

CM-WAVELENGTH FLUXES AND POLARIZATIONS OF COMPACT EXTRA-GALACTIC X-RAY SOURCES

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**Abstract:** Cm-wavelength observations of 15 BL Lac objects are presented. The degree of radio-wavelength variability is compared with the strength of the emission at optical and X-ray wavelengths.

We present observations of the total flux density and linear polarization at 4.8, 8.0 and 14.5 GHz for 15 BL Lac and related type objects obtained with the University of Michigan 26-meter telescope since fall 1979. Almost all of the sources in our sample are well-established X-ray emitters and both active and quiescent objects are represented. The average fluxes and polarizations are summarized in Table I.

Table I  
Average Radio Flux and Polarization Data

Source	4.8 GHz			8.0 GHz			14.5 GHz			$\alpha$
	S(Jy)	P(%)	$\chi$	S(Jy)	P(%)	$\chi$	S(Jy)	P(%)	$\chi$	
3C 66A	1.68	1.9	87	0.98	2.4	78	0.68			-0.81
0521-365	7.3	2.5	72	6.15	2.6	70	4.2	1.7	66	-0.89
OJ 287	2.43	5.4	86	3.31	6.1	81	4.10	6.1	89	-1.16
Mrk 421	0.71	2.0	128	0.66			0.71	8.0	100	-0.74
Mrk 180				0.34	12.	158	0.40			-0.65
1400+162	0.43	4.4	6	0.41	<4		0.33			-0.91
1413+135	1.07			1.98			2.87	0.9	67	-1.14
1418+546	1.54	1.2	171	2.08	1.6	163	2.19	1.5	92	
4C 14.60	1.35	5.2	153	1.59	7.0	137	1.68	4.7	133	-1.01
Mrk 501	1.21	1.7	147	1.26	2.8	152	1.16	2.5	104	-0.74
I Zw 187	0.21	3.0	54	0.24			0.21			-0.72
3C 371	1.86	1.5	38	2.06	3.0	0	2.08	3.1	139	-0.89
2155-304	0.39	4.9	158	0.36			0.34			-0.57
BL Lac	6.8	1.5	23	6.2	0.3	23	7.4	1.0	45	<-0.92
OY 091	0.4			0.46			0.47			-0.95

The flux densities were generally determined to an accuracy of 0.02 Jy or better; in cases where one decimal digit is indicated, the values were determined to an accuracy of only 0.1 Jy. The degrees of polarization given satisfy the criterion  $P/\sigma_p \geq 3$ , with the exception of the value for I Zw 187 which is a  $2\sigma$  measurement.

Large and well-defined radio outbursts in total flux density were observed in OJ 287, the unusual red BL Lac object 1413+135, 1418+546 and BL Lac; 0521-365, 4C 14.60 and 3C 371 showed moderate variability. The well-studied X-ray sources Mrk 421 and Mrk 501 exhibited little variability.

While at optical wavelengths the degree of polarization is by definition high, the degrees of polarization shown here are generally less than 8% and are typically 2-3%. These values are comparable to those we have observed in active quasars but are significantly lower than those observed at optical wavelengths. The radio position angles for 4C 14.60 and 0521-365 are related to the published optical position angles (parallel and perpendicular, respectively). Any possible relation for the other sources is less clear.

Spectral indices formed between 14.5 GHz and approximately 2 keV using published X-ray data are shown in the last column of Table I. The mean value of these indices is -0.86. There is a wide spread in the values of this parameter which may in part be due to the fact that the radio and X-ray data were not taken at the same epoch. The sources which are most highly variable at 14.5 GHz (OJ 287, 1413+135) have spectral indices steeper than -1.1 while in contrast well-studied sources which have shown little or no variability at 14.5 GHz (Mrk 421, Mrk 501) have spectral indices of approximately -0.7.

We conclude that a relatively high degree of polarization at radio wavelengths, while sometimes present, is not a characteristic property of all BL Lac objects. Although some of these objects are extremely active, others are quiescent for periods of at least several years. Based on our small sample of objects there is an apparent anticorrelation between cm-wavelength variability and the strength of the X-ray emission.

We thank the staff of the University of Michigan Radio Astronomy Observatory for their assistance in obtaining the data shown here. This work was supported by the National Science Foundation under grant AST 80-21250.