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BL LACERTAE: LONG-TERM, INTRADAY AND INTRAHOUR VARIABILITY

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We present preliminary results of the optical observations of BL Lacertae during the period June–November 2001 carried out using an ST-6 charge-coupled device camera attached to the Newtonian focus of the 70 cm meniscus telescope of the Abastumani Observatory. The aim of these observations is to study the long-term variability, intranight variability and intrahour variability of BL Lacertae.

The overall long-term variation in the R band has a magnitude of 1.80 (rms, 0.03). We also demonstrated that the typical average amplitudes of the intraday variability and the intrahour variability in the R band are of magnitudes 0.30 ± 0.02 and 0.10 ± 0.01 respectively. The maximum amplitudes of both types of variation are of magnitude 0.40 ± 0.02 .

Keywords: Active galaxies; BL Lacertae; Quasars

1 INTRODUCTION

The BL Lacertae was discovered in 1929 by Guno Hoffmeister, who found it to vary by a factor of more than two in 2 week and classified it as a short-period variable star (Hoffmeister et al., 1990). Its true extragalactic nature was determined when Miller found faint emission lines at a red shift of 0.069 (Miller et al., 1978). It exhibits a core-jet morphology and has ejected several superluminal components, effectively modelled as planar shocks embedded within a relativistic flow (Hughes et al., 1989). Historically, BL Lac is known to show a variation in the optical band of approximate magnitude 5.0 with episodic outbursts (Maesano et al., 1997; Fan et al., 1998a; Webb et al., 1988). The maximum variation in the infrared K band is of approximate magnitude 3.0 (Fan et al., 1998b). During the summer 1997 outburst it showed very strong activity including intranight activity (Nesci et al., 1998; Clements and Carini, 2001). Strong activity was also detected in the radio, X-ray and γ -ray bands (Bloom et al., 1997; Madejski et al., 1999; Sambruna et al., 1999; Böttcher and Broom, 2000; Tanihata et al., 2000).

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2 OBSERVATIONS AND DATA REDUCTION

We have been intensively monitoring BL Lacertae at Abastumani Observatory since August 1997, when it remained in a high state for more than 2 months.

The observations during the period June–November 2001 were carried out with the 70 cm meniscus telescope using an ST-6 charge-coupled device (CCD) camera attached to the Newtonian focus (Kurtanidze and Nikolashvili, 2002a). To study the long-term variability (LTV) we observed BL Lacertae during 48 nights. More than 2194 frames were obtained in R band during 32 nights to study the intraday variability (IDV) (Wagner and Wintzel, 1995; Wagner, 2001) and intrahour variability (IHV) (Miller et al., 1989). The duration of observational runs varied from 2 to 6 h. The exposure times varied from 60 to 180 s depending on the brightness of the object and the filter used.

Instrumental magnitudes were obtained using DAOPHOT II routines (Stetson, 1987). Magnitudes are calculated relative to the comparison stars C and H, which 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 et al., 2000) the apertures are taken to include the whole host galaxy.

3 RESULTS

The results of optical observations of BL Lacertae during the great summer 1997 outburst have been presented by different groups (Webb et al., 1998; Sobrito et al., 1999; Speziali and Natali, 2000; Clements and Carini, 2001; Fan et al., 2001).

On the basis of our observations of BL Lacertae during the period from August 1997 to August 1998 it was clearly demonstrated that the variations are larger in the B band or the object become bluer in the active phase (Kurtanidze and Nikolashvili, 1999; 2001a,b; 2002b; Nikolashvili et al., 1999a,b; Kurtanidze et al., 2002) that were also confirmed by other groups (Nesci et al., 2001). Maximum variation in BL Lacertae is observed during

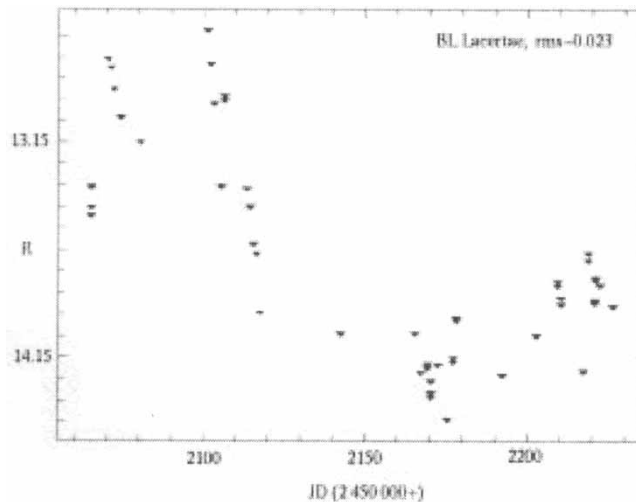


FIGURE 1 The LTV light curves of BL Lacertae (June–November 2001).

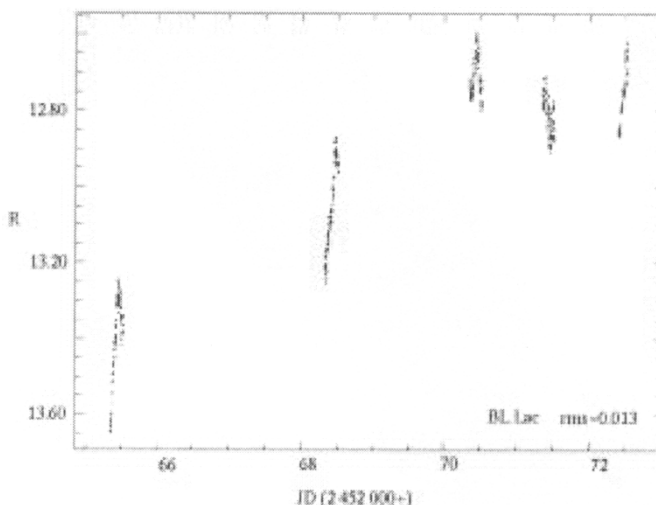


FIGURE 2 The IDV and IHV light curves of BL Lacertae (4–12 June 2001).

the great summer 1997 outburst and has a magnitude of 3.0 (rms, 0.03) in the B band (Nikolashvili et al., 1999a; Kurtanidze and Nikolashvili, 2001b).

Variations over one magnitude in the R band have been observed almost every year since the great outburst. The R-band LTV light curves obtained during the period June–November 2001 are presented in Figure 1. As it is clearly seen the overall magnitude variation equals 1.8. Evidence of IDV and IHV was found during almost every night of observations. Their typical average amplitudes in the R band are of magnitudes 0.30 ± 0.02 and 0.10 ± 0.01 respectively. The maximum amplitude reached on both time scales during the observing period has a magnitude of 0.4, which is also clearly demonstrated in Figure 2.

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