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Visual Method for Spectral Energy Distribution Calculation of Blazars

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Abstract. In this work, we propose to use 'The Geometer's Sketchpad' to the fitting of a spectral energy distribution of blazar based on three effective spectral indices, $\alpha_{\rm RO}$, $\alpha_{\rm OX}$, and $\alpha_{\rm RX}$ and the flux density in the radio band. It can make us to see the fitting in detail with both the peak frequency and peak luminosity given immediately. We used our method to those sources whose peak frequency and peak luminosity are given and found that our results are consistent with those given in the work of Sambruna *et al.* (1996).

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

1. Introduction

Blazars are a very interesting group of extragalactic objects showing rapid variability, high and variable polarization, superluminal motion and even γ-ray emissions (Fan *et al.* 2013a). Blazars can be divided into two subclasses, viz. BL Lacertae objects (BLs) and flat spectral radio quasars (FSRQs). The two subclasses can be divided further. Sambruna *et al.* (1996) compiled the multiwavelength observations and fitted the spectral energy distribution using a parabola as proposed by Landau *et al.* (1986). Sambruna *et al.* (1996) found that the bolometric luminosity depended on the peak frequency with different relations for different subclasses of blazars. The peak frequency itself is used to separate different classes of blazars with FSRQs having the lowest frequency and HBLS having the highest peak frequency (Fossati *et al.* 1998; Fan *et al.* 2013b). However, it is not easy to fit SED. Recently, Abdo *et al.* (2010) fitted SED for a sample of Fermi blazars and proposed a method to estimate the peak frequency.

2. Method and results

In this work, we used 'The Geometer's Sketchpad' software to fit SED visually and dynamically.

The SED can be described using the mathematical model: Given three points (x_0, y_0), (x_1, y_1) and (x_2, y_2) on the plane and fitting the data $\{(x_0, x_0+y_0), (x_1, x_1+y_1)$ and $(x_2, x_2+y_2)\}$ by a parabola curve C, we find the peak coordinates (x_c, y_c) of the curve C.

We can solve the model by 'The Geometer's Sketchpad' as follows:

(1) Construct three points $A_0(x_0, y_0)$, $A_1(x_1, y_1)$ and $A_2(x_2, y_2)$;
(2) Construct three points $C_0(x_0, x_0+y_0)$, $C_1(x_1, x_1+y_1)$ and $C_2(x_2, x_2+y_2)$;
(3) Draw the curve $C: f(x) = (x_0+y_0)l_0(x) + (x_1+y_1)l_1(x) + (x_2+y_2)l_2(x)$, where $l_0(x) = \frac{(x-x_1)(x-x_2)}{(x_0-x_1)(x_0-x_2)}$, $l_1(x) = \frac{(x-x_0)(x-x_2)}{(x_1-x_0)(x_1-x_2)}$ and $l_2(x) = \frac{(x-x_1)(x-x_0)}{(x_2-x_1)(x_2-x_0)}$;
(4) Draw the curve (a line!) $y = f'(x)$;
(5) Construct the intersection point of the two lines $y = f'(x)$ and $y = 0$, the coordinate of this intersection is $(x_c, 0)$;
(6) Let $y_c = f(x_c)$, then (x_c, y_c) is the peak point of the parabola curve C.

When we used our method to the sources fitted by Sambruna *et al.* (1996), we found that there is a close correlation between the peak frequency and those from the fitting SED for the best fitting parabolas $\log \nu_{TW} = 0.736 \log \nu_{\rm Sam} + 3.452$. It seems that our method is quite good.

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