Astrophys Space Sci
DOI 10.1007/s10509-013-1667-z

ORIGINAL ARTICLE

The evolutionary sequence of Fermi blazars

Yongjuan Cha · Haojing Zhang · Xiong Zhang · Dingrong Xiong · Bijun Li · Xia Dong · Jin Li

Received: 18 May 2013 / Accepted: 7 October 2013

Abstract Using γ-ray data (α_γ, F_γ) detected by Fermi Large Area Telescope (LAT) and black hole mass which has been compiled from literatures for 116 Fermi blazars, we calculated intrinsic γ-ray luminosity, intrinsic bolometric luminosity, intrinsic Eddington ratio and studied the relationships between all above parameters and redshift, between α_γ and L_γ. Furthermore, we obtained the histograms of key parameters. Our results are the following: (1) The main reason for the evolutionary sequence of three subclasses (HBLs, LBLs, FSRQs) may be Eddington ratio rather than black hole mass; (2) FSRQs occupy in the earlier, high-luminosity, high Eddington ratio, violent phase of the galactic evolution sequence, while BL Lac objects occur in the low luminosity, low Eddington ratio, late phase of the galactic evolution sequence; (3) These results imply that the evolutionary track of Fermi blazars is FSRQs $\longrightarrow$ LBLs $\longrightarrow$ HBLs.

Keywords Galaxies evolution · Black hole physic · Fundamental parameters · Fermi blazars

1 Introduction

Blazars are the brightest and the most variable high-energy sources among active galactic nuclei and have continuous spectral energy distributions (SEDs). They exhibit a non-thermal continuum from radio to optical/UV, X-ray, and even γ-ray wavelengths. Blazars are often divided into subcategories of BL Lacs objects and flat spectrum radio quasars (FSRQs). The classes are characterized by rapid optical variability, high and variable optical polarization, and flat radio spectra. All of these extreme properties can indicate that blazars are the most active objects in the universe. The main difference between the two blazars classes lies in their distributions of redshift and their emission lines strength: BL Lacs are characterized by the lack of strong emission lines (equivalent width EW ≤ 5 Å) and mostly found at low redshift ($z < 0.1$) on the basis of the absorption lines of underlying elliptical galaxies (Xie et al. 2004b), while FSRQs have strong broad emission lines of similar strength to normal quasars (Scarpa and Falomo 1997).

Traditionally, BL Lac objects discovered in radio sky surveys are called radio-selected BL Lac objects (RBLs), and those discovered in X-ray sky surveys are called X-ray-selected BL Lacs (XBLs). Recently, a new classification has been introduced, based on the fact that the peak wavelength of the synchrotron luminosity in blazars is anti-correlated with the ratio of X-ray to radio flux. On this basis, BL Lacs can be divided into "High-energy peaked BL Lacs" (HBLs) and "Low-energy peaked BL Lacs" (LBLs; Padovani and Giommi 1995). The relationship between HBLs and LBLs has been studied by many authors (Bao et al. 2008; Giommi et al. 1990, 1995; Padovani and Giommi 1995). Giommi et al. (1995) found the observed peak of emitted power of two subclasses located at different wavelengths. The SEDs of HBLs and LBLs are significantly different. Padovani and Giommi (1995) and Giommi et al. (1990) found two subclasses that occupy different regions in the $\alpha_{\mathrm{r.o}}$–$\alpha_{\mathrm{o.x}}$ plane. There exist the correlations between minimum soft X-ray flux and radio flux, and also between radio and optical fluxes for the subsample of HBLs, but not for that of LBLs (Padovani and Giommi 1995). In a word, the classification of HBLs and LBLs is based on a physical difference but

Y. Cha · H. Zhang (✉) · X. Zhang · D. Xiong · B. Li · X. Dong · J. Li
Department of Physics, Yunnan Normal University, 650500, Kunming, China
e-mail: kmzhanghj@yahoo.cn

Published online: 05 November 2013