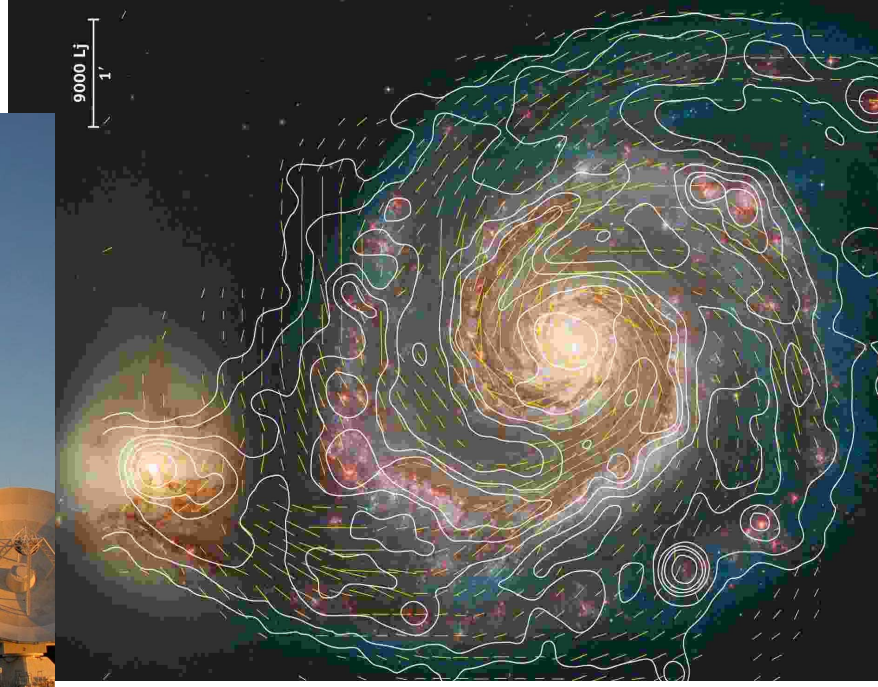

Faraday Depths of Compact Array calibration sources

Carlos Sotomayor

Supervisor: Dr Dominic Schnitzeler

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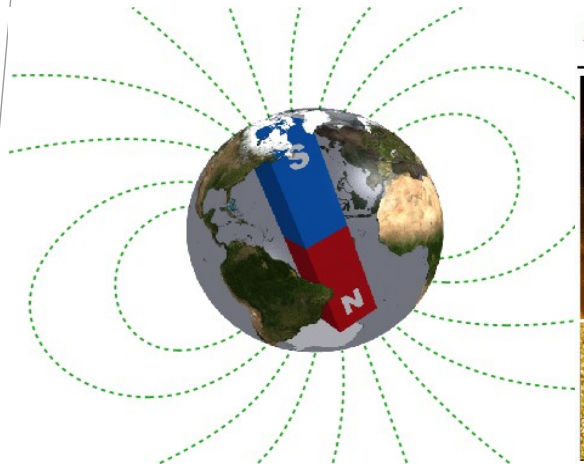
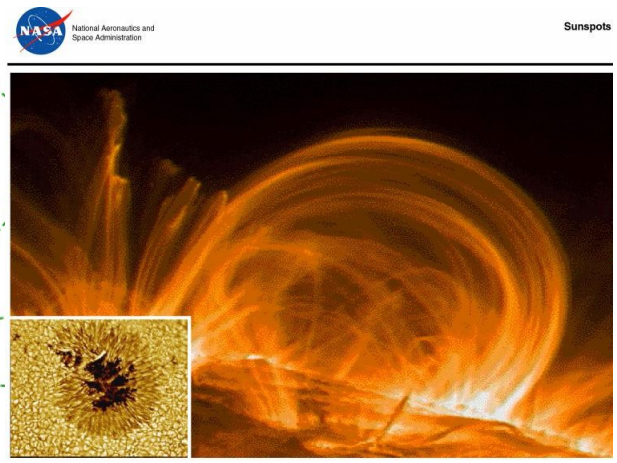
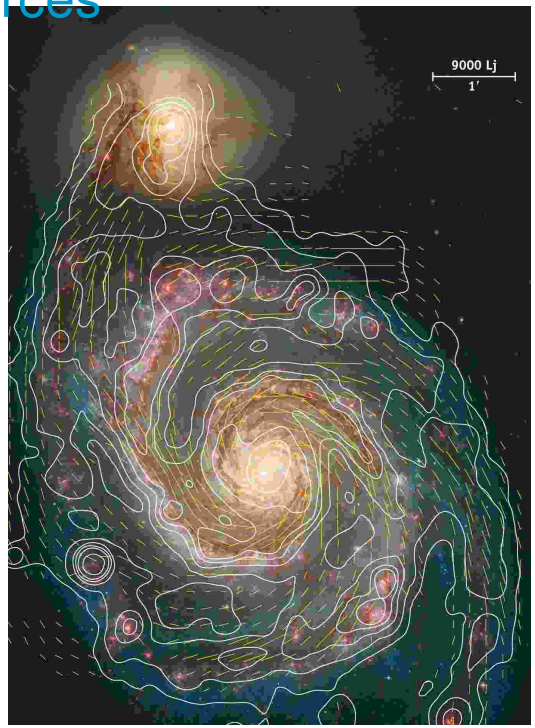
What is the science behind this project?

- Study the properties of cosmic magnetic fields!
- But, WHY?
- Magnetism is part of the four fundamental forces
- They are present everywhere ...







- And we don't know much about their fundamental properties:
  - Origin; Structure; Evolution

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What is the main goal of this project?

- Calculate Faraday Depths of ATCA calibration sources
- What is this Faraday Depth?

$$\phi(\boldsymbol{r}) = 0.81 \int_{\text{there}}^{\text{here}} n_e \boldsymbol{B} \cdot \mathrm{d}\boldsymbol{r} \ \mathrm{rad\ m^{-2}},$$

where n_e is the electron density in cm^{-3}, $\boldsymbol{B}$ is the magnetic induction in μGauss, and $\mathrm{d}\boldsymbol{r}$ is an infinitesimal path length in parsecs.

- How do we calculate the Faraday Depth
  - Faraday Rotation Measure synthesis technique

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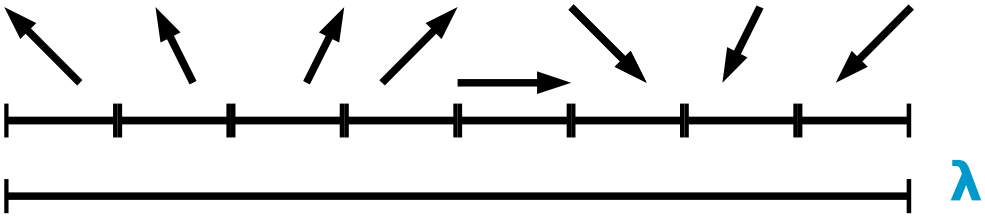
Rotation Measure synthesis

Takes advantage of modern radio telescopes spectral coverage to reliably calculate Faraday depths.

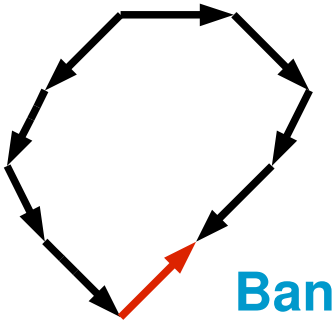


problems with large bandwidths

$$P = ||p||Ie^{2i\chi}$$

or equivalently,

$$P = pI = Q + iU.$$



Bandwidth depolarization

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Rotation Measure synthesis

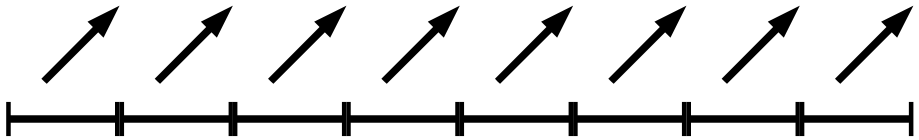
Intrinsic polarized radiation along the LOS

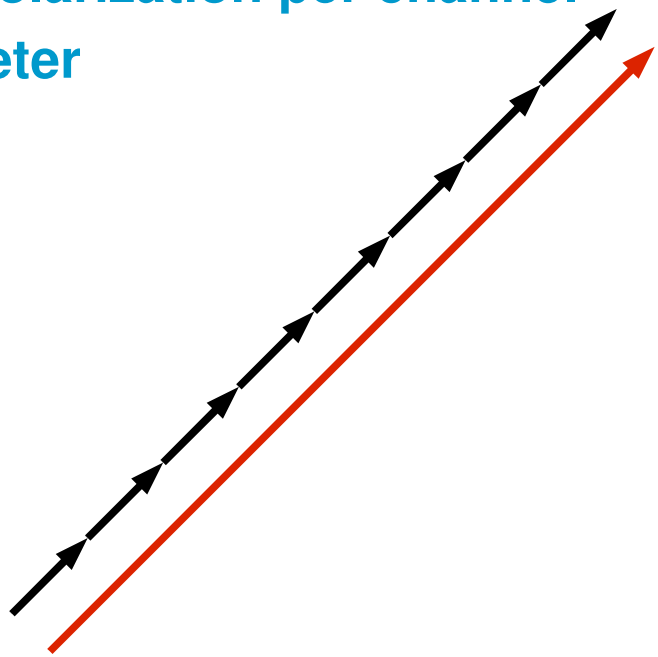
$$\tilde{F}(\phi) \approx K \sum_{i=1}^{N} \tilde{P}_i e^{-2i\phi(\lambda_i^2 - \lambda_0^2)}$$

Observed polarization per channel

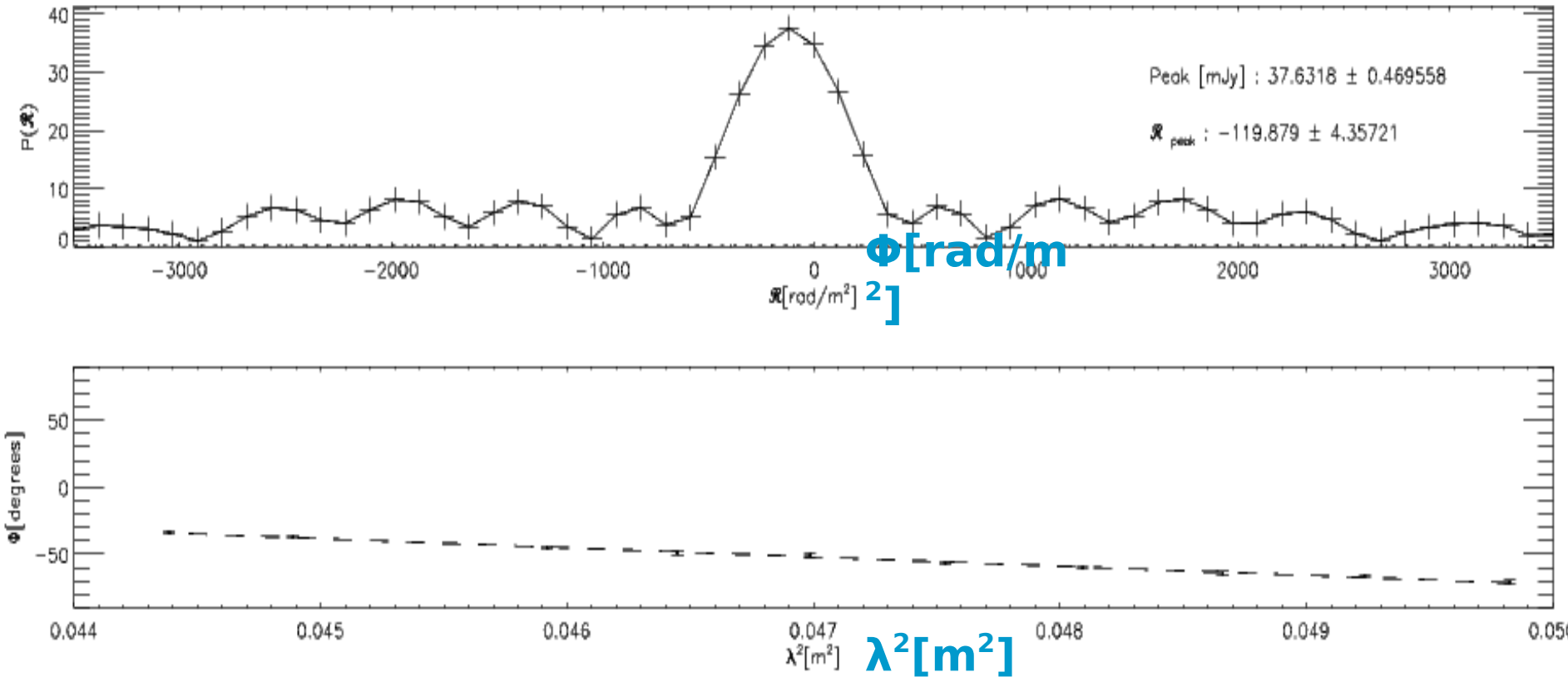
weighting parameter

de-rotate the obs. pol. vectors assuming a Faraday depth





Faraday rotation measure spectra

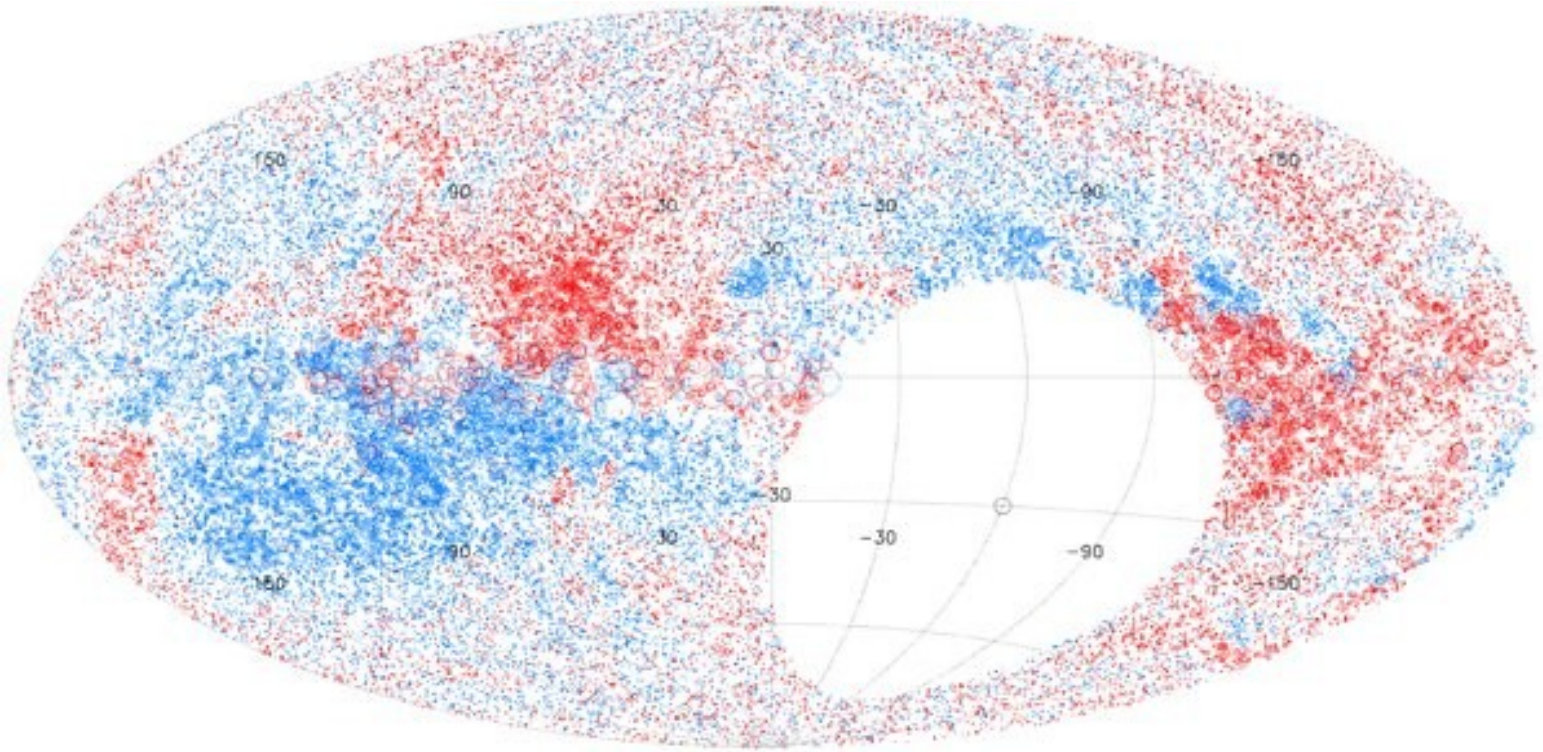


Source: 1520-58

11 channels in the L-band.

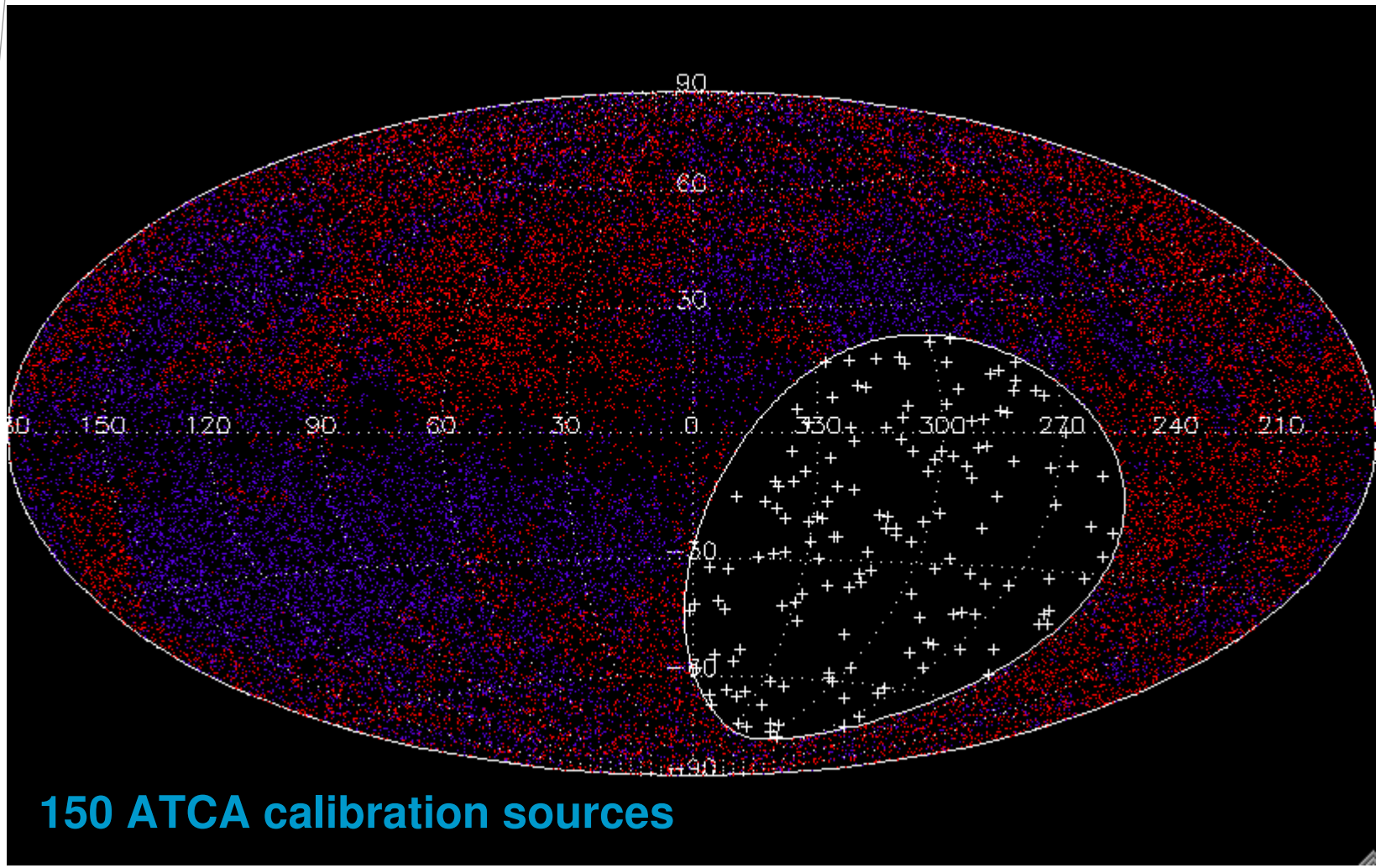
RM NRAO VLA Sky Survey

more than 30,000 RM values at dec. > -40°



from Taylor et al. 2009

ATCA calibration sources with dec. < -40°



150 ATCA calibration sources

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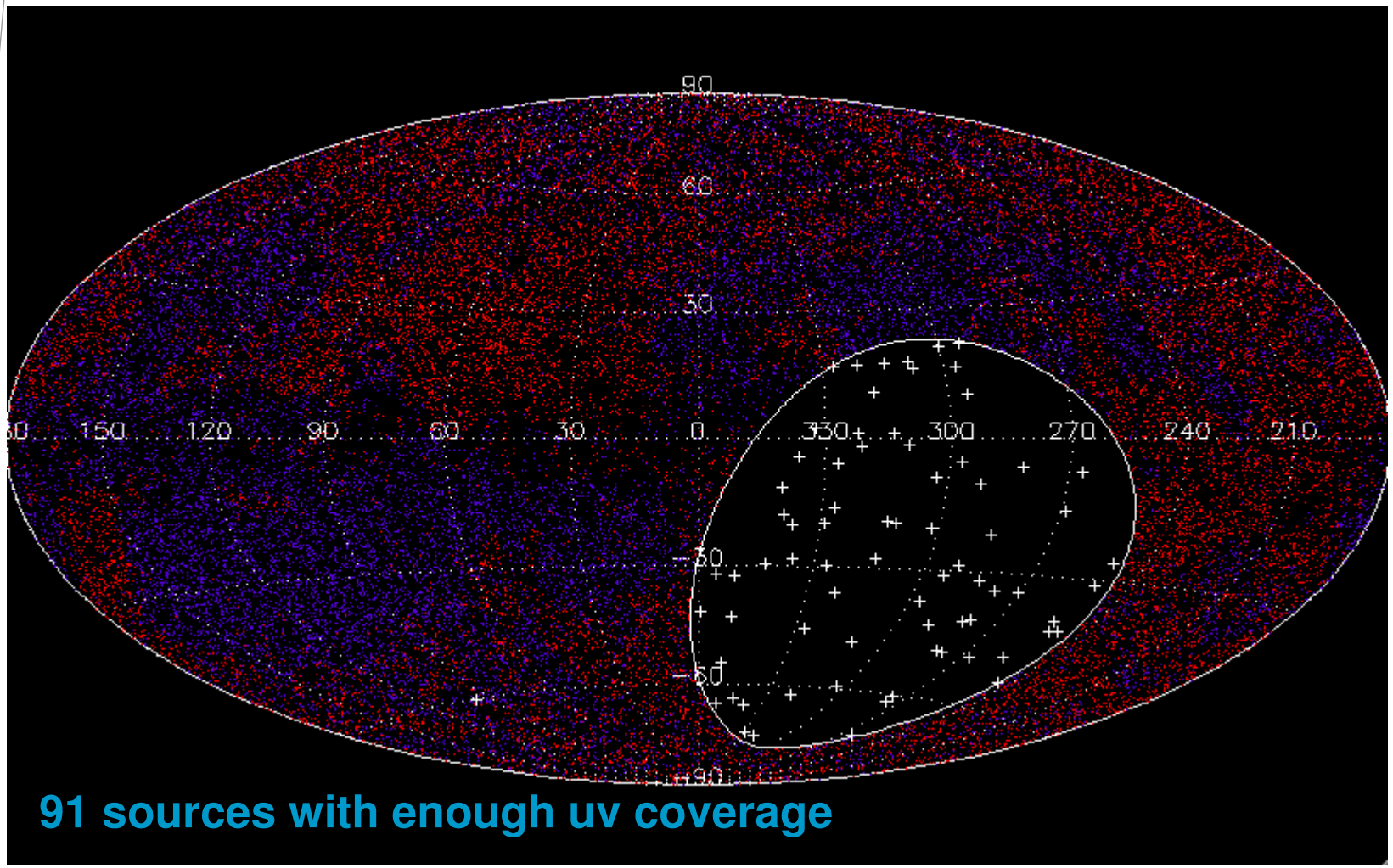
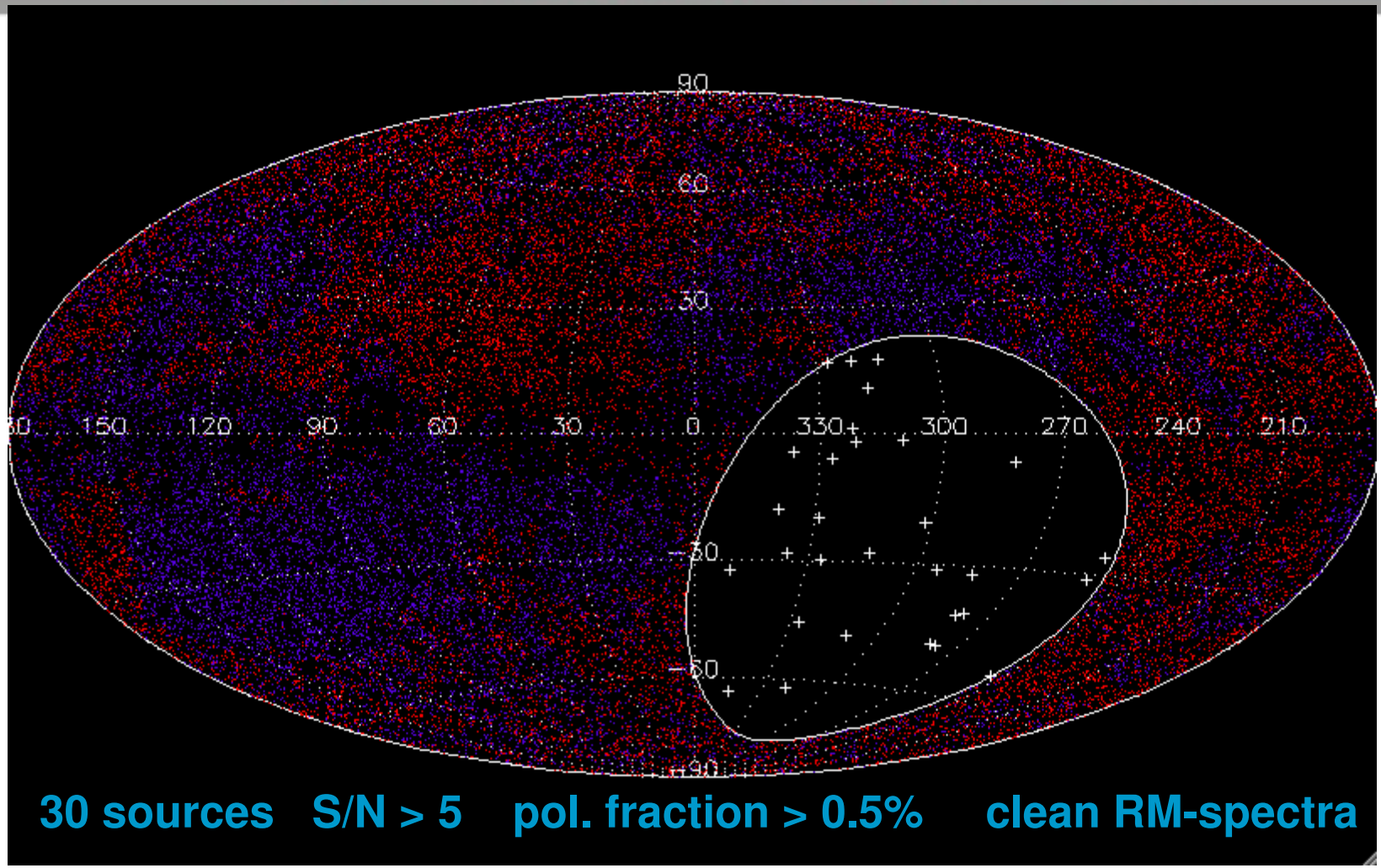
ATCA calibration sources with good uv coverage



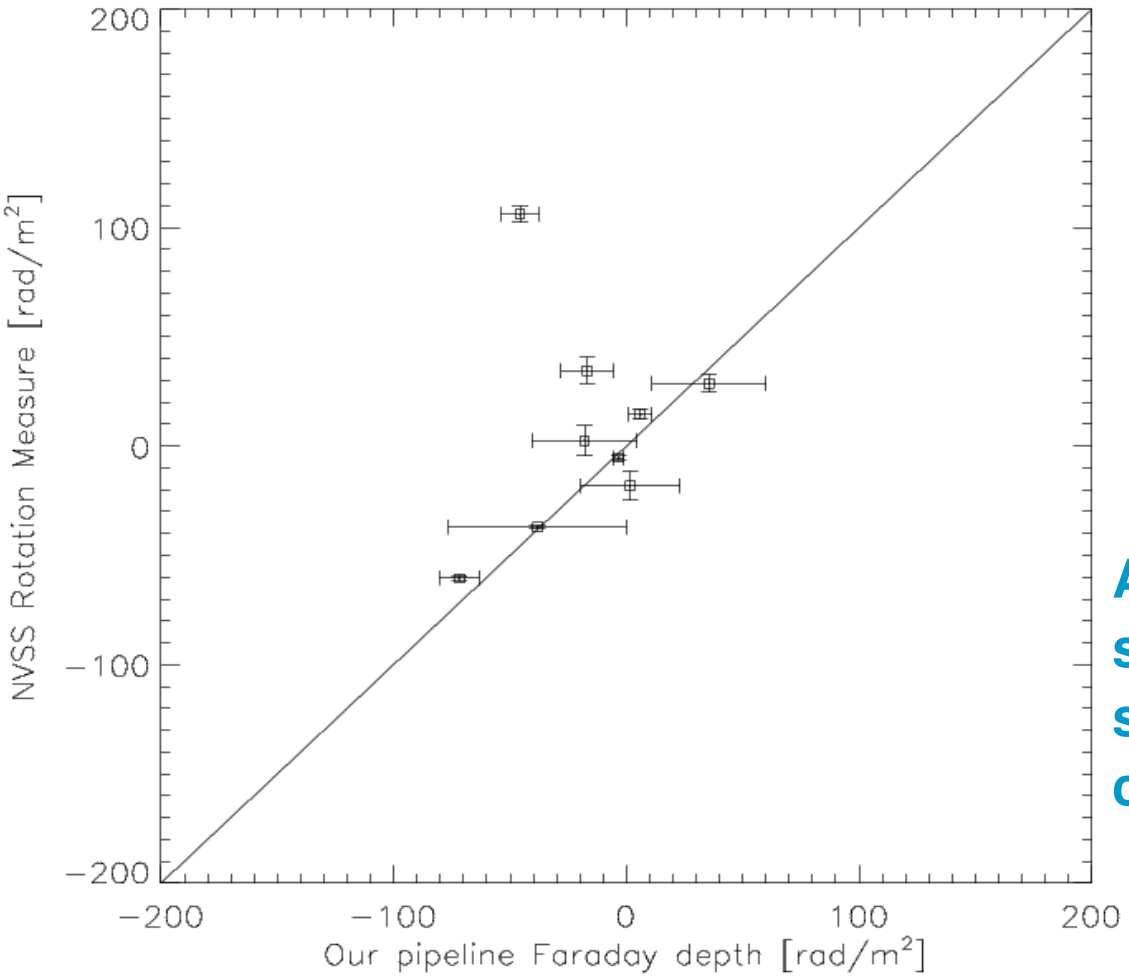
91 sources with enough uv coverage

Polarized ATCA calibration sources



30 sources S/N > 5 pol. fraction > 0.5% clean RM-spectra

Faraday depths of some NVSS sources



ATCA calibration sources > 1 Jy were selected for this comparison

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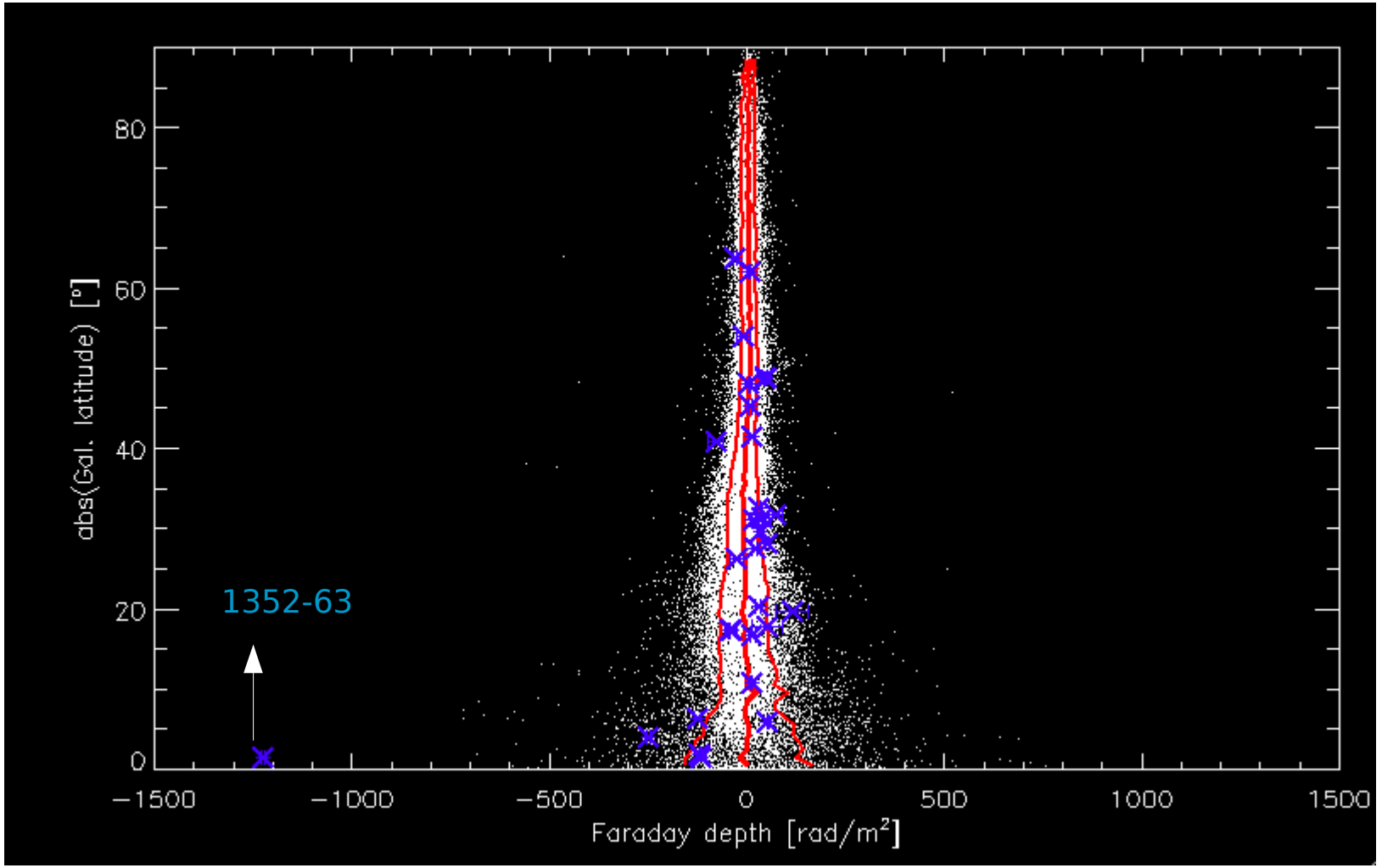
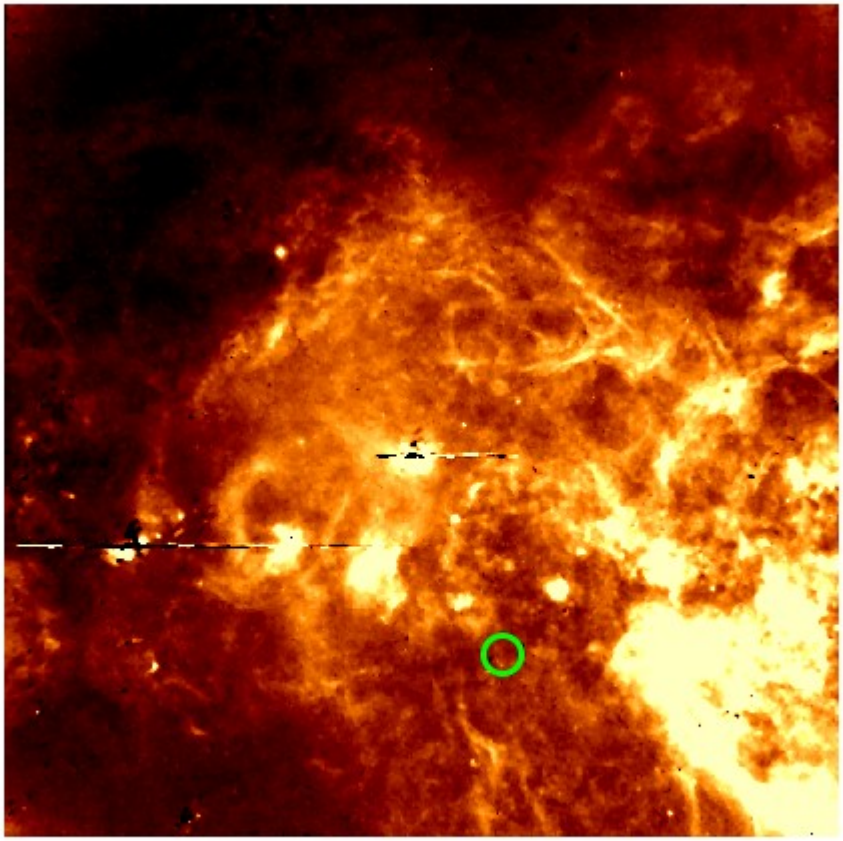
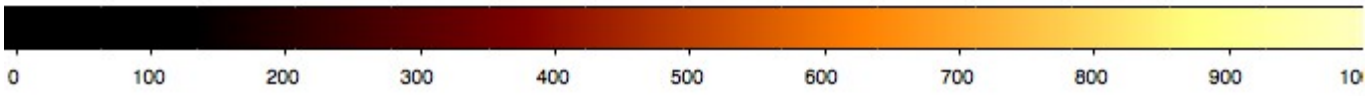
|Gal. Lat.| vs Faraday depth



H_α intensity map of 1352-63





very large DM

an intensity of ~44 Rayleigh

this map ranges from 0-100 Rayleigh

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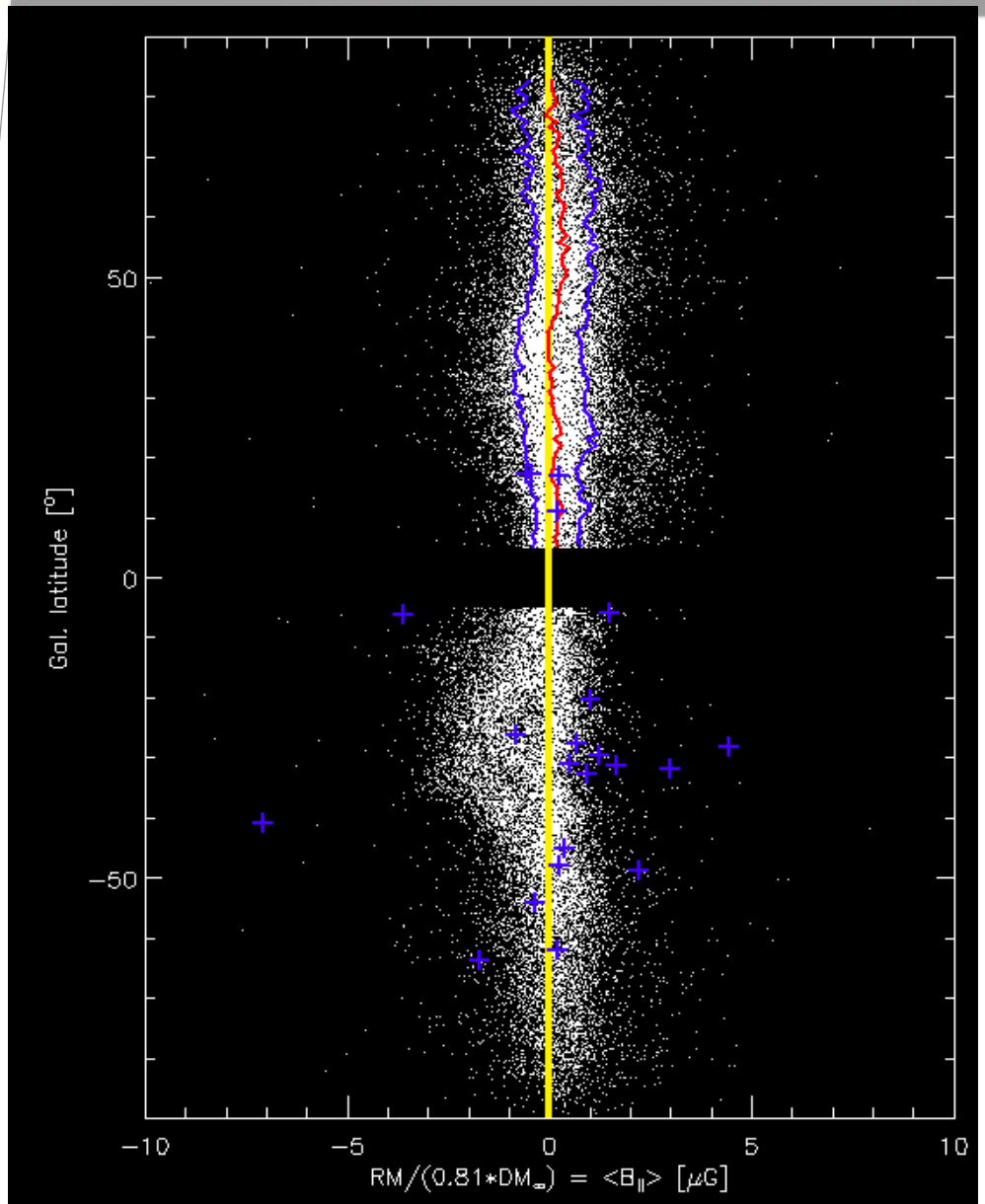
Average magnetic field along the line of sight



NVSS sources: white dots

our 30 sources: purple crosses

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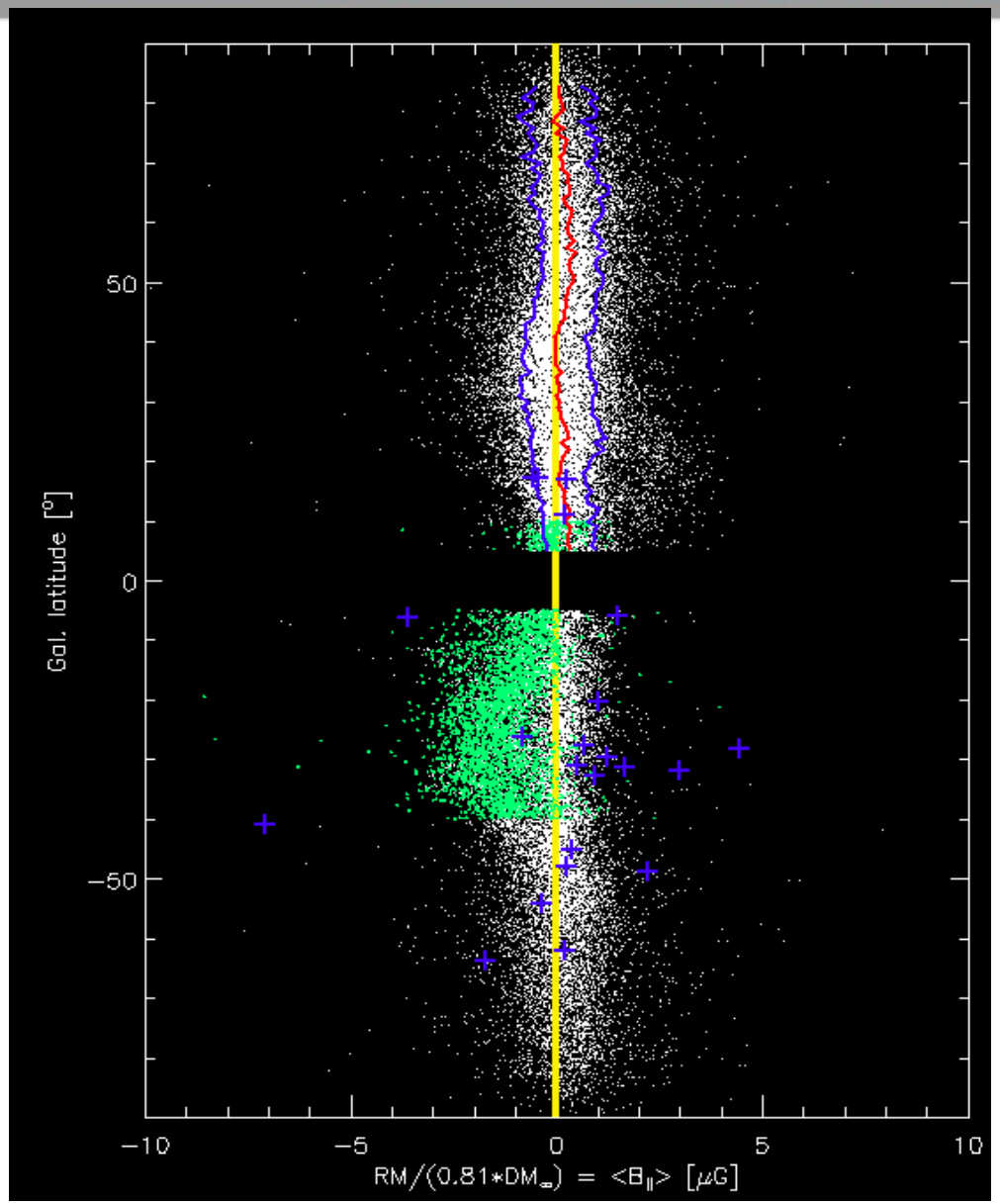

Same figure as before

But the NVSS sources located in Region A are indicated with green points

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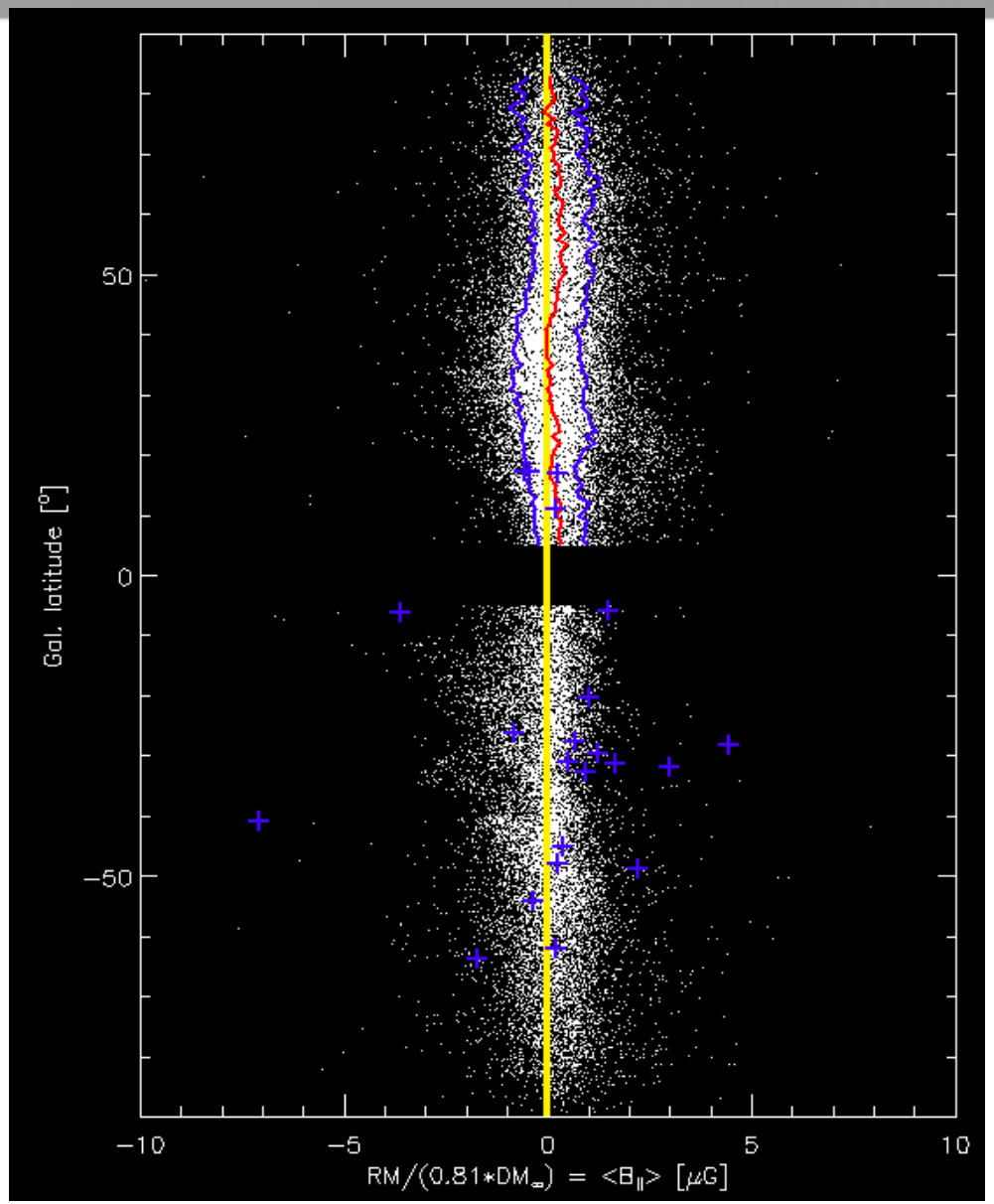

Same figure as before

But the sources from Region A have been removed

<B$_{\parallel}$> along positives galactic latitudes look similar than before

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Conclusions/Future Work

- At high *b,* Faraday Depth decreases. Is it due to small electron density? weak magnetic fields? or only a effect of the line of sight?
- At low *b,* Faraday Depth increases. LOS effect plays a important role. high electron density. What about the magnetic fields?
- 1352-63 deserves further investigation due to its high Faraday depth. However, H_{α} map reveals high electron density.
- For positive *b* the $<B_{\parallel}>$ is constant which will be further analysed.

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