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A Polarization Study of Quasar 4C 71.07

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Abstract. Parsec-scale polarization observations of the quasar 4C 71.07 show a misalignment between the inferred magnetic field direction and the structural direction of the jet. Dual frequency VLBI polarimetry was used to to determine whether Faraday rotation was the origin of the misalignment. We find insufficient rotation to realign the field and jet. Other possible mechanisms which may result in a misalignment are discussed.

1. Introduction

The magnetic field structures of jets in quasars have been found to show scale dependent characteristics. On the kilo-parsec scale the magnetic field tends to align well with the structural direction and this is attributed to shear (Bridle et al. 1994). On parsec-scales substantial misalignments between the structural direction and the implied magnetic field direction have been found (Cawthorne et al. 1993). One of the largest of these misalignments, 35° at λ6 cm, was found in quasar 4C 71.07 (0836+71, z=2.17) and this source, having a relatively simple jet and being strongly polarized, was selected for further study. The origin of the misalignment was suspected to be due to an external Faraday screen of gas in the in the narrow line region. To test whether the misalignments on parsec scales are due to Faraday rotation, 5 GHz and 8.4 GHz polarization sensitive VLBI observations were made in 1992 and 1995. The inferred magnetic field and polarization structure, and Faraday rotation measures have important consequences for the dynamical model of the jet and the nature of the surrounding medium. The 1992 VLBI results showed little rotation between the two frequencies indicating an intrinsically misaligned magnetic field (Hutchison & Cawthorne 1997). Preliminary discussion of results from the 1995 VLBA data are presented here.

2. The Search for Faraday Rotation

One explanation for the observed misalignments between inferred field direction and the jet is that the jet does have a parallel field, but is seen behind a Faraday screen. Dual frequency VLBI polarization observations allow us to test this hypothesis. Rotation measures from VLA polarimetry indicate just 2±1° rotation at λ6 cm (Wrobel 1993; Rusk 1988), insignificant in comparison to the misalignment. However due to polarization structure on intervening scales, this result does not immediately settle the issue. The 1995 VLBI data confirm our previous result that the correction for the small difference of position angles at the two frequencies does *not* result in alignment of the inferred magnetic field with the jet. The only significant detection of rotation is for the innermost component detected at both frequencies.

3. Other Origins of Magnetic Field Misalignments

Other explanations for the field misalignments involve (1) parallel fields in twisted jets (e.g. see Otterbein et al., these Proceedings, p. 73), or (2) complex magnetic field structure in straight jets, or (3) gravitational lensing, which rotates the jet, but not the polarization vectors. Higher resolution polarization sensitive observations will help distinguish between (1) and (2). Wiggles in the jet of the kind required in explanation (1) have been reported (Otterbein et al., these Proceedings, p. 73), but at present, the precise relationship between these and the polarization structures is unclear. Work on the possible role of a lens system is in progress.

4. The Jet Environment

Faraday rotation is detected for one component close to the core, inferring a rotation measure of 47 ± 6 rad m^{-2}. This low RM poses interesting questions as to the environment of the jet on these scales. It appears that the line of sight to the jet misses narrow line region clouds and this may be evidence that we are looking down through a cocoon which immediately surrounds the jet.

5. Summary and Conclusions

The 1995 VLBA observations of the quasar 4C 71.07 follow the jet out to around 40 mas, three times further than our previous observations. Insignificant differences in the polarization position angle at the two frequencies were found throughout the jet except for a component near the core. Here, a low Faraday rotation measure has been detected but it is not sufficient to realign the field and jet. We confirm our previous result that the magnetic field appears to be intrinsically misaligned with the jet in this source. We conclude that a mechanism other than Faraday rotation causes the misalignment in this source.

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References

Bridle, A. H., et al. 1994. *AJ*, **108**, 766–820.
Cawthorne, T. V., et al. 1993. *ApJ*, **416**, 519–535.
Hutchison, J. M., & Cawthorne, T. V. 1997. *Vistas in Astronomy*, **41**, 231–235.
Wrobel, J. M. 1993. *AJ*, **106**, 444–454.
Rusk, R. 1988. *Ph.D Thesis*, University of Toronto.