

# Detection of magnetic fields in the intergalactic medium

Matthis Maupas, Ievgen Vovk, Jia Liu

# Intergalactic magnetic fields

Magnetic field generated during early stages of the universe

Survived until today due to high conductivity of the medium

Origin of fields in galaxies or in clusters

# Previous work

Vernstrom et al. 2019: Analyzing a dataset of galaxies

- Upper limit on the magnetic field: 37 nG

Pomakov et al. 2022: Monte Carlo simulation of galaxies

- Best-fitting result: 2 nG

# Faraday rotation effect

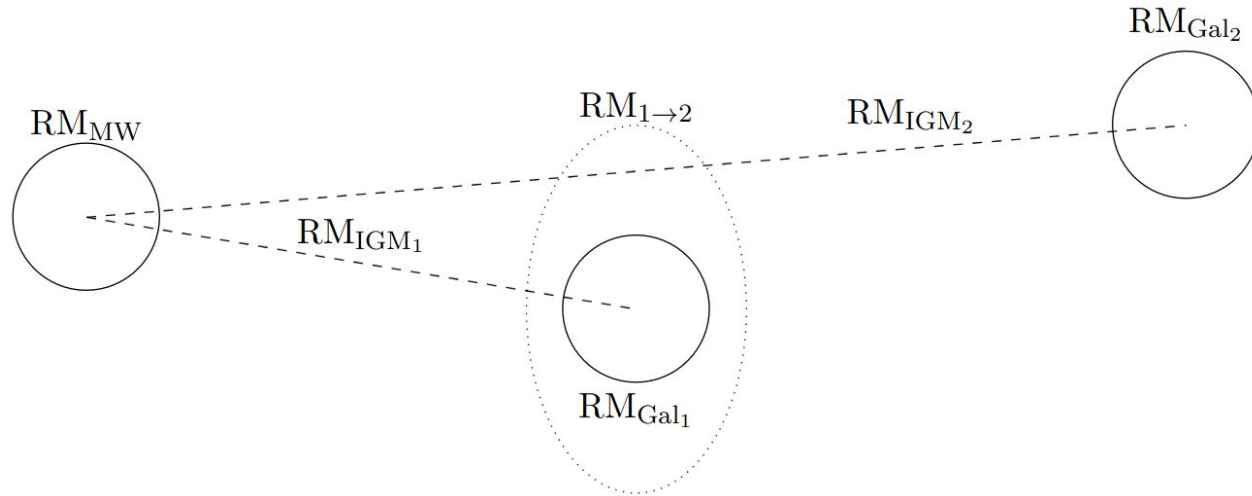
Polarized light propagating in magnetized plasma causes a rotation of the polarization plane.

The rotation depends on the wavelength.

$$RM = \frac{\Delta(\kappa)}{\Delta(\lambda^2)} \propto \int_0^{z_s} n_e B_{\parallel} (1+z)^{-2} \frac{dl}{dz} dz$$

# Method

We consider random pairs of galaxies in the same line of sight:



$$\Delta RM = \Delta RM_{gal_{12}} + RM_{IGM_2} + \Delta RM_{MW} + RM_{1 \rightarrow 2}$$

# Data

Sloan Digital Sky Survey (SDSS):

Optical telescopes, redshift measurements

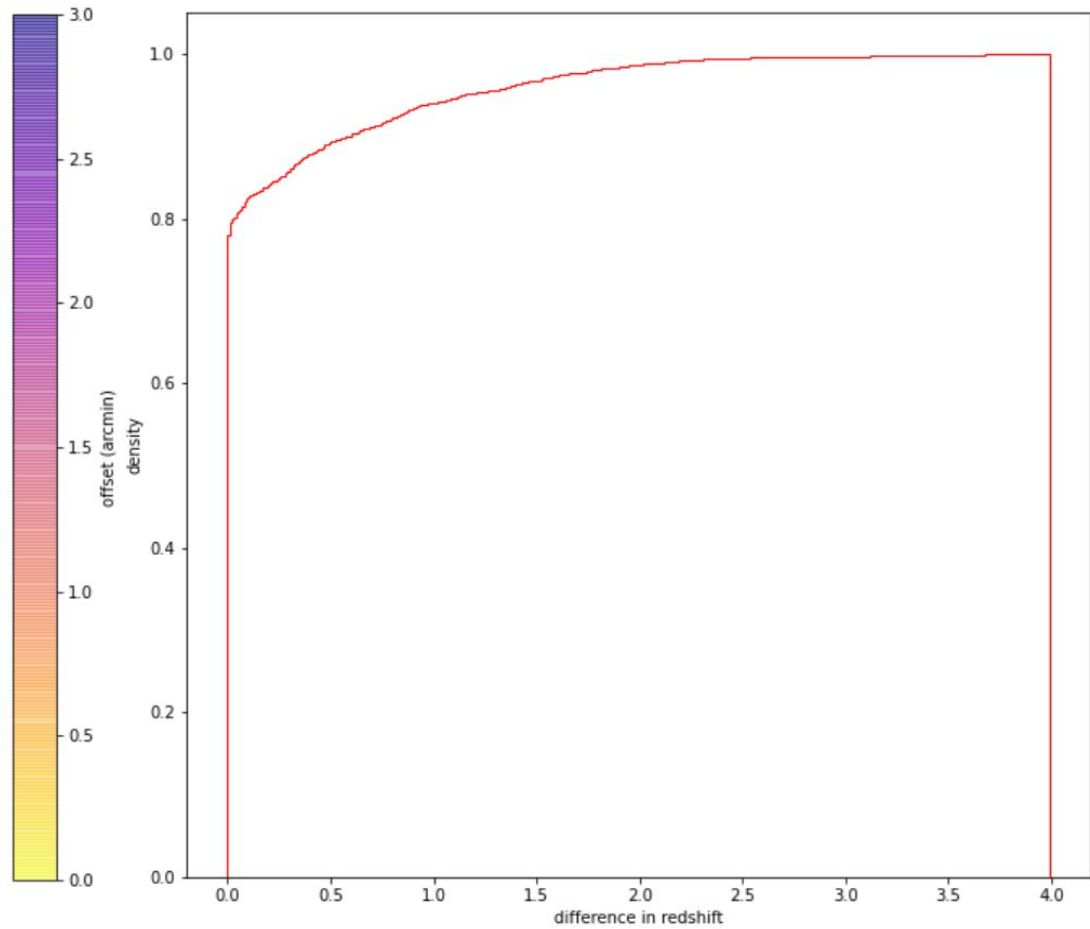
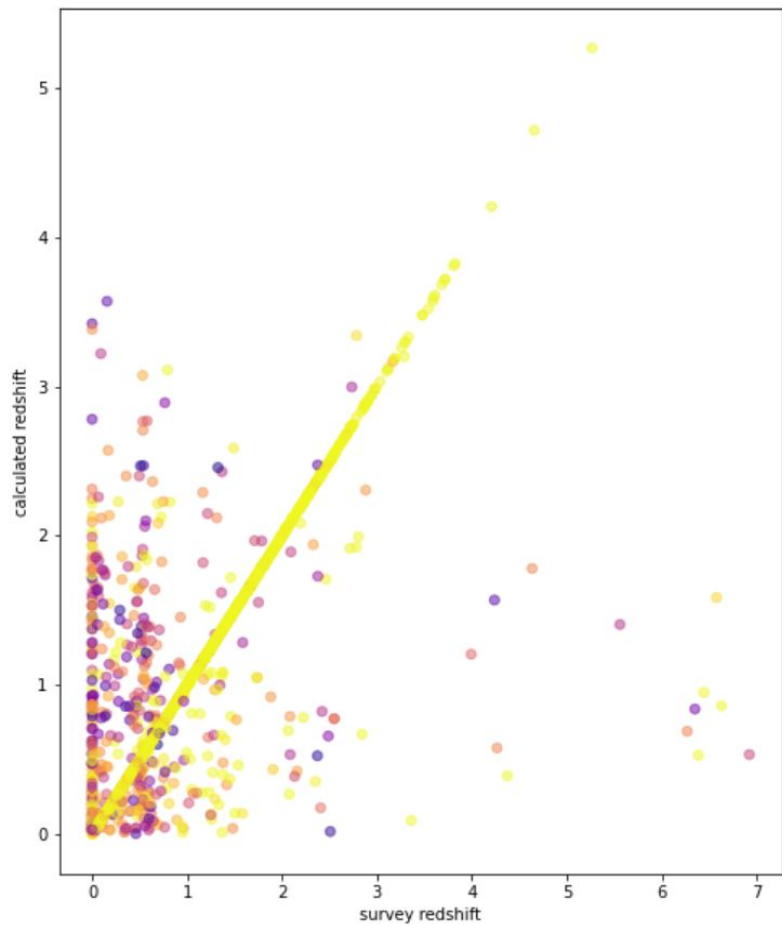
5M spectra

NRAO VLA Sky Survey (NVSS):

Radio observatory, rotation measures

4000 galaxies

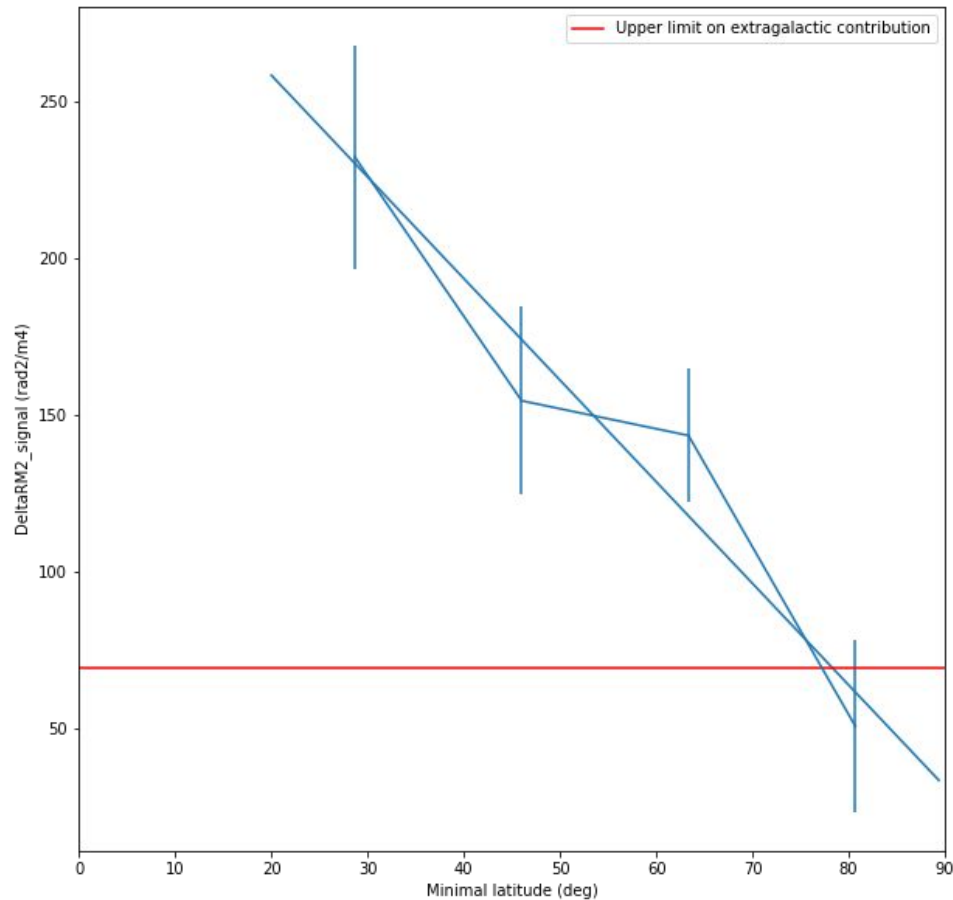
# Calculating redshifts



# Galactic contribution

$$\langle \Delta RM^2_{extragalactic} \rangle \leq 69.34 \text{ rad}^2 \text{ m}^{-4}$$

With  $1-\sigma$  uncertainty

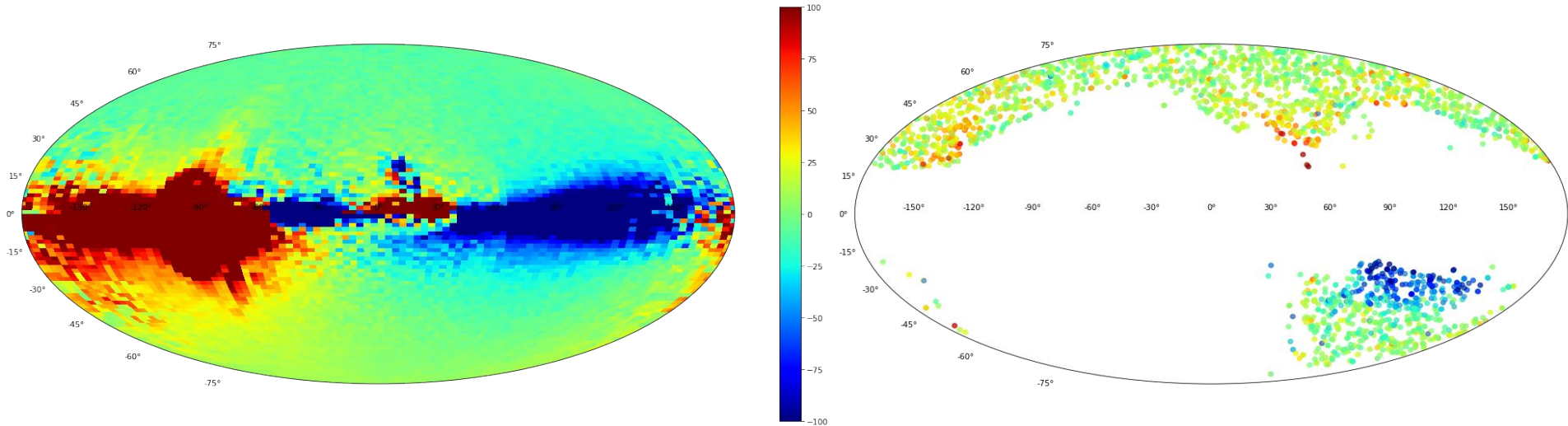




# Milky Way model

Jansson, Farrar, 2012: Magnetic field model

Cordes et al. 2003: Electron distribution model



# Contribution of the nearest galaxy

Galactic halo of the order of  $\sim 1-10 \mu\text{G}$

Intracluster field:  $\sim 100 \text{ nG}$

Estimate the impact parameter: harder for low redshift

