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# Debeamed Sequence of LBAS Blazars

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**Abstract.** We have collected a sample of 71 $\gamma$-ray blazars selected from the Fermi LAT Bright AGN Sample (LBAS). The correlation between synchrotron peak luminosities $L_{\rm p}$ and synchrotron peak frequencies $\nu_{\rm p}$ have been studied and there is a weak negative correlation. But after correcting the effect of redshift and Doppler boosting, the relation between intrinsic $L'_{\rm p}$ and $\nu'_{\rm p}$ show significant positive correlation.

*Key words.* LBAS blazar: Doppler boosting: blazar sequence: synchrotron peak frequency: synchrotron peak luminosity.

## 1. Introduction

Blazars are an extreme subclass of AGNs with characteristics such as rapid and large amplitude flux variation, high and variable polarization, superluminal motion and Doppler boosting. The Fermi mission has detected a large number of blazars (Abdo *et al.* 2010) which associate to strong beaming effect (Fan *et al.* 2012). Blazars can be divided into two subtypes: the Flat Spectrum Radio Quasars (FSRQs) and BL Lacertae objects. In $\log \nu F_\nu - \log \nu$ representation, SED of blazars show two-bump structures: the low-frequency component is generally believed to be produced by the synchrotron radiation of relativistic electrons in the jet and the high-frequency component is usually believed to be produced by Compton radiation from the same electrons. Based on position of the synchrotron peak frequency, BL Lacertae objects can be divided into LBLs ($\log \nu_{\rm p}$ (Hz) $< 14$), IBLs ($14 < \log \nu_{\rm p}$ (Hz) $< 15$), and HBLs ($\log \nu_{\rm p}$ (Hz) $> 15$). Fossati *et al.* (1998) and Ghisellini *et al.* (1998) have proposed the so-called blazar sequence: the higher power sources have relatively lower synchrotron peak frequencies, i.e., the synchrotron peak luminosities $L_{\rm p}$ is negatively related to the synchrotron peak frequencies $\nu_{\rm p}$. In this work, we will study the blazar sequence of LBAS blazars by comparing the correlation between the observed $L_{\rm p}$ and $\nu_{\rm p}$ to the correlation between the debeamed $L'_{\rm p}$ and $\nu'_{\rm p}$.

## 2. Data description

In this paper, we have collected 71 Fermi blazars (including 37 HBLs, 14 IBLs, 14 LBLs, and 6 FSRQs) which have the value of redshifts $z$, the Doppler factors $\delta$, the observational synchrotron peak frequencies $\nu_{\rm p}$ and synchrotron peak luminosities $L_{\rm p}$ (Hovatta *et al.* 2009; Wu *et al.* 2009; Chen & Bai 2011). The redshift and Doppler corrections are performed using the equations (Wu *et al.* 2009): $L'_{\rm p} = L_{\rm p}/\delta^{2+\alpha}$ (assuming $F = \nu^{-\alpha}$, $\alpha = 1$ in this case) and $\nu'_{\rm p} = \nu_{\rm p}/\delta$.

## 3. Correlation analysis

In the left panel of Fig. 1, we present the correlation between the observed peak luminosity $\log \nu_{\rm p} L_{\rm p}$ and synchrotron peak frequency $\log \nu_{\rm p}$. There is a weak negative correlation with the Spearman correlation coefficient $r = -0.38$. The relation of the debeamed $\log \nu'_{\rm p} L'_{\rm p}$ and $\log \nu'_{\rm p}$ have been shown in the right panel of Fig. 1. As can be clearly seen, after correcting the beaming effect both in the peak luminosity and synchrotron peak frequency, there is a significant positive correlation with the Spearman correlation coefficient $r = 0.66$. Our result suggested that higher synchrotron peak frequency corresponds to higher intrinsic luminosity of synchrotron radiation.

## 4. Discussion

In this paper, the Doppler factors come from the estimation using the radio flux in different wavebands (22 GHz, 37 GHz, 408 MHz) by different methods (Hovatta *et al.* 2009; Wu *et al.* 2007). Moreover, the Doppler factors of blazars at different wavebands may not be the same (Zhang *et al.* 2002). So there is some uncertainty in our Doppler-correction. But it is really hard to explain the result of strong positive correlation between the Doppler-corrected synchrotron peak luminosities and peak frequencies. Nieppola *et al.* (2008) (including 135 radio-bright AGNs) and Wu *et al.*

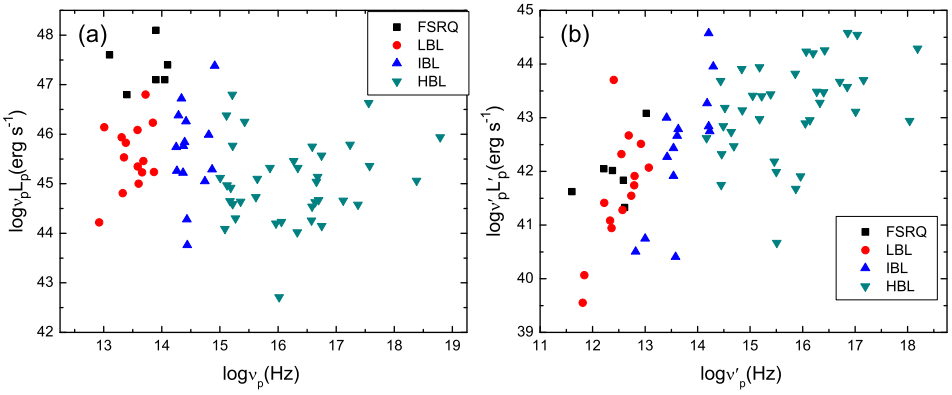


**Figure 1.** The correlations: (**a**) observed $\log \nu_{\rm p} L_{\rm p}$ and $\log \nu_{\rm p}$; (**b**) debeamed $\log \nu'_{\rm p} L'_{\rm p}$ and $\log \nu'_{\rm p}$.

(2009) (including 170 BL Lac objects) have suggested similar positive correlation results. But the Spearman correlation coefficient of our 71 Fermi-selected blazars sample is relatively larger. It is very likely that the well-known blazar sequence is just an observational phenomenon, especially for Fermi blazars.

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