Astrophysical Phenomena Revealed by Space VLBI
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The Pearson-Readhead Survey at 43 GHz

Matthew L. Lister[1], R.A. Preston[1], B. Glenn Piner[1]
& S.J. Tingay[2]

[1] *Jet Propulsion Laboratory, California Institute of Technology*
[2] *Australia Telescope National Facility*

Abstract

We present results of a program to obtain 43 GHz ground VLBI polarization images of a sample of AGNs from the Pearson-Readhead survey that we are also observing with HALCA at 5 GHz. The sources analyzed so far display bright, weakly polarized cores with magnetic fields predominantly perpendicular to the inner jet direction. The polarizations of components in the jets increase with distance from the core, and have magnetic field orientations that are consistent with oblique relativistic shocks.

1 Introduction

In this paper we present preliminary results of a VLBA polarization study at 43 GHz of flat-spectrum AGNs in the Pearson-Readhead (PR) survey. This work complements our 5 GHz space-VLBI observations of this sample (Preston et al. 2000), with the goal of better understanding the physics and dynamics of the core regions of AGNs.

The original VLBI polarization study of the PR sample was carried out at 5 GHz (Cawthorne et al. 1993), and revealed that quasars tend to have magnetic fields that are parallel to the jet, while in the jets of BL Lacertae objects, the orientations are mostly perpendicular. Observations at higher frequencies (e.g., Nartallo et al. 1998, Lister et al. 1998) indicate that this dichotomy might not hold for jet regions closer to the core, however. This may be related to the nature of the underlying longitudinal field component and/or relativistic shocks in these regions. Our 43 GHz polarization study represents the first high-resolution survey of a complete sample of objects with which to investigate these issues.

2 Observations

To date we have obtained VLBA 43 GHz polarization snapshot observations of 25 of 34 flat-spectrum ($\alpha_{5-15\,\mathrm{GHz}} > -0.5$) PR objects that

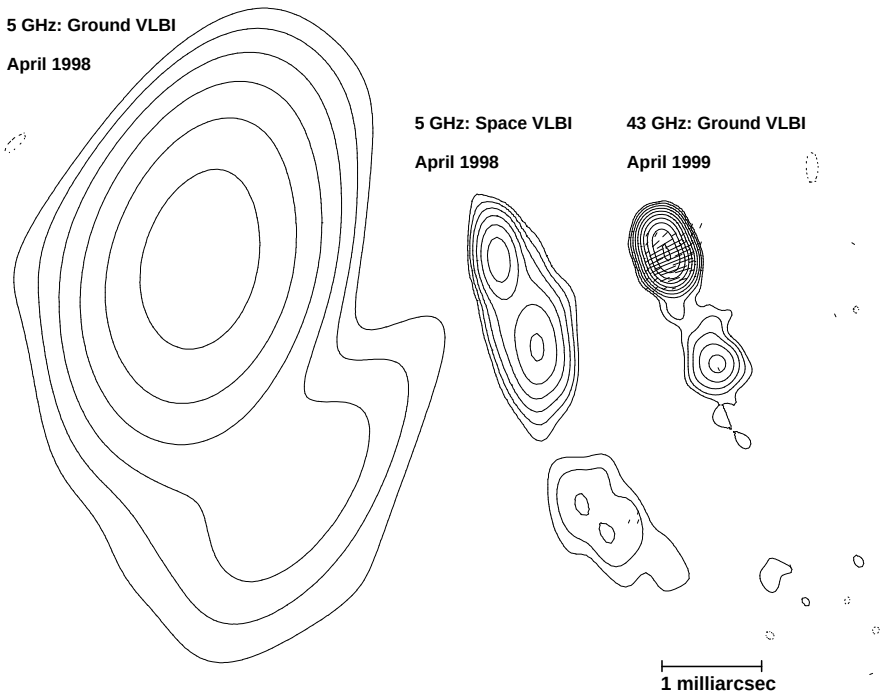

Figure 1: Images of the quasar 1637+574, taken with space and ground VLBI at two epochs. Electric polarization vectors are shown in the 43 GHz image.

have total 43 GHz flux densities > 300 mJy. Nearly all of the 19 objects that we have imaged so far are highly core-dominated, with the exception of the two radio galaxies in the sample: 2021+614 and 3C 84. In three sources (0016+731, 0804+499, and 0954+658), the core accounts for over 92% of the total cleaned flux, which illustrates the usefulness of this sample for identifying good targets for future high-frequency space VLBI. In Fig. 1 we show the improvements in resolution obtained with various VLBI techniques for the quasar 1637+574.

3 Polarization Properties

The core components of our sources are generally weakly linearly polarized ($< 3\%$), with more than half displaying magnetic fields that

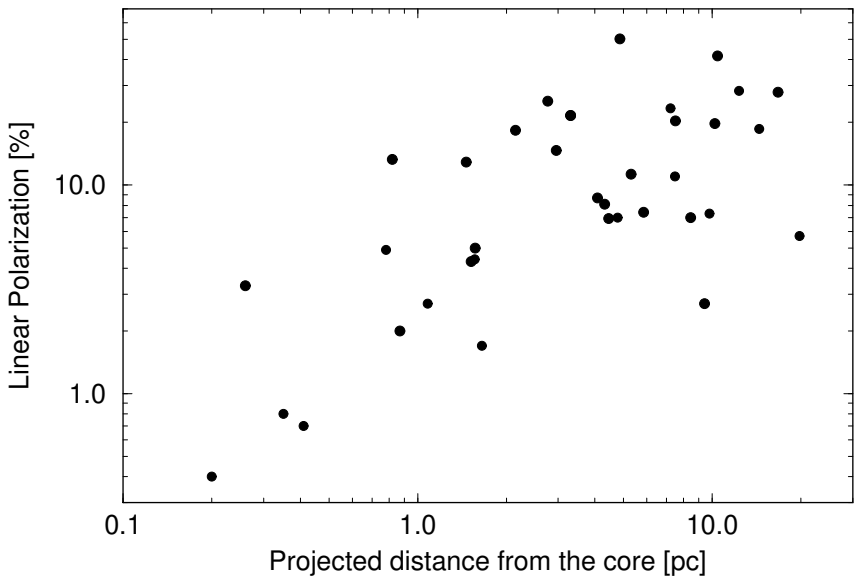

Figure 2: Fractional polarization of jet components versus projected distance from the core in parsecs.

are nearly perpendicular to the innermost jet direction. We find no strong correlations between the measured core brightness temperatures at 5 GHz and the polarization properties of the core components.

The components found in the jets are generally more polarized than the cores, and follow an exponential trend of increasing polarization with distance from the core (Fig. 2). This may be due to a general increase in shock strength, or relativistic aberration as the jets bend away from the line of sight (Lister & Smith 2000).

The electric vectors of the jet components are predominantly parallel to the upstream jet direction (Fig. 3), as would be expected from transverse shocks that amplify the component of the magnetic field perpendicular to the jet (e.g., Hughes et al. 1985). However, the distribution also contains many components at oblique angles, and is more consistent with a family of oblique shocks moving at various speeds down the jet (e.g., Lister et al. 1998). Those components with electric vectors nearly perpendicular to the jet are more weakly polarized, which also supports this interpretation. Finally, we find no significant difference in the **B** field orientations of the BL Lac objects and quasars in our sample.

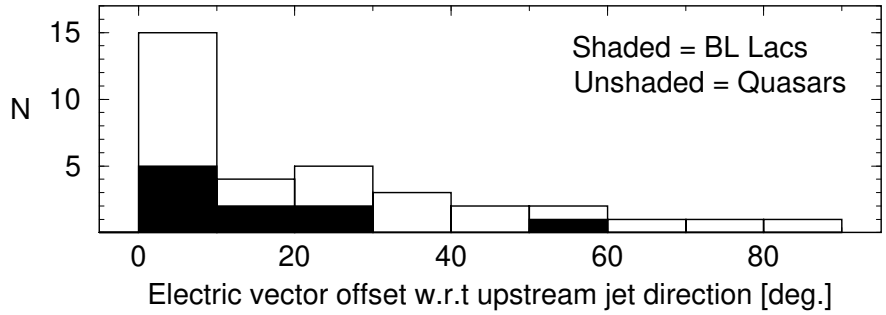

Figure 3: Distribution of electric polarization vector offset with respect to the upstream jet direction, for polarized jet components.

4 Conclusions

We have undertaken the first detailed polarization study of a complete sample of AGNs at 43 GHz, which is also being observed by HALCA at 5 GHz. Our preliminary results show the objects to be dominated by strong, unresolved cores at 43 GHz, which are weakly polarized and have magnetic fields mostly perpendicular to the inner jet direction. The fractional polarization of the jets increases exponentially with distance from the core, and their polarization orientations are consistent with those of a family of oblique shocks that are moving with various speeds down the jet.

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