

## ACTIVITY OF BL LACERTAE DURING 1997-2005: LONG-TERM AND INTRADAY VARIABILITY

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### ABSTRACT

We present the results of optical observations of BL Lacertae from August 1997 to May 2002 carried out with ST-6 CCD Camera attached to the Newtonian focus of the 70-cm meniscus telescope of Abastumani Observatory.

The long-term, intraday and intrahour variabilities of BL Lacertae were studied on the bases of 600 and 440 nights, respectively. The variability patterns showed by BL Lacertae are very complex.

The maximum amplitude of the long-term variability in B band equals to  $3^m.0$  (rms=0.03), while the variation in V and R bands are within  $2^m.71$  (0.02) and  $2^m.53$  (0.01), respectively. This means that variations are larger at shorter wavelength or the object become bluer in the active phase.

It were also demonstrated that BL Lacertae shows intraday variability within  $0^m.30$  (0.02), while intrahour variability within  $0^m.10$  (0.01) magnitudes.

Key words: BL Lacertae; CCD Photometry; Variability.

### 1. INTRODUCTION

BL Lacertae is the prototype of one of the most extreme subclass of AGNs. It was discovered in 1929 by Guno Hoffmeister, who found it to vary by more than a factor two in one week and classified it as a short period variable star (Hoffmeister, 1990). Since its identification as an extragalactic source it was the subject of numerous studies in many frequency bands.

Historically, BL Lac is known to show  $5^m.0$  variation in optical band with episodic outbursts (Fan (1998), Webb (1988), Maesano (1997)). Maximum variation in the infrared K band is  $3^m.0$  (Fan, 1999). During the summer

1997 outburst it showed a very strong activity including intranight ones (Nesci (1998), Clements (2001)). The strong activity was also detected in the radio, X-ray and  $\gamma$ -ray bands (Bloom (1997), Sambruna (1999), Madejiski (1999), Tanihata (2000), Bottcher (2000)).

Observational Periods				Nights	$\delta m(R)$
Aug	1997	-	May 1998	74	2.53
May	1998	-	Aug 1998	39	1.10
Aug	1998	-	Jan 1999	50	0.80
July	1999	-	Aug 1999	78	0.90
Aug	1999	-	June 2000	72	1.85
June	2000	-	Nov 2000	69	1.40
May	2001	-	Nov 2001	83	1.80

### 2. OBSERVATION AND DATA REDUCTION

We are intensively monitoring BL Lacertae at Abastumani Observatory since Aug 1997, when it remained in a high state for more than two months. Rapid and large amplitude flux variations characterized the source during this period. Here we present observations carried out from Aug 1997 to Nov 2001. All observations were carried out with 70-cm meniscus telescope and ccd camera ST-6 attached to the Newtonian focus (1/3). To study the long-term variability we observed BL Lacertae during 317 nights, collected 320 frames in every of the BVI bands and 465 frames in R band. More than 16 000 frames were obtained in R band during 259 nights to study intraday variability (Wagner (1995), Wagner (2001)) and intrahour variability (Miller, 1989)).

The duration of observational runs varied from two hours to six hours. The exposure times varied from 60 to 180 sec depending on the brightness of the object and the

filter used. Instrumental differential magnitudes were calculated relative comparison stars C and H, that have nearly the same colours as the object under study (Smith et al. 1985). The images are reduced using Daophot-II (Stetson, 1987). The highest differential photometric accuracy reached in R band is  $0^m.005$  (rms) magnitude at  $m_r=14^m.00$  during 180 sec. Magnitudes are calculated relative comparison stars C and H, that have nearly the same colours as the object under study (Smith et al. 1985). To eliminate the effects of seeing induced spurious IDV and IHV (Cellone, 2000) the apertures are taken to include the whole host galaxy.

### 3. RESULTS AND CONCLUSIONS

The constructed long-term variability lightcurves have shown that maximum variation in B band was observed during August 1997 and equals to  $3^m.0$  (rms=0.03), while the maximum amplitude in R band equals to  $2^m.53$  (0.01). The amplitudes of variation in R band of the other observing seasons are presented in the table.

The results of optical observations of BL Lacertae during great summer 1997 outburst are presented by different blazar monitoring groups (Webb (1998), Sobrito (1999), Speziali (2000), Fan (2001), Clements (2001), Villata (2002), Villata (2003), Villata (2004)). On the basis of observations of BL Lacertae during the period from August 1997 to November 2001 it was clearly demonstrated that variations are larger in B band or the object become bluer in the active phase (Nikolashvili (1999), Kurtanidze (2001), Nesci (2001)), that were also confirmed by other groups (Clements (2001), Fan (2001)).

The significant statistical evidences of intraday and intrahour variabilities are found during many nights of observations. The typical intraday and intrahour variability amplitudes in R band are within  $0^m.30$  (0.02) and  $0^m.10$  (0.01) magnitudes, respectively. Detailed study of BL Lacertae during multiwavelength campaigns carried out in the frame of WEBT collaboration are most extensive study of this prototype source ever conducted (Villata (2003), Villata (2004)).

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