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/S1743921309031226

The polarized emission from the galactic plane at arcminute angular resolution

Tom L. Landecker[1], W. Reich[2], R. I. Reid[1]†, P. Reich[2], M. Wolleben[1,2], R. Kothes[1,3], D. Del Rizzo[1], B. Uyanıker[1]‡, A. D. Gray[1], E. Fürst[2], A. R. Taylor[3], and R. Wielebinski[2]

[1]National Research Council of Canada, Herzberg Institute of Astrophysics, Dominion Radio Astrophysical Observatory, P.O. Box 248, Penticton, British Columbia, V2A 6J9, Canada

[2]Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, 53121 Bonn, Germany

[3]Department of Physics and Astronomy, University of Calgary, 2500 University Drive N.W., Calgary, AB, Canada

Abstract. As part of the Canadian Galactic Plane Survey (CGPS) we have imaged the polarized emission from the plane of the Milky Way at 1420 MHz, covering 1200 square degrees with arcminute resolution. Structure on all scales is represented by combining aperture-synthesis data with single-antenna data. The survey depicts the Magneto-Ionic Medium at a resolution that matches images of other components of the Interstellar Medium within the CGPS database (http://www4.cadc.hia.nrc.gc.ca).

Keywords. Polarization – Techniques: polarimetric – Surveys – ISM: magnetic fields

1. A new survey

We describe a survey of the polarized emission at 1420 MHz, the first extensive survey to combine aperture-synthesis data (from the DRAO Synthesis Telescope - Landecker *et al.* 2000) with single-antenna data (from the Effelsberg 100-m Telescope – Reich *et al.* 2004 – and from the DRAO 26-m Telescope – Wolleben *et al.* 2006). The survey images accurately portray all polarized emission features from the broadest scales to the limit imposed by the angular resolution, $\sim 1'$. Data on structures of size $S > 40'$ comes mainly from the 26-m Telescope, $40' > S > 15'$ from the 100-m Telescope, and $15' > S > 1'$ from the Synthesis Telescope. The survey covers $\ell = 65°$ to $\ell = 175°$ over a range $-3.5° < b < 5.5°$ along the northern Galactic plane, with a high-latitude extension from $\ell = 105°$ to $\ell = 120°$ up to $b = 20°$. This survey (Landecker *et al.* in prep.) is a component of the Canadian Galactic Plane Survey (CGPS - Taylor *et al.* 2003).

2. The data

With 1.7×10^7 independent data points, this is the largest polarization survey made to date, but we can present only a small region here (see Fig. 1). Polarized intensity (PI) is high in the top right corner of Fig. 1, and structure is smooth: this is part of the Fan region seen prominently in single-antenna surveys (*e.g.* Wolleben *et al.* 2006). Superposition of other features lowers PI across the rest of the image. We focus our attention on three

† Present address: National Radio Astronomy Observatory, 520 Edgemont Rd., Charlottesville, VA, 22903, USA

‡ Present address: 35/3737 Gellatly Road, Westbank, British Columbia, V2T 2W8, Canada

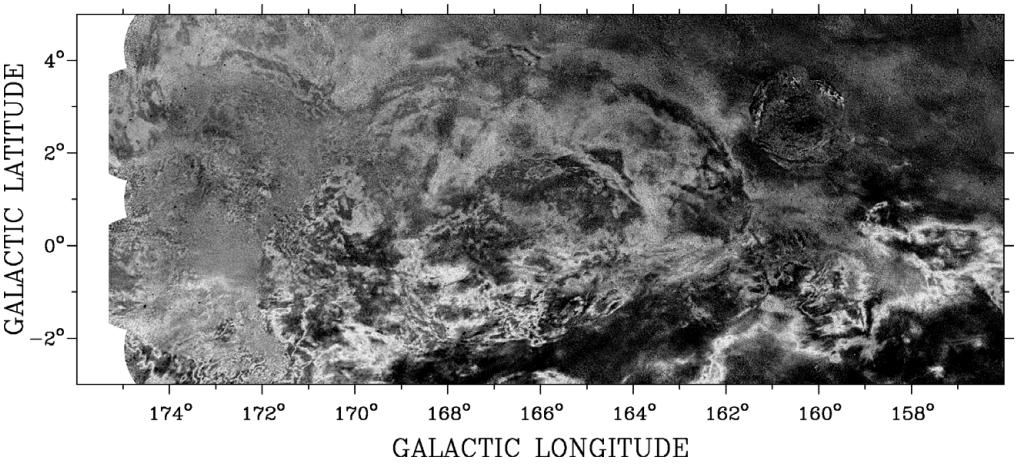

Figure 1. Polarized intensity along the Galactic plane from $\ell = 156°$ to $\ell = 175°$. The intensity scale is linear from zero (white) to 500 mK (black).

distinct objects seen in Fig. 1. They are different in nature, and illustrate the diversity of phenomena that can be studied with polarization data of this quality.

The supernova remnant (SNR) HB9 (G160.9+2.6) is seen prominently as a polarized feature, but as a *decrease* in PI relative to its surroundings. The superposition of polarized SNR emission on a polarized background (or foreground) leads to this reduction.

The planetary nebula Sharpless 2-216 (G158.4+0.2) generates a polarization feature through Faraday rotation in its ionized shell (Ransom *et al.* 2008). The ionized shell, of density $n_e \approx 8$ cm^{-3}, generates a barely detectable feature in total intensity, but a strong Faraday rotation signature, with $\Delta\psi \approx 110°$, produced in a field whose line-of-sight component is $\sim 5\mu$G. This bears witness to the sensitivity of polarization measurements.

The third object would not have been discovered by any means other than its Faraday rotation signature. It is seen in Fig. 1 as a large shell, at least 8° in extent, centered at $\ell = 166°, b = -1°$. Association with an atomic hydrogen shell at $v_{lsr} = -20\,\mathrm{km\,s^{-1}}$ places the object in the Perseus Arm at a distance of ∼2 kpc. Kothes *et al.* (in preparation) interpret this object as a stellar-wind bubble whose extent is some 350 pc. Once identified through its polarization signature, the object can be recognized in other wavebands.

We conclude from this remarkable result that (a) Faraday rotation is a powerful tool for the detection of ionized gas, (b) there are Galactic objects many degrees in extent which can only be detected in data with arcminute resolution, and (c) the data for this object would be impossible to interpret without the incorporation of single-antenna data into the polarization images. Further work on the survey will include correlations of polarization features with other ISM tracers, studies of depolarization by foreground HII regions, and statistical (power-spectrum and structure-function) studies.

References

Landecker, T. L., Dewdney, P., Burgess, T. A., *et al.* 2000, *A&AS* 145, 509
Ransom, R., Uyanıker, B., Kothes, R., & Landecker, T.L. 2008, *ApJ* 684, 1009
Reich, W., Fürst, E., Reich, P., *et al.* 2004, in The Magnetized Interstellar Medium, ed. B. Uyanıker, W. Reich, & R. Wielebinski, 45
Taylor, A. R., Gibson, S. J., Peracaula, M., *et al.* 2003, *AJ* 125, 3145
Wolleben, M., Landecker, T. L., Reich, W., & Wielebinski, R. 2006, *A&A* 448, 411

https://doi.org/10.1017/S1743921309031226 Published online by Cambridge University Press