

# HIGH-PRECISION FARADAY ROTATION MEASURES,

*from*



**LOFAR** PULSAR OBSERVATIONS,

*towards*

## RECONSTRUCTING THE 3-D GALACTIC MAGNETIC FIELD

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### CONTEXT

Within galaxies, magnetic fields play an important role in many astrophysical processes over many scales. The Milky Way provides us with a unique opportunity for higher resolution studies of galactic magnetic field structure. However, our knowledge of its 3-D structure, particularly in the halo, remains insufficient.

### AIMS

Here, we focus on using a large sample of Faraday rotation measures (RMs) and dispersion measures (DMs) towards pulsars, to efficiently investigate the 3-D Galactic magnetic field (GMF) structure (see, e.g., van Eck et al. 2011). Of the ~2500 known pulsars, only ~30% have RM data: ~65% of which are located in the southern sky near the Galactic plane. The average observation used for these measurements was taken at 1.4 GHz, using 128 MHz of bandwidth.

### METHODS

We observed many pulsars using the Low-Frequency Array (LOFAR), centred at ~150 MHz. The low-frequency, large instantaneous bandwidth, and large collecting area provides high-quality polarisation data (see, e.g., Noutsos et al. 2015) that is complimentary for measuring *precise* RMs. RM-synthesis (see, e.g., Brentjens & de Bruyn 2005) was used to determine the RM from the on-pulse Stokes parameters. The RM due to the ISM *alone* was determined by subtracting the Faraday rotation due to the ionosphere (calculated using a previously tested and verified code; Sotomayor et al. 2013).

### RESULTS

We have determined precise RMs towards 150 pulsars (so far!) in the northern sky, see Figure 1, 69 of which do not have previously published measurements. The uncertainties are 30x smaller, on average, than previous measurements. These precise measurements can also be used to monitor DM and RM variations (intrinsic, or due to the changing line of sight). With the advent of the Square Kilometre Array (and its pathfinders), our knowledge of the 3-D Galactic magnetic field is set to improve.

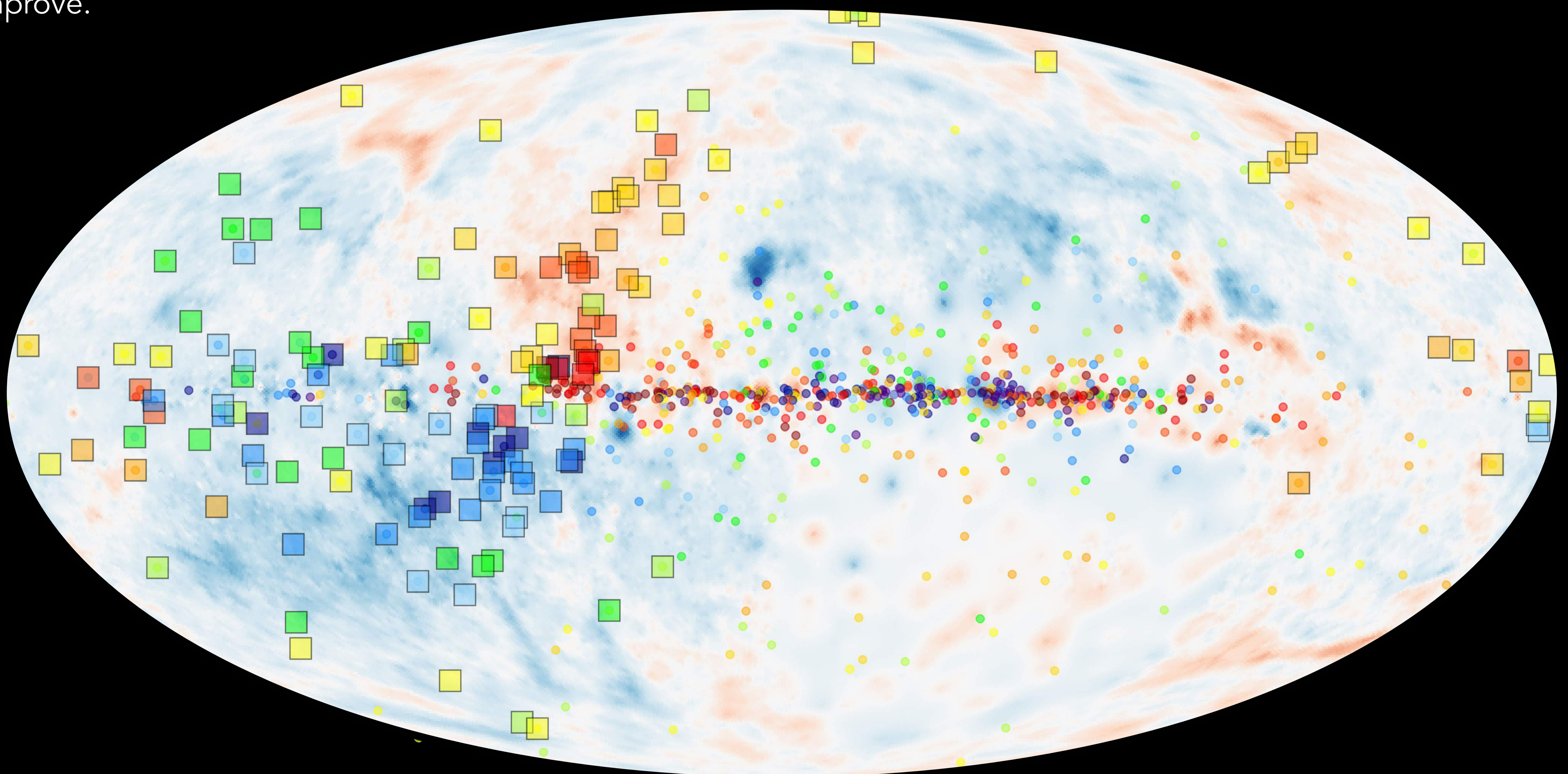


Figure 1: Faraday rotation measurements: Squares: LOFAR pulsars (Sobey et al. in prep). Points: Pulsar catalogue (Manchester et al. 2005, and references therein). Background: Signal towards extragalactic sources (Oppermann et al. 2012, and references therein). [colours yellow-orange-red show increasingly positive values (GMF directed towards us), green-blue-indigo show increasingly negative values (GMF directed away)]