HORIZONTAL DIPOLES, INTRINSIC CROSS-POLARISATION RATIO AND SKA-LOW

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Most radio telescopes have polarimetric capability, i.e. they can discriminate between orthogonal polarisations. Some years back, a new metric was introduced for the polarisation capability of a system, viz. the Intrinsic Cross-Polarisation Ratio (IXR) [1]. The IXR is not dependent on a particular coordinate system and is intended to be a fundamental characterisation of polarisation performance. The original paper does not, however, provide much in the way of details on how to evaluate this. This is especially so of a receive-only system, which is usually simulated numerically in transmit mode, following which the reciprocity principle is exploited.

Low-frequency radio telescopes typically use crossed dipoles, or dipole-like elements, mounted horizontally over ground. This can be either the real ground or a wire mesh. Examples include LOFAR, MWA and the SKA-Low prototypes. Crossed short horizontal dipoles provide a good starting point, since the IXR is known analytically for this case [2], making for a useful for verification test case. All antenna texts provide the radiation fields for both short and finite-length thin dipoles, but these are almost always for the vertical case, with the axis of the dipole coinciding with the z-axis. This paper will review analytical expressions available in the published literature for the radiation patterns of short horizontal dipoles [3].

Using these expressions, the IXR for a cross-dipole polarimeter have been computed. The coordinate independence of IXR is confirmed by comparing results obtained using spherical field components in the normal r-theta-phi system, as well as fields transformed using the Ludwig II definition – see Fig. 1. With the veracity of the simulation method established, results will also be presented for SKA-Low prototype stations.

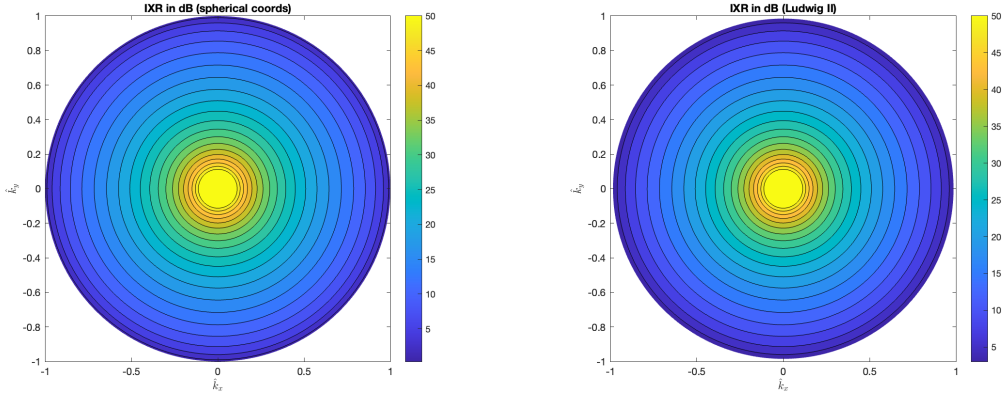

Fig. 1: IXR (in dB – colour bar) for crossed short HEDs: left, computed using theta and phi component, right, computed using the Ludwig II representation.

[1] T. D. Carozzi and G. Woan, "A Fundamental Figure of Merit for Radio Polarimeters," in *IEEE Transactions on Antennas and Propagation*, vol. 59, no. 6, pp. 2058-2065, June 2011, doi: 10.1109/TAP.2011.2123862.

[2] T. D. Carozzi, "Intrinsic cross-polarization ratio (IXR) for antenna arrays and improving polarimetry via polarization diversity," *1st URSI Atlantic Radio Science Conference (URSI AT-RASC)*, Gran Canaria, Spain, 2015, pp. 1-1, doi: 10.1109/URSI-AT-RASC.2015.7303206.

[3] J. Ramsay, J. Thompson and W. White, "Polarization tracking of antennas," 1958 IRE International Convention Record, New York, NY, USA, 1962, pp. 13-42, doi: 10.1109/IRECON.1962.1147020.