A Polarization Survey of the Galactic Plane at 1420 MHz: the Canadian Galactic Plane Survey

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The Canadian Galactic Plane Survey is producing a database of images of the northern Milky Way portraying the major constituents of the Interstellar Medium with arcminute resolution. Among these data products is a survey of Stokes parameters Q and U at 1420 MHz made with the DRAO Synthesis Telescope. Although the nearer supernova remnants can be recognized by their polarized emission, the polarization images are dominated by a widespread chaotic emission with structure on all scales from degrees to arcminutes. There is almost no correlation between regions of polarized emission and features in total intensity. The linearly polarized emission has its origin in synchrotron emission in the Galactic disk and halo, but the appearance of the sky at this frequency is dominated by Faraday rotation in the intervening medium rather than structure in the emission regions. The polarization images are therefore revealing the magneto-ionic medium (MIM), widely distributed ionized gas threaded by magnetic fields. This talk will present results from a number of directions towards the outer Galaxy. These results will be compared with computed polarization images based on models of the synchrotron background and the MIM.

Beam depolarization and depth depolarization are operative, reducing the apparent fractional polarization. Both effects increase with propagation distance, and there is therefore a distance beyond which polarized emission cannot be detected; this is the polarization horizon. At 1420 MHz, the polarization horizon is at 2 kpc in the Cygnus direction ($l \approx 90°$), and we do not "see" structures beyond the Local arm. Towards $l \approx 135°$ the polarization horizon is more distant, at least as distant as the Perseus arm.

The Faraday rotation is produced within the Warm Ionized Medium (WIM). The telescope can more easily detect ionized gas by the Faraday rotation it produces than by its total-intensity emission. The polarized fraction is rapidly reduced if many Faraday rotating regions are superimposed along the line of sight. The very fact that linear polarization can be detected at 1420 MHz means that the filling factor of the WIM must be considerably less than one.