also carry out simultaneous observations in the infrared J, H and K filters at the AZT24 telescope of Campo Imperatore (110 cm). The already studied BL Lac object S5 1803+78 (Nesci et al. 2002) was included in our sample. A few observations for five of these sources in the optical-ultraviolet and in the X-ray ranges were performed by the UVOT and XRT instruments on board the *Swift* satellite. Here we report the results for three sources, characterized by a well sampled Spectral Energy Distribution and detected in the X-ray range by *Swift*. These sources are BZB J0753+5352 (S4 0749+540), BZB J0818+4222 (S4 0814+425, also known as OJ 425) and BZB J1800+7828 (S5 1803+78).

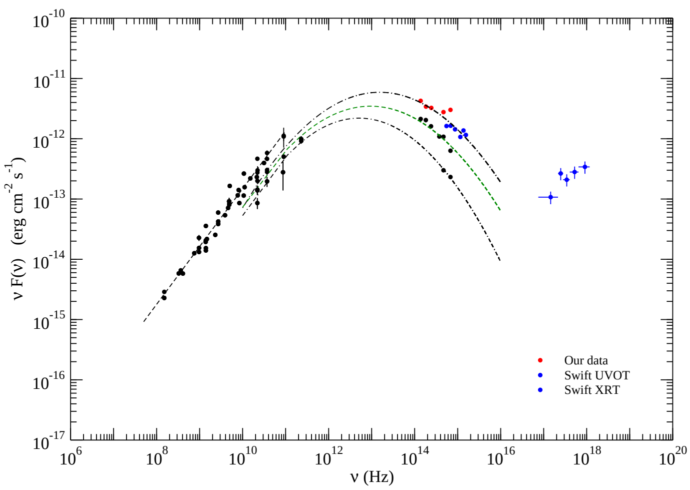

Figure 2: Spectral energy distribution of BZB J0818+4222.

3. Results

Figs.1 to 3 show the SEDs of the considered sources. In the radio band we applied a power law fit $F(\nu) = K\nu^{-\alpha_r}$ while in the region around the synchrotron peak we applied a log parabolic fit:

$$\nu F(\nu) = \nu_p F(\nu_p) \cdot 10^{-b\,[\mathrm{Log}(\nu/\nu_p)]^2} \tag{3.1}$$

The obtained parameter's values are reported in Table 1. As expected all the sources, particularly BZB J0818+4222 and BZB J1800+7828, reveal a significant variability in the optical band. For this reason we applied the log parabolic fit to opportunely selected points to evaluate possible changes of ν_p: in particular we distinguished "faint" and "high" state. The spectral changes confirm a high frequency shift of the peak and a lower curvature parameter b when bright states occur. This change is particularly evident in BZB J1800+7828, whose peak moved in frequency by more than a factor of 30. This behaviour has already been put in evidence for Mrk 421 (Tramacere et al. 2007) and other HBL objects (Massaro F. et al. 2008). For the two other sources no such large flare was observed: the amplitude was within a factor of 2 or 3 and ν_p remained close to 10^{13} Hz.

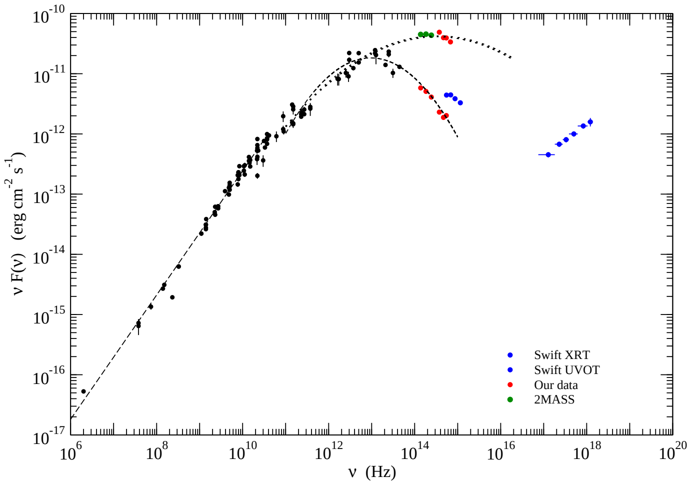

Figure 3: Spectral energy distribution of BZB J1800+7828; 2MASS points are simultaneous to one of the observations of our campaign, reported in this plot and catching the source in the highest state ever detected.

		Faint			High		
Source	α_r	ν_p	$\nu_p\,F(\nu_p)$	b	ν_p	$\nu_p\,F(\nu_p)$	b
BZB J0753+5352	-0.45	1.04	3.19	0.16	1.98	3.87	0.14
BZB J0818+4222	0.04	0.51	2.20	0.22	1.54	5.90	0.19
BZB J1800+7828	-0.03	0.95	18.29	0.32	33.55	41.75	0.12

Table 1: Values of radio spectral index α_r, peak frequency ν_p, corresponding $\nu_p\ F(\nu_p)$ and curvature parameter b are reported. ν_p is given in 10^{13} Hz, while $\nu_p\ F(\nu_p)$ is given in 10^{-12} erg cm^{-2} s^{-1}. Values relative to faint and high state are distinguished.

We compared the spectral evolution of BZB J1800+7828 in the optical band with that of Mrk 421 in the X-ray band (for which a large collection of observations is available) and superposed their SEDs after a shift in frequency (by a factor $\sim 5 \cdot 10^{-4}$) and in $\nu F(\nu)$ (by about a decade) of the SED of Mrk 421. In this way the synchrotron peaks of the two sources overlap both in the high and in the faint state, indicating a similar spectral dynamics. Note that we are comparing source fluxes, but their luminosities are very different: with a redshift $z = 0.034$, Mrk 421 is much closer than BZB J1800+7828 ($z = 0.680$), then its luminosity is lower by a factor of ~ 60. This similar behaviour suggests that particle acceleration mechanisms responsible of non thermal emission in these two BL Lac objects having different ν_p work in the same way.

4. Acknowledgements

We acknowledge funding from ASI grant I/010/06/0.

References

[1] Antón S. & Browne I.W.A., 2005, MNRAS **356**, 225

[2] Costamante L., Ghisellini G., Giommi P. et al., 2001, A&A **371**, 512

[3] Massaro E., Perri M., Giommi P., Nesci R., 2004, A&A **413**, 489

[4] Massaro F., Tramacere A., Cavaliere A. et al. 2008, A&A, **478**, 395

[5] Nesci R., Massaro E., Maesano M. et al., 2002, AJ **124**, 53

[6] Tramacere A., Giommi P., Massaro E. et al., 2007, A&A **466**, 521