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ORIGINAL ARTICLE

The broad band spectral index of TeV blazars detected by Fermi LAT

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Abstract Using γ-ray data detected by Fermi Large Area Telescope (LAT) and multi-wave band data for 35 TeV blazars sample, we have studied the possible correlations between different broad band spectral indices ($\alpha_{\mathrm{r.ir}}$, $\alpha_{\mathrm{r.o}}$, $\alpha_{\mathrm{r.x}}$, $\alpha_{\mathrm{r.}\gamma}$, $\alpha_{\mathrm{ir.o}}$, $\alpha_{\mathrm{ir.x}}$, $\alpha_{\mathrm{ir.}\gamma}$, $\alpha_{\mathrm{o.x}}$, $\alpha_{\mathrm{o.}\gamma}$, $\alpha_{\mathrm{r.x}}$, $\alpha_{\mathrm{x.}\gamma}$) in all states (average/high/low). Our results are as follows: (1) For our TeV blazars sample, the strong positive correlations were found between $\alpha_{\mathrm{r.ir}}$ and $\alpha_{\mathrm{r.o}}$, between $\alpha_{\mathrm{r.ir}}$ and $\alpha_{\mathrm{r.x}}$, between $\alpha_{\mathrm{r.ir}}$ and $\alpha_{\mathrm{r.}\gamma}$ in all states (average/high/low); (2) For our TeV blazars sample, the strong anti-correlations were found between $\alpha_{\mathrm{r.ir}}$ and $\alpha_{\mathrm{x.}\gamma}$, between $\alpha_{\mathrm{r.o}}$ and $\alpha_{\mathrm{ir.}\gamma}$, between $\alpha_{\mathrm{r.o}}$ and $\alpha_{\mathrm{o.}\gamma}$, between $\alpha_{\mathrm{r.o}}$ and $\alpha_{\mathrm{x.}\gamma}$, between $\alpha_{\mathrm{ir.o}}$ and $\alpha_{\mathrm{o.}\gamma}$, between $\alpha_{\mathrm{r.x}}$ and $\alpha_{\mathrm{x.}\gamma}$, between $\alpha_{\mathrm{ir.x}}$ and $\alpha_{\mathrm{x.}\gamma}$ in all states (average/high/low). The results suggest that the synchrotron self-Compton radiation (SSC) is the main mechanism of high energy γ-ray emission and the inverse Compton scattering of circum-nuclear dust is likely to be a important complementary mechanism for TeV blazars. Our results also show that the possible correlations vary from state to state in the same pair of indices, Which suggest that there may exist differences in the emitting process and in the location of the emitting region for different states.

Keywords Blazars · General-radiation mechanisms · The broad band spectral index

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1 Introduction

35 TeV blazars sample[1] have been detected in the TeV or very high energy regime (VHE; $E > 100$ GeV). Recently, they have also been detected at MeV-GeV energies by Fermi Large Area Telescope (LAT) (Abdo et al. 2010a, 2012). Blazars are one of the most extreme classes of active galactic nuclei (AGN), with high luminosity, large amplitude and rapid variability, high and variable polarization, radio core-dominance, and apparent super-luminal speeds (Urry and Padovani 1995; Zheng et al. 2007). The broad band emission extends from radio up to γ-ray band, being observed almost at the full electromagnetic spectrum from radio to γ-ray band, and dominated by nonthermal processes. The majority opinion is that for most blazars the seed photons are external to the jet, coming mainly from the accretion disk and the broad line region clouds. Synchrotron photons (internal to the jet) may also contribute, and for TeV sources SSC models are indeed the favored explanation. Blazars are often divided into subcategories of BL Lac objects, characterized by almost completely lacking of emission lines or only showing weak emission lines (EW ≤ 5 Å), and highly polarized quasars or flat spectral radio quasars (FSRQs), showing broad strong emission lines.

Generally, a large γ-ray luminosity emitted in a compact volume is attenuated by strong photon-photon absorption (Dondi and Ghisellini 1995). Many models have been proposed to explain the origin of the blazars γ-ray emission, including synchrotron self-Compton (SSC), i.e., the seed photon may be from the synchrotron radiation themselves (Maraschi et al. 1992; Ghisellini and Madau 1996), inverse Compton (IC) scattering on photons produced by the accretion disk (Dermer et al. 1992; Zhang and Cheng

[1] http://tevcat.uchicago.edu/.