

Study of variability in BL Lac objects

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Abstract. We have monitored some of the BL Lac objects, such as OJ287, Mrk 421, Mrk 501 etc from Mt Abu Infrared Observatory, using optical photopolarimeter, CCD and NICMOS-3 IR array mounted at the Cassegrain focus of the 1.2 m telescope. The data obtained indicate existence of variability at various time scales. Some of the results on OJ 287 and Mrk 421 are presented here.

Key words : AGN, blazars, variability, polarization, OJ287, Mrk 421

1. Introduction

It is now generally believed that Blazars are radio loud active galactic nuclei (AGNs) with relativistic jets pointed towards us. These include both BL Lac objects, which have very weak line emission, and more luminous flat spectrum radio quasars (FSRQ) having normal, strong emission lines (Ulrich et al. 1997). To understand their nature and energy generation mechanism, a good time sampled multifrequency monitoring of the long and short timescale variations in these objects is required. Short time scale variations of the polarised light, help to understand the dynamics of the jet and provide direct insight into the central engine. Here we present photopolarimetric observations of Mrk 421 and photometric monitoring of OJ 287 performed using 1.2 m telescope at Mt. Abu IR observatory.

2. Photometry of OJ 287 : Observations and results

OJ 287 is one of the most thoroughly monitored BL Lac object. The observations reported here were carried out using 1024 x 1024 CCD camera mounted at 1.2 m telescope of the Mt. Abu Infrared Observatory (MIRO) during December 1998 and January 1999. Several standard stars were also observed for comparison. The data reduction and analysis were performed using IRAF. The observations were made using standard photometric bandpasses B, V (Johnson) and R (Cousins) under photometric conditions.

The results are plotted for individual nights. Small variations can be noticed during December 20, 1998, Jan. 13, 14 and 16, 1999 which appear to be due to intermittent processes. However, there seems to be no high activity in OJ 287 during this period. Since late 1996, the brightness of OJ 287 has declined quite a bit and now it is in quiescent phase.

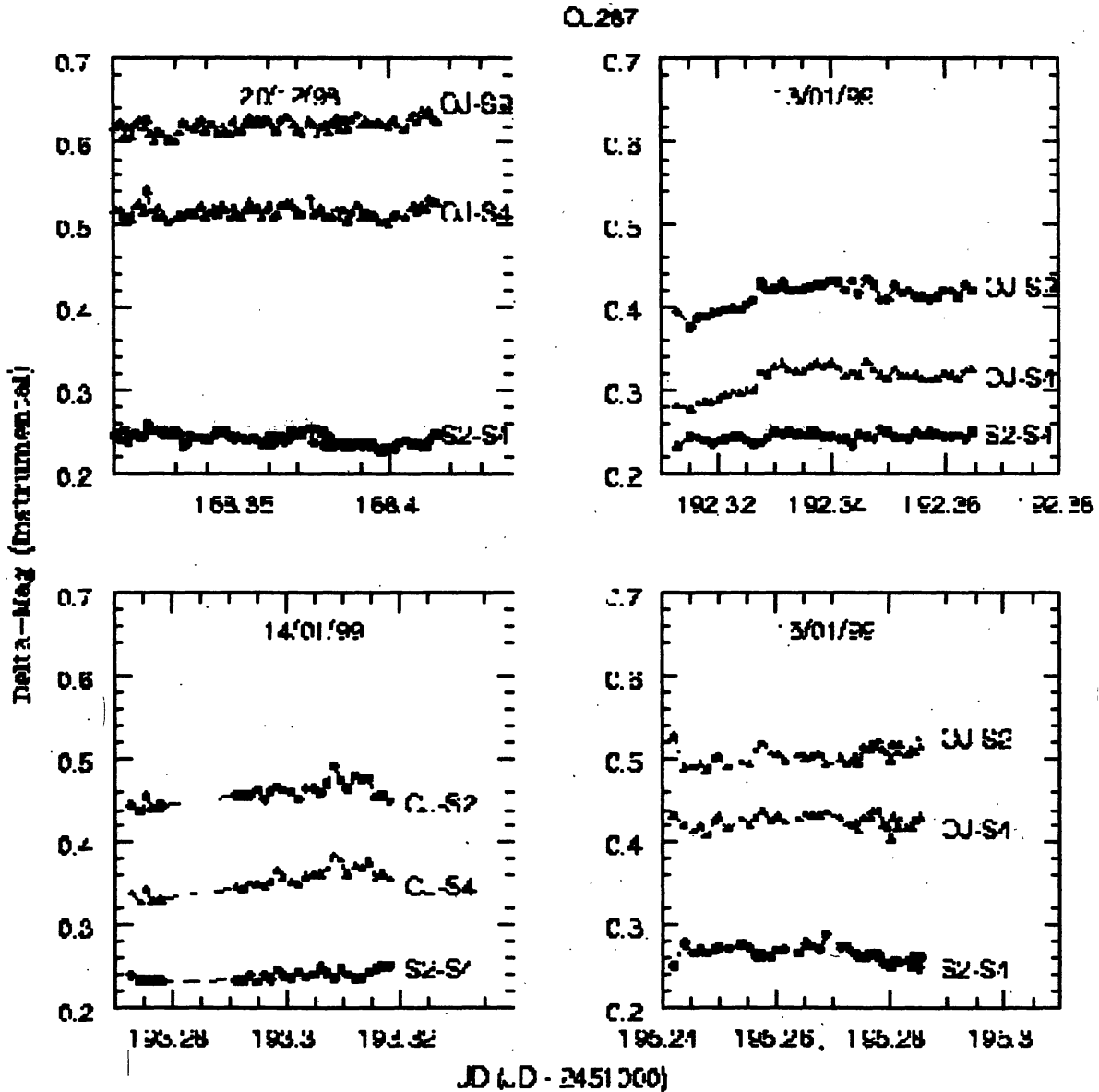


Figure 1. Optical band variations in BL Lac object OJ287. S2 & S4 are comparison stars

2.1 Polarimetry of Mrk 421 : Observations and results

We have made photopolarimetric observations of Mrk 421 in B, V and R bands during 1996-98 over several nights using PRL-photopolarimeter mounted at the Cassegrain focus of the 1.2 m IR telescope at MIRO. The results are plotted with degree of linear polarisation as a function of time (Julian date) in figure 2. Various standard stars e.g. γ Gem ϕ Cas, Q Sco were also observed to be used in the calibration of the instrument and polarization position angle. Mrk 421 usually shows moderate polarization for a BL Lac, varying in polarization from 1% to about 7%. However, we detected unusually large polarization $\approx 10\%$ in B band on Dec. 17, 1996. Tosti et al (1998) report peak values of the degree of polarisation at JD 2450466.6 to be $P_U = 16.3\%$, $P_B = 15.1\%$, $P_V = 13.8\%$ and $P_R = 12.51\%$, which we seem to have missed.

In January 1996, a low percentage polarization is seen in all bands. An increased degree of linear polarization during December 1996 is followed by a period of moderate high polarization during Feb. 1997. It can be seen that degree of polarization decreased with increase in wavelength, indicating dilution of the polarization by the unpolarised emission from the host galaxy. The sudden flaring in the Mrk 421 exhibited by increase in degree of polarization during 16-17 December 1996 can be attributed to physical changes within the jet such as change in the electron energy distribution due to propagation of relativistic shock or change in the alignment of the magnetic field. Since the polarization in Mrk 421 is produced by synchrotron radiation

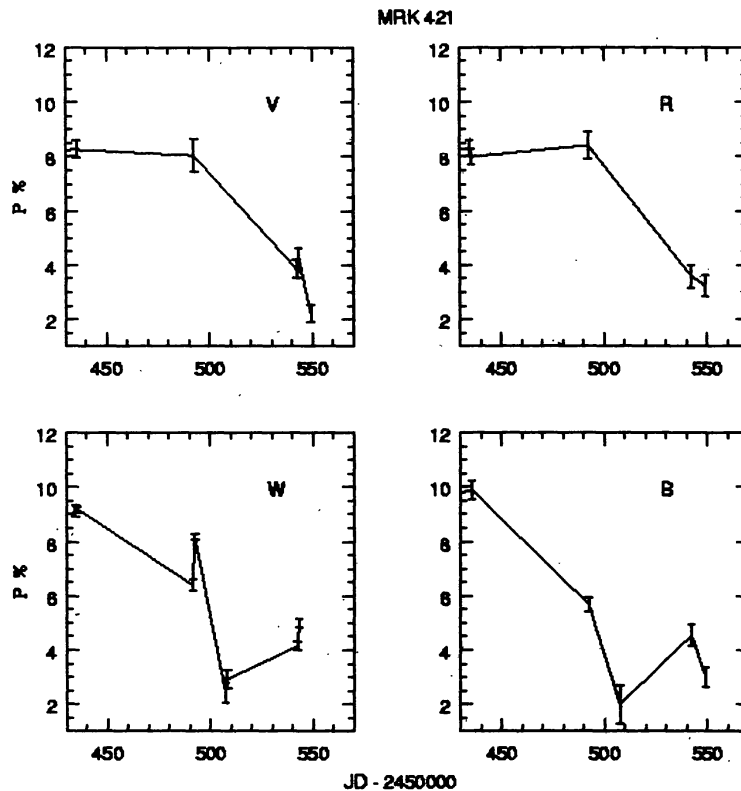


Figure 2. Variations in the degree of linear polarization in Mrk 421.

in the jet close to the nucleus, we expect % P variations to correlate with those in the X-ray flux. Simultaneous monitoring in optical, X-ray and γ -rays should be of great help to identify exact causes of these variations and help to understand the behaviour of the (HBL) blazars.

3. Conclusions

The present work reports photometric and polarimetric study of the variability in BL Lac objects OJ287 and Mrk 421 in optical bands. The CCD observations during 1998-99 reveal that OJ287 is in its quiescent state. However, small scale variations appear as amplitude flickerings due to intermittent processes. On the other hand, Mrk421 shows substantial increase in the percentage polarization in agreement with the observations of Tosti et al (1998). This sudden flaring in the Mrk 421 could be due to some physical changes in the jet such as re-alignment of the magnetic field. A simultaneous multiwavelength monitoring of this object will be helpful to understand the processes involved.

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References

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