ASTRON

Netherlands Institute for Radio Astronomy

Evolving the POSSUM science case

George Heald

POSSUM meeting

24 August 2012

Key questions

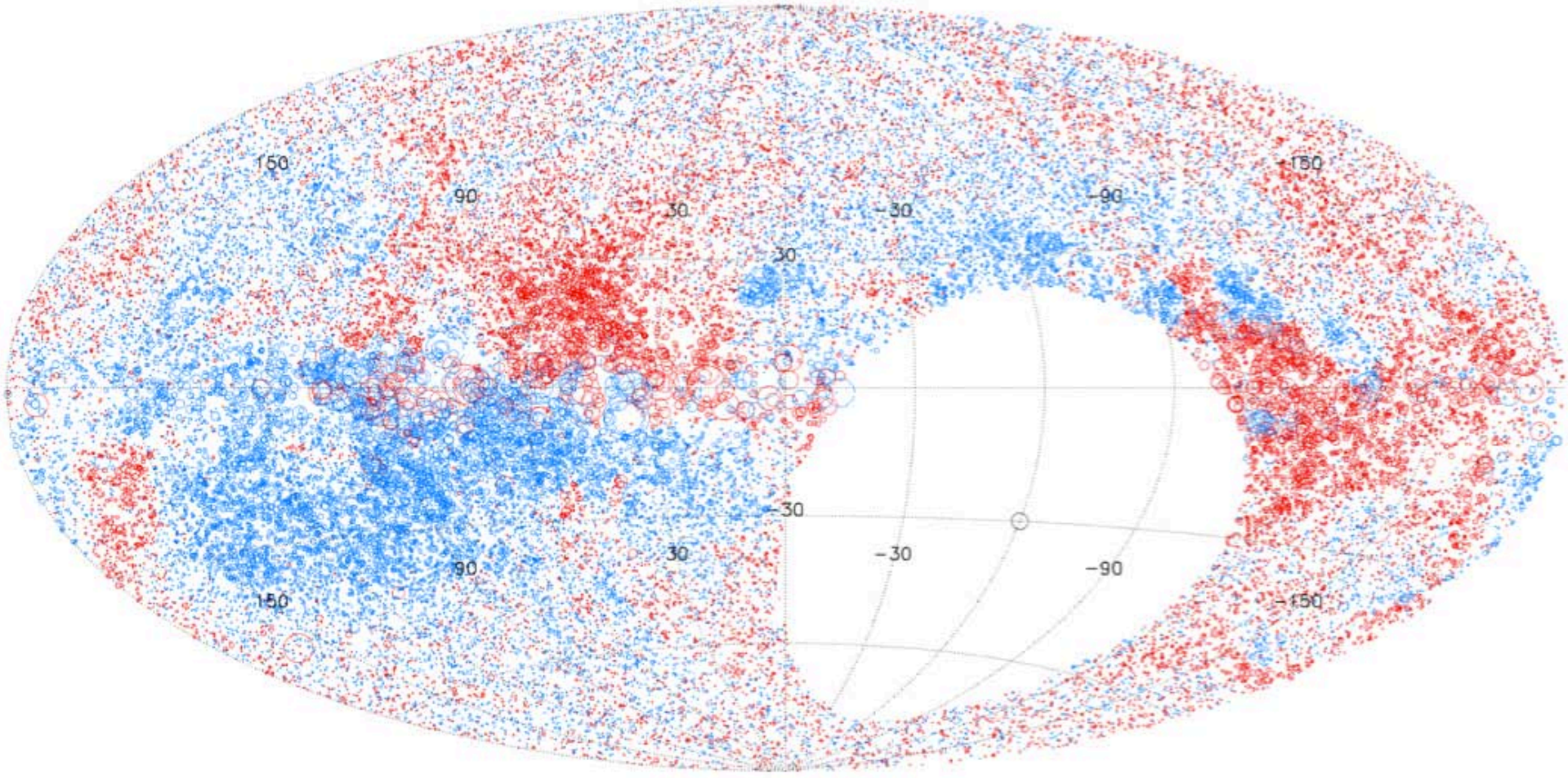
- POSSUM science case built around
  - What are the magneto-ionic properties of the interstellar medium & its components?
  - What is the structure and geometry of the large-scale field of the Milky Way?
  - What are the magnetic properties of galaxies, AGN, clusters, & the intergalactic medium?
  - How do magnetic fields evolve with cosmic time?

- Are these questions still relevant? Need to be updated?

PPC density

ASTRON

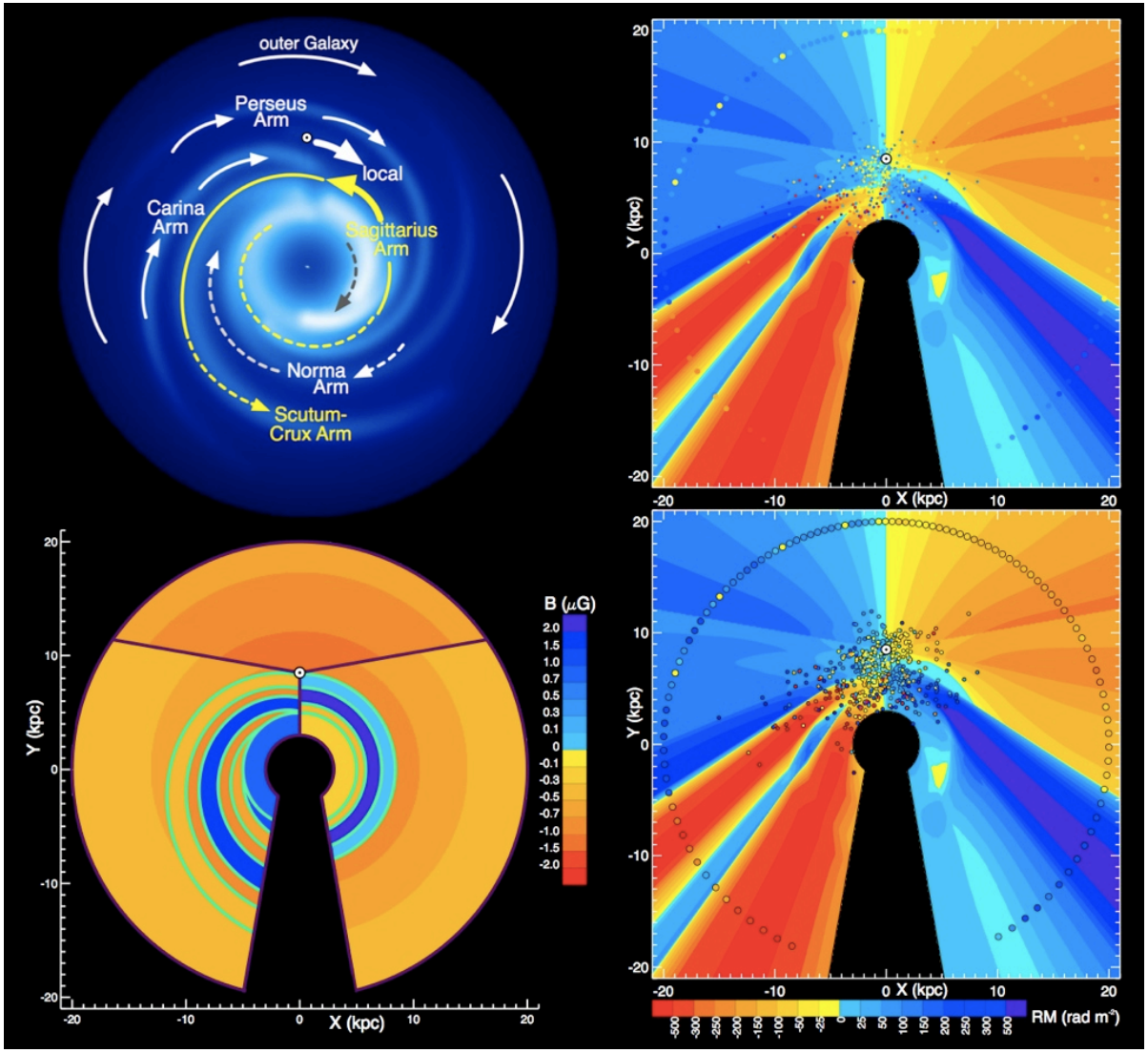
- Taylor et al. (2009) catalog has average density of 1 / sq deg
- PPC expected to have average density of 100 / sq deg



Milky Way magnetic field

ASTRON

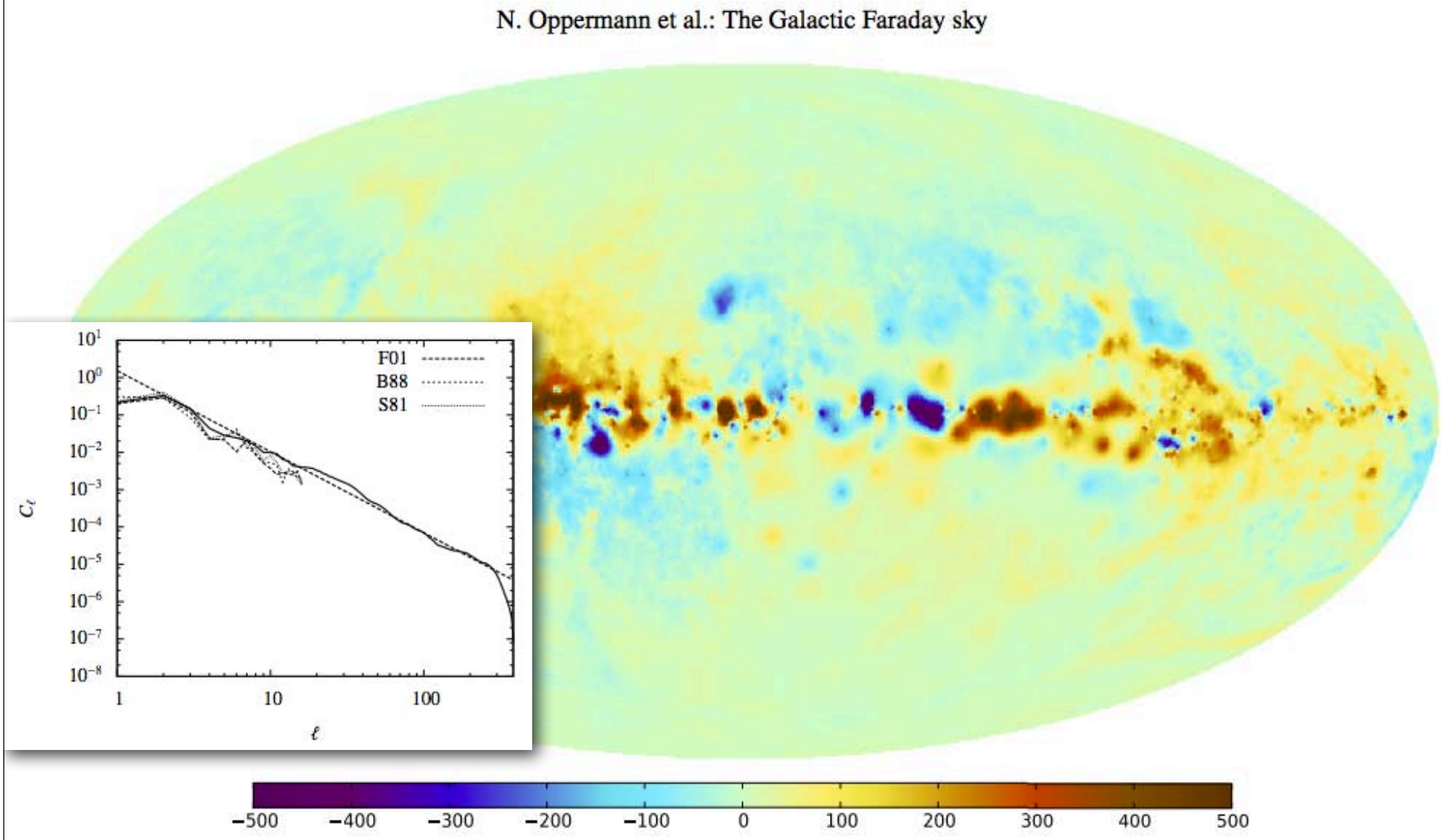
- Need to identify pulsars as such...



van Eck et al (2011)

Using the PPC

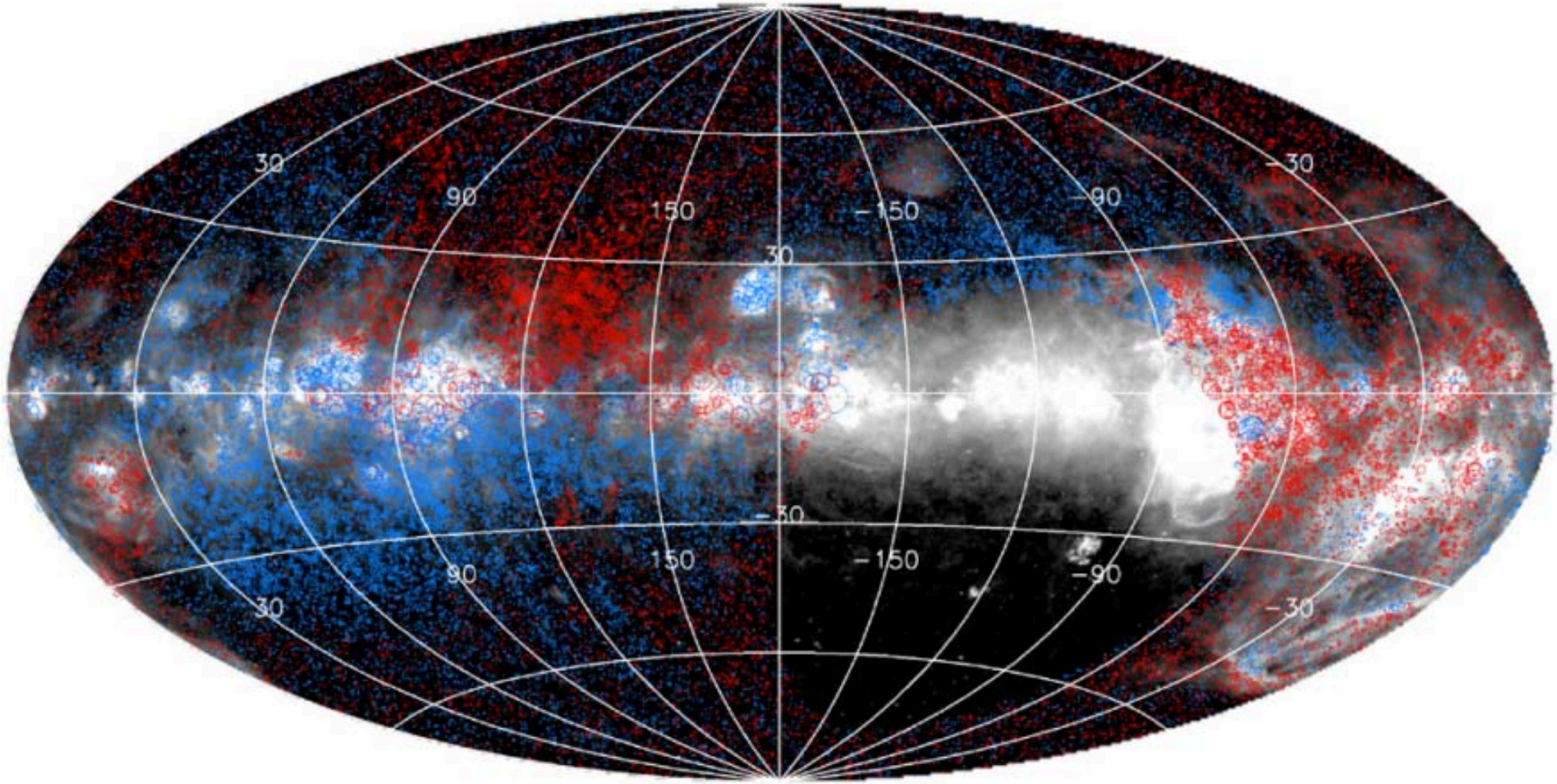
- Analysis like Oppermann et al (2012) - what is required?



Local structures

ASTRON

- Search for correlations with small-scale structures in MW
- Note: is Hα map resolution (6’ FWHM) sufficient?

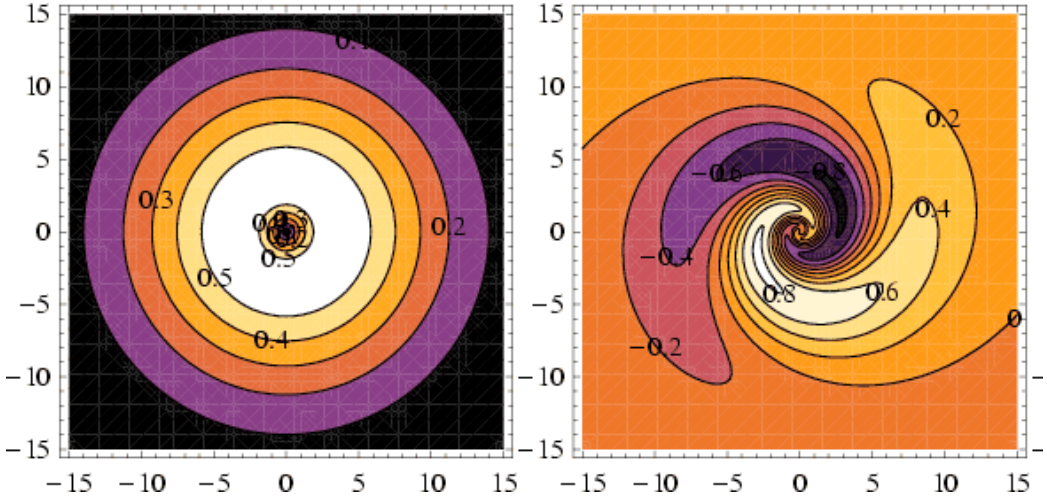


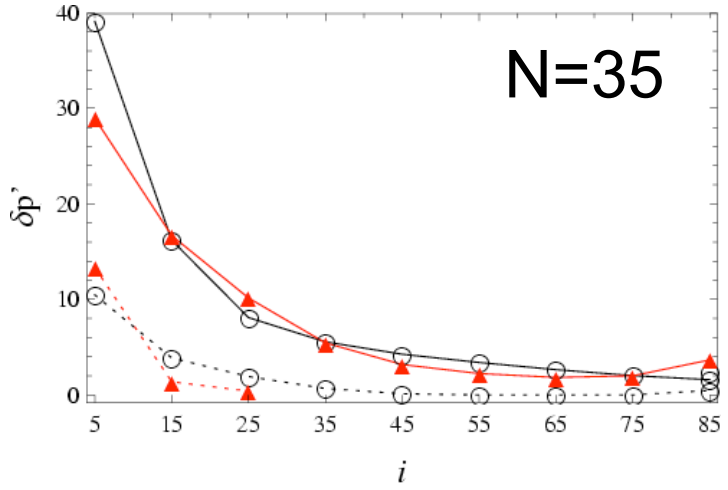
Stil et al (2009), Hα map from Finkbeiner (2003)

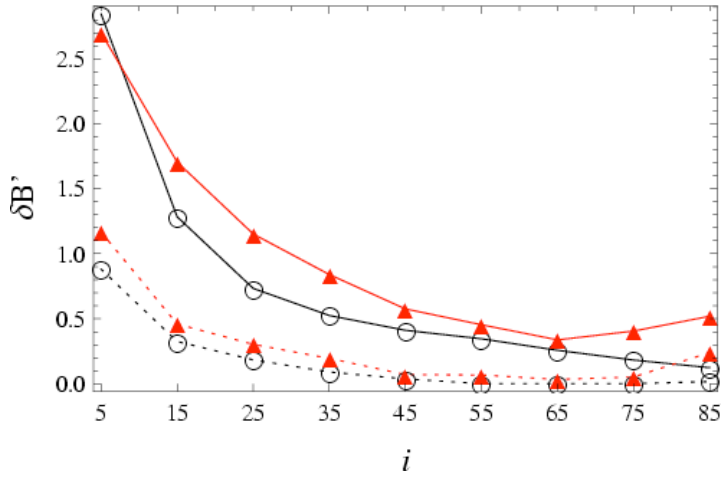
Extended sources

ASTRON

- Stepanov et al (2008) describe reconstruction of galactic fields using limited numbers of background sources
- With our expected source density of ~100 / sq deg, and the need for at least 20-30 RMs per galaxy, this limits the applicability to galaxies with angular size D≳20’

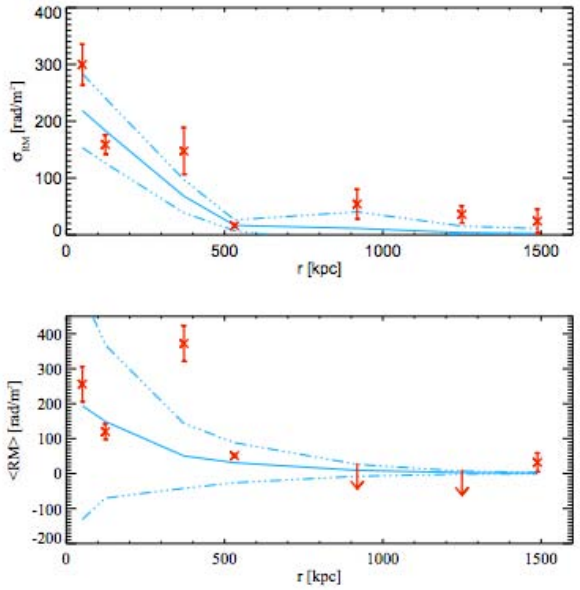




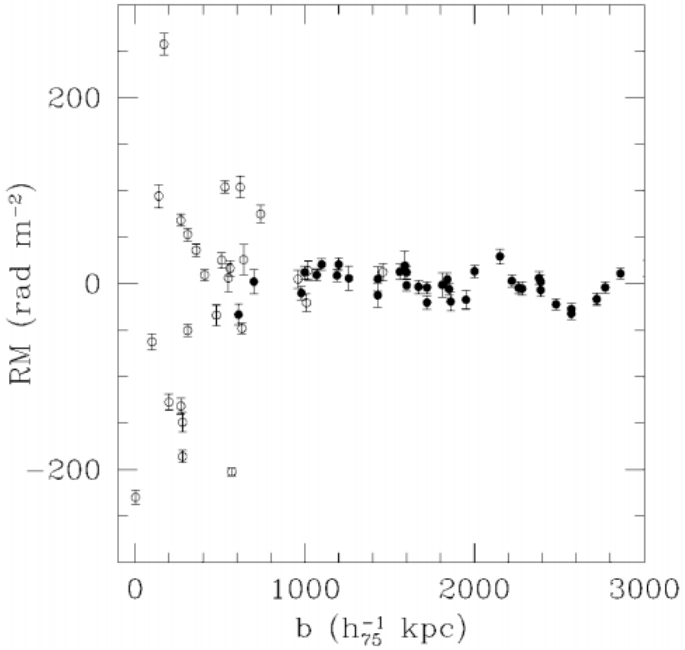


Variance stacking

- Clarke et al (2001) 'stacked' RMs as a function of impact parameter (b) for a sample of 16 Abell clusters
- Even in the absence of sufficient density to derive the detailed structure of individual galaxies / clusters, this will be a very powerful tool to recover the average scale of various objects
  - Importantly, giving access to the variation with foreground source properties!



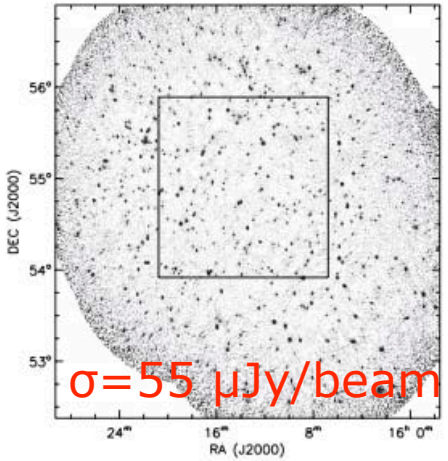
Bonafede et al (2010)

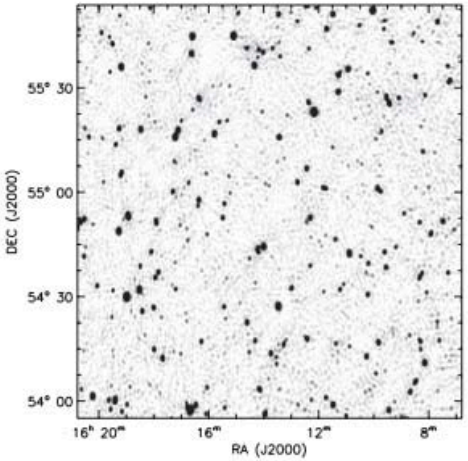


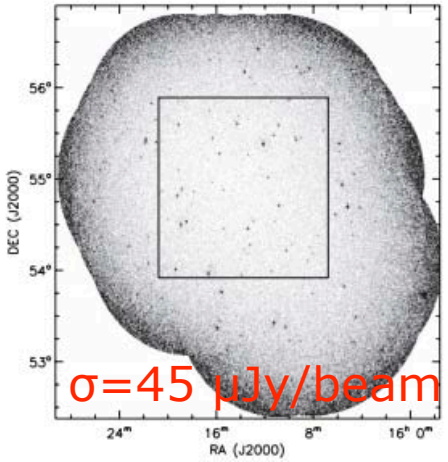
Clarke et al (2001)

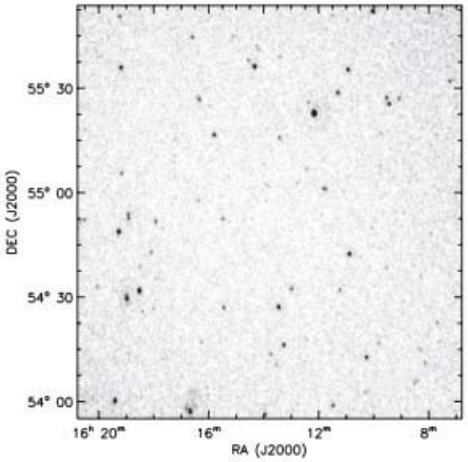
Source counts

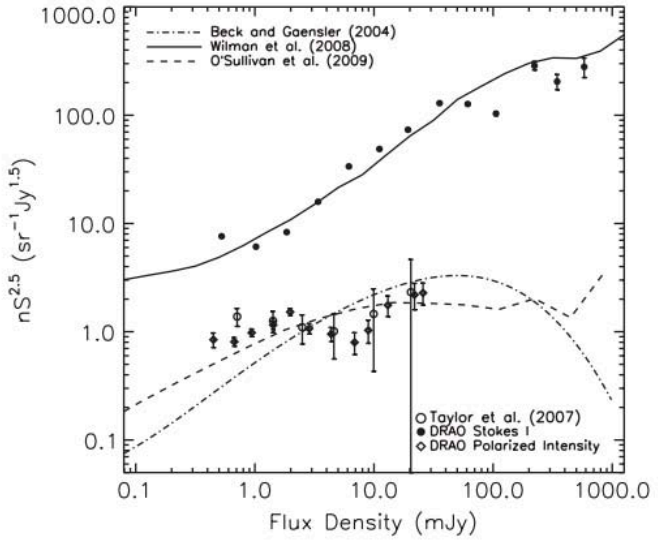
- Huge leverage on source counts and extension to still fainter (polarized) flux densities

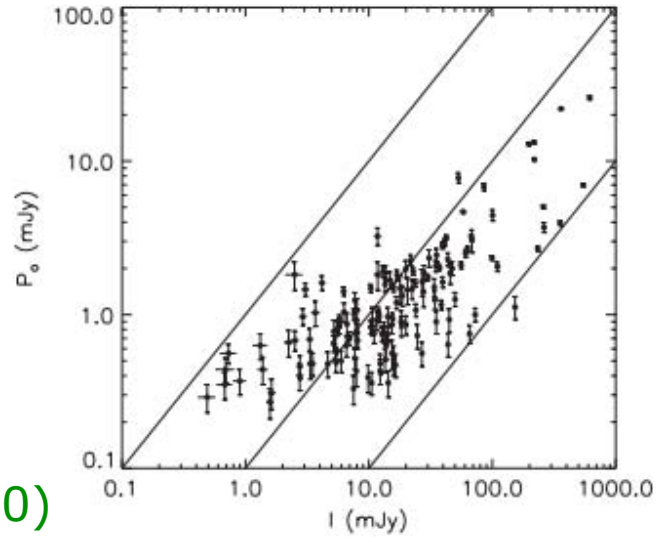








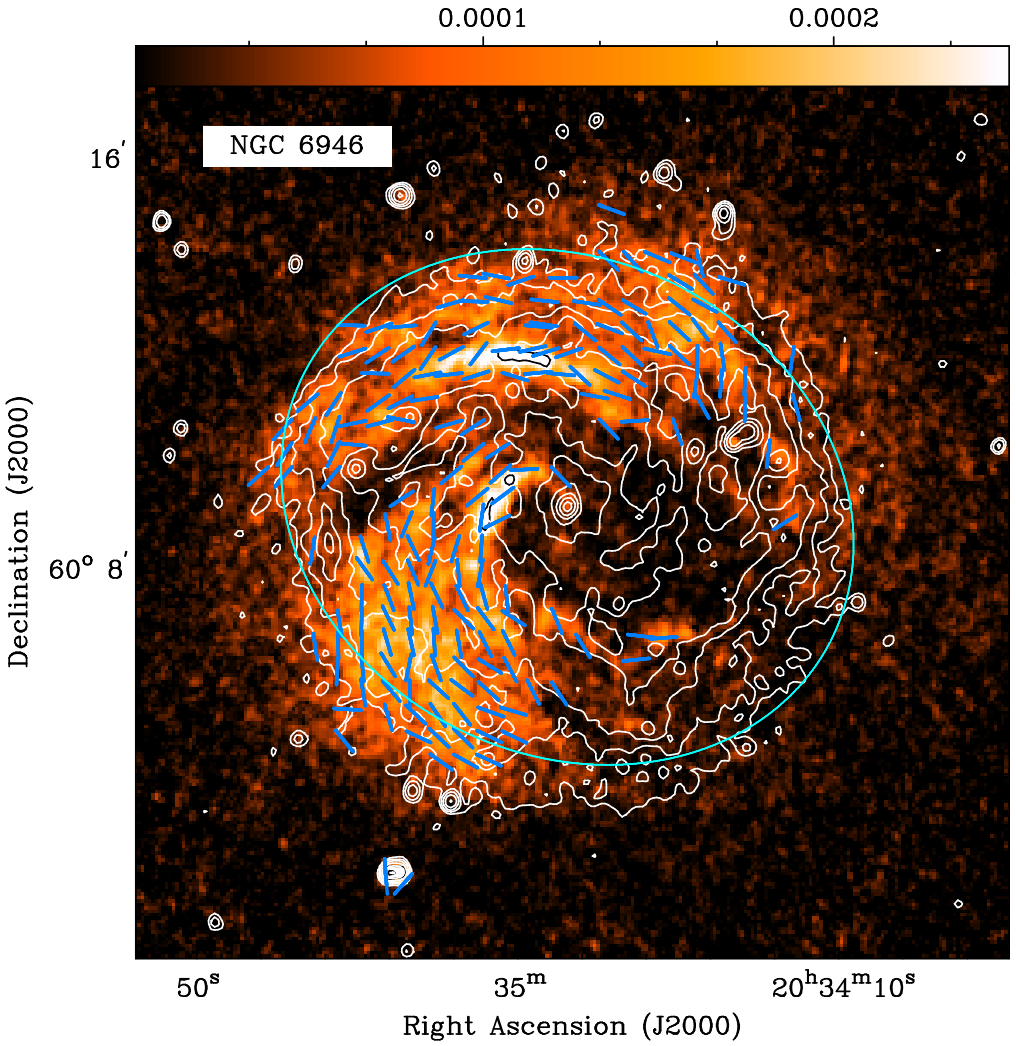




Grant et al (2010)

What about diffuse emission in galaxies?

- WSRT-SINGS noise level was $\sigma_{Q,U}$~10-15 μJy/beam, clearly giving sufficient sensitivity to diffuse emission in spirals



Heald et al (2009)

What about diffuse emission in galaxies?

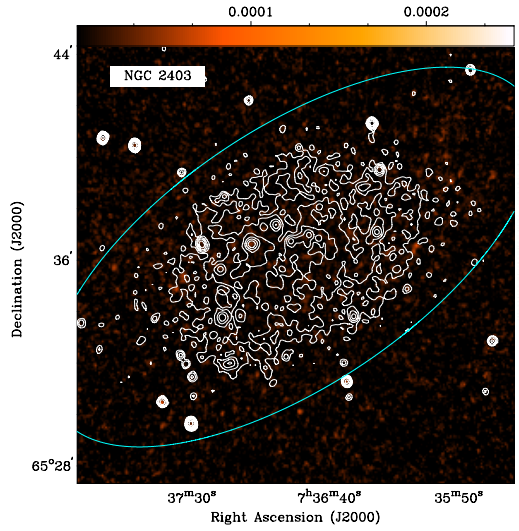
- But how the imaging is done (final image resolution) is crucial to recovery of faint diffuse structures
- (This *calibration and imaging issue* carries information about the typical fluctuation angular scales in Q,U)

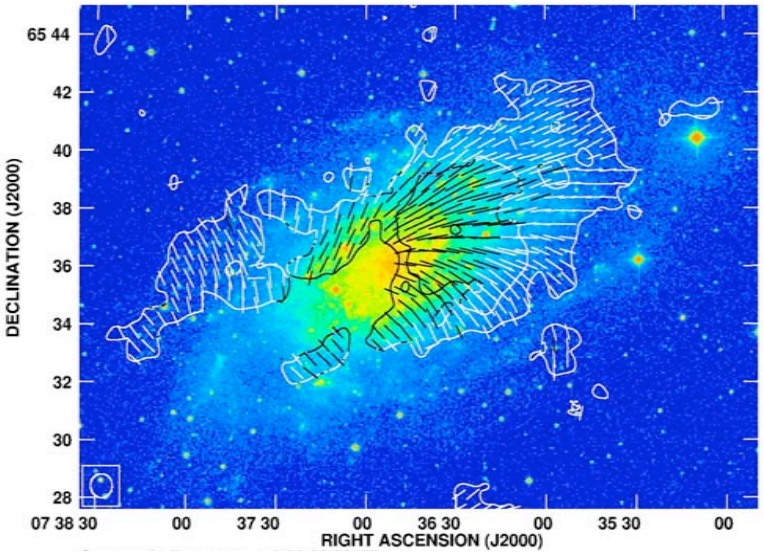
(original) P

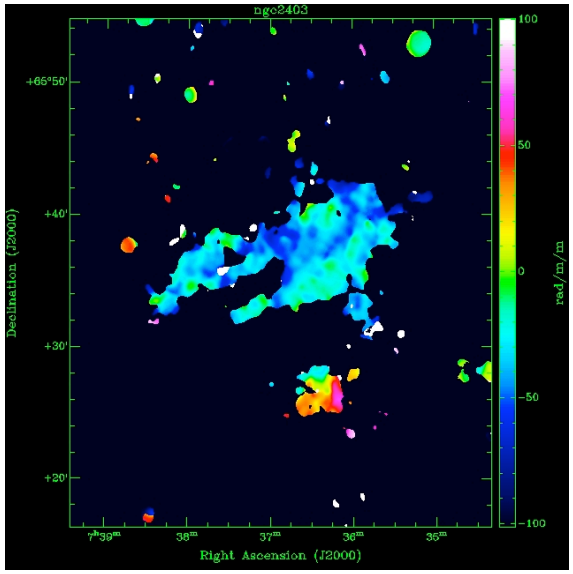
(new) P

(new) RM

NGC 2403





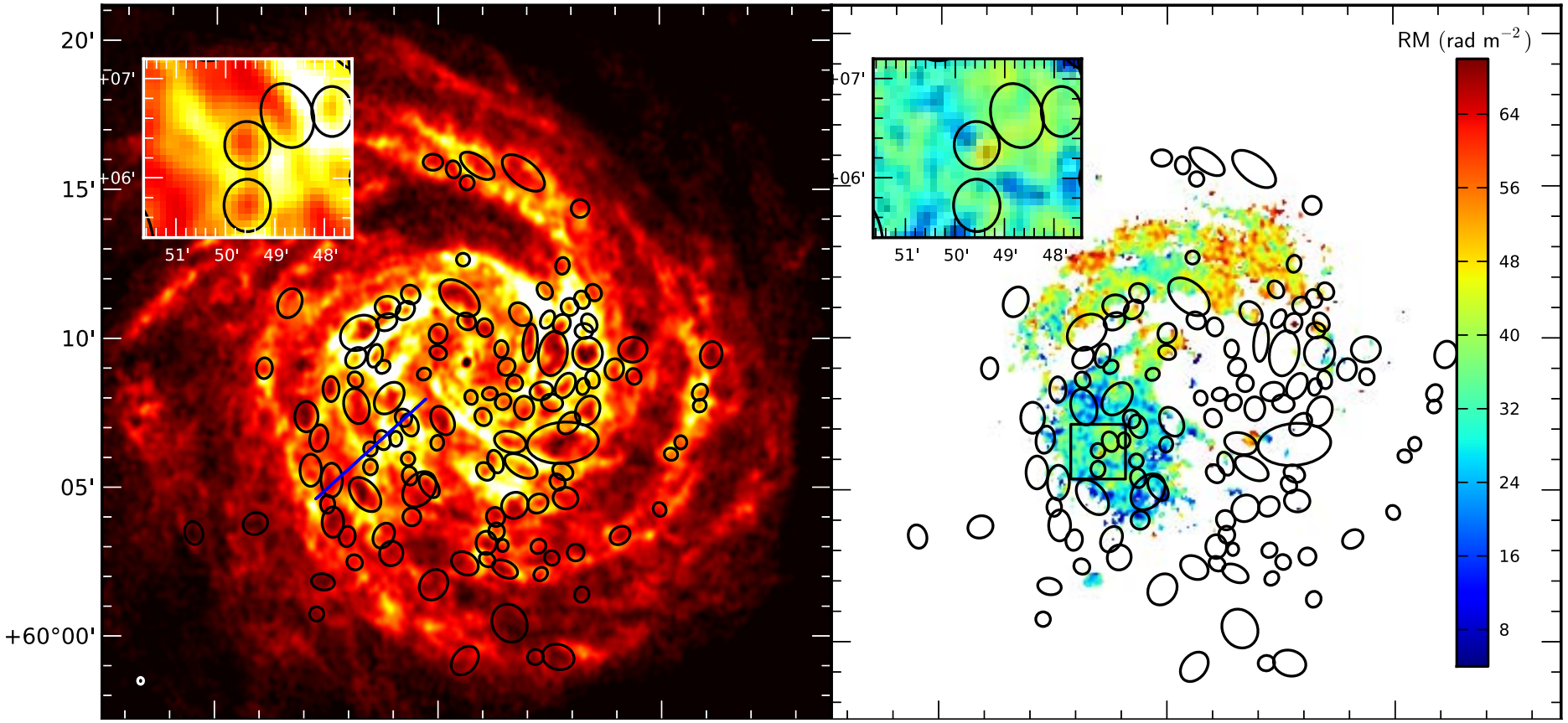


Drzazga et al (in prep)

Diffuse emission in galaxies

ASTRON

- Synergy with WALLABY ... !
- Comparison between HI structures and RM variations can give new leverage on the physics of the magnetized ISM

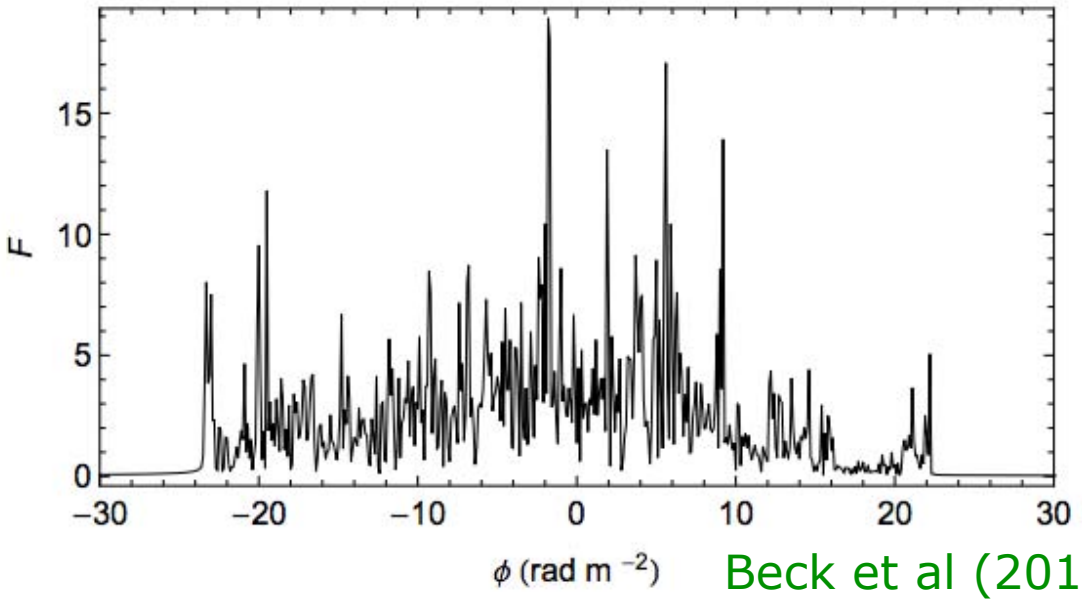


Heald (2012)

Complicated Faraday dispersion functions

ASTRON

- Not just to be discarded...! See Dmitry's talk, also O'Sullivan et al (2012) and Heald et al (2009)
- Faraday dispersion function of complicated (here, turbulent) sources shows up as increased variance within a certain RM range
- For best recovery, combination with FLASH is essential (see Beck et al 2012)

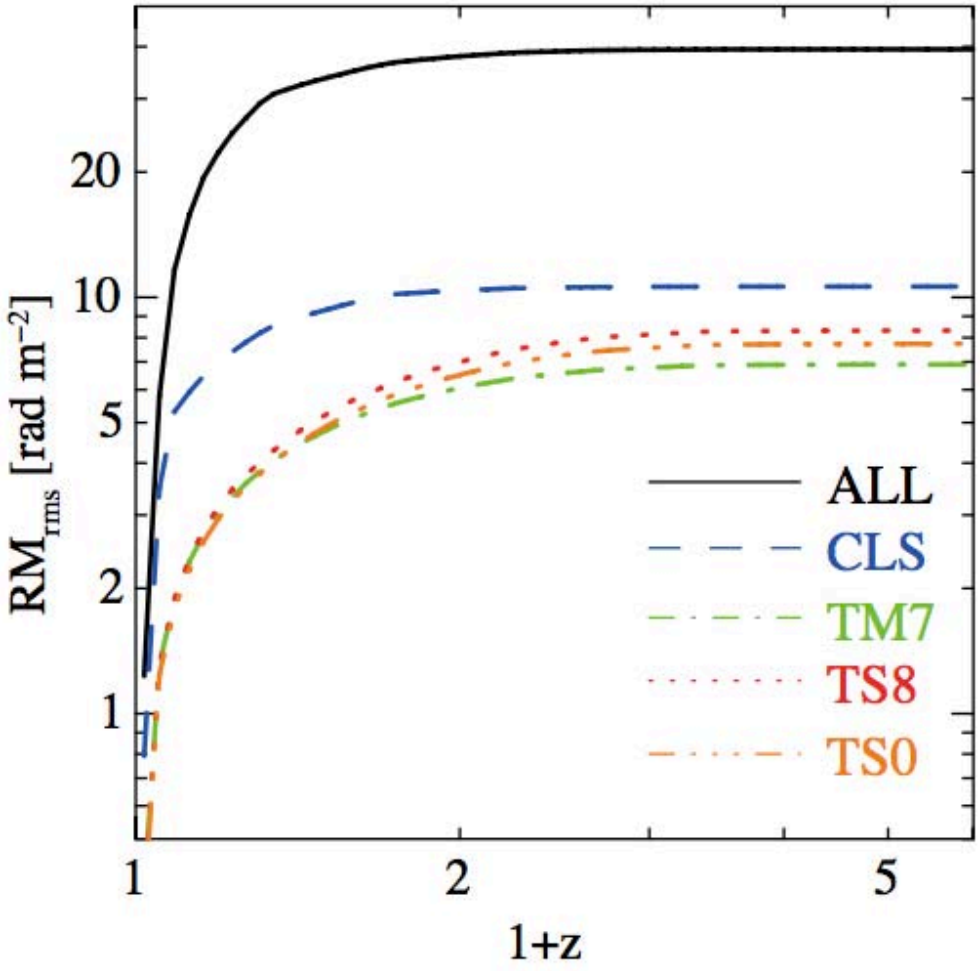


Beck et al (2012)

IGM magnetic field

ASTRON

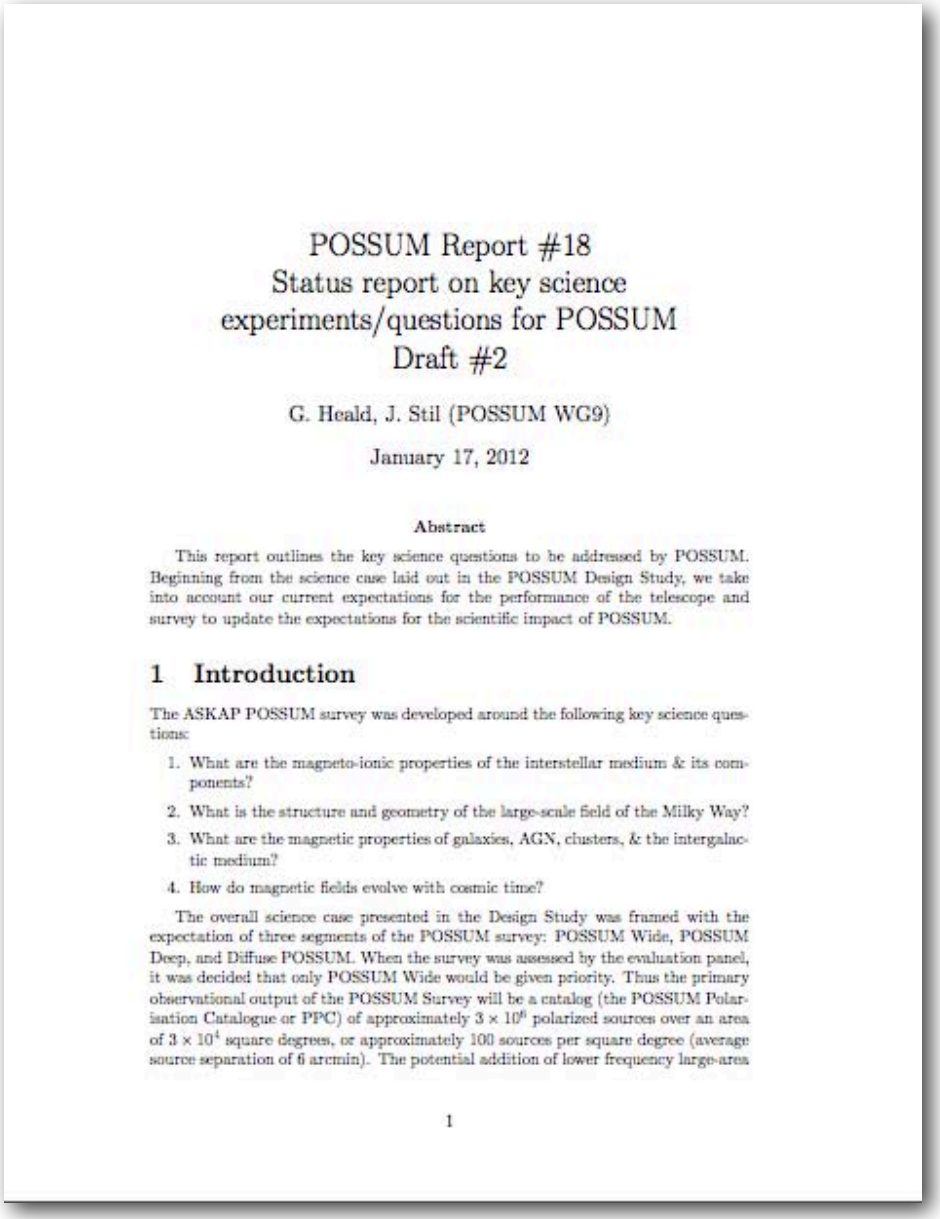
- Spread in RM as function of z probes IGM magnetic field
- Requires low measurement errors - (of order ~1 rad/m^2)



Akahori & Ryu (2011)

POSSUM report 18

- Needs further work
- Update with Jeroen, followed by distribution to WG9 for additions and improvements



POSSUM Report #18
Status report on key science experiments/questions for POSSUM
Draft #2

G. Heald, J. Stil (POSSUM WG9)

January 17, 2012

Abstract

This report outlines the key science questions to be addressed by POSSUM. Beginning from the science case laid out in the POSSUM Design Study, we take into account our current expectations for the performance of the telescope and survey to update the expectations for the scientific impact of POSSUM.

1 Introduction

The ASKAP POSSUM survey was developed around the following key science questions:

1. What are the magneto-ionic properties of the interstellar medium & its components?
2. What is the structure and geometry of the large-scale field of the Milky Way?
3. What are the magnetic properties of galaxies, AGN, clusters, & the intergalactic medium?
4. How do magnetic fields evolve with cosmic time?

The overall science case presented in the Design Study was framed with the expectation of three segments of the POSSUM survey: POSSUM Wide, POSSUM Deep, and Diffuse POSSUM. When the survey was assessed by the evaluation panel, it was decided that only POSSUM Wide would be given priority. Thus the primary observational output of the POSSUM Survey will be a catalog (the POSSUM Polarisation Catalogue or PPC) of approximately 3×10^6 polarized sources over an area of 3×10^4 square degrees, or approximately 100 sources per square degree (average source separation of 6 arcmin). The potential addition of lower frequency large-area

1