VLA POLARIMETRY OF VLBI CORE–JET SOURCES

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Radio imaging of VLBI core–jet sources can be used to examine the case for continuity of jet–like features between parsec and circumgalactic scales. Futhermore, polarimetry of such sources allows investigation of the dominant magnetic field topologies as a function of linear offset from the central engine. Examination of these continuity and field topology issues is essential for an understanding of how energy is channeled from the nuclear regions to the circumgalactic environment.

Linear polarization position angles (χ_λ) in radio images, especially those at wavelengths $\geq$ 18 cm, must be corrected for Faraday rotation before intrinsic magnetic field configurations can be inferred. Rotation measures of VLBI core–jet sources are difficult to determine from broad–band (e.g., 2, 6, and 20 cm) polarimetry, for two reasons (Rudnick and Jones 1983). First, the wavelength–dependent opacity alters the electron population emitting at different wavelengths. Second, structural complexities and time variations which do not appear simultaneously at all wavelengths make polarization position angle comparisons dubious. Rudnick and Jones (1983) demonstrated that these problems can be overcome by conducting simultaneous, multi–wavelength polarimetry within the 20–cm window of the NRAO VLA.

This technique was applied to 7 VLBI core–jet sources from the survey of Pearson and Readhead (1984). Some properties of these 7 are given in Table I. Snapshots of each source were taken at wavelengths of 21.6, 21.2, 20.5, 19.8, 18.3, and 18.0 cm. The resolution was $\sim 1''$. χ_λ is plotted in Figure 1 as a function of λ^2. The data for each source involve measurements either of its unresolved VLA core (size $< 1''$ or ≤ 4 kpc – see col. 4), or of its kpc–scale emission adjacent to the VLA core. For each source, the data were fit to a straight line by the method of least squares. Each fit yielded a zero–wavelength intercept (χ_0, col. 5) and a rotation measure (RM, col. 6).

The rotation measures resemble those of nine 3C sources with similar ranges of Galactic longitude and latitude (l^{II} = 75–115^0 and b^{II} = 20–50^0; Simard–Normandin, Kronberg, and Button 1981). This is consistent with a primarily Galactic origin for the rotation measures of both the (presumably steep–spectrum) 3C sources and the VLBI core–jet sources. If the Galactic disk behaves like an unresolved foreground screen, then it should cause Faraday rotation but no depolarization (Laing 1984). Such behavior is shown by 1803+784, the core–jet source with the largest rotation, for which the observed percent polarization p_λ is remarkably constant at 3.9 percent between 21.6 and 18 cm. For comparison, if the RM was due to mixed thermal and emitting plasma, then a simple uniform slab model would predict a factor of 5 drop in p_λ between 21.6 and 18 cm.

For 5 sources χ_0 refers to the unresolved VLA core and can be compared to the VLBI structural position angle χ_v at 6 cm for 1642+690 (Pearson *et al.* 1986) and at 18 cm for 0836+710, 1749+701, 1803+784, and 1928+738 (Eckart *et al.* 1987). Col. 7 gives the value of the acute angle A between χ_0 and χ_v. For sources with multiple VLBI components, χ_v refers to the outermost one. If the linearly polarized emission is due to optically thin synchrotron emission, then A $\geq 75^0$ (0836+710, 1642+690, 1928+738) indicates a projected magnetic field fairly well aligned with the VLBI jet. Bridle (1984) finds a similar trend among kpc–scale jets that, like the VLBI jets, are one–sided. The small A values found for 1749+701 and 1803+784 could be caused by, for example, the polarized emission originating in regions whose structural angles differ from those of the VLBI components; or else in regions with similar structural angles but whose magnetic fields are associated with shocks in the jet.

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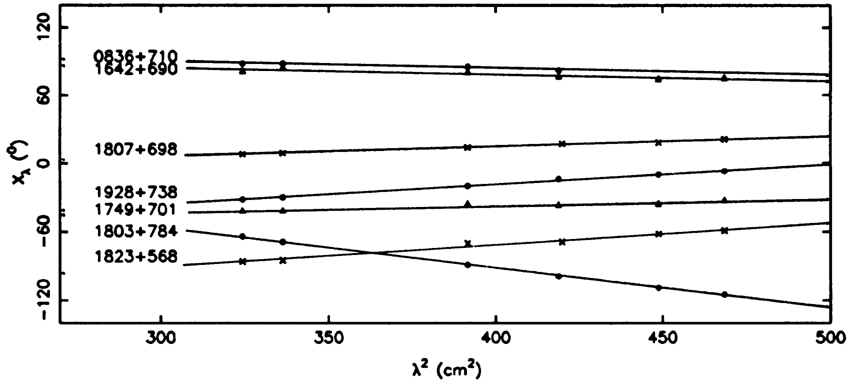

Fig. 1. – Linear polarization position angle χ_λ as a function of λ^2. Symbols distinguish between polarimetry of an unresolved VLA core (< 1″, filled symbols) and of adjacent kpc-scale emission (crosses). Straight lines are the results of least-squares fits.

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Table I. Seven VLBI Core–Jet Sources

IAU	Common	Id[a]	Scale [b] (kpc/″)	χ_0 (°)	RM (rad m^{-2})	A (°)
0836+710	4C71.07	Q	4.0	+109±4	-11±2	75
1642+690	4C69.21	Q	4.1	+103±5	-11±2	88
1749+701	...	B	4.1	- 61±4	+10±2	16
1803+784	...	B	4.0	+ 51±2	-62±1	30
1807+698	3C371	G	0.7	- 20±2	+15±1[c]	...
1823+568	4C56.27	B	3.9	-148±6	+33±2	...
1928+738	4C73.18	Q	2.7	- 89±2	+31±1	83

Notes –

[a] Q = quasar, B = BL Lac object, G = galaxy.

[b] H_0 = 100 km s^{-1} Mpc^{-1} and q_0 = 0.5. Redshifts are from Pearson and Readhead 1984, Lawrence *et al.* 1986, Eckart *et al.* 1987, and Lawrence, private communication.

[c] Preliminary RM given by Wrobel 1987.

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