J. Astrophys. Astr. (2014) **35,** 385–386

Delta-function Approximation SSC Model in 3C 273

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Abstract. We obtain an approximate analytical solution using δ approximate calculation on the traditional one-zone synchrotron self-Compton (SSC) model. In this model, we describe the electron energy distribution by a broken power-law function with a sharp cut-off, and non-thermal photons are produced by both synchrotron and inverse Compton scattering of synchrotron photons. We calculate the radiation energy spectrum of electrons by the δ function. We apply this model to the multi-wavelength Spectral Energy Distributions (SED) of the 3C 273 in different states, and obtain excellent fits to the observed spectra of this source.

Key words. Galaxies: active—quasars: individual: 3C 273.

1. Introduction

Blazars, as a special class of Active Galactic Nuclei (AGNs), are characterized by non-thermal emission as well as rapid and large amplitude variability. The broad SEDs are dominated by two components, shown as two humps. Generally, the first hump originates from the synchrotron radiation of extremely relativistic electrons in the jet with a jet viewing angle of around 0°. The origin of the second hump is still an open issue, which may originate from inverse Compton scattering of synchrotron photons (SSC model) or some other photon populations (EC model).

2. SSC model with δ function approximation

The homogeneous SSC radiation model is widely used for explaining the multi-band energy spectra of blazars. Traditionally, the radiation energy spectrum of electrons is calculated from the classical synchrotron radiation process. However, the radiation energy spectrum of electrons is also calculated by using δ approximate calculation, where the method can be solved by the analytical solution of SEDs (Rybicki & Lightman 1979). Based on the double power-law electron distribution in the homogeneous one-zone SSC model, we can obtain the synchrotron radiation power of a single electron by using a function $\delta(\nu - \gamma^2\nu_c)$. The inverse

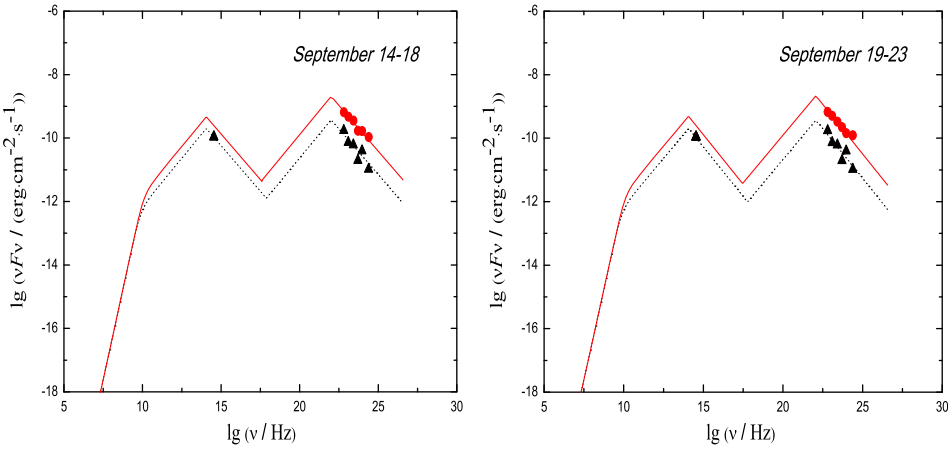

Figure 1. Modelling and observing data of the SEDs for 3C 273 that were observed from 2009 September 14–18 (*left*) and 2009 September 19–23 (*right*) respectively.

Compton radiation emissivity can be obtained using a fair approximation $\delta(\nu - \frac{4}{3}\gamma^2\nu_{\rm ps})$ (Rybicki & Lightman 1979).

3. Application to 3C 273

The flat spectrum radio quasar 3C 273 is one of the brightest sources in nearby ($z = 0.158$) quasars. Its multi-band non-thermal radiation exhibits significant variability. The outburst events were observed by Fermi-LAT in 14–18 and 19–23 September 2009, respectively, in 3C 273 (Abdo *et al*. 2010). Using the δ-function approximate SSC model, we fit SED of the pre-burst and obtain the model parameters. Then keeping the model parameters (the strength of the magnetic field, the radius of radiation region and the Doppler factor) fixed (Kang *et al*. 2012) and changing only the electron spectrum of the source, we obtain the multi-band SEDs of the object 3C273 at in-burst of the two outburst events, respectively. The model results are given in Fig. 1, where the solid triangles and dots, respectively, are the observed results for pre-burst and in-burst of the 3C 273, and the dotted and solid lines represent model results for pre-burst and in-burst of the 3C 273 respectively. From Fig. 1, we find that the above δ-function approximate SSC model can also reproduce the multi-band energy spectra of the object 3C 273 very well.

Acknowledgements

This work is supported by NSFC under grants 11178019, 11103003 and 11133005.

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