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Correlation between Spectral Index and Doppler Factor for a Sample of Fermi Blazars

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Abstract. Relativistic beaming effect is important for blazars. In a very recent work, γ-ray Doppler factors were calculated for a sample of Fermi blazars (Fan *et al.* 2013). In this work, we investigated the correlation between the Doppler factor and the effective spectral index, $\alpha_{\rm OX}$, and found an anticorrelation between them.

Key words. Galaxies: active—galaxies: BL Lacertae objects—galaxies: quasars—galaxies: emission.

1. Introduction

Blazars are a particular subclass of Active Galatic Nuclei (AGNs) showing luminous brightness, rapid variability, high and variable polarization, superluminal motion, and even γ-ray emissions (Fan *et al.* 2013). Blazars can be divided into two subclasses, viz. BL Lacertae objects (BLs) and Flat Spectral-Radio Quasars (FSRQs). The γ-ray emissions have been detected for more than 1000 blazars (Abdo *et al.* 2010; Nolan *et al.* 2012). Relativistic beaming effect are discussed by some authors (e.g., Fan *et al.* 2013). Massaro *et al.* (2009) compiled a sample of blazars with available effective spectral index, $\alpha_{\rm RO}$, $\alpha_{\rm RX}$ and $\alpha_{\rm OX}$. In this paper, we tried to investigate the correlation between the Doppler factor and spectral index. Therefore, we obtained a sample of Fermi blazars with available Doppler factor and the effective spectral indices.

2. Sample and result

From the work of Massaro *et al.* (2009) and Fan *et al.* (2013), we obtained a sample of 119 blazars (38 flat spectrum radio quasars – FSRQs, 33 low-peaked BL Lacertae objects – LBLs, and 48 highly-peaked BL Lacertae objects – HBLs). From our sample, we have averaged values of beaming factor and spectral index for different subclasses. $\overline{\log \delta^{\rm FSRQs}} = 0.98 \pm 0.31$, $\overline{\alpha_{\rm OX}^{\rm FSRQs}} = 1.25 \pm 0.18$ for FSRQs, $\overline{\log \delta^{\rm HBLs}} =$

0.52 ± 0.18, $\overline{\alpha_{\rm OX}^{\rm HBLs}} = 1.35 \pm 0.34$ for HBLs, and $\overline{\log \delta^{\rm LBLs}} = 0.59 \pm 0.59$, $\overline{\alpha_{\rm OX}^{\rm LBLs}} = 1.58 \pm 0.28$ for LBLs. There is a tendency of $\overline{\log \delta^{\rm FSRQs}} > \overline{\log \delta^{\rm LBLs}} > \overline{\log \delta^{\rm HBLs}}$ for the Doppler factors, but $\overline{\alpha_{\rm OX}^{\rm FSRQs}} < \overline{\alpha_{\rm OX}^{\rm HBLs}} < \overline{\alpha_{\rm OX}^{\rm LBLs}}$ for the effective spectral index, $\alpha_{\rm OX}$.

For the whole sample, we have $\alpha_{\rm OX} = -0.40 \log \delta + 1.66$. When we considered the subclasses separately, we have following results: $\alpha_{\rm OX} = -0.19 \log \delta + 1.44$ for FSRQs, $\alpha_{\rm OX} = -0.85 \log \delta + 1.79$ for HBLs, and $\alpha_{\rm OX} = -0.53 \log \delta + 1.90$ for LBLs.

The beaming effect is discussed for blazars, particularly for the γ-ray loud blazars, which have smaller viewing angles, higher polarization, and are core-dominated. Since the Doppler factor is an important parameter in dealing with the emission nature of blazars, it is worth investigating the correlation between that and other physical parameters (Fan *et al.* 2013). The correlation between Doppler factor and the spectral index can be discussed using a bigger sample.

The relativistic beaming effects are also discussed in this proceedings (Li *et al.* 2014; Wu *et al.* 2014; Nie *et al.* 2014). The effective spectral index $\alpha_{\rm OX}$ is anticorrelated with the viewing angle, and claimed to be anticorrelated with Doppler factors for 14 sources (Maraschi *et al.* 2008).

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