High Energy Blazar Astronomy
ASP Conference Series, Vol. 299, 2003
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S5 0716+71 from 1994 to 2001: optical and radio variability

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Abstract. The radio and optical behaviour of the BL Lacertae object 0716+714 from 1994 to 2001 has been investigated by a wide international collaboration including eight optical telescopes in Italy, Greece, Georgia (FSU), and Uzbekistan and two radio antennas in USA and in Finland. The optical light curves show a long-term trend on which fast variations are superposed. The mean brightness level seems to vary with a typical time scale of about 3.3 years. No clear evidence of correlation between variations in the optical and radio bands has been found.

1. Introduction

A wide collaboration of radio and optical astronomers was formed to study the emission properties of the BL Lacertae object S5 0716+71. Data were taken from 1994 to 2001 with eight optical telescopes in Italy, Greece, Georgia (FSU), and Uzbekistan (see Table 1) and with the radio antennas of the University of Michigan Radio Astronomy Observatory (UMRAO), in USA, and of the Metsähovi Radio Observatory, in Finland.

Table 1. Participating optical observatories, telescopes size (m), and number of $UBVRI$ data collected from 1994 to 2001

Observatory	Label	Size	N_U	N_B	N_V	N_R	N_I	$N_{\rm tot}$
Greve (Italy)	GR	0.32	0	31	33	38	38	140
Perugia (Italy)	PG	0.40	0	23	312	522	376	1233
Vallinfreda (Italy)	VA	0.50	5	214	180	244	194	837
Monte Porzio (Italy)	MP	0.70	19	29	28	37	39	152
Abastumani (Georgia)	AB	0.70	0	166	143	490	135	934
Torino (Italy)	TO	1.05	0	257	163	523	21	964
Skinakas (Greece)	SK	1.30	0	53	0	54	0	107
Mount Maidanak (Uzbekistan)	MA	1.50	14	273	14	196	14	511
Total			38	1046	873	2104	817	4878

2. Variability in the optical band

Figure 1 shows the light curve of S5 0716+71 in the R band; the dashed line represents a cubic spline interpolation through the data (binned every 200 days), evidencing the long-term trend during the best sampled observing period; dotted lines are drawn by shifting the spline by ± 0.75 mag in order to define a 1.5 mag constant variation area. Taking into account the sampling differences among the various seasons, one can say that the source variability is essentially constrained within this area up to October 2000, when a strong enhancement in the variation amplitude was observed, triggering a ToO pointing by the X-ray satellite BeppoSAX.

Statistical analysis (Discrete Fourier Transform, Discrete Autocorrelation Function, Structure Function) applied to the data shown in Figure 1 suggests that the long-term trend has a characteristic variability time scale of about 3.3 years. Details can be found in Raiteri et al. (2002).

3. Comparison between radio and optical behaviours

A comparison between the optical and radio behaviour of the source is shown in Figure 2, where the R magnitudes have been converted into fluxes (mJy) in the top panel, and radio data expressed in Jy are from the Metsähovi Radio Observatory (37 and 22 GHz) and from UMRAO (14.5, 8.0, and 4.8 GHz). Data from Sagar et al. (1999) have been added to the optical light curve, and those from Venturi et al. (2001) to the radio ones.

The radio behaviour at different frequencies is similar, but very different from the optical one: when the main optical outbursts occur, only weak signals

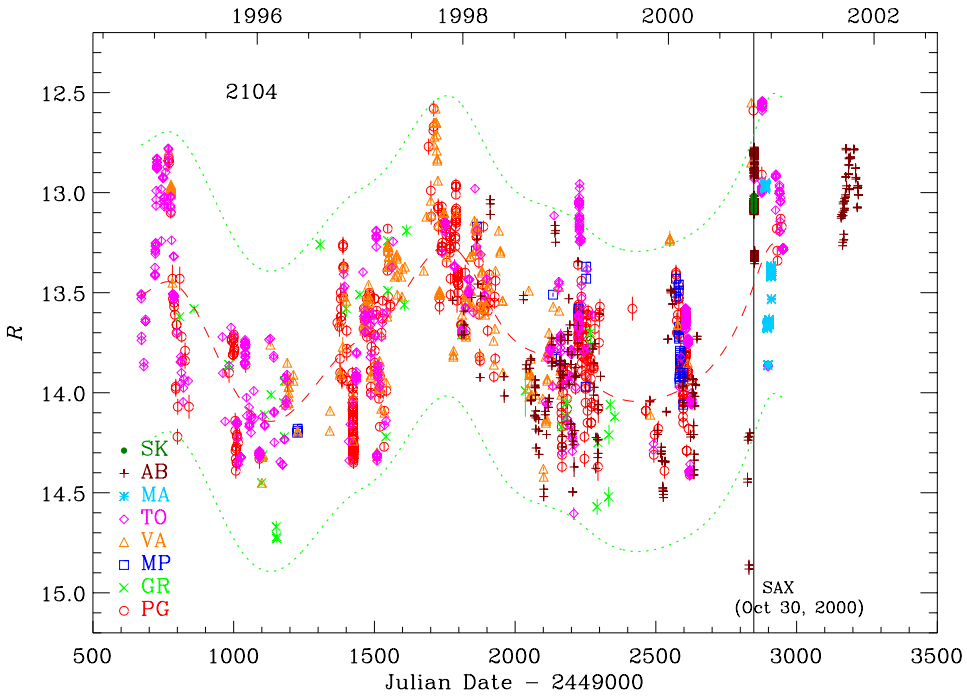

Figure 1. The R-band light curve of S5 0716+71; labels are defined in Table 1; the solid line indicates the ToO pointing by the X-ray satellite BeppoSAX.

(if any) are found in the radio bands (follow the dashed lines in Figure 2). This is quite a different behaviour with respect to the strong optical-radio correlation that was found, for instance, in another BL Lac object: AO 0235+16 (Raiteri et al. 2001).

Here the big radio outburst starting in 1998 might be related to the strong optical outburst of autumn 1997, but the existence of an optical-radio connection with a $\sim$ 200 day delay cannot be properly tested because of the limited time extension of our study.

References

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Sagar, R., et al. 1999, A&AS, 134, 453
Venturi, T., et al. 2001, A&A, 379, 755

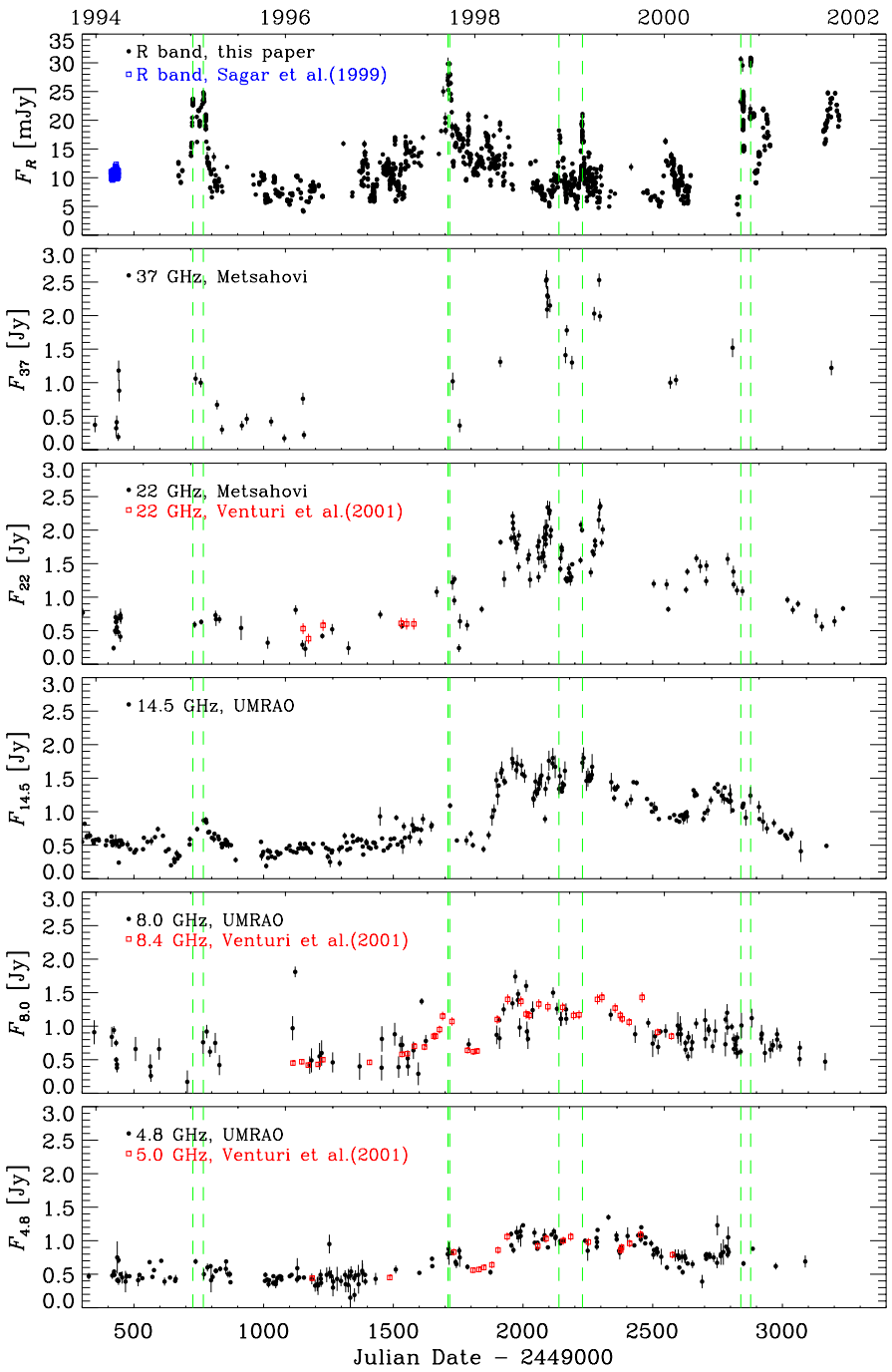

Figure 2. Optical (top panel, mJy) and radio (Jy) fluxes from 1994 to 2001.