Light Curves of OJ 287, 3C 66A, AO 0235+164 and S5 0716+714 observed during the OJ-94 Project

A. Sillanpää¹, L.O. Takalo¹, T. Pursimo¹, H.J. Lehto¹, K. Nilsson¹, P. Teerikorpi¹, P. Heinämäki¹, M. Lainela¹, M. Kidger², J.A. de Diego², J.N. González-Pérez², J.-M. Rodríguez-Espinosa², T. Mahoney², P. Boltwood³, D. Dultzin-Hacyan⁴, E. Benítez⁴, G.W. Turner⁵, J.W. Robertson⁵, R.K. Honeycut⁵, Yu.S. Efimov⁶, N. Shakhovskoy⁶, P. A. Charles⁶, K. J. Schramm⁶, U. Borgerst⁶, J.V. Linde⁶, W. Weneit⁶, D. Kühl⁶, T. Schramm⁶, A. Sadun⁶, R. Grashuis¹⁰, J. Heid¹¹, S. Wagner¹¹, H. Bock¹¹, M. Kümmel¹¹, A. Heines¹¹, M. Fiorucci¹², G. Tosti¹², G. Ghisellini¹³, C.M. Raiteri¹³, M. Villata¹³, G. De Francesco¹³, S. Bosio¹³, G. Latini¹³

¹ Tuorla Observatory, FIN-21500 Piikkiö, Finland
² Instituto de Astrofísica de Canarias, La Laguna, 38200 Tenerife, Spain
³ 1655 Main St. Stittsville, Ont. K2S 1N6, Canada
⁴ Instituto de Astronomía-UNAM, Apdo. Postal 70-264, 04510, Mexico, D.F. Mexico
⁵ Department of Astronomy, Indiana University, Swain West 319, Bloomington, IN 47405, USA
⁶ Crimea Astrophysical Observatory, P/O Nauchny, 334413 Crimea, Ukraine
⁷ University of Oxford, Dept. of Astrophysics, Nuclear & Astrophysics Laboratory, Keble Road Oxford, OX1 3RH, England
⁸ Hamburger Sternwarte, Hamburg Universität, Gajensbergweg 112, D-21029 Hamburg 80, Germany
⁹ Bradley Observatory, Agness Scott College, Decatur, GA 30030, USA
¹⁰ Peak Observatory, University of New Mexico, Albuquerque, NM 87191. USA
¹¹ Landessternwarte Königstuhl, D-69117 Heidelberg, Germany
¹² Osservatorio Astronomico, Universita di Perugia, I-601123 Perugia, Italy
¹³ Osservatorio Astronomico di Torino, Strada Osservatorio 20, I-10025, Pino Torinest, Italy

Abstract

During the OJ-94 campaign we have been concentrating mainly on two objects, OJ 287 and 3C 66A but we have a lot of data also on the BL Lac objects S5 0716+714 and AO 0235+164. In OJ 287 we observed the predicted outburst in the fall 1994. 3C 66A has been in the strong outburst all the time. On the other hand, AO 0235+164 has been very faint in all of our observations. S5 0716+714 has been very variable, like normally, but we can also see a huge outburst at the beginning of the year 1995. In this paper we will present the V-band (AO 0235+164 in R-band) light curves of these four objects as observed during our project.
1. Results

The main aim of the OJ-94 project was to check if the optical outburst of the BL Lac object OJ 287 really happens in the fall 1994 as predicted in Sillanpää et al. (1988). This outburst was also detected. The whole historical light curve with the OJ-94 data is shown in the Fig.1. As the by-product we have got the best light curve ever seen in any extragalactic source. For OJ 287 we also have a very good time coverage in all the optical bands B, V, R and I. The V-band light curve is seen in Fig.2.

Another of our main targets is 3C 66A. Historically its magnitude has been around 16 in V (see e.g. Takalo et al. 1996) but during our project it has been all the time brighter than 15. The brightest value is about 13.6, so it has been in an extended outburst more than two years now. However, the total variation range has been only 1.5 magnitude which is much lower compared to OJ 287. The 3C 66A light curve is shown in Fig.3. and will be discussed in more details in the forthcoming paper by Takalo et al. (1996).

Besides of our two main targets we have monitored also two another interesting BL Lac objects. S5 0716+714 (about 50 data points) and AO 0235+164 (30 points). AO 0235+164 has been very faint during the whole project and the average V- magnitude has been around 18.5 which is below of the limiting magnitude of the smallest telescopes in the project. The R-band light curve is shown in Fig.4. and the direct imaging and spectroscopy of this object during the project will be discussed in more details in Nilsson et al. 1996. S5 0716+714 is the only observed BL Lac object which shows microvariability all the time (Heidt 1994). It is also one of the brightest known BL Lac objects. The spectrum has no emission lines at all so we don’t know the redshift for this object. During our project S5 0716+714 has been very variable (Fig.5.) like normally but the most, interesting feature has been the large outburst occurring at the beginning of the year 1995. This outburst coincides almost with the EGRET pointing so it will be interesting to compare the behaviour of the object in these different energy regimes.

All of our four objects have also been observed at least marginally with the EGRET experiment in the gamma rays. For the OJ 287 the detection was the first one and occurred using the To0 program during the optical outburst in the fall 1994.

References

Figure 1: The historical (1891-1995) V-band light curve of OJ 287 showing the 12 year outburst cycle.
Figure 2: The light curve of OJ 287 in V-band during the OJ-94 project.
Figure 3: The light curve of 3C 66A in V-band during the OJ-94 project.
Figure 4: AO 0235+164 in R-band during the OJ-94 project.

Figure 5: S5 0716+714 in V-band during the OJ-94 project.