Observation of blazars with the high energy SED peak in the Fermi-LAT band

Gino Tosti (UNIV.PG/SLAC), Claudia Monte (INFN/Bari), Stefano Ciprini (INAF/ASI), Silvia Rainò (INFN/Bari),
on behalf of the Fermi Large Area Telescope Collaboration

Introduction

The Large Area Telescope (LAT) onboard the Fermi Gamma-ray Space Telescope is an very suitable instrument to studying the variability and spectral characteristics of blazars. In fact, thanks to its large field of view (covering the 20 % of the sky at any instant and the full sky in about 3 hours), large effective area and sensitivity, and the all-sky operating mode, the LAT is an unprecedented instrument to monitor the emission of blazars in the energy band 20MeV to > 300GeV.
Among the blazars included both in the first Fermi-LAT catalog of AGN (1LAC, [1]), a particular and interesting group of objects is the one composed by those blazars that have their Spectral Energy Distribution (SED) high-energy peak in the Fermi-LAT band (from 20 MeV to 300 GeV). The brightest of these sources have been analyzed over a period of 22 months of Fermi LAT gamma-ray data in order to investigate their spectral features in the gamma-ray band and to characterize the temporal evolution of their gamma-ray spectra.

The sample

The blazars included in our sample has been extracted starting from the 1LAC [1]. All blazars detected with Test Statistic (TS) greater then 100 have been taken into account. A preliminary analysis has been performed in the energy band from 100 MeV to 300 GeV using a deconvolution technique (unfolding method [2]) to reconstruct the source energy spectra from the one year observed data after background subtraction.
Looking at the reconstructed Spectral Energy Distributions obtained in this way, a selection has been made among the blazars, including in our sample only those objects showing their SED high energy peak in the Fermi-LAT energy band. First of all, the sources with the high energy peak greater than 200 MeV have been included; than also sources that could probably have an extrapolated peak between 20 MeV and 200 MeV have been added. The final sample includes 17 sources (12 BL Lacs and 5 FSRQs).

Data Analysis and Results

All the sources in our selected sample have been analyzed using the Fermi-LAT data covering a period of 22 months from August 4, 2008 (the starting date of the science phase of the mission) to June 4, 2010. For each source, only photons with energy in the range from 200 MeV to 300 GeV have been selected in a Region of Interest (RoI) of 15° centered around the source itself. The data have been analyzed using a binned maximum likelihood technique, implemented in the gtlike [3] analysis tool developed by the LAT team, in three different ways.
In the first case, the whole energy range has been divided into energy bins and the gtlike tool has been used to calculate the flux in each band: a Power Law parametric model with Spectral Index fixed at 2, is assumed in each individual energy bin both for the source spectrum and for the background components. In the second and third method of analysis, a maximum likelihood fit is performed in the whole energy band (200 MeV – 300 GeV) modeling the source under investigation respectively with a Power Law (PL) or with a Log Parabola (LP).

The flux light curves for our sources have been generated dividing the total observation period (22 months) in 1 month time bins and applying the maximum likelihood fit across the overall energy band for each time bin. Looking at the adjacent bins in which the source showed the maximum flux (high state, red selection in the plot on the right) and the minimum flux (low state, blue selection in the plot on the right) have been considered and the gtlike analysis has been repeated for each source both in the high and in the low state with the three different techniques used for the analysis in the 22 months period. For PKS 0118-272, CRATES J0334-3725, 4C +55.17 and B2 1229+29 it has not been possible to identify clearly the high and/or low-state in their light curves.

The results of the fit with a PL to the 22 moths data and to the high and low-flux states are reported in the table. The spectra of PKS 0537-441, one of the most variable source in our sample, obtained during the faint and high states here considered is reported on the right.

Conclusions

A sample of 17 sources has been selected from the 1LAC. A preliminary spectral analysis performed over a period of 22 months seems to show that the Log Parabola function is better than the Power Law function in order to model the shape of the SED high-energy peak in the gamma-ray energy range for these sources. The spectral analysis performed in the selected high and low state for each sources show different spectral behaviors during faint and high states.

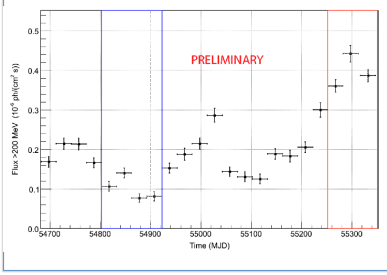
References

[1] Abdo, A. A. et al. 2010, ApJ, 715, 429
[2] M. N. Mazziotta, Proc. of the 31° ICRC, LODZ 2009
[3] http://fermi.gsfc.nasa.gov/ssc/data/analysis/documentation/Cicerone/Cicerone_Likelihood

Sources List

1FGL name	Other name	$\Gamma(22-m)$	Γ_{Low}	Γ_{High}
J0112.0+2247	CGRaBS J0112+2244	2.20 ± 0.03	2.41 ± 0.13	2.03 ± 0.08
J0120.5−2700	PKS 0118−272	...	...	...
J0217.9+0144	PKS 0215+015	2.24 ± 0.04	2.08 ± 0.13	2.15 ± 0.06
J0222.6+4302	3C 66A	1.99 ± 0.02	1.99 ± 0.05	1.88 ± 0.03
J0238.6+1637	PKS 0235+164	2.22 ± 0.02	2.77 ± 0.19	2.12 ± 0.02
J0334.4−3727	CRATES J0334−3725	...	...	...
J0428.6−3756	PKS 0426−380	2.12 ± 0.01	2.16 ± 0.05	2.07 ± 0.02
J0538.8−4404	PKS 0537−441	2.19 ± 0.01	2.37 ± 0.06	2.00 ± 0.02
J0719.3+3306	B2 0716+33	2.19 ± 0.03	2.28 ± 0.13	2.20 ± 0.08
J0721.9+7120	CGRaBS J0721+7120	2.13 ± 0.02	2.14 ± 0.11	2.12 ± 0.03
J0818.2+4222	B3 0814+425	2.24 ± 0.03	2.15 ± 0.14	2.22 ± 0.07
J0957.7+5523	4C +55.17	...	...	...
J1231.6+2850	B2 1229+29	...	...	...
J1246.7−2545	PKS 1244−255	2.36 ± 0.03	2.35 ± 0.19	2.27 ± 0.05
J1542.9+6129	CRATES J1542+6129	2.06 ± 0.03	2.13 ± 0.14	2.05 ± 0.08
J2139.3−4235	CRATES J2139−4235	2.18 ± 0.04	2.25 ± 0.12	2.11 ± 0.06
J2344.6−1554	CGRaBS J2345−1555	2.34 ± 0.05	2.53 ± 0.12	2.09 ± 0.06

Light Curve of PKS 0537-441



Spectrum of PKS 0537-441