Future polarization observations at high frequency

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ATUC meeting, Parkes Science Day – 4 December 2013

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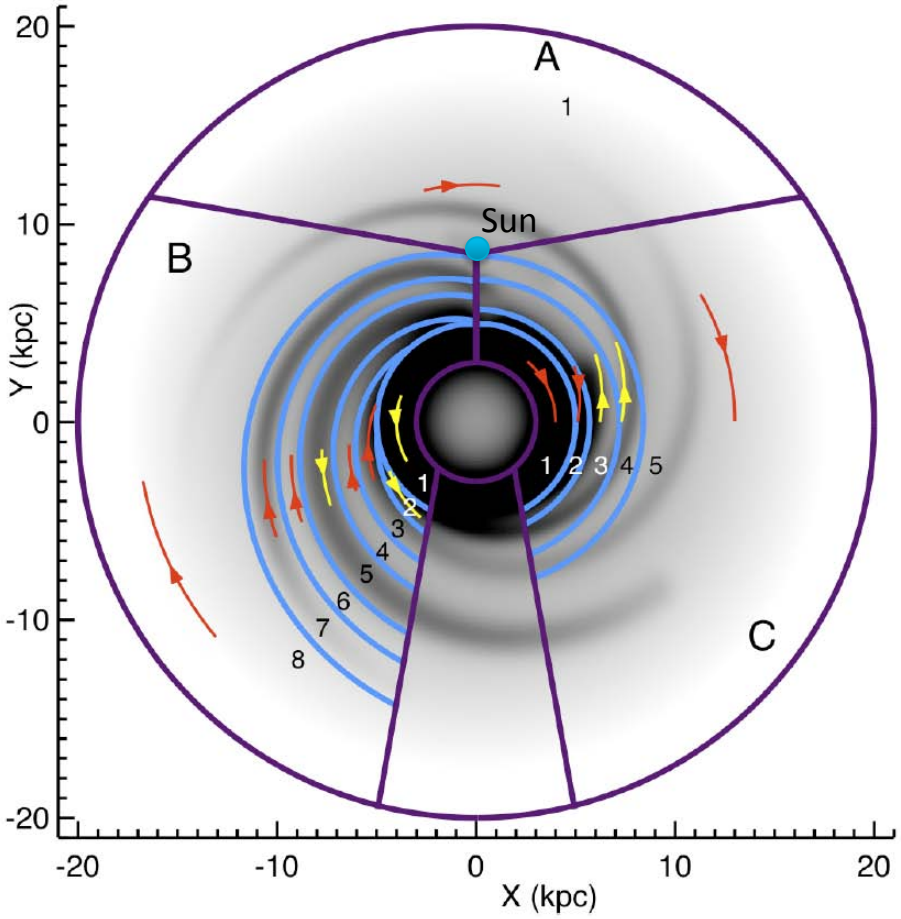
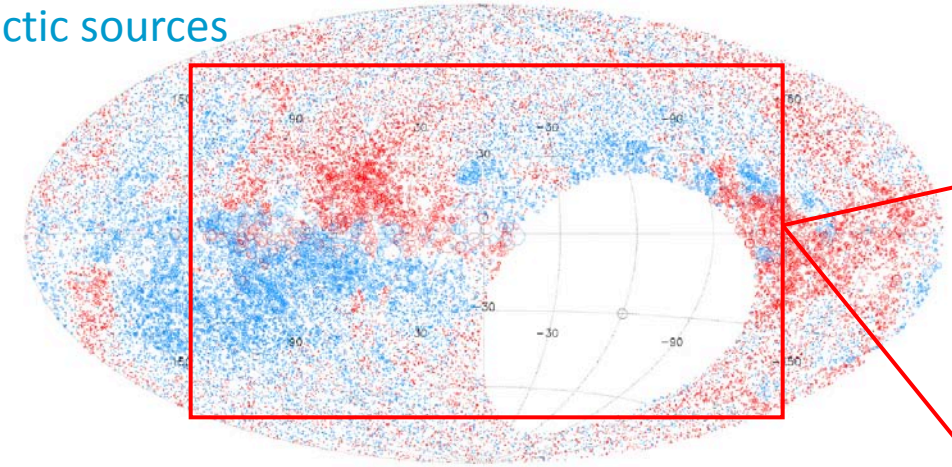
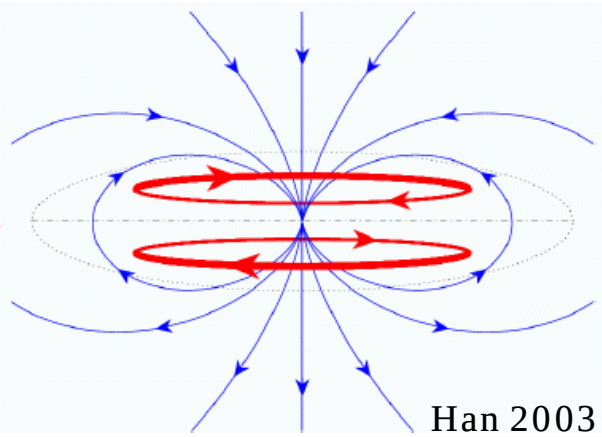
Galactic Disc magnetic field



Anti-symmetry in the inner Galaxy: local structure or signature of dynamo?

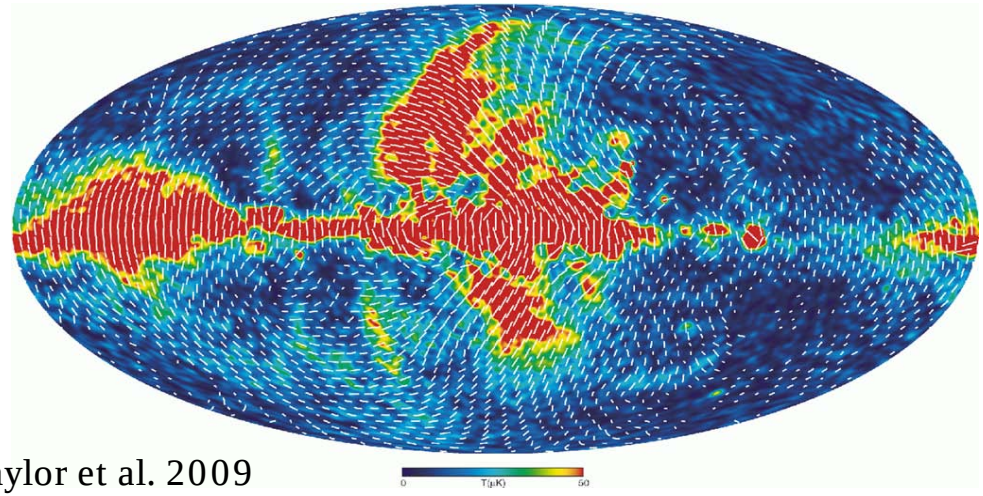
Extragalactic sources





Han 2003

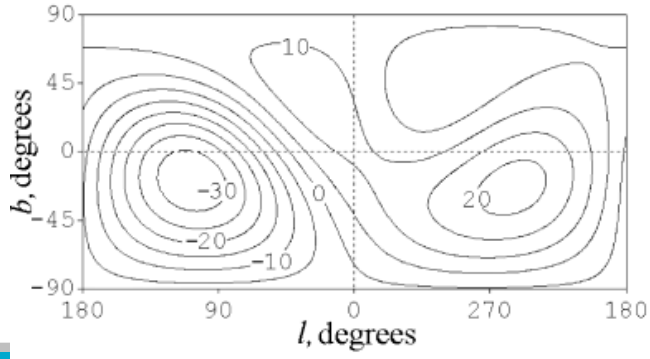
An $\alpha\Omega$ dynamo…



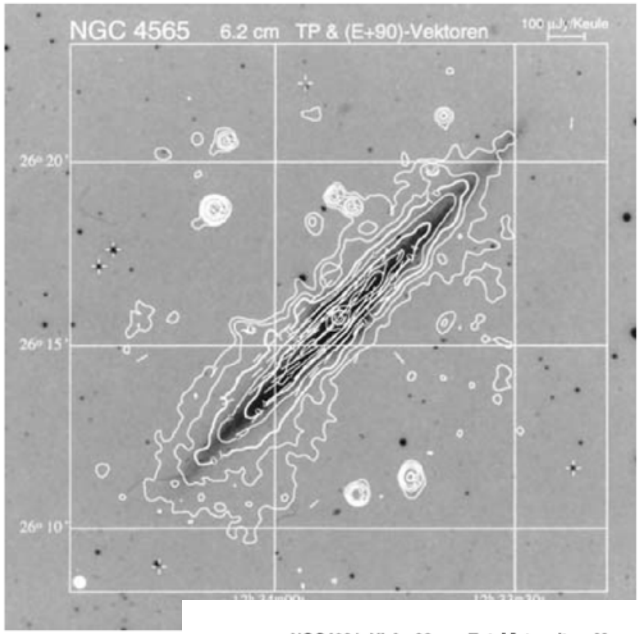
Taylor et al. 2009

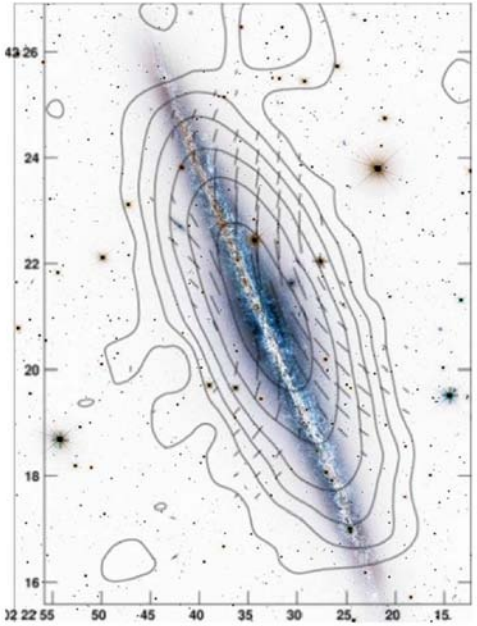
…or an even field and the North Polar Spur?

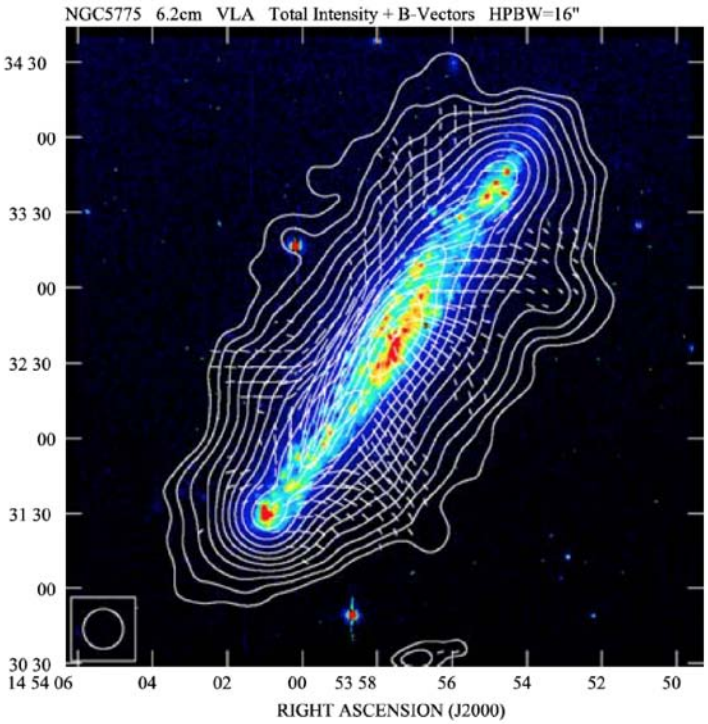
Frick et al 20

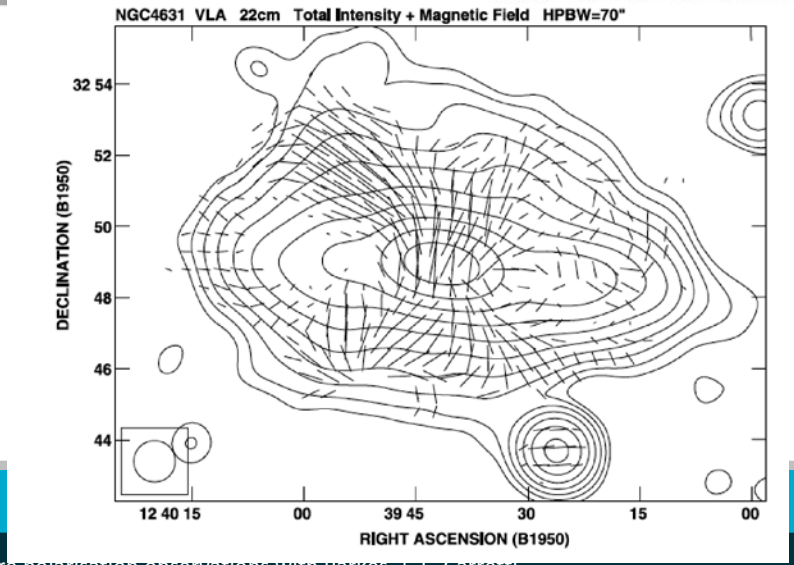


Halo magnetic field: external galaxies









[Dumke 1997]
[Krause 2007]
[Tuelmann 2000]
[Beck 2005]

Why Diffuse Polarized Emission?

- Compact sources RM: only B parallel (to the line of sight)

- Diffuse emission: polarized emission
  - Diffuse polarized synchrotron emission
  - to probe the ordered magnetic field
  - Faraday Rotation (RM) ⇒ B parallel to the line of sight
  - Synchrotron polarisation angles ⇒ B perpendicular
  - B and ISM turbulence (RM)
  - Galactic structure

- Multiple MIM layers info encoded in
- … but harder to extract!

- RM maps has higher resolution than those with sources

What has been done

- 3 Southern surveys completed (Parkes)
  - 300-480 – 700-900 MHz (GMIMS – Parkes)
  - 1300-1800 MHz (STAPS – Parkes)
  - 2200-2400 MHz (S-PASS -- Parkes)

Polarisation surveys: 1.4 GHz

- ALL SKY maps at **1.4 GHz**, FWHM ~ **36'**
- FR modifications:
  - Galactic Disc strongly depolarised |b| < 30°
  - FR modification
  - at |b |< 50°

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- **1.4 GHz: not sufficient**

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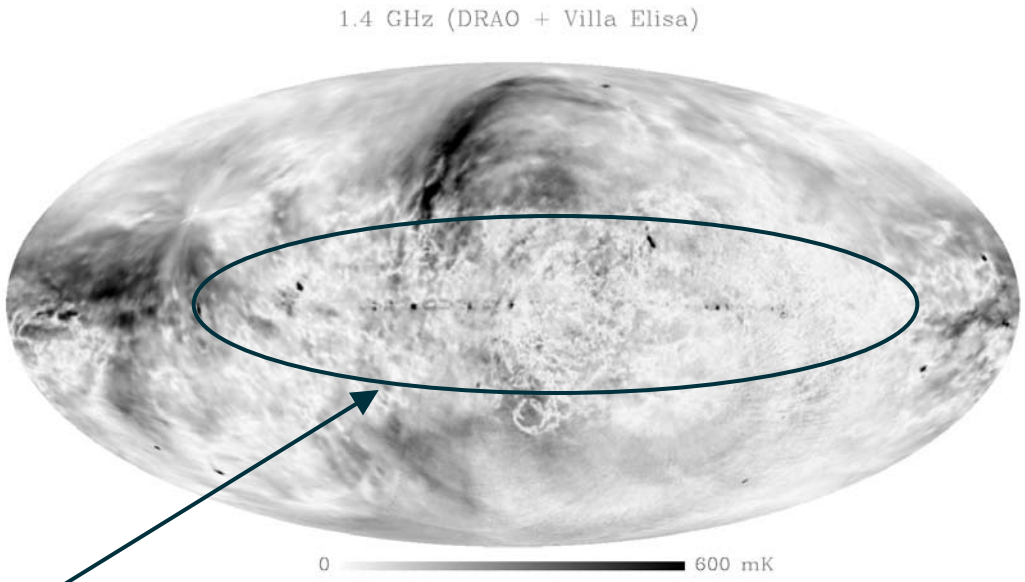
- **Higher frequency!!**

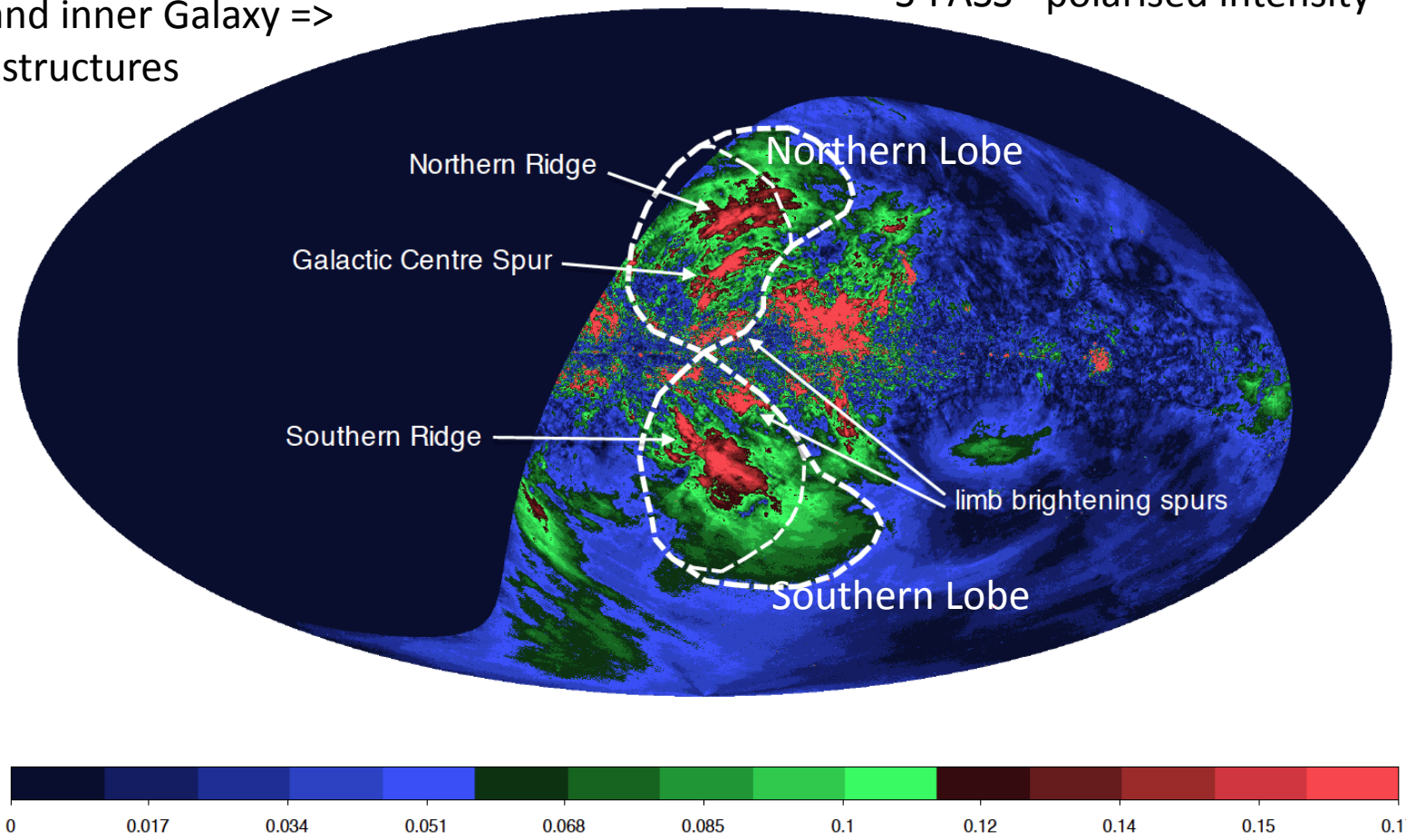


Polarisation surveys: 2.3 GHz

- Higher frequency
- Peer through the Galactic disc
- Unveil disc and inner Galaxy => unexpected structures

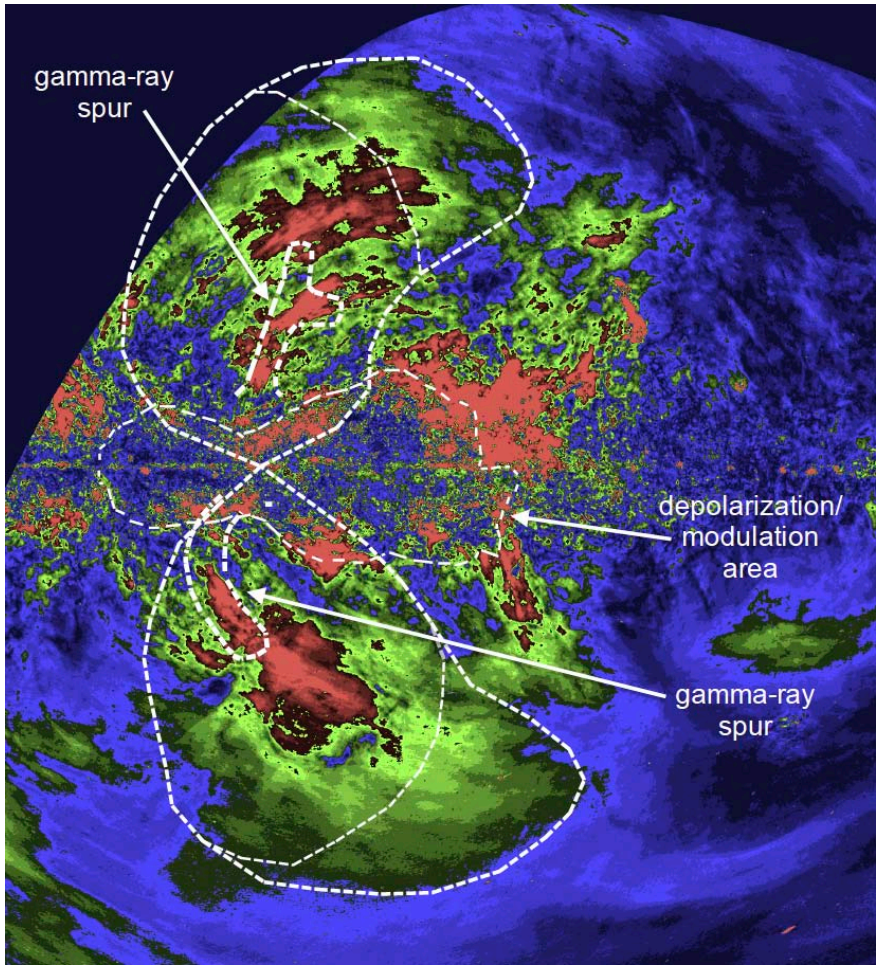
Carretti et al., 2013, Nature, 493, 66

S-PASS - polarised intensity

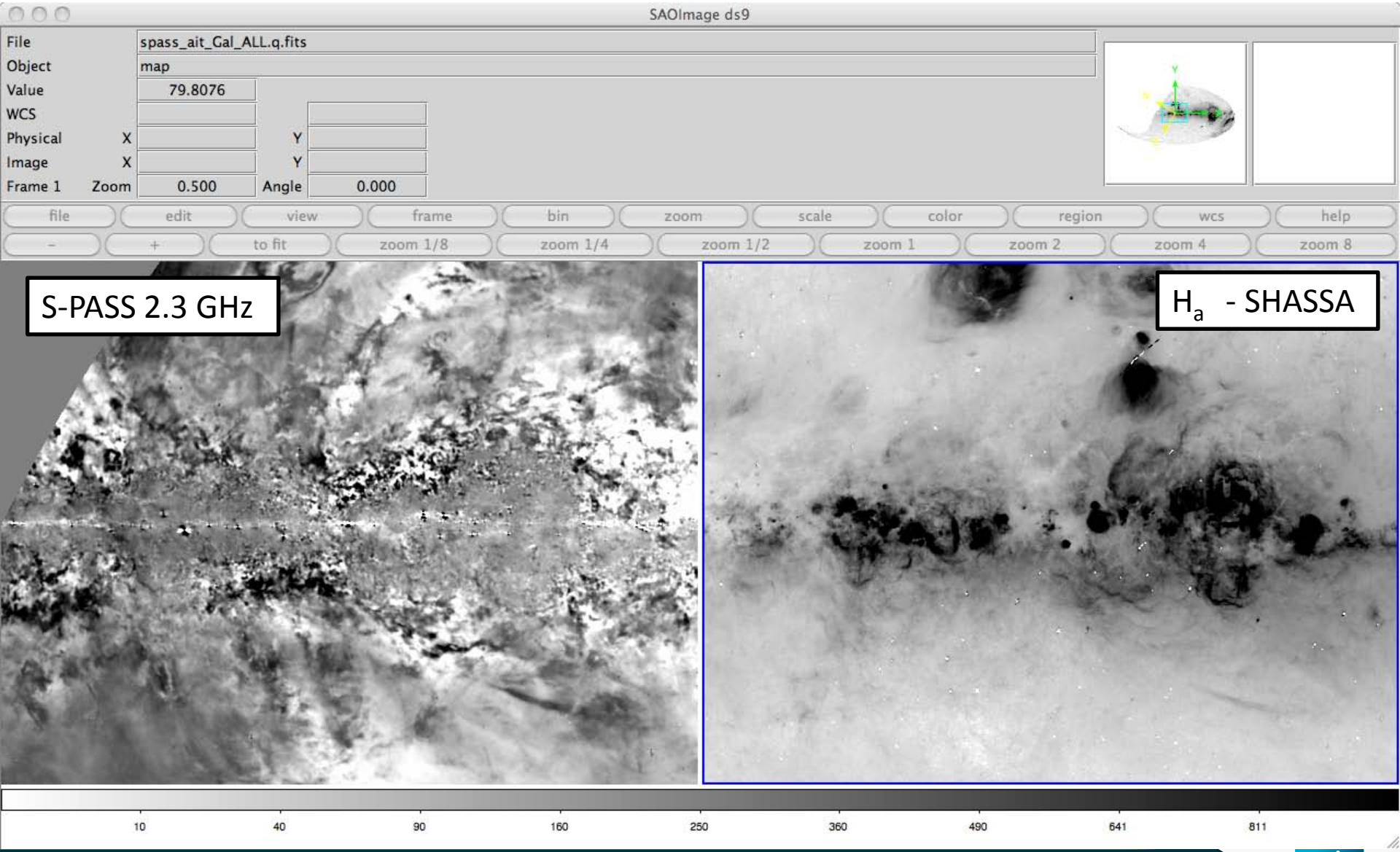


Polarized radio lobes

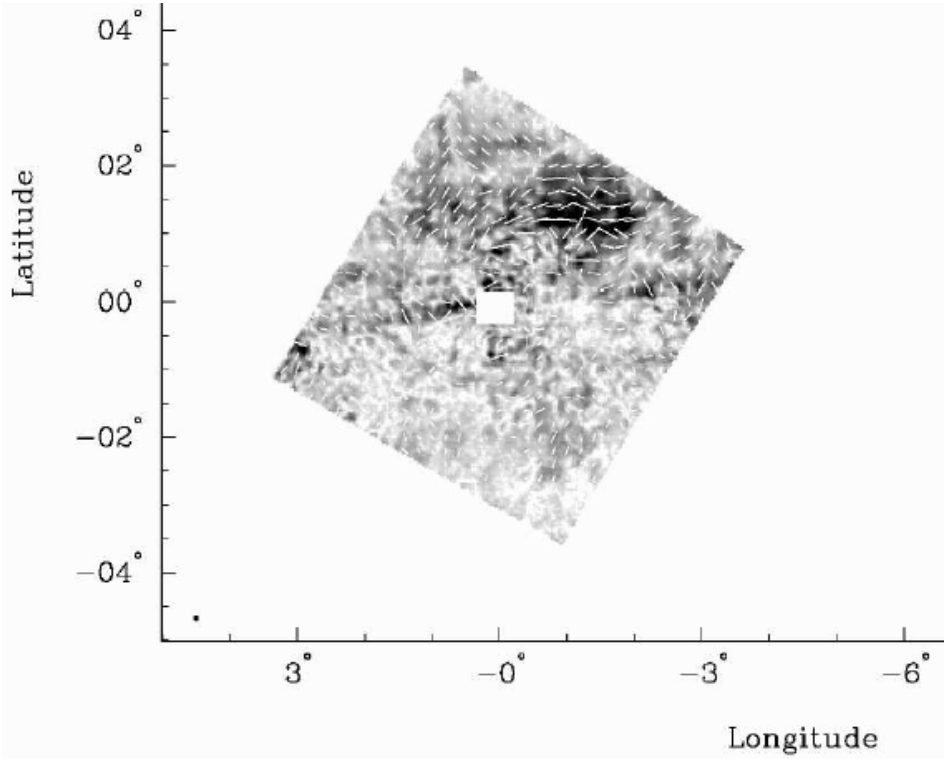
Carretti et al., 2013, Nature, 493, 66



Depolarization area: Radio and H_α

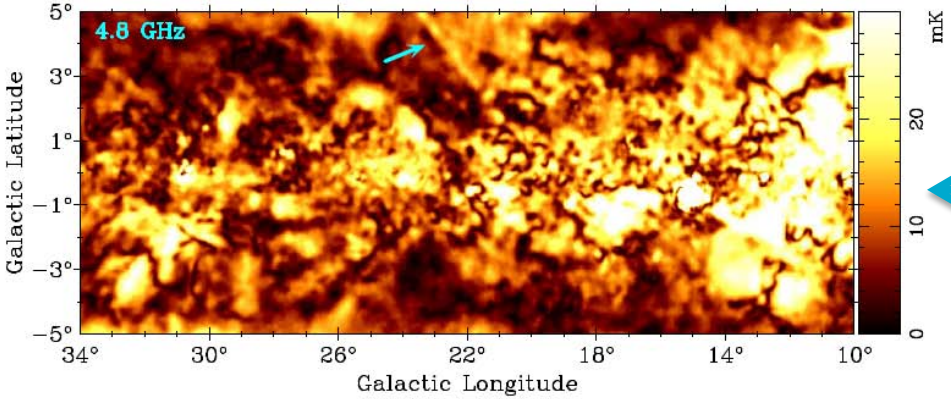


Polarised emission at 5 GHz



4.8 GHz: Galactic Centre area still depolarised
[Duncan+, 1998, MNRAS, 299, 942]

- Galactic plane emission starts to appear at 5 GHz
- But still depolarisation and Faraday modulation.



4.8 GHz Sino-German Galactic Plane survey (l > 10 deg)
[Sun+, 2013, arXiv:1310.8344]

High frequency polarisation observations (1)

- To complete low frequency mapping (not subject of this talk)

- 1.4 GHz => 2.3 GHz unexpected huge Galactic polarisation structures.
- Going up in frequency has shown us fundamental structures, but invisible at 1.4GHz

- **Inner Galaxy at |b| < 5-10^{o} still depolarised at 2.3 GHz**

- **Observations at 5+ GHz to unveil the emission from:**
  - The Galactic plane.
  - The inner Galaxy spiral arms.
  - The Galactic Centre area and the Bulge (8+ GHz).

High frequency polarisation observations (2)

- How the Milky Way lobes connect to the Galactic Centre?
- What's the polarised emission (and magnetic field) structure on the Galactic Plane?
- What's the polarised emission structure in the spiral arms?
- How the Galactic bar connect to the spiral arms?
- What's the structure and the magnetic field in the GC area?
- Lesson from S-PASS: discovering the unexpected

What done and what to do.

- 3 Southern surveys completed (Parkes)
  - 300-480 – 700-900 MHz (GMIMS – Parkes)
  - 1300-1800 MHz (STAPS – Parkes)
  - 2200-2400 MHz (S-PASS -- Parkes)

- To complete
  - 700-900 MHz with better sensitivity (ASKAP and Galactic physics)
  - 900-1300 MHz
  - 1800-2200 MHz
  - **2400-4000 MHz**
  - **4000-12000+ MHz**

Gray: not this receiver
Black: science for the UWB high frequency

Summary

- Inner Galaxy and Galactic plane still depolarized at 2.3 GHz

- Need to go to higher frequencies

- At least 5-6 GHz,
- 8+ GHz for the Inner Galaxy.

- Component separation: 4-12 GHz
  - Polarisation => synchrotron
  - Total intensity:
    - Two components: synchrotron and free-free
    - Free-free emission leads emission budget on the plane at high frequencies
  - 4-12 GHz => precise frequency behaviour
  - Able to discriminate the two components

Thank you

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