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Correlation between γ-Ray and Radio Bands for γ-Ray Loud Blazars

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Abstract. The most identified sources observed by Fermi are blazars (Flat Spectrum Radio Quasars (FSRQs) and BL Lacertae objects (BLs). In this paper, we obtained 124 γ-ray loud blazars with available γ-ray and radio (core and total) data. It is interesting that the γ-ray luminosity have a good correlation with the radio luminosity. This phenomenon exists in the core radio luminosity (L_c) and total radio luminosity (L_t). The correlation between the γ-ray and the radio luminosities is still stronger even after we eliminated the redshift effect, which suggests that the γ-ray radiations in the γ-ray loud blazars are strongly beamed.

Key words. AGNs—jets—γ-ray.

1. Introduction

Blazars as a subgroup of Active Galactic Nuclei (AGNs) have two subclasses namely BL Lacertae objects (BLs) and Flat Spectrum Radio Quasars (FSRQs). More than 1000 blazars (see Abdo *et al.* 2010; Ackermann *et al.* 2011; Nolan *et al.* 2012) were detected by Fermi, which provide us with a good opportunity to discuss the properties and mechanisms of γ-ray emissions in blazars. Some authors investigated correlation between the γ-ray emissions and the lower energetic bands, and found the correlation between γ-ray and radio bands (see Fan *et al*. 2011). For blazars, the total radio emissions are from two components (core and extended), we have collected data for the two components for a sample of 1223 radio sources (Fan *et al.* 2011). So, it is perhaps interesting to do correlation analysis between γ-rays and core/total radio emissions.

2. Samples and results

Based on the second catalogue of Fermi γ-ray LAT (2FGL) (Nolan *et al.* 2012) and the radio sources (see Fan *et al.* 2011), a sample of 124 γ-ray loud blazars with available core and extended radio emission was compiled. In order to investigate the emission property of γ-ray emissions in γ-ray loud blazars, we considered the relationship between γ-ray luminosity ($\log L_\gamma$) and the radio luminosity ($\log L_c$ and $\log L_t$). The results are as follows: $\log L_\gamma = (0.73 \pm 0.097) \log L_c + 14.53 \pm 4.24$ with a correlation coefficient $r = 0.83$ and a chance of probability $p < 10^{-4}$,

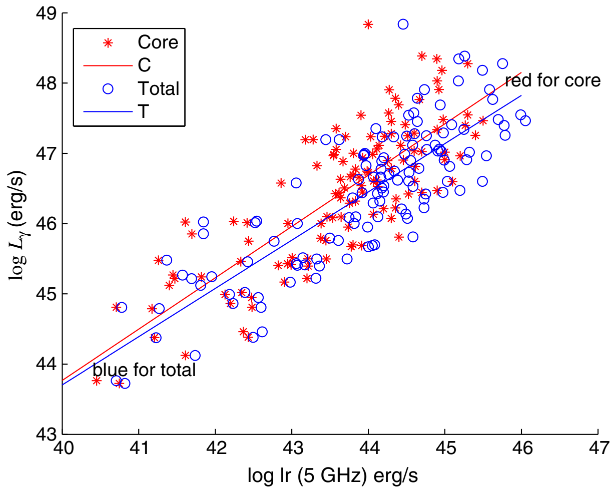

Figure 1. Plots of the γ-ray luminosity against the radio luminosity (log L_c and log L_t). Red stellate point and solid line stand for the log L_c against log L_γ, the blue circle and solid line stand for the log L_t against log L_γ.

log $L_\gamma = (0.69 \pm 0.083)$ log $L_t + 16.22 \pm 3.64$ with a correlation coefficient $r = 0.83$ and a chance of probability $p < 10^{-4}$ for the whole sample. The corresponding plots are shown in Fig. 1.

3. Discussion and conclusion

It is well known that the luminosity depends on the luminosity distance, therefore, it is possible that redshift will result in an apparent correlation between radio and γ-ray luminosity. To investigate a real correlation, the effect of redshift should be removed. Therefore, we can use a method by Padovani (1992), the equation $r_{12,3} = \frac{r_{12} - r_{13}r_{13}}{\sqrt{(1-r_{13}^2)(1-r_{23}^2)}}$ which stands for the correlation coefficient between variables 1 and 2 after removing the effect of variable 3. Here r_{12} stands for the correlation coefficient between variables 1 and 2, r_{13} for the variables 1 and 3, and r_{23} for the variables 2 and 3. When the effect of redshift (variable 3) was removed, we got $r_{r\gamma,z} = 0.38$ with $p < 10^{-4}$ for the correlation between γ-ray and core radio emissions, and $r_{r\gamma,z} = 0.30$ and $p = 9.6{*}10^{-4}$ for the correlation between γ-ray and total radio emissions, which show that γ-ray and radio correlation is still close suggesting that the γ-ray radiations in γ-ray loud blazars are strongly beamed.

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