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VLBA Polarimetry of Lobe-dominated Quasars from the Jodrell Bank Survey

Christian E. Aars and David H. Hough

Dept. of Physics & Astronomy, Trinity Univ., San Antonio, TX 78212

Abstract. We present images of the parsec-scale polarization structure in the nuclei of three lobe-dominated quasars from the Jodrell Bank 966 MHz survey: 0723+679 (3C179), 1150+497, and 1317+520. Studies of extended sources, whose jets cover a wide range of orientations, are important for testing physical models of polarized emission. The core in 0723+679 shows a rest-frame rotation measure of $\sim$1400 rad m^{-2}. All three sources have low-polarization ($<$ 2%) cores and moderately-polarized (often $>$ 10%) jets, with evidence for strong polarization ($\geq$20%) on the component edges. All three jets exhibit predominantly longitudinal magnetic fields, with no Faraday rotation. The cores have flatter spectra than the jets.

Most of our knowledge of the polarization properties of parsec-scale jets in quasars and active galaxies comes from VLBI studies of powerful, compact radio sources. These properties are predicted to have strong orientation dependence on models that incorporate beaming and a specific geometry for obscuring material. Hence studies of the nuclei in extended sources, thought to cover a wide range in orientation, are important for testing these models.

Previous VLBI polarization work on extended sources has included detailed studies of some nearby objects (e.g., M87 in Zavala & Taylor 2003), and initial efforts on complete samples of 3CR FRII radio galaxies and lobe-dominated quasars (e.g., Taylor, Hough, & Venturi 2001; Hough et al. 2002) with a polarized flux detection rate of $<$50% thus far.

The present work aims to increase the detection rate for VLBI polarization structure in lobe-dominated quasars. Eight such objects in the Jodrell Bank 966 MHz sample (Owen, Porcas, & Neff 1978) have significant VLA core polarization (Owen & Puschell 1984). The first three objects observed with the VLBA (at 5, 8, and 15 GHz at epoch 2002.92) *all* have definite parsec-scale polarization:

0723+679 (Fig. 1): The core has a flux density $S \sim 0.3$ Jy, a percentage polarization m = 1-2%, and a rest-frame rotation measure of $\sim$1400 rad m^{-2}. The jet to the west is more strongly polarized, with m ranging from 3% to $\sim$20% and suggestions of $m > 20\%$ on its edges.

1150+497 (Fig. 2): The core has $S \sim 0.6$ Jy and m = 0.5-2%. The jet to the south is more strongly polarized, with m ranging from 3% to $\sim$20% and evidence of $m > 20\%$ on its eastern edge.

1317+520 (Fig. 3): The core has $S \sim 0.3$ Jy, with $m < 0.1\%$ at 5 and 8 GHz and $m = 2\%$ at 15 GHz. The jet to the southeast is more strongly polarized, with $m \sim 10\%$ and hints of $m > 20\%$ on its edges.

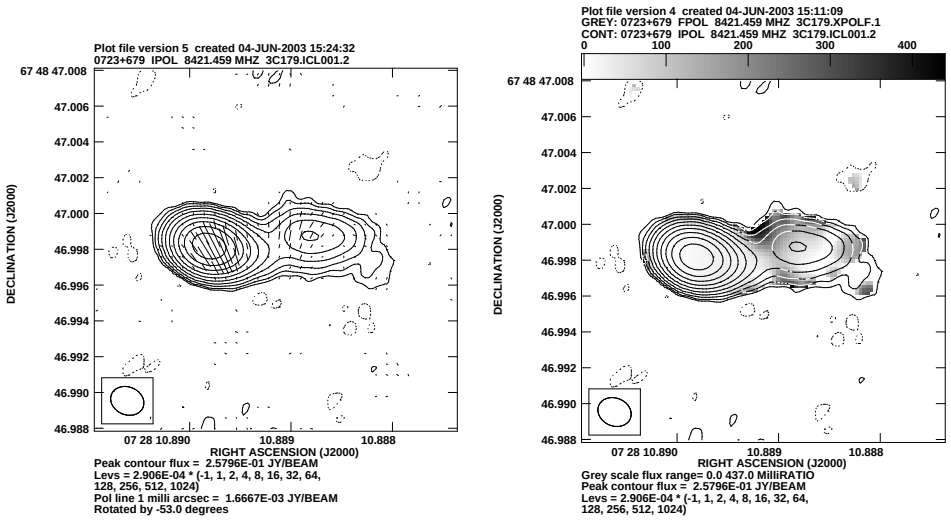

Figure 1. 8 GHz VLBA image of 0723+679: electric vector position angle (left) and fractional polarization (right).

All three sources share some common features. Clearly, they have weakly-polarized cores and more strongly-polarized jets, with signs of especially high polarization on the jet boundaries. The electric vectors are predominantly perpendicular to the jet axes, with no Faraday rotation, indicative of longitudinal projected magnetic field structures. The core spectra do not have simple shapes, but they are generally flatter than the jet spectra.

The sample is obviously still small, but these Jodrell Bank quasars show a higher detection rate for VLBI polarized emission thus far. This result is consistent with their jets pointing closer to our line of sight and hence being less obscured by a Faraday screen (Taylor 2000). The apparent enhancement of fractional polarization on the jet boundaries could be due to, e.g., shearing effects or helical magnetic fields (Gabuzda 2004).

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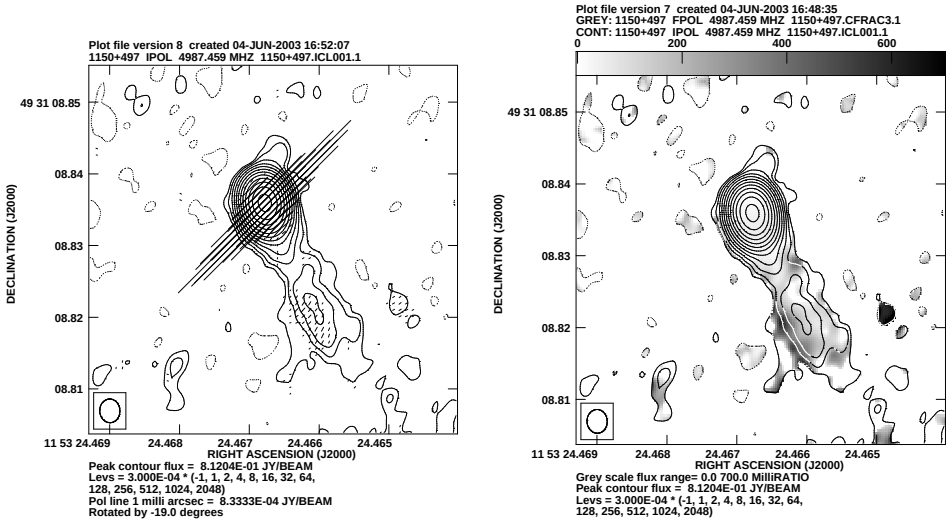

Figure 2. 5 GHz VLBA image of 1150+497: electric vector position angle (left) and fractional polarization (right).

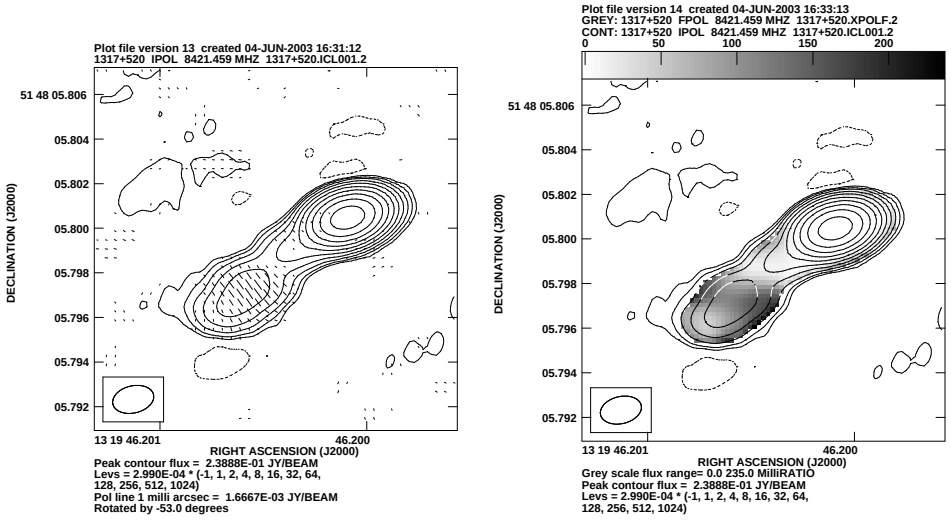

Figure 3. 8 GHz VLBA image of 1317+520: electric vector position angle (left) and fractional polarization (right).