Cosmic Magnetic Fields:
From Planets, to Stars and Galaxies
Proceedings IAU Symposium No. 259, 2008
K.G. Strassmeier, A.G. Kosovichev & J.E. Beckman, eds.

doi:10.1017/S1743921309031329

DRAO deep polarization study at 1.4 GHz

Julie K. Grant[1], A. R. Taylor[1], J. M. Stil[1], R. Ricci[1], S. P. O'Sullivan[2], T. L. Landecker[3], R. Kothes[3] and R. R. Ransom[3]

[1]Centre for Radio Astronomy, University of Calgary, Alberta, Canada

[2]Department of Physics, University of Cork, Ireland

[3]Dominion Radio Astrophysical Observatory, Herzberg Institute of Astrophysics, National Research Council Canada, Penticton, British Columbia, Canada

Abstract. The Dominion Radio Astrophysical Observatory synthesis telescope (DRAO-ST) was used to produce a deep polarization mosaic at 1.4 GHz to a noise level of 45 microJy beam^{-1} for both Stokes Q and U at $1'$ resolution. The DRAO deep field covers 8.6 sq. degrees in polarization centered on the ELAIS N1 field. We identified over 1700 total intensity (Stokes I) radio sources of which 197 are linearly polarized down to a flux density level of 203 microJy. The fractional polarization of faint polarized sources are flat down to a polarized flux density of about 4 mJy, at which point the numbers increase, until the counts drop for polarized flux densities below 1 mJy. These faint polarized radio sources are mostly AGNs with luminosities below the traditional FRI/FRII boundary. Follow-up observations with the VLA show that the origin of the polarization of the radio sources down to a polarized flux of 1 mJy comes from both the lobes and central region of these objects.

Keywords. Galaxies: magnetic fields – galaxies: ELAIS N1 – techniques: polarimetric

1. Introduction

Very little is known about the polarization properties of the faint radio source population. Previous studies of polarized radio sources were done by Mesa *et al.* (2002) and Tucci *et al.* (2002) who used NVSS (Condon *et al.* 1998) polarized sources with $S_{1.4} > 100$ mJy. These results indicate that for steep-spectrum radio sources, the mean fractional polarization increases as flux density decreases. This was confirmed by Taylor *et al.* (2007) for sources with $P > 500$ microJy.

The European Large Area *ISO* Survey North 1 (ELAIS N1) is the area for the DRAO ELAIS N1 deep field (Taylor *et al.* 2007). This area was selected for deep polarization imaging as a window on the extragalactic sky previously observed by *ISO* (Oliver *et al.* 2000) and the *Spitzer* Wide Area Extragalactic Survey (SWIRE, Lonsdale *et al.* 2003). This region is ideal for studies of the faint extragalactic polarized radio source population because of the large amount of data available at other frequencies that cover the ELAIS N1 region.

The deepest observations of the polarized extragalactic sky was achieved with the Dominion Radio Astrophysical Observatory synthesis telescope (DRAO ST) which reached a noise level of 45 microJy beam^{-1} for both Stokes Q and U at $1'$ resolution. Observations begun in August 2004 and completed in July 2008, creating the final mosaic of 40 fields at 1.4 GHz in both total intensity and linearly polarized intensity.

2. The Polarized Source Population

The euclidean-normalized polarized source counts (left plot in Figure 1) for the DRAO deep field are shown down to 800 microJy in polarized intensity. In order to understand

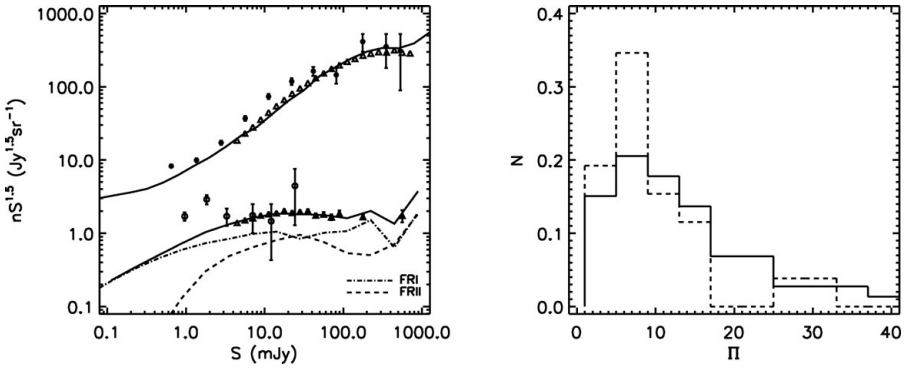

Figure 1. Left: Euclidean-normalized radio source counts in both total intensity (•) and polarized intensity (○) from the DRAO deep field while the △ are the NVSS source counts. The upper solid black line is the Stokes I model from Wilman *et al.* (2008) and the lower solid black line is the polarized intensity model from Stil *et al.* (2008). Right: Histogram of DRAO deep field polarized sources in polarized flux density ranges of $0.7 < P < 2.0$ mJy (—) and $4.0 < P < 100$ mJy (- - -).

the nature of this faint polarized source population, the observed ELAIS N1 source counts and the NVSS polarized source counts (Ricci *et al.* 2008) were modelled using a semi-empirical simulation of the extragalactic Stokes I continuum developed by Wilman *et al.* (2008) and theoretical percent polarization distributions for FRI and FRII radio sources from Stil *et al.* (2008). The models fit well down to $P \sim 3$ mJy, but are unable to fit the polarized source counts below 3 mJy.

The right plot in Figure 1 shows the histogram of polarized sources in a polarized flux density range of $0.7 < P < 2.0$ mJy (—) and $4.0 < P < 100$ mJy (- - -). The distribution of these two histograms indicates an increase in percentage polarization ($\Pi = P/S$) for sources with a lower flux density. Polarized sources in a flux density range of $0.7 < P < 2.0$ mJy have a median Π of 12.3% while sources in a flux density range of $4.0 < P < 100$ mJy have a median Π of 8.8%.

Observations were made of a sample of these polarized sources at 1.4 GHz in the A configuration, in full polarization mode. The total polarized emission is seen to be dominated by emission from the central region in some cases and from lobes in others.

Acknowledgments: Observations and research on the DRAO Planck Deep Fields are supported by the Natural Science and Engineering Council of Canada (NSERC).

References

Condon, J. J., Cotton, W. D. *et al.* 1998, *AJ* 115, 341
Oliver, S., Rowan-Robinson, M., Alexander, D. M. *et al.* 2000, *MNRAS* 316, 749
Lonsdale, C., Smith, H. E., Rowan-Robinson, M., Surace, J. *et al.* 2003, *PASP* 115, 897
Mesa, D., Baccigalupi, C. *et al.* 2002, *A&A* 396, 463
Ricci, R., Stil, J. M., Taylor, A. R. *et al.* 2008, in prep.
Stil, J. M., O'Sullivan, S. P., & Taylor, A. R. 2008, in prep.
Taylor, A. R., Stil, J. M., Grant, J. K. *et al.* 2007, *ApJ* 666, 201
Tucci, M., Martinez-Gonzalez, E. *et al.* 2004, *MNRAS* 349, 1267
Wilman, R. J., Miller, L., Jarvis, M. J. *et al.* 2008, *MNRAS* 388, 1335