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Optical variability of X-ray selected blazars

Omar M. Kurtanidze, Maria G. Nikolashvili, Givi N. Kimeridze, Lorand A. Sigua and Bidzina Z. Kapanadze

Abastumani Astrophysical Observatory, 383792 Abastumani, Georgia

Abstract. We present optical R band photometry of nine X-ray selected BL Lac objects: 1ES 0229+200, 1ES 0323+022, 1ES 502+675, 1ES 0647+250, 1ES 0806+524, 1ES0927+500, 1ES 1028+511, 1ES 1959+650, 1ES2344+514.

Variability on long time scales within one magnitude in R band was found for all of the observed objects, except 1ES 0229+200 and 1ES0927+500. Largest variation was detected for 1ES 0502+675 and equals to 1.07 mag. Only few objects show statistically significant variation on intra-day scale.

Keywords. BL Lacertae objects – X-ray blazars – variability

1. Observation and data reduction

Blazar Monitoring Program at Abastumani Observatory was started in the May 1997 and is carried out with ST-6 CCD camera attached to the Newtonian focus of the 70 cm meniscus telescope (1:3, 14.9×10.7 square arcmin). All observations are performed using combined filters of glasses that match the standard B, V (Johnson) and Rc, Ic (Cousins) bands well (Kurtanidze 1999). Reference sequences in the blazar fields are calibrated using the equatorial standard stars (Landolt 1992). List of target objects was compiled from Einstein Slew Survey Sample of BL Lacertae objects (Perlman 1996). During more than 200 nights about 1400 CCD frames were obtained in R band to study long-term and intra-day variability of selected objects.

The most frequently observed object in our sample (on long-term as well as on intra-day scales) is 1ES 1959+650. The duration of observational runs varied from two hours to six hours and exposure times varied from 60 to 180 sec depending on the brightness of the object and the filter used. The images were reduced using Daophot-II (Stetson 1987). To eliminate the effects of seeing induced spurious IDV and IHV variability (Cellone 2000) the apertures are taken into account to include the whole host galaxy.

2. Results and conclusions

2.1. *1ES 0323+022 and 1ES 0502+675*

The brightest state $R = 15.62$ was detected in Dec 1982 (Feigelson 1986). Largest amplitude 0.67 mag in R band was detected during three years (23.10.1996–23.01.1999) of observation by the Torino group with a maximum of $R = 16.60$ mag (Villata 2000). Our observations include the period from 04 Oct 1997 to 04 Feb 2002. There were two dramatic changes of brightness: first, up to 0.43 mag from 31 Aug 1998 to 23 Nov 1998 and the second one from 12 Sept 1999 to 23 July 2000 about 0.26 mag, while the maximum amplitude was 0.45 mag. Early observations of 1ES 0502+675 (31.10.1996–22.02.1997) show that maximum amplitude in R band equals to 0.58 (Raiteri 1998). Our observations include the period from 09 Nov 1997 to 12 Feb 2000. Dramatic changes $R = 15.67$–16.74 was detected before 23 Nov 1998 with an amplitude 1.07 mag. After the minimum it

rapidly increases again and reach a mean state characterised by $R = 16.40$ and with a maximum amplitude of variation 0.36 mag.

2.2. *ES 0647+250, 1ES 0806+524 and 1ES 1028+511*

The previous observation of 1ES 1028+511 during December 3, 1996 – May 8, 1997 revealed variation d$R = 0.18$ and maximum brightness $R = 16.53$ (Villata 2000). Our observations of these objects include the period from 25 Nov 1997 to 25 Jan 2002. All three objects show significant light variations that are equal to 0.37 mag (25 Nov 1997-13 Dec 1998), 0.88 (28 Dec 1997-06 June 2000) and 0.60 (28 Jan 1998-25 Jan 2002), respectively.

2.3. *1ES 1959+650 and 1ES 2344+514*

Observations of 1ES 1959+650 from February 29,1996 to May 30, 1997 shows that the light curve in the R band is characterized by rapid flickering, a decrease of 0.28 mag in 4 days (Villata 2000). Both objects during our observations show light variations bellow 0.4 mag in R band. Largest one is observed for 1ES 1959+650 (Kurtanidze 2001). The 1ES 2344+514 show obvious long-term variability trend over the observing period at 0.1 mag level (Fan 2004). Consequently, the intra-day variability is very week bellow 0.05 mag and may only be detected in exceptional cases of very high photometric accuracy. More higher level activity of 1ES 1959+650 relative to 1ES 2344+514 may be attributed to its higher radio luminosity (Raiteri 1998).

2.4. *Conclusion*

Seven of the nine X-Ray BL Lacertae object studied show variability on long-term scale. Three of them show variation over 0.5 mag (1ES 0502+675, 1ES 0806+524 and 1ES 1028+511), while other four bellow 0.5 (1ES 0323+022, 1ES 0647+250, 1ES 1959+650 and 1ES 2344+514). Long-term variability was not detected for two BL Lacertae 1ES 0229+200 and 1ES 0927+500. Intra-day variability of 1ES 1959+650 and 1ES 2344+514 is bellow 0.05 mag. In general, X-ray selected blazars show week optical variability in comparison with radio selected blazars.

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