J. Astrophys. Astr. (2014) **35,** 349–351

γ-Rays Radiation of High Redshift Fermi Blazars

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Abstract. Based on the 31 high redshift ($z > 2$) Flat Spectral Radio Quasars (FSRQs), which is from the second Fermi-LAT AGNs catalogue (2LAC), we studied the correlation between flux densities ($F_{\rm R}$, $F_{\rm K}$, F_γ) in the radio, infrared and γ-ray wave bands. We found that there is a significant positive correlation between F_γ and $F_{\rm R}$, and a weak anticorrelation between F_γ and $F_{\rm K}$ in the average state. For high redshift blazars, we argue that the seed photon of γ-ray emission mainly comes from the jet itself and partially from the dusty torus.

Key words. Galaxies: high redshift—blazars: FSRQs—methods: statistical—γ rays: theory.

1. Introduction

High redshift ($z > 2$) blazars are usually connected with large luminosity and powers. Studies of the samples are crucial for learning more evolution sequences of the jet (Ghisellini *et al.* 2013). By fitting the good coverage Spectral Energy Distributions (SEDs), we can characterize the properties of high redshift blazars and their radiation mechanism. In addition, by analysing the correlations among the multiwavelenght flux densities, we can learn the origin of γ-ray emissions and their generation mechanisms, because different radiation models imply various correlations between different wavelengths (e.g., Fan *et al.* 1998).

2. Data reduction

Under the redshift limit condition ($z > 2$), 31 high redshift Flat Spectral Radio Quasars (FSRQs) were selected from the second Fermi-LAT AGN catalogue (2LAC) (Ackermann *et al.* 2011). We compiled the γ-ray energy flux F_γ, detected by Fermi-LAT at 0.1–100 GeV (Nolan *et al.* 2012). We also collected data of the radio (8.4 GHz) flux density $F_{\rm R}$ and infrared K-band (2.2 μm) magnitude at high and low states from the NASA/IPAC Extragalactic Database (NED)[1] and the VizieR

[1]http://ned.ipac.caltech.edu/

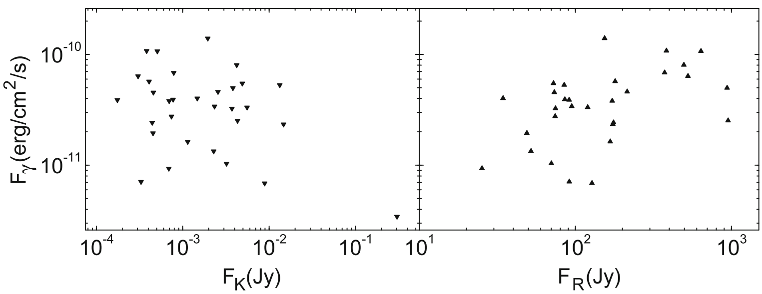

Figure 1. Correlations between $F_{\rm K}$ and F_γ (left panel), and between $F_{\rm R}$ and F_γ (right panel) in the average states.

Catalogue Service (VCS)[2]. If the average state data could not be obtained, the mean values of the high and low states data will be used to approximate them. As for all the data that we collected, the magnitude value at the K-band were complete, but unfortunately, there were only 16 sources that showed the observation in both high and low states in the radio band. The K-band magnitude was corrected by galactic extinction (Schlegel *et al.* 1998), and then it was converted into flux density $F_{\rm K}$ in the unit of janskys (see e.g., Zheng *et al.* 2007). All bands flux density were k-corrected according to $F_\nu^{\rm in.} = F_\nu^{\rm ob.}(1+z)^{(\alpha_\nu - 1)}$, where α_ν is the spectral index of the corresponding frequency with $F_\nu \propto \nu^{-\alpha_\nu}$.

3. Results and conclusion

The linear regression analysis is applied to analyse the correlation of the flux density among different wavelengths. The results are shown in Fig. 1. Our analysis results indicate that there is a weak anticorrelation between $F_{\rm K}$ and F_γ with the correlation coefficient $r = -0.37232$, the chance probability $p = 0.03915$, and there is a significant positive correlation between $F_{\rm R}$ and F_γ with $r = 0.48378$, $p = 0.00676$.

The multiwavelength connection of blazars have been already studied by many authors (e.g., Fan *et al.* 1998; Xie *et al.* 1998). According to our analyses, the significant correlation between $F_{\rm R}$ and F_γ support the radiation mechanism of the γ-ray emission mainly from the relativistic jet by Synchrotron Self-Compton process (SSC). Xie *et al.* (1998) found a strong correlation between $F_{\rm K}$ and F_γ, which provides direct evidence that γ-ray emission are created by Inverse Compton (IC) scattering of IR photons by a relativistic electron beam. The hot circum-nuclear dust and the synchrotron radiation models are the two models of the origin of IR photons for IC process, the former one points out that the radiation field of dust grains provides seed photons for IC process, and it can be explained by the External Compton (EC) mechanism. The observed correlations are also compatible with the Standard Synchrotron Self-Compton (SSC) mechanism (e.g., Xie *et al.* 1998). Our results are also well-consistent with the results of other authors, by model fitting (e.g., Ammando *et al.* 2012; Ghisellini & Tavecchio 2009).

[2]http://vizier.u-strasbg.fr/viz-bin/VizieR.

According to the above discussion, we conclude that the seed photon of γ-ray emission for the high redshift-FSRQs mainly come from the jet itself and partially from dusty torus. That is to say, the radiation mechanism of γ-ray emission is mainly from the relativistic jet by Synchrotron Self-Compton process (SSC), and partially from Compton-scattering of a dusty torus external to the jet (EC-dust).

Acknowledgements

This work is supported by the National Natural Science Foundation of China (11163007, U1231203). This research has made use of the NASA/IPAC Extragalactic Database (NED), which is operated by the Jet Propulsion Laboratory, Caltech, under contract with NASA. This research has made use of the VizieR catalogue access tool, CDS, Strasbourg, France.

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