What can BeppoSAX tell us about X-ray spectra of BL Lacs ?

Anna Wolter[a],Andrea Comastri[b], Gabriele Ghisellini[a], Paolo Giommi[c], Matteo Guainazzi[c], Tommaso Maccacaro[a], Laura Maraschi[a], Paolo Padovani[d], Claudia Raiteri[e], Gianpiero Tagliaferri[a], C.Megan Urry[d], Massimo Villata[e]

[a]Osservatorio Astronomico di Brera, Milano

[b]Osservatorio Astronomico di Bologna, Bologna

[c]A.S.I. BeppoSax Science Data Center, Roma

[d]Space Telescope Institute, Baltimore

[e]Osservatorio Astronomico di Torino, Pino Torinese.

The wide energy band of **BeppoSAX**, together with its good energy resolution, offers the opportunity to investigate the overall X-ray spectra of BL Lacs, in order to measure in detail their shape, to establish where the Compton component becomes dominant over the synchrotron component. We present here preliminary results from the first year of BeppoSAX observations for a sample of **soft X-ray selected BL Lacs**.

Ten XBL have been observed and analyzed so far: variability with respect to previous observations is very common, spectra are generally well fitted by a single power law, although a few examples of more complex spectra are present. We show **BeppoSAX spectra** and compare the results on the correlation between the X-ray slope and the **peak frequency** of the overall spectral energy distribution with those for a sample of radio selected BL Lacs.

1. Introduction

The emission from radio to γ-rays of the BL Lac class can be explained as due to synchrotron radiation up to a certain maximum frequency (that ranges from about 10^{13} to 10^{18} Hz), above which a sharp turnover occurs until a second component due to Compton scattered radiation dominates, making these objects detectable up to the highest energies so far accessible (e.g. [1]). The extreme properties of BL Lacs however require that the matter emitting the radiation moves at relativistic speeds in the direction of the observer. The two components (synchrotron and Compton) intersect in the X-ray band. We have undertaken a program to study the X-ray spectrum of a well defined sample of XBL with the aim of measuring in detail the shape of the most energetic part of the synchrotron emission in XBL, and trying to establish where and how the Compton component becomes dominant. The *BeppoSAX* satellite has an unprecedented capability of detecting X-rays in a very wide energy band with a good energy resolution.

2. The sample and data analysis

We present here the first 10 objects of the XBL sample observed by the Narrow Field Instruments of *BeppoSAX*. For two objects, 1ES0414+009 and 1ES0502+675, the LECS instrument was not available during the observation. All sources appear pointlike in both the LECS and MECS images. Counts are extracted in circular regions containing at least 95% of the source photons, i.e. of 8.5'/4' (LECS/MECS). We fitted together LECS and MECS, assuming that the spectral shape is a single power-law model plus free low energy absorption.

The brightest source of the sample (1ES1101–232) has been detected (at 3.5σ) also in the PDS, at least up to 50 keV, in just about 6ks of on-source observing time, probably aided by the fact the spectrum is flat, and seems to continue with

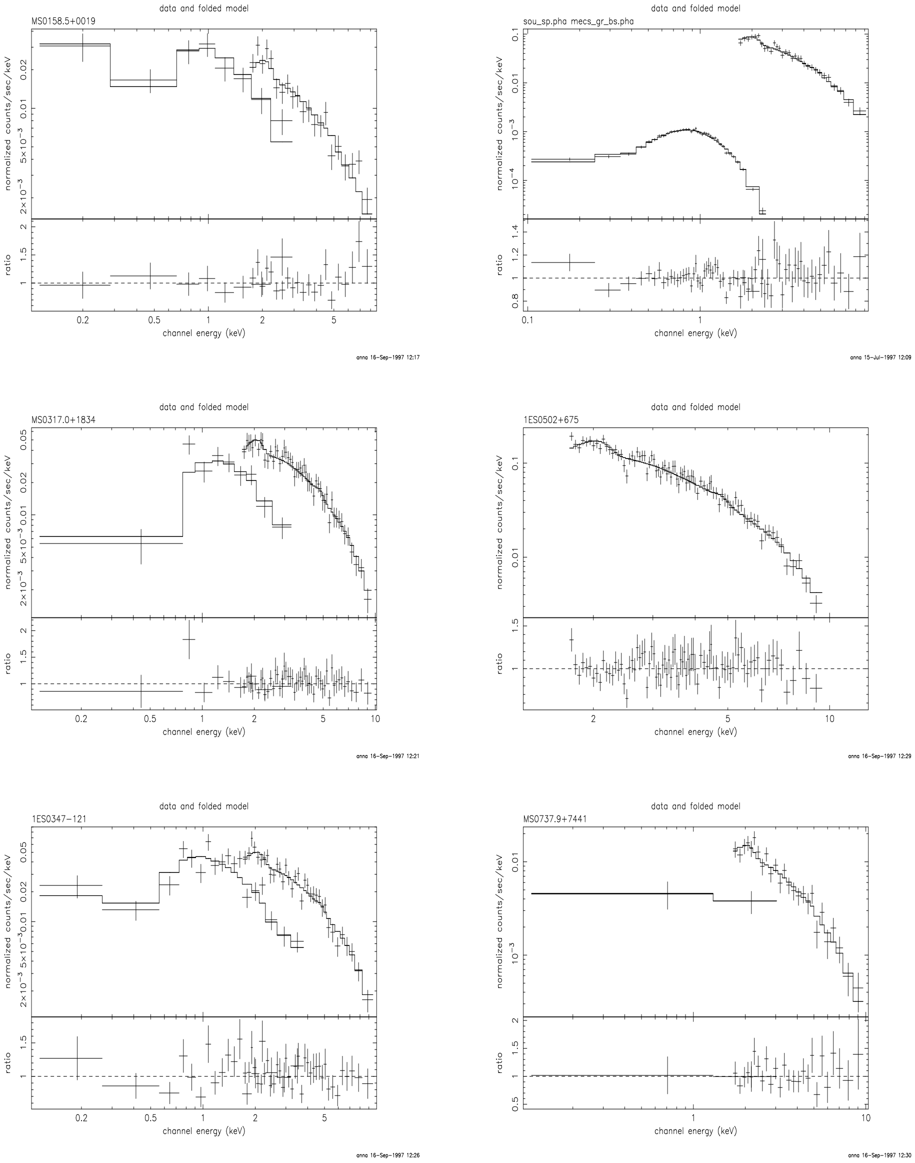

Figure 1. X-ray data and fitted spectrum, and ratio of data to fit.

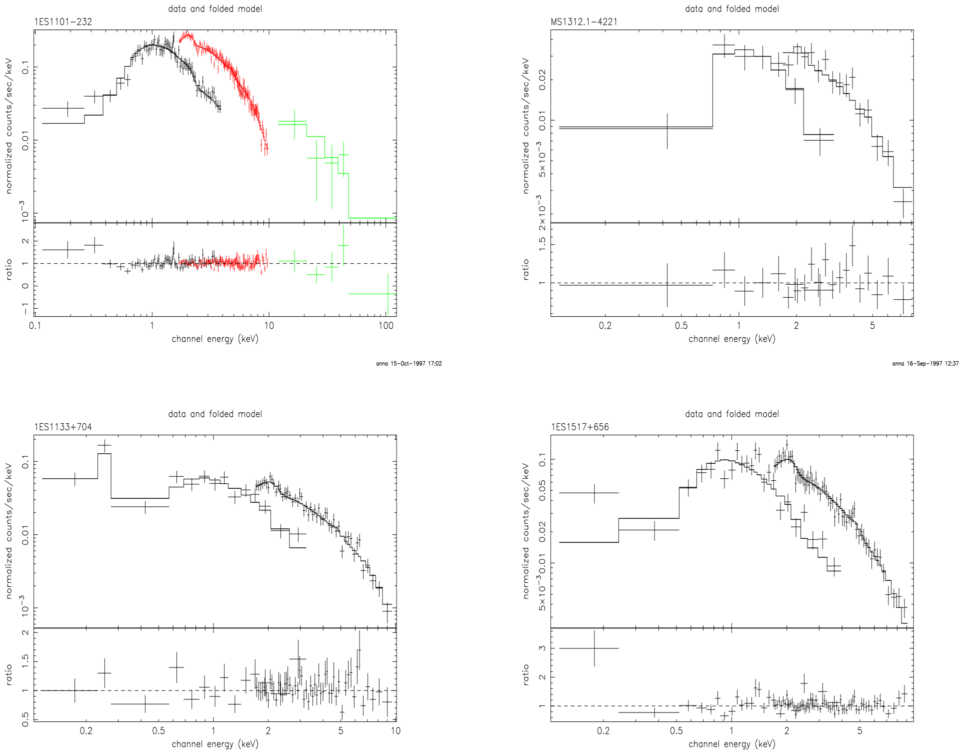

Figure 1. X-ray data and fitted spectrum, and ratio of data to fit.

the same flat slope in the PDS band.
We plot the spectra for all sources in Figure 1. All the objects except 1ES1101–232 are well fitted by a power law with low energy absorption at a confidence level $\geq$ 90%; in two cases however (1ES1133+704 and 1ES1517+656) the fitted N_H is higher than the galactic value by more than a factor of two, and skewed residuals appear in 1ES0347–121, 1ES1101–232 and 1ES1517+656.
For these objects we have tried a more complex model for the fit, using a broken power law with low energy absorption fixed to the Galactic value. A significant improvement is found in only 2 cases, 1ES1101–232 and 1ES1517+656 (the worst χ^2 for a single power law), and marginal improvement for 1ES0347–121 and 1ES1133+704. Therefore, the hypothesis that the apparent eccess in absorption is due instead to a curved spectrum seems to be acceptable.

3. Spectral Energy Distributions

We have searched the literature to produce the overall spectral energy distribution (SED) of the observed sources. We have also added the SAX spectra as computed here, and the magnitudes derived from optical observation obtained at the same time as the SAX observations from the Torino Astronomical Observatory.
The SED of the objects in our sample are characterized by a smooth distribution, rising from the radio to the optical-UV and X-ray bands. Variability is evident, expecially in the most often observed objects. Many objects show a fall off at high energies. In order to obtain a reliable estimate of the peak energy, the SED of each object has been fitted with a cubic polynomial function (see [2]). For the fit, we fixed the SAX data for the X-ray band, and same-epoch optical data

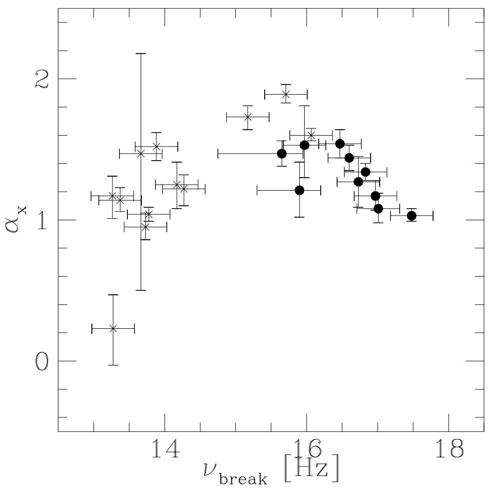

Figure 2. Plot of α_x as a function of ν_{peak}; Solid circles are XBLs: α_x values from *BeppoSAX* spectra and ν_{peak} from fit of SED. Crosses are RBLs adapted from [2].

when available. For the other data, we used the maximum observed value in each band in order to minimize variability effects.
We plot in Figure 2 the α_x values vs. the peak frequency of the SED. We include also the data for RBL objects as taken from [2].

4. Summary

We have presented the first 10 *BeppoSAX* spectra of a sample soft X-ray selected BL Lacs. The spectra are generally well fitted by a power law, but in a number of cases there seems to be a convex curvature, mimicked by an enhancement of the low energy absorption. The overall energy distribution is smooth, rising from the radio to the UV–X-ray band. The X-ray spectrum follows the overall shape. In one case we have a detection also in the PDS, up to $\sim 50keV$, implying that this harder energy band is within reach with exposures of some tens of ksec. The correlation of α_x with ν_{peak} is very tight in the XBL objects, probably also due to having a same-epoch optical observation that well constrains the determination of the SED peak.

The comparison of α_x vs. ν_{peak} for RBL and XBL supports the view that we see in the X-ray band, as the peak of the distribution moves to higher frequencies, the Compton component becoming less dominant in the LBL (Low-Peaked BL Lacs) objects, and the syncrotron emission in the HBL (High-Peaked BL Lacs) objects flattening as the peak comes closer to the observed range, as was proposed by [3] using ROSAT data.

Only a handful of objects, in a very high intenstity state, have been found with a higher peak frequency, but according to this picture there should be a number of XBL (or HBL) in which the steepening of the X-ray spectrum due to the Compton bump starts to emerge, that in their "normal" state peak at frequencies $\geq 10^{18}$ Hz.

A detailed description of the *BeppoSAX* observations is in progress (Wolter et al., in preparation)

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