Highlights of Astronomy, Volume 15
XXVIIth IAU General Assembly, August 2009
Ian F. Corbett, ed.

doi:10.1017/S1743921310010227

Magnetic fields in the Galactic halo

M. Haverkorn[1,2]

[1]ASTRON, P.O. Box 2, 7990 AA, Dwingeloo, the Netherlands
email: haverkorn@astron.nl

[2]Leiden University, P.O. Box 9513, 2300 RA, Leiden, the Netherlands

Abstract. Interstellar magnetic fields play a major role in the ionized gas away from the Galactic disk, but their strength and direction is still unclear. Radio spectro-polarimetry and rotation measure synthesis, for example used in the Parkes Galactic Meridian Survey and a number of all (southern and northern) sky surveys, enable determination of the properties of magnetic fields in the Galactic halo and their role in the disk-halo interaction.

Keywords. magnetic fields,polarization,techniques: polarimetric,ISM: magnetic fields,ISM: general,Galaxy: halo,radio continuum: ISM

1. Introduction

As magnetic fields are frozen into ionized gas, and have comparable energy density to the (turbulent) gas and cosmic rays, they are believed to be an important part of the organization of the Galactic halo†. However, not much is known about the magnetized Galactic halo: estimates of its scale height vary widely, and there is no agreement on its parity across the Galactic plane e.g. Han *et al.* (1997), Frick *et al.* (2001). Radio spectro-polarimetry will play a large role in clarifying these issues in the near future.

2. The Parkes Galactic Meridian Survey (PGMS)

The Parkes Galactic Meridian Survey (PGMS) is a radio spectro-polarimetric survey at 2180-2420 MHz, performed with the 64m single-dish at Parkes, NSW, at about 9 arcmin resolution. The survey spans a 5° wide strip around Galactic longitude $l = 254°$, in the Galactic latitude range $0° > b > -90°$‡. The scientific goals of the PGMS are two-fold. Firstly, limits of Galactic foreground polarization, in preparation for measurements of the polarization B-mode in the CMB, are described in Carretti *et al.* (2009). Secondly, the PGMS is used to study the

† The term "Galactic halo" in this context means the thick disk of magnetized interstellar gas and non-thermal emission that exists away from the Galactic plane.
‡ It also includes a $10° \times 10°$ extension centered at $l = 251°$ and $b = -35°$, observed to coincide with the area observed in the BOOMERanG mission to detect Cosmic Microwave Background (CMB) polarization (Masi *et al.* (2006)).

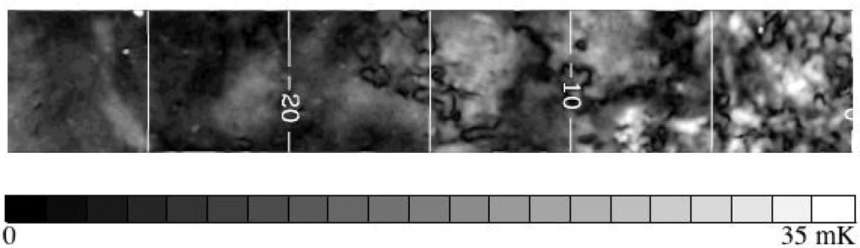

Figure 1. Polarized intensity in part of the Parkes Galactic Meridian Survey closest to the Galactic plane, i.e. in the range $251.5° < l < 256.5°$, $0° > b > -30°$.

polarization structure in the Galaxy, from the Galactic disk through the disk-halo interaction region into the halo.

Figure 1 shows polarized intensity $\sqrt{Q^2 + U^2}$ in the PGMS from the Galactic plane down to $b = -30°$. Structure in polarization, caused by differential Faraday rotation in the interstellar medium, is strong and on small scales close to the plane, and becomes weaker and varying on larger scales going away from the plane. However, degree-scale structure in polarized synchrotron radiation can still be seen on a 10 mK level all the way to the Galactic South pole (Carretti *et al.* (2009)).

Polarized intensity maps of the same region at the lower frequency of 1.4 GHz (Testori *et al.* (2008)) shows major depolarization around the Galactic plane at $b <\sim 30°$ (discussed in Wolleben *et al.* (2006)). At 2.3 GHz, however, Faraday depolarization is much less because of its strong wavelength dependence. Therefore, the PGMS enables us to study polarized emission down to much lower Galactic latitudes. Ongoing work on comparison of the two surveys will result in estimates of the strength and scale of fluctuations in rotation measure (RM) from the plane up to the Galactic halo. Also, dozens of polarized extragalactic point sources have been detected in the PGMS, allowing comparison of RM of background point sources and diffuse Galactic emission.

3. Other ongoing and future surveys

New technologies such as high spectral resolution spectro-polarimetry and new analysis methods such as RM synthesis (Burn(1966), Brentjens & de Bruyn (2005)) are enabling a great step in the study of galactic magnetism. The largest effort to realize this promise is the Global Magneto-Ionic Medium Survey (GMIMS, Wolleben *et al.* (2009)), a global project to map the diffuse polarized emission over the entire sky in six separate surveys in the approximate frequency bands of 300-800 MHz, 800-1300 MHz and 1300-1800 MHz, in both northern and southern skies. Related efforts are the S-band Polarization All-Sky Survey (S-PASS; PI Carretti) at 2.3 GHz and the Southern Twenty-cm All-sky Polarization Survey (STAPS; PI Haverkorn) at 1.4 GHz, the latter of which may form one of the GMIMS surveys. Continuous coverage of the whole sky from 300 MHz to 1.8 GHz will result in superb Faraday depth resolution in the RM synthesis analysis.

Low-frequency telescopes such as the LOw Frequency ARray (LOFAR) will expand the reach of these surveys to very low RM, i.e. very weak magnetic fields and/or old synchrotron electrons.

References

Brentjens, M. A. & de Bruyn, A. G. 2005, *A&A*, 441, 1217

Burn, B. J. 1966, *MNRAS*, 133, 67

Carretti, E., Haverkorn, M., McConnell, D., Bernardi, G., *et al.* 2009, *A&A*, submitted.

Frick, P., Stepanov, R., Shukurov, A., & Sokoloff, D. 2001, *MNRAS*, 325, 649

Han, J. L., Manchester, R. N., Berkhuijsen, E. M., & Beck, R. 1997, *A&A*, 322, 98

Masi, S., Ade, P. A. R., Bock, J. J., *et al.* 2006, *A&A*, 458, 687

Testori, J. C., Reich, W., & Reich, P. 2008, *A&A*, 484, 733

Wolleben, M., Landecker, T. L., Reich, W., & Wielebinski, R. 2006, *A&A*, 448, 411

Wolleben, M., Landecker, T. L., Carretti, E., Dickey, J. M., *et al.* 2009, *Cosmic Magnetic Fields: From Planets, to Stars and Galaxies*, IAU Symposium, vol. 259, p. 89

https://doi.org/10.1017/S1743921310010227 Published online by Cambridge University Press