Multifrequency Monitoring of Blazars OJ 287 and 3C 66A


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ABSTRACT. We present preliminary results from an intensive multifrequency monitoring of blazars OJ 287 and 3C 66A. In both blazars we observe continuous small amplitude variability in time scales of days. This is the first time that such continuous variations have been observed. 3C 66A has been in outburst, being about one magnitude brighter than during the previous observations. In OJ 287 we observed a large outburst in November 1994, that lasted about three months. This outburst occurred almost at the predicted time (Sillanpää et al. 1988), confirming the 12 year periodicity in this blazar.
1. Introduction

One of the most productive means in quasar and blazar studies has been photometric monitoring programs. The observed variations in the object brightness gives important information on the energetics and the sizes of the emitting region(s). Long term monitoring programs have been conducted at Florida (Webb et al. 1988), Hamburg (Schramm et al. 1994) and Tuorla (Sillanpää et al. 1991), with sporadic observations at other observatories around the world. In all these monitoring observations the sampling has not been very extensive, with only a handful of data points per object in a year. Several multifrequency monitoring campaigns have also been conducted. Usually these campaigns have lasted a couple weeks, with the data being mostly quasisimultaneous (e.g Brown et al. 1989, Gear et al. 1986). So, at best these multifrequency campaigns have managed to get a “snapshot” of an object. Lately it has become evident that this kind of “snapshot” approach does not give a true picture of the blazar behaviour, nor cannot it explain in detail the energy producing mechanism(s) in these objects.

OJ 287 is the only blazar, for which a very long historical light curve can be drawn. The first observations date back to 1891, so we have over one hundred years of data on it. This historical light curve shows clear outbursts with a period of 11.65 years (Sillanpää et al. 1988; Babadhanyants et al. 1992 and Kidger et al. 1992). Sillanpää et al. also predicted that a new outburst would occur late 1994. These periodic outbursts were explained by a binary black hole model by Sillanpää et al. (1988). OJ-94 project, was created for verifying the new outburst and for doing a comprehensive study on OJ 287. 3C66A was selected for the project as a comparison object for OJ 287, mainly because in it we had not observed any intranight variability. We received the 5% international observing time (ITP) on the Canary Island telescopes for this project for half a year during winter 1993-1994. In order to improve our time resolution and to fight the weather conditions we have created around the ITP project a huge international collaboration for this project. At this moment the OJ-94 project consists of over 50 astronomers in 16 different observatories, most of which observe in the optical bands (Sillanpää et al. 1994). This project is the largest monitoring project ever created for observing blazars. Here we will present some preliminary results from this multifrequency monitoring program.

2. Observations and results

We have collected during this project the best light curves ever observed on OJ 287 and 3C 66A. We have extensive light curves of these blazars in all optical bands (UBVRI), infrared (JHK) and in radio (4:8,8,14,22,37 GHz). Of OJ 287 we have over 7000 data points and on 3C 66A we have 3000 observations. Both these data sets more than double the observations on these objects. Most of the optical data are in the V-band, it being available at most observatories. Figure 1. displays the observed V-band light curve on OJ 287. Notice the almost continuous small amplitude variability and the large outburst that occured in November 1994. This outburst occured almost at the predicted time,
confirming the 12 year periodicity in OJ 287. This can be also seen from figure 2, where we plot the historical light curve of OJ 287. In this historical light curve the average magnitude has been one magnitude lower after the 1984 outburst than previously. Due to this the maximum brightness during this outburst is somewhat lower than during the last two outbursts. During this outburst we had also TOO observations on OJ 287 with the IUE, ASCA, ROSAT and GRO-satellites. All these satellites detected OJ 287. GRO for the first time. This satellite data is still being analysed. The radio monitoring of OJ 287 during the project has shown it at a very low flux level, with very little activity (see Sillanpää et al. these proceedings).

OF 3C66A here exists only a little previous observations, with the average V-band magnitude being 15.0 (see Takalo et al. 1995). During our monitoring 3C 66A was in outburst all the time, with the average magnitude being one magnitude above the historical one. The V-band light curve is shown in figure 3. Notice the very fast variability observed throughout the project. All other optical bands and the infrared show similar behaviour (Takalo et al. 1995). Of this object we do not have any radio observations.

3. Discussion

We have presented the best ever observed light curves of OJ 287 and 3C 66A. In both objects we see continuous small amplitude variability. This is the first time that this kind of behaviour has been observed in blazars. All the optical and the infrared frequencies show similar behaviour. In the radio bands OJ 287 is very weak, with only small variations. Previously the time resolution in the monitoring has not been good enough for detecting this behaviour. The optical to infrared spectrum of both objects can be modelled with a powerlaw \( f_\nu = k \nu^{-\alpha} \), with little variations in the powerlaw index. These observations will provide new tools for the theoreticians modelling the blazar emission mechanisms.

The large outburst observed in OJ 287, at almost the predicted time is a major discovery. This is the first time that a predicted outburst has been seen in an extragalactic object. These outbursts occur with a mean period of 12 years (Sillanpää et al. 1995). There seems to be small fluctuations in the exact period. Also there exists very good data only for the last three outbursts, which makes all periodicity analysis very difficult.

Acknowledgements

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Fig. 1. The V-band light curve of OJ 287 observed during the OJ-94 project.

Fig. 2. The historical light curve of OJ 287, showing the periodic outbursts.
Fig. 3. The observed V-band light curve of 3C66A.

References

Mem. S.A.It., 1996
DISCUSSION

J. MATTOX: What might be driving a -11.7 years periodicity?


J. MATTOX’s comment: Chris Shrader (from the CR science support center) had a proposal accepted to observe a blazar flaring in the optical with EGRET as a target of opportunity. OJ 297 was included on his target list. An EGRET observation resulted from this program just fall during the flare. A weak EGRET detection resulted.

W. KUNDT: Have you evaluated the power spectrum of your light-curve?

L. TAKALO: Not yet. Work is presently in progress.

J. BEALL: I suppose other than a binary system, a precessing disk might be a possible model for such -11.7 year bursts.

L. TAKALO: A precessing disk does not work. A. Sillampaa discussed this in his thesis (1989, University of Turku).