Stacking for Cosmic Magnetism

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Why Stacking?

Measure fractional polarization in rest frame of the source. Use SKA bandwidth in a manner that is orthogonal to Faraday Synthesis.

Polarization information to the detection limit in Stokes I. Up to 90\% of sources in an SKA survey not detected individually in polarization. Root-N improvement of noise up to $N=10^5$ demonstrated in NVSS.

Study samples for which deep fields are limited by source statistics.

Polarization of samples selected at other wavelengths.

Polarization angle related stacking is possible (see chapter).

Information from stacking: Astrophysical modeling of trends/correlations revealed by stacking related subsamples.
Differentiate the sample by observable parameters to reveal correlations that astrophysical models must reproduce. Beware of unintended selection effects that may also correlate with signal strength.
Magnetic Field Evolution from Diffuse Polarized Emission of Galaxies

Relation to star formation rate and stellar feedback in galaxies.

Faraday Synthesis gives \%pol averaged over the observed frequency range. Fractional polarization is best studied at consistent wavelength in the restframe of the source.

Faraday Synthesis of integrated polarization as a function of redshift

Large and small scale structure in the magnetized Interstellar Medium
Fractional polarization p/I spectrum of a sample galaxy disk (integrated)

\[ \phi = 0.81 \int_{ \text{l.o.s.} } n_e \vec{B} \cdot d\vec{l} \]

Not indicative for S/N per band!
Magnetic fields in Dwarf and Low-Surface Brightness Galaxies

Magnetic Field regularity in samples of galaxies covering a wide range of dynamo-related parameters such as shear and sSFR.

HI-selected samples

Polarization in small, low-luminosity starburst haloes?
Requirements for Stacking

- **Image cubes** including “empty sky” (compromise on frequency resolution).
- **Uniform** angular resolution and sensitivity (not different from Stokes I requirements; should be OK, avoid field edges).
- **Flexible access to complete** SKA survey archive (post pipeline).
- Access to computing (small footprint but enduring). MC simulations for polarization bias can be done anywhere.

Synergy with continuum surveys, HI surveys and other wavelengths. Stack all Stokes IQUV.

Potential targets include galaxies, AGN, clusters, stars, ......