

CCD PHOTOMETRY OF X-RAY SELECTED BLAZARS

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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, 1ES 0927+500, 1ES 1028+511, 1ES 1959+650, 1ES 2344+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 $1^m.07$. Only few objects show statistically significant variation on Intraday scale.

Key words: X-Ray Blazars; CCD Photometry; 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 sq. arcmin). All observations are performed using combined filters of glasses that match the standard B, V (Johnson) and Rc, Ic (Cousins) bands well (Kurtanidze, et al., 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, et al., 1996). During more than 200 nights about 1400 ccd frames were obtained in R band to study long-term and intraday variability of selected objects. In the Table the list of the target X-ray BL Lacertae objects, along with the number of nights observed and frames obtained in R band are given. Last column shows the number of frames obtained to study the intraday (IDV) variability. Most frequently observed object, as on long-term as well as on

intraday 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 are reduced using Daophot-II (Stetson, et al., 1987). To eliminate the effects of seeing induced spurious IDV and IHV variability (Cellone, et al., 2000) the apertures are taken to include the whole host galaxy.

2. RESULTS AND CONCLUSIONS

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

1ES 0323+022 is the most frequently studied object. Brightest state $R=15^m.0.62$ was detected in Dec 1982 (Feigelson, et al., 1986). Largest amplitude $0^m.67$ in R band was detected during three years (23.10.1996-23.01.1999) of observation by Torino group with a maximum $R = 16^m.60$ (Villata, et al., 2000). Our observations include the period from 04 Oct 1997 to 04 Feb 2002. There were two dramatic changes of brightness: first, up to $0^m.43$ from 31 Aug 1998 to 23 Nov 1998 and second one from 12 Sept 1999 to 23 July 2000 about $0^m.26$, while the maximum amplitude was $\Delta R^m.45$.

Early observations of 1ES 0502+675 (31.10.1996-22.02.1997) show that maximum amplitude in R band equals to $0^m.58$ (Raiteri, et al., 1998). Our observations include the period from 09 Nov 1997 to 12 Feb 2000. Dramatic changes $R=15^m.67-16^m.74$ was detected before 23 Nov 1998 with an amplitude $1^m.07$. After the minimum it rapidly increases again and reach a mean state characterised by $R=16^m.40$ and $\Delta R=0^m.36$.

Table 1. A list of X-Ray selected blazars

Source	RA ₂₀₀₀	DEC ₂₀₀₀	N _{LTV} ^{Nights}	N _{LTV} ^{Frames}	N _{IDV} ^{Nights}	N _{IDV} ^{Frames}	ΔR
1ES 0229+200	02 32 48.6	20 17 17	13	23			0 ^m .00
1ES 0323+022	03 26 13.9	02 25 15	27	37			0 ^m .45
1ES 0502+675	05 07 56.2	67 37 24	32	37			1 ^m .07
1ES 0647+250	06 50 46.5	25 03 00	09	13			0 ^m .30
1ES 0806+524	08 09 49.2	52 18 58	33	36			0 ^m .88
1ES 0927+500	09 30 37.6	49 50 26	06	07			0 ^m .00
1ES 1028+511	10 31 18.5	50 53 36	28	32			0 ^m .60
1ES 1959+650	19 59 59.9	65 08 55	43	48	23	732	0 ^m .40
1ES 2344+514	23 47 04.8	51 42 18	13	25	10	373	0 ^m .10

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

The previous observation of 1ES 1028+511 during Dec 3, 1996 - May 8, 1997 revealed variation $\Delta R=0^m.18$ and maximum brightness $R=16^m.53$ (Villata, et al., 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 $0^m.37$ (25 Nov 1997-13 Dec 1998), $0^m.88$ (28 Dec 1997-06 June 2000) and $0^m.60$ (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 $0^m.28$ in 4 days (Villata, et al., 2000). Both objects during our observations show light variations bellow $0^m.4$ in R band. Largest one is observed for 1ES 1959+650 Kurtanidze (et al.). 1ES 2344+514 show obvious long-term variability trend over the observing period at $\Delta R=0^m.1$ level (Fan, et al., 2004). Consequently, the intraday variability is very week bellow $0^m.05$ and may only be detected in exceptional cases of very high photometric accuracy. More higher level activity of 1ES 1959+650 in comparison with 1ES 2344+514 may be attributed to its higher radio luminosity (Raiteri, et al., 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 $0^m.5$ (1ES 0502+675, 1ES 0806+524 and 1ES 1028+511), while other four bellow $0^m.5$ (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.

Intraday variability of 1ES 1959+650 and 1ES 2344+514

is bellow $0^m.05$. In general, X-ray selected blazars show week optical variability in comparison with radio selected blazars.

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