Intranight Variability of Blazar Mrk 180

A. Aghaee[1,2], C. S. Stalin[3], P. Petitjean[4], N. Sohrabkhani[5], M. Sabzi Sarvestani[1]

[1] Department of Physics, Faculty of Science, University of Sistan and Baluchestan, Zahedan, Iran
[2] School of Astronomy, Institute for Research in Fundamental Sciences (IPM), Tehran, Iran
[3] Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital, India
[4] Institut d'Astrophysique de Paris, UMR7095 CNRS, Université Pierre & Marie Curie, Paris, France
[5] Department of Physics, Sharif University of Technology, Tehran, Iran
E-mail(Alireza Aghaee): aghaee@ipm.ir

Abstract

Blazars vary at all wavelengths over a variety of timescales. Various models have been proposed to explain blazar variability, however, the mechanism responsible for variability is not conclusively understood. One factor which can discriminate among the various variability models is that of colour (spectral index) variations of blazars. By this one may be able to better understand the mechanism of blazar variability. It is also, currently inconclusive if all blazars have similiar spectral variability nature. We carried out quasi-simultaneous multiband monitoring of one of the brightest GeV blazar, Mrk 180, on 23 Apr 2009 at OHP (Observatoire de Haute-Provence) observatory.

Key words: Blazar: variability — Variaility models: spectral index variations

1. Introduction

Blazars form a sub-group of radio loud AGN showing extreme variability at all wavelengths, high degrees of linear polarization and strong gamma ray emission. They include BL Lac objects as well as quasars with flat radio spectrum. Blazars vary over a wide range of timescales both within a night and over long term. Several models have been proposed to explain the variability of blazars, the most commonly accepted one is the shock in jet model (Marscher & Gear 1985). Alternative models invoke interstellar scintillation (Rickett et al. 2001), microlensing (Schneider & Weiss 1987), accretion disk instability (Mangalam & Wiita 1993) and binary black hole (Sillanpaa et al. 1988). However, the mechanism responsible for variability is not yet known conclusively.

2. Variability Models

Although optical variability on intranight timescales is now a well established phenomenon for blazars (Stalin et al. 2005; Sagar et al. 2004) its relationship to long-term variability remains unclear. Possible clues could come from monitoring the optical spectrum for correlation with brightness. This will also enable one to better constrain variability models. Nearly simultaneous multiband monitoring of blazars is very limited and most studies reported in literature are confilicting too. No bluer when brighter trend was noticed both on intranight and internight timescales in S5 0716+714 (Stalin et al. 2006), whereas BL Lac showed a bluer when brighter trend on intranight and a similar trend (although of less significance) on the internight timescale (Stalin et al. 2006; Papadakis et al. 2007).

If the trend of bluer when brighter is found to be (nearly) universal, at least for variations on hour like timescales, one interesting explanation posits short term fluctuations of only the electron injection spectral index (Bottcher & Reimer 2004). However, some blazars are found to show anomalous spectral behaviour (Ramirez et al. 2004). For example, PKS 0736+017 showed a tendency for its spectrum to become redder when brighter, both for internight and intranight timescales.

3. Immediate Objective

The presence or absence of bluer when brighter trend in blazars on intranight and internight timescales can provide interesting clues to the origin of blazar variability from hour like to much longer timescales. It is currently not known if this trend is universal in blazars. It is known that GeV/TeV detected blazars tend to be more variable than other blazars (Stalin et al. 2005). We will present the result of blazar Mrk 180.

4. Observations and Data Reduction

Our observations of Mrk 180 ($\alpha = 11 : 36 : 26.4$, $\delta = 70 : 09 : 27$ and $v_{mag} = 15.5$) was performed using 1.20 m OHP telescope. This telescope has a Newton focus (f/6) with a thinned back-illuminated AR-coated SITe 1024×1024 CCD. We monitored the GeV blazar Mrk 180

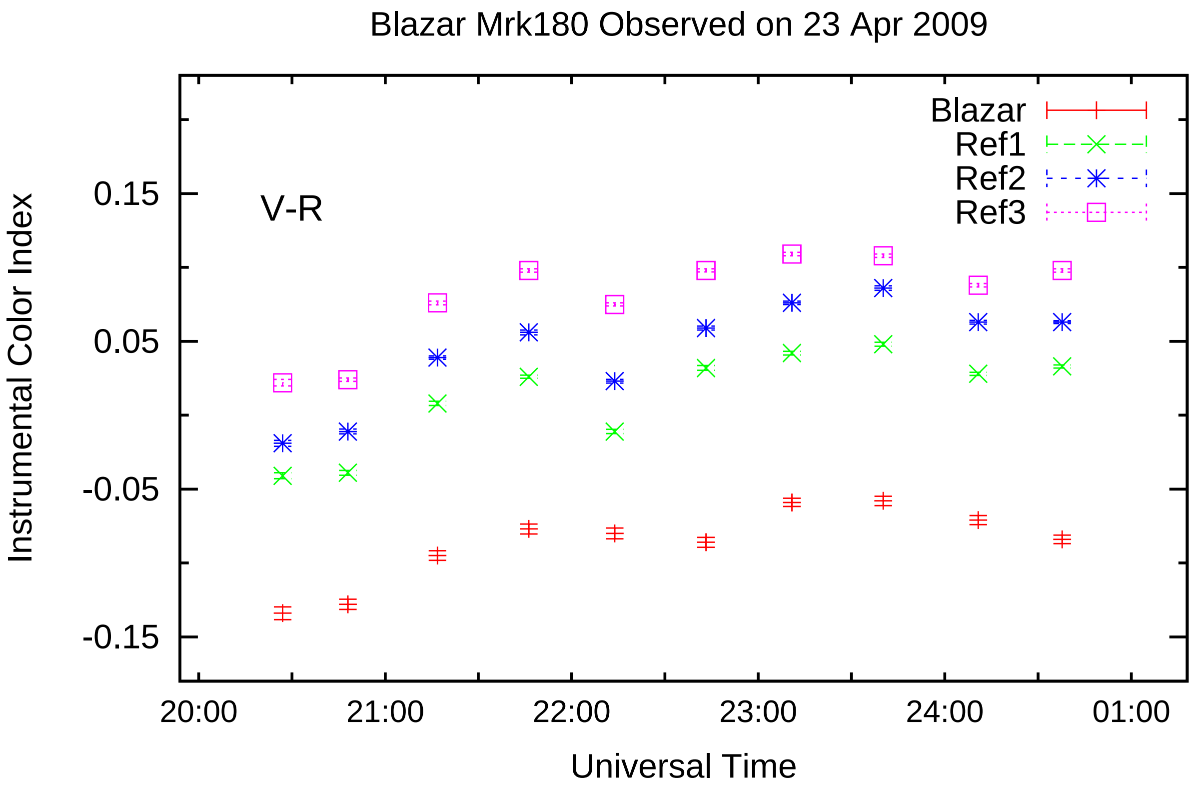

Fig. 1. The Instrumental Color of blazar Mrk 180 and three reference stars in function of universal time on 23 Apr 2009.

in two optical bands, alternating V and R filters, with the aim of detecting flux variability as low as 1%, throughout the night of 23 Apr 2009. This was achievable on the 1.2 m with integration times of 15 minutes in V-band and 10 minutes in R-band. Enough S/N have been obtained so as to detect variability as low as 1% as well as studying spectral variability if any.

The raw photometric data were processed by standard methods which are briefly described here. For image processing, we generated a master bias frame by taking the median of all bias frames. The master bias frame for the night was subtracted from all flat and source image frames taken on the night. Then the master flat in each passband was generated by median combine of all flat frames in each passband. Next, the normalized master flat for each passband was generated. Each source image frames was flat-fielded by dividing by the ormalized mater flat in the respective band to remove pixel-to-pixel inhomogeneities. Finally, cosmic ray removal was done from all source image frames. Data processing used the standard routines in ESO MIDAS software.

5. Results

In Figure 1 we compare Instrumental Color Index (V-R), ICI, for the Blazar and three References. As seen clearly from the Fig, Color Index for all of the references has nearly the same patern during the night. Comparin the patern of the Blazar with that of the references shows first an increasing and then decreasing of ICI for the blazar between 22:00 and 23:00 universal time on 23 Apr and another decreasing between 00:30 and 01:00 on 24 Apr 2009.

The Differential Instrumental Magnitude of blazar Mrk 180 with reference stars is shown in Figure 2.

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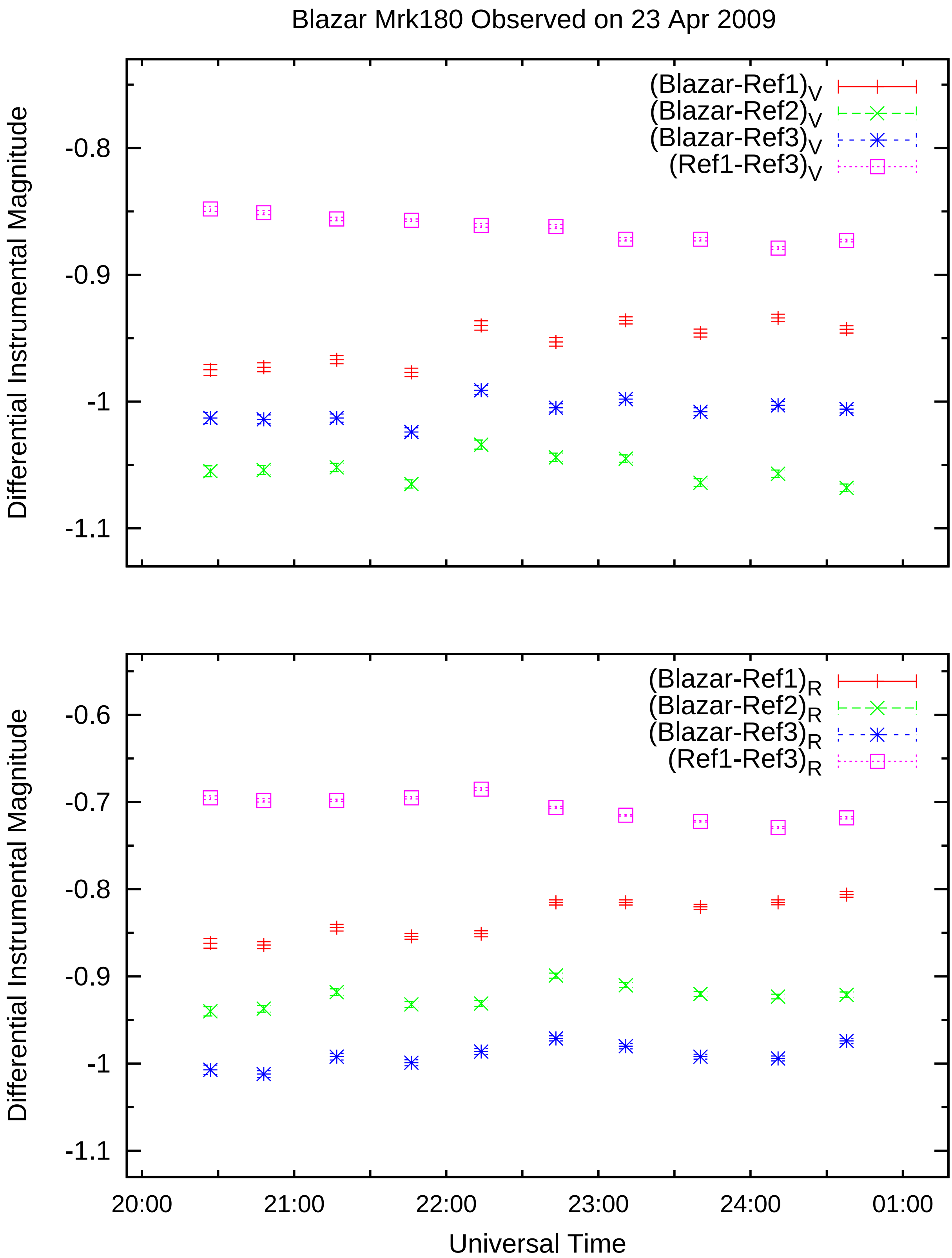

Fig. 2. Differential Instrumental Magnitude of blazar Mrk 180 with reference stars in function of universal time on 23 Apr 2009 in filter V (top panel) and R (bottom panel).