Recent Trends in the Study of Compact Objects (RETCO-II): Theory and Observation
ASI Conference Series, 2015, Vol. 12, pp 77–78
Edited by Indranil Chattopadhyay, Anuj Nandi, Santabrata Das and Samir Mandal

Optical and X-ray Variability of Blazars

A. C. Gupta*
ARIES, Manora Peak, Nainital – 263002, India

Abstract.

Here we report our recent results of variability studies in optical and X-ray bands of three blazars namely 3C 273, PKS 2155 – 304 and BL Lacertae with XMM-Newton. We found large amplitude optical to X-rays variability in 3C 273, and PKS 2155 – 304 on year time scale. In 3C 273, we noticed that synchrotron cooling and particle acceleration are at work at different epoch of observations. In PKS 2155 – 304, spectral energy distribution from optical to X-ray is fitted with LPPL (log parabolic + power law) model. In BL Lacertae, optical flux and degree of polarization were anti-correlated.

Keywords : galaxies: active – BL Lacertae objects: individual:PKS 2155–304, 3C 273

1. Introduction

BL Lac objects (BLLs) and flat spectrum radio quasars (FSRQs) which belong to radio-loud active galactic nuclei (AGNs) are clubbed together and known as blazar. BLLs show featureless optical spectra while FSRQs show prominent emission lines in their optical spectra. Blazars emit relativistic charged particle jets close to our line of sight ($\leq 10^{\circ}$) (Urry and Padovani 1995). They show large amplitude flux variation in the complete electromagnetic (EM) spectrum and variation is strongly polarized. They show variable flux on diverse timescales e.g. timescales ranging from a few tens of minutes to less than a day is known as intra-day variability (IDV) (e.g. Wagner and Witzel 1995), or intra-night variability or micro-variability; timescales ranging from days to several weeks is known as short term variability (STV); and timescales from months to years is known as long term variability (LTV) (e.g. Gupta et al. 2004).
In the present work, I summarize some of our recent results in optical and X-ray EM bands on the blazars: BL Lacertae, 3C 273 and PKS 2155–304. We reported the detailed work on these blazars in (Gaur et al. 2014, Bhagwan et al. 2014, Kalita et al. 2015).

*email: acgupta30@gmail.com

2. Observations and Analysis

For the blazar BL Lacertae, we have taken optical flux and polarization data using 1.5 m KANATA telescope in Japan (Gaur et al. 2014). For the blazar PKS 2155-304 and 3C 273, simultaneous observations from EPIC/pn in (X-ray) and by OM (Optical Monitor) of XMM-Newton telescope are taken. During year 2000 to 2012, there were total 20 such observations for PKS 2155-304 (Bhagwan et al. 2014) and 30 observations for 3C 273 (Kalita et al. 2015).

3. Results and Discussion

Here I briefly report the results of individual blazars.
BL Lacertae ($\alpha_{2000.0}$ = 22h 02m 43.3s, $\delta_{2000.0} = +42^0 16' 40"$; z = 0.069)
Optical V band light curve, degree of polarization, and polarization angle are plotted in Fig 1 of (Gaur et al. 2014) from bottom to top, respectively. We found that, in the segment 2 of the light curve, flux and degree of polarization is anti-correlated (see Fig. 2, Gaur et al. 2014). Anti-correlation in flux and degree of polarization is unique result and probably detected for the first time for BL Lacertae. The observed phenomenon can be explained by the more generalized recent model by Larionov et al. (2013), where small variation in Lorentz factor by keeping other parameters as fixed may show variety of variation in flux and polarization.
PKS 2155–304 ($\alpha_{2000.0}$ = 21h 58m 52.1s, $\delta_{2000.0} = -30^0 13' 32"$; z = 0.117)
In long term optical to X-ray variability, we found that: (a) variations in all bands on years timescale with a rms amplitude of $\sim 35 - 45$ %; (b) visual inspection show that optical and X-ray band light curves are not correlated; (c) variability amplitude decreases from optical to X-ray bands; (d) optical to X-ray spectral energy distribution is well fitted by log parabolic (LP) + power law (PL) i.e. LPPL model (Bhagwan et al. 2014).
3C 273 ($\alpha_{2000.0}$ = 12h 29m 06.7s, $\delta_{2000.0} = +02^0 03' 09"$; z = 0.1575)
In long term optical to X-ray variability, we found that: (a) variations in all bands on years timescale with a rms amplitude of $\sim 68 - 76$ % in optical/UV and $\sim 36 - 42$ % in X-rays; (b) visual inspection show that optical and UV band light curves, soft and hard X-ray bands are well correlated but optical/UV are not correlated with X-ray; (c) in hardness ratio vs flux plots, we found clockwise and anti-clockwise loops at different epochs of observations which show synchrotron cooling and particle acceleration are at work at different epochs (Kalita et al. 2015).

References

Bhagwan J., Gupta A. C., Papadakis I. E., Wiita P. J., 2014, MNRAS, 444, 3647
Gaur H., Gupta A. C., Wiita P. J., et al., 2014, ApJL, 781, L4
Gupta A. C., Banerjee D. P. K., Ashok N. M., Joshi, U. C., 2004, A&A, 422, 505
Kalita N., Gupta A. C., Wiita P. J., et al., 2015, MNRAS, 451, 1356
Larionov V. M., Jorstad S. G., Marscher A. P., et al., 2013, ApJ, 768, 40
Urry C. M., Padovani P., 1995, PASP, 107, 803
Wagner S. J., Witzel A., 1995, ARA&A, 33, 163