MCMC estimation of SED model parameters using multi-wavelength data of the blazar Mrk 421

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Introduction

A type of active galactic nuclei (AGN) whose jet is directed toward us. Blazars are ideal objects to study the mechanisms of generation and acceleration of jets.

Multi-wavelength studies have been actively performed. By modeling the Spectral Energy Distribution (SED), it is possible to investigate the physical quantity.

The Synchrotron Self–Compton (SSC) model

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
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<tbody>
<tr>
<td>$B$</td>
<td>magnetic field</td>
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<tr>
<td>$\gamma$</td>
<td>Lorentz factor</td>
</tr>
<tr>
<td>$T$</td>
<td>electron temperature</td>
</tr>
<tr>
<td>$\delta$</td>
<td>seed photon index</td>
</tr>
<tr>
<td>$\delta_0$</td>
<td>seed photon index</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>temperature</td>
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We confirmed that $B$, $\gamma$, and $T$ are strongly correlated, and to achieve MCMC convergence, the prior distributions are required for at least two parameters among.

Method

A method of estimating the probability distribution of parameters using random numbers. It is possible to optimize the model:

posterior distribution: $P \propto$ likelihood function

prior distribution: $p$

We estimated the model parameters of SED for 22 epochs from 2009 to 2015.

Result

SED model parameter estimation of Mrk 421

We found that the total number of electrons showed no major variations against the X-ray variations.

Discussion

$B$, $\delta_0$, $K_x$, $\gamma_x$, $\delta_0$, $\sigma$, $\gamma$, and $K_x$ significantly change with time even when the uncertainty is considered.

$\gamma_x$ and $K_x$ are parameters of the electron energy distribution, and show strong correlations with the X-ray flux.

Conclusion

- We developed a method to estimate the physical quantity of the radiation area of jets using MCMC and succeeded in finding the optimal parameters and uncertainties.
- The variation of the X-ray flux was caused by the fluctuation of the break energy, as reported in Itoh et al. 2015 and Bartoli et al. 2016.
- Our MCMC analysis confirmed it with the uncertainties of the parameters. We found that the total number of electrons showed no major variations against the X-ray variations.
- We will apply this method to the other SSC blazars in the future.