LOW FREQUENCY POLARIMETRY

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I will present and discuss low frequency (< 500 MHz, linear) polarimetric observations . These contain important and unique information about low density plasmas, cosmic rays and magnetic fields in the Universe. The measurements are difficult due to time variable ionospheric Faraday rotation and instrumental (off-axis) polarization. Moreover, most astrophysical sources are weakly polarized, often as a result of beam depolarization and/or bandwidth polarization. For these reasons few radio telescopes have been active in this field. The good sensitivity, equatorial mount, wide field imaging capabilities and new broadband spectrometer of the Westerbork Synthesis Radio Telescope, have been crucial factors in its popularity and success in doing widefield low frequency polarimetry.
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n this talk I will concentrate on observations and results obtained with the WSRT in the last decade at frequencies from 310-390 MHz and below. They have revealed that the Galactic sky is highly polarized with a very rich angular and (depth) de-polarization structure. We expected this to be the case at still lower frequencies and we will present first results of observations with a new suite of low-frequency frontends (LFFEs) mounted on the WSRT. These receivers operate from 115-180 MHz which the backend can cover all at once. Preliminary observations from the commissioning phase in Nov 2004 already prove very exciting and some results on clusters of galaxies will be shown.
The major remaining obstacle to conduct polarization observations around 150 MHz is the rapidly changing ionospheric Faraday rotation. More accurate (e.g. GPS and ionosonde-based) forecasting is needed. The alternative is polarization selfcalibration, which is possible with one or more in-beam discrete polarized sources or sufficiently bright diffuse 'background' emission.
With the use of new wideband spectrometers this field is at the brink of a revolution. A powerful technique to utilise a wide bandwidth yet avoid bandwidth smearing effects is RM-synthesis (Brentjens and de Bruyn, 2005). Using this technique we have shown that one can reach thermal noise limited sensitivities: below 0.1 mJy/beam at 350 MHz, permitting imaging far below the Stokes I confusion limit. Areas where RM-synthesis can be applied are clusters of galaxies (de Bruyn and Brentjens, 2005, face-on disks and haloes of nearby galaxies and the diffuse emission from our Galaxy (Wieringa, 1993; Haverkorn et al, 2003). They can also be used to detect scatter broadenend pulsars, which are often highly polarized. Using the diffuse Galactic background polarization as a probe it will be possible to study the interplanetary magnetic field during conditions of enhanced solar activity.
Finally, using the much higher angular resolution, and sensitivity, of LOFAR and other planned low frequency arrays beam depolarization will become much less of a problem opening up a new field of research.