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# Relation between X-Ray and $\gamma$-Ray Emissions for Fermi Blazars

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**Abstract.** Using $\gamma$-ray band data detected by Fermi Large Area Telescope (LAT) and X-ray band data for 78 blazars, we find a medium correlation between X-ray and $\gamma$-ray fluxes in the average state. A medium anticorrelation is also found between X-ray (1 KeV) mean spectral index $\alpha_x$ and $\gamma$-ray mean spectral index $\alpha_\gamma$ for blazars. Our results suggest that the most likely radiation mechanism for the high energy $\gamma$-ray would be SSC. And that the $\gamma$-ray emission mechanism may be somewhat different for BL Lacs and FSRQs.

*Key words.* Galaxies: active—BL Lacertae objects: general—$\gamma$-ray: general—non-thermal.

## 1. Introduction

Blazars are the brightest and most dominant population of Active Galactic Nuclei (AGN) in the $\gamma$-ray sky (e.g., Abdo *et al.* 2010). Many models have been proposed to explain the origin of blazar $\gamma$-ray emission, including synchrotron self-Compton and inverse Compton scattering (e.g., Maraschi *et al.* 1992). However, there is no consensus on the dominant emission process. These emission models may imply various correlations in different wavelengths that can be used to distinguish among themselves observationally. The relation between X-ray and $\gamma$-ray is believed to be the key for understanding the origin of $\gamma$-ray emission in blazars. So it is important to explore the relation between X-ray and $\gamma$-ray emissions.

In this paper, we considered the sample of blazars studied by Zhang *et al.* (2001) which constructed a relatively large sample of Fermi blazars with information about X-ray and $\gamma$-ray emissions and the spectral index. Then some of the X-ray flux are cross-correlated from Fossati *et al.* (1998). All flux densities are *k*-corrected (Zhang *et al.* 2003) according to $F_\nu = F_\nu^{\rm obs}(1+z)^{\alpha-1}$, where $\alpha$ is the spectral index ($f_\upsilon \propto \upsilon^{-\alpha}$), for some objects whose spectral indexes are not obtained using $\alpha_x = 1.47$ for BL Lacs, and $\alpha_x = 0.87$ for other sources (Xiong *et al.* 2012).

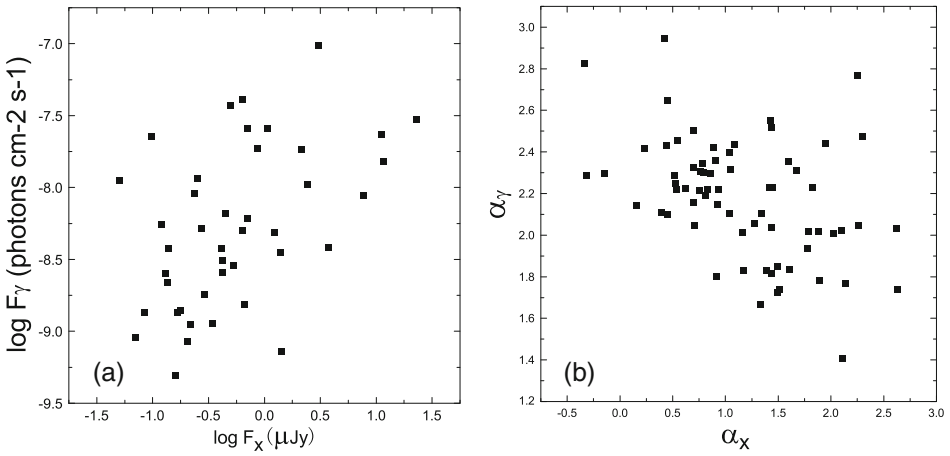


**Figure 1.** Correlations between $F_x$ and $F_\gamma$ in the average state (**a**), and between $\alpha_x$ and $\alpha_\gamma$ (**b**).

## 2. Correlation of $\gamma$-ray emission with X-ray emission

According to our collected data, linear correlation is applied to the analysis of flux and spectral index (Figures 1 and 2) . The analysis results are as follows:

1. There is a medium correlation between $F_\gamma$ and $F_x$ in the average state for 40 objects with observations in both low and high states, $r = 0.48$ and $P = 0.00125$.
2. There is a medium anticorrelation between X-ray spectral index $\alpha_x$ and $\gamma$-ray spectral index $\alpha_\gamma$ for 68 objects, $r = -0.43$ and $P = 2.40 \times 10^{-4}$.
3. We also explore the correlation between $F_\gamma$ and $F_x$ separately for different subclasses of blazars in the average state. For 42 BL Lacs, $r = 0.22$ and $P = 0.15941$; for 36 FSRQs, $r = 0.32$ and $P = 0.06089$.

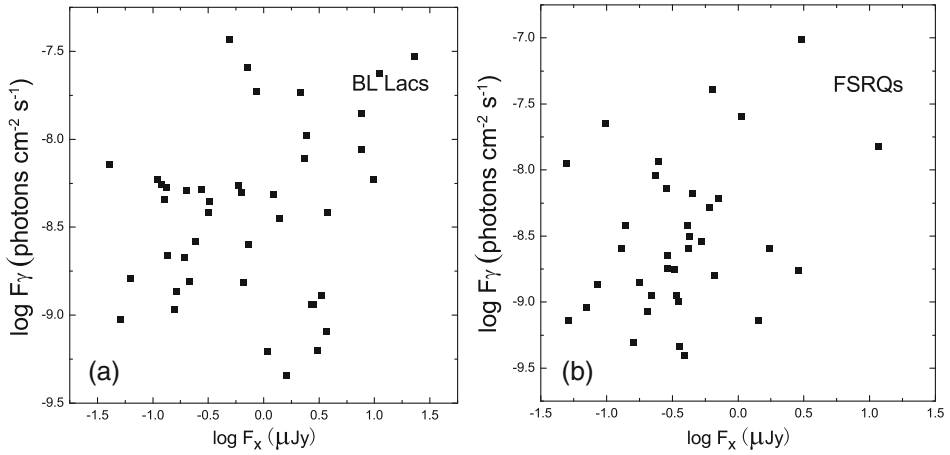


**Figure 2.** Correlations between $F_x$ and $F_\gamma$ in the average state for **(a)** BL Lacs and **(b)** FSRQs.

## 3. Discussion

The medium correlation between Fermi/LAT $\gamma$-ray and X-ray flux is a strong indication of the common origin of X-ray and $\gamma$-ray radiations in Fermi blazars. From the above results, we can conclude that for blazars, the most likely radiation mechanism for the high energy $\gamma$-rays would be SSC. But we cannot rule out other possible models completely. Since the beaming effect may smear out a possible correlation between the intrinsic flux (Mucke *et al.* 1997), we assume that X-ray and $\gamma$-ray emission regions are co-spatial. Finally, our results support the view that $\gamma$-rays are produced co-spatially with X-ray radiation, mainly through SSC process. Co-spatial origin of X-ray and $\gamma$-ray emissions would also serve as a natural explanation of the possibly similar relativistic boosting properties in the two bands. Besides, we conclude that $\gamma$-ray emission mechanism may be somewhat different for BL Lacs and FSRQs. BL Lac objects are a subclass of blazars that have a low accretion rate, $\dot{m}$, in the range of 0.0201–0.0970 (Xie *et al.* 2004). FSRQs are another subclass of blazars that have a high accretion rate, $\dot{m}$, in the range of 0.0620–0.1682 (Xie *et al.* 2004), which may explain the result that FSRQs have stronger emission than BL Lacs.

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