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Correlation Analysis of Multi-Wavelength Luminosity of Fermi Blazars

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Abstract. We have studied the correlations between luminosities ($L_{\rm R}$, $L_{\rm O}$, $L_{\rm X}$, L_{γ}) in radio, optical, X-ray and γ-ray wave bands for Fermi blazars, and found that there are significant correlations between $L_{\rm R}$ and Lγ, $L_{\rm X}$ and Lγ and $L_{\rm O}$ and Lγ for blazars, BL Lacs and FSRQs, but no correlation between Lγ and $L_{\rm O}$ for BL Lacs. These results suggest that for Fermi blazars, the high energy γ-ray emission can be related with radio, X-ray and optical emissions.

Key words. BL Lacertae objects: general—gamma rays: observations—radiation mechanisms: nonthermal.

1. Introduction

Blazars are observed over a wide range of electromagnetic spectrum from radio to very-high-energy (VHE) γ-rays (e.g., Arshakian *et al*. 2012). Generally, synchrotron emission is believed to be dominant in the radio band. Many models have also been proposed to explain the origin of the γ-rays emission of blazars, including leptonic and hadronic models (e.g., Cheng *et al*. 2000; Maraschi *et al*. 1992). However, there is no consensus on the dominant emission process. The various correlations in different wavelengths can be used to constrain models of γ-ray emissions. In addition, since the launch of the Fermi satellite, we have entered into a new era of blazars research (e.g., Ackermann *et al*. 2011a).

In this paper, on basis of the 2FGL catalogs given by Ackermann *et al.* (2011a) and Nolan *et al.* (2012), we have compiled a sample of clean blazars, including 569 blazars (379 FSRQs and 190 BL Lacs). In order to examine correlations between luminosities (($L_{\rm R}$, $L_{\rm O}$, $L_{\rm X}$, L_{γ}) in radio (4.85 GHz), optical (5500 Å), X-ray (1 Kev) and γ-ray (1–100 GeV) wave bands for our sample, we performed a K-correction for the observed fluxes by using $S(v) = S_{\rm obs}(1+z)^{\alpha-1}$, where z is the redshift and α is the spectral index. The luminosity can be expressed as $L_v = 4\pi d_{\rm L}^2 S(v)$, where $d_{\rm L}$ is the luminosity distance. The cosmological parameters $H_0 = 70$ km s^{-1} Mpc^{-1}, $\Omega_{\rm m} = 0.27$ and $\Omega_{\Lambda} = 0.73$ have been adopted in this work.

2. Results of correlation analysis

Pearson partial correlation analysis excluding dependence on the redshift is applied to analyse the correlations among different multi-wave luminosities (Machalski & Jamrozy 2006). The analysis results are given in Fig. 1 and Table 1. The main results

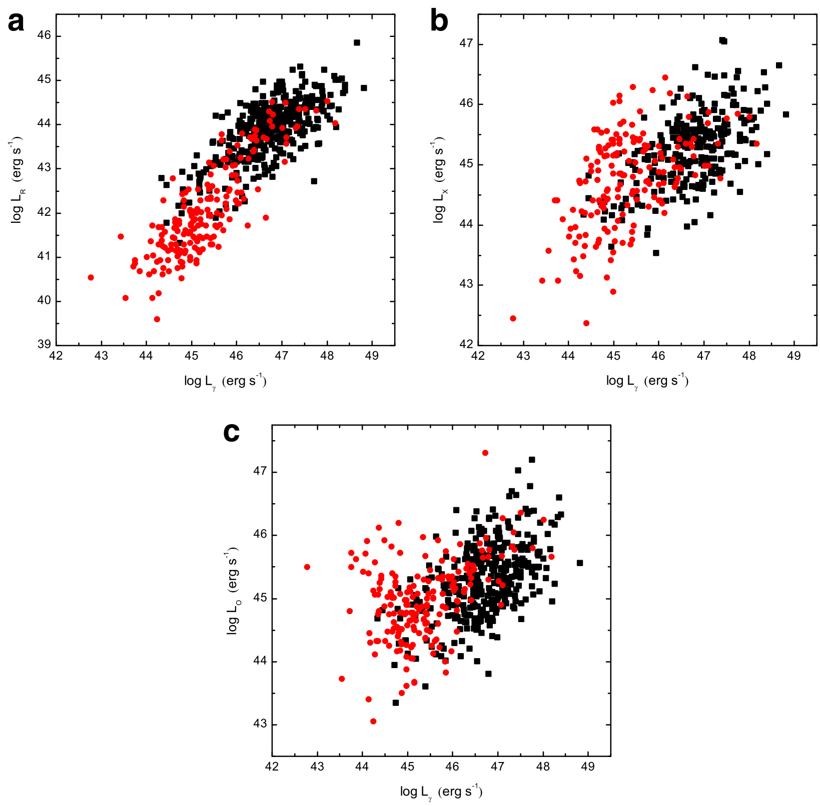

Figure 1. Correlations between L_{R} and L_γ (**a**), L_{X} and L_γ (**b**) and L_{O} and L_γ (**c**). The black squares are FSRQs and the red circles are BL Lacs.

Table 1. The results of partial correlation analysis.

Source	Relation	r	P
All source	L_γ–L_{R}	0.64	$<10^{-4}$
	L_γ–L_{X}	0.34	$<10^{-4}$
	L_γ–L_{O}	0.21	$<10^{-4}$
FSRQ	L_γ–L_{R}	0.47	$<10^{-4}$
	L_γ–L_{X}	0.26	$<10^{-4}$
	L_γ–L_{O}	0.27	$<10^{-4}$
BL Lac	L_γ–L_{R}	0.49	$<10^{-4}$
	L_γ–L_{X}	0.40	$<10^{-4}$
	L_γ–L_{O}	0.11	0.134

are as follows: there are significant correlations between L_γ and L_R, L_γ and L_X, and L_γ and L_O for blazars, BL Lacs and FSRQs (the chance probability $P < 0.0001$), but no correlation between L_γ and L_O for BL Lacs (the chance probability $P = 0.13$). These results are consistent with other findings (e.g., Arshakian *et al*. 2012; Ackermann *et al*. 2011b), and suggest that for Fermi blazars, the high energy γ-ray emission can be related with radio, X-ray and optical emissions. In addition, from Fig. 1c, we can find that the large variation of blazars can explain no significant correlation between L_γ and L_O for BL Lacs. At last, we stress that our results should be tested by simultaneous multiwavelength observations.

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References

Ackermann, M. *et al.* 2011a, *Astrophys. J.*, **743**, 171.
Ackermann, M. *et al.* 2011b, *Astrophys. J.*, **741**, 30.
Arshakian, T. G. *et al.* 2012, *Astron. Astrophys.*, **537**, 32.
Cheng, K. S., Zhang, X., Zhang, L. 2000, *Astrophys. J.*, **537**, 80.
Machalski, J., Jamrozy, M. 2006, *Astron. Astrophys.*, **454**, 95.
Maraschi, L. *et al.* 1992, *Astrophys. J.*, **397**, 5.
Nolan, P. L. *et al.* 2012, *Astrophys. J. Suppl.*, **199**, 31.