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Future polarization observations with the Parkes Telescope

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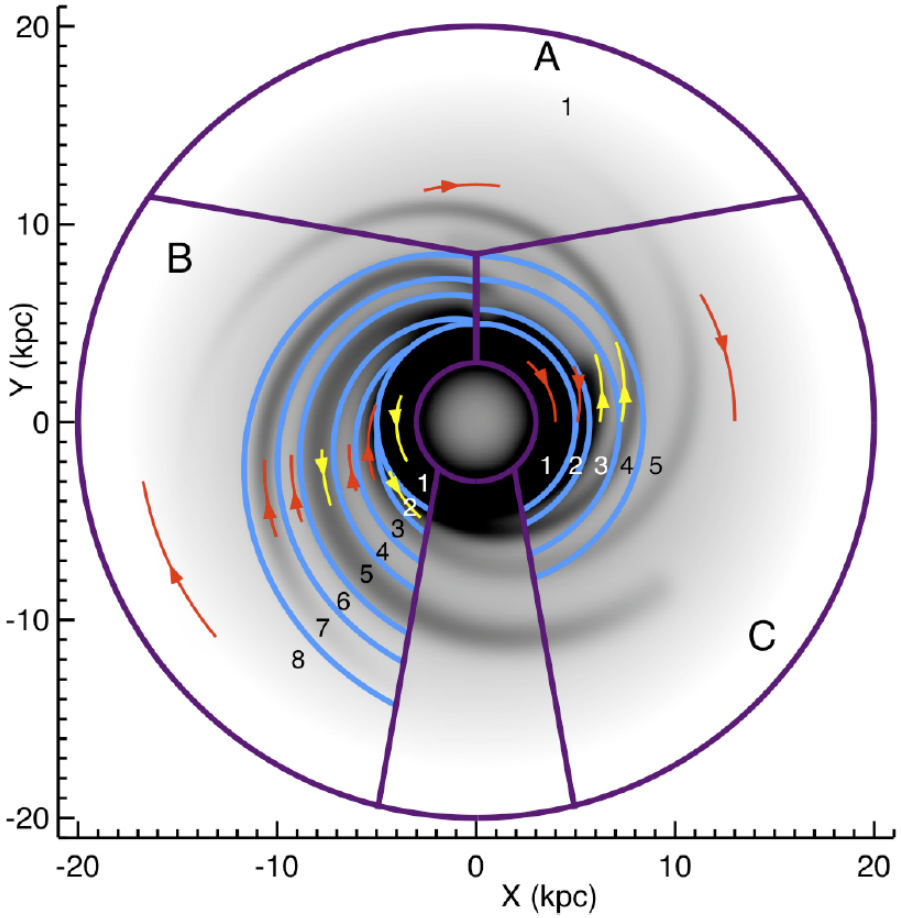
CSIRO

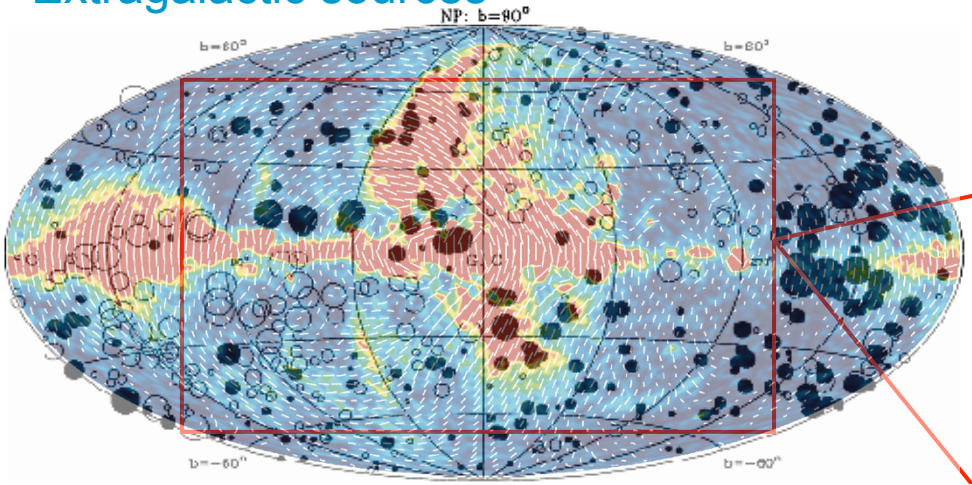
Galactic Disc magnetic field

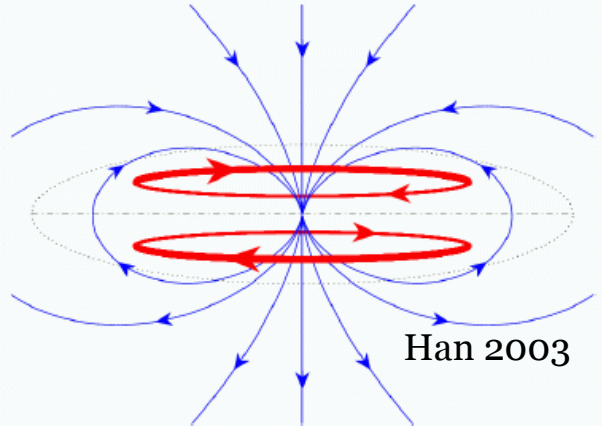


[van Eck et al. 2010]

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

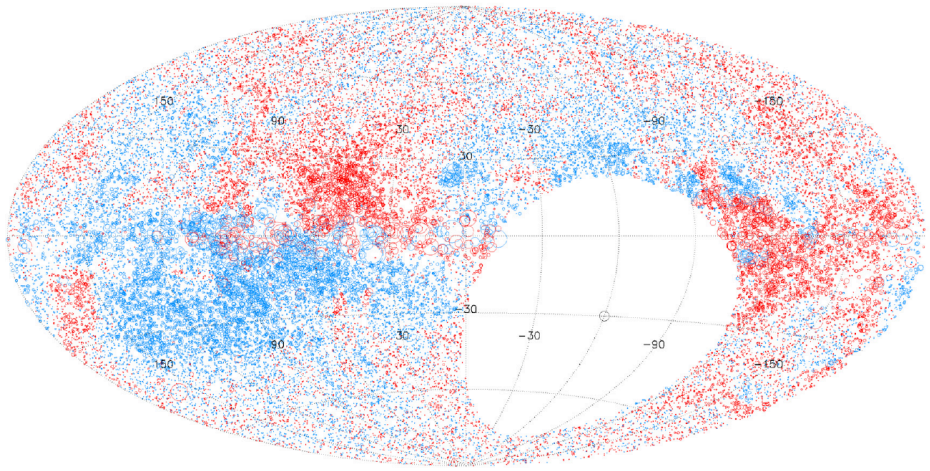
Extragalactic sources





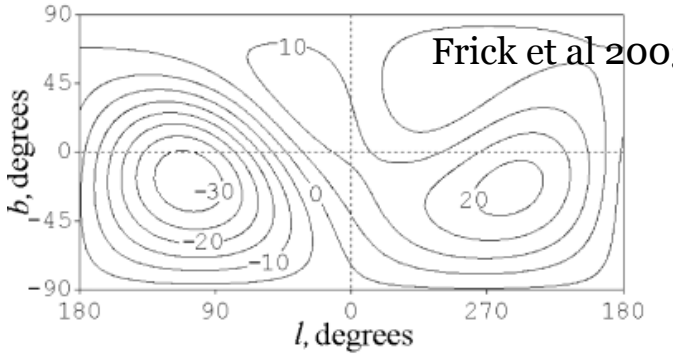
Han 2003

An A0 dynamo…



Taylor et al. 2009

…or an even field and the North Polar Spur?



Frick et al 2003

slide courtesy by M. Haverkorn

S-PASS: news in the Milky Way structure.

F = 2300 MHz

Unexplored space of parameters
=> new discoveries

Why Diffuse Polarized Emission?

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

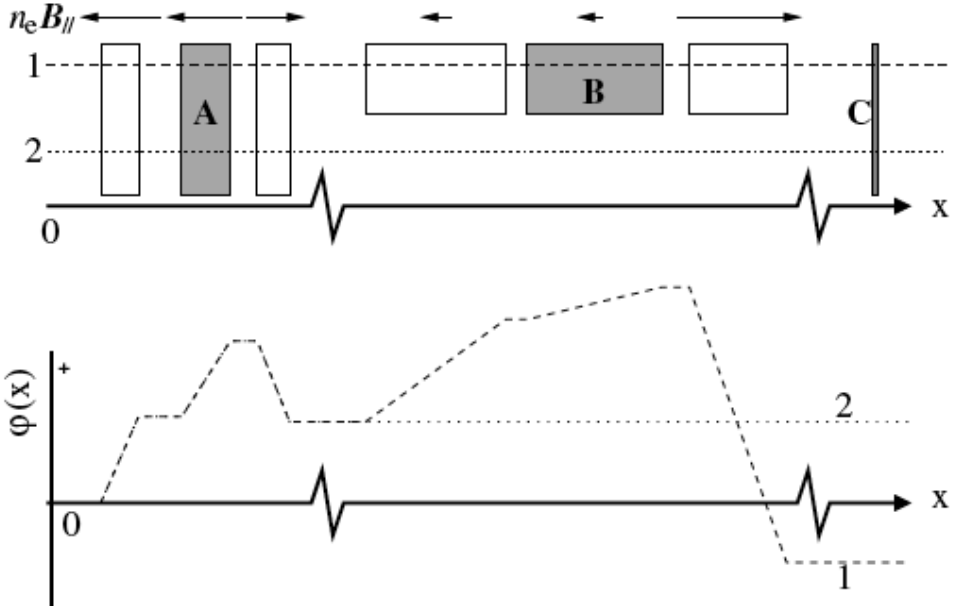
- Diffuse emission: polarized emission
  - Diffuse polarized synchrotron emission
  - to probe the ordered magnetic field
  - Faraday Rotation (RM) ⇒ B parallel to the line of sight
  - Synchrotron polarisation angles ⇒ B perpendicular
  - B and ISM turbulence (RM)
  - Galactic structure

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

- RM maps has higher resolution than those with sources

RM-Synthesis

- RM: information integrated



$$\Delta\chi = \mathrm{RM}\,\lambda^2.$$

$$\mathrm{RM} = 0.81 \int n_e \mathbf{B} \cdot d\mathbf{r}$$

$$\begin{aligned} P &= |P|\, e^{i2\chi} \\ &= Q + iU. \end{aligned}$$

$$P(\lambda^2) = \int F(\phi)\, e^{2i\phi\lambda^2} d\phi.$$

$$\phi(\mathbf{r}) = 0.81 \int_{\mathbf{r}}^{0} n_e \mathbf{B} \cdot d\mathbf{r}$$

RM-synthesis survey needs

- Ingredients for a survey (Interferometer-like parameters)

$$\delta\phi \approx \frac{2\sqrt{3}}{\Delta\lambda^2}$$

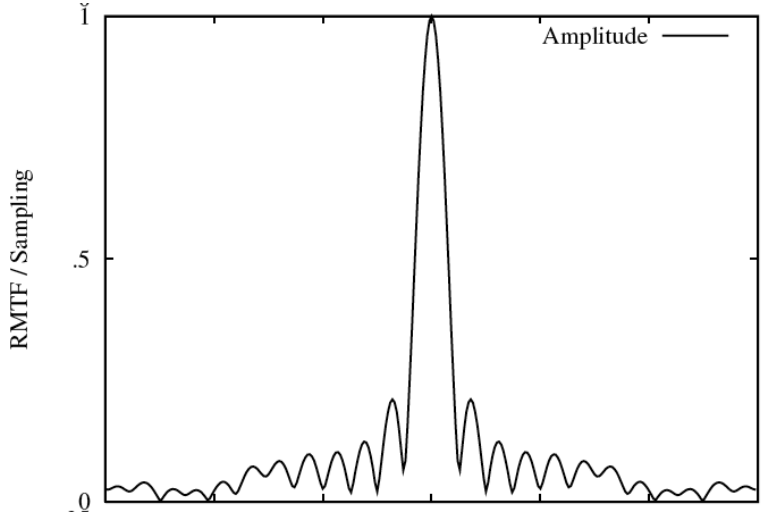
⇒ low frequency (300 MHz) and wide BW

$$\text{max-scale} \approx \frac{\pi}{\lambda^2_{\text{min}}}$$

⇒ high frequency (2400 MHz)

$$\|\phi_{\text{max}}\| \approx \frac{\sqrt{3}}{\delta\lambda^2}.$$

⇒ (many) narrow channels (thousands)



⇒ the narrower the gaps

⇒ the better the “PSF”

Ultra broad band spectro-polarimetry

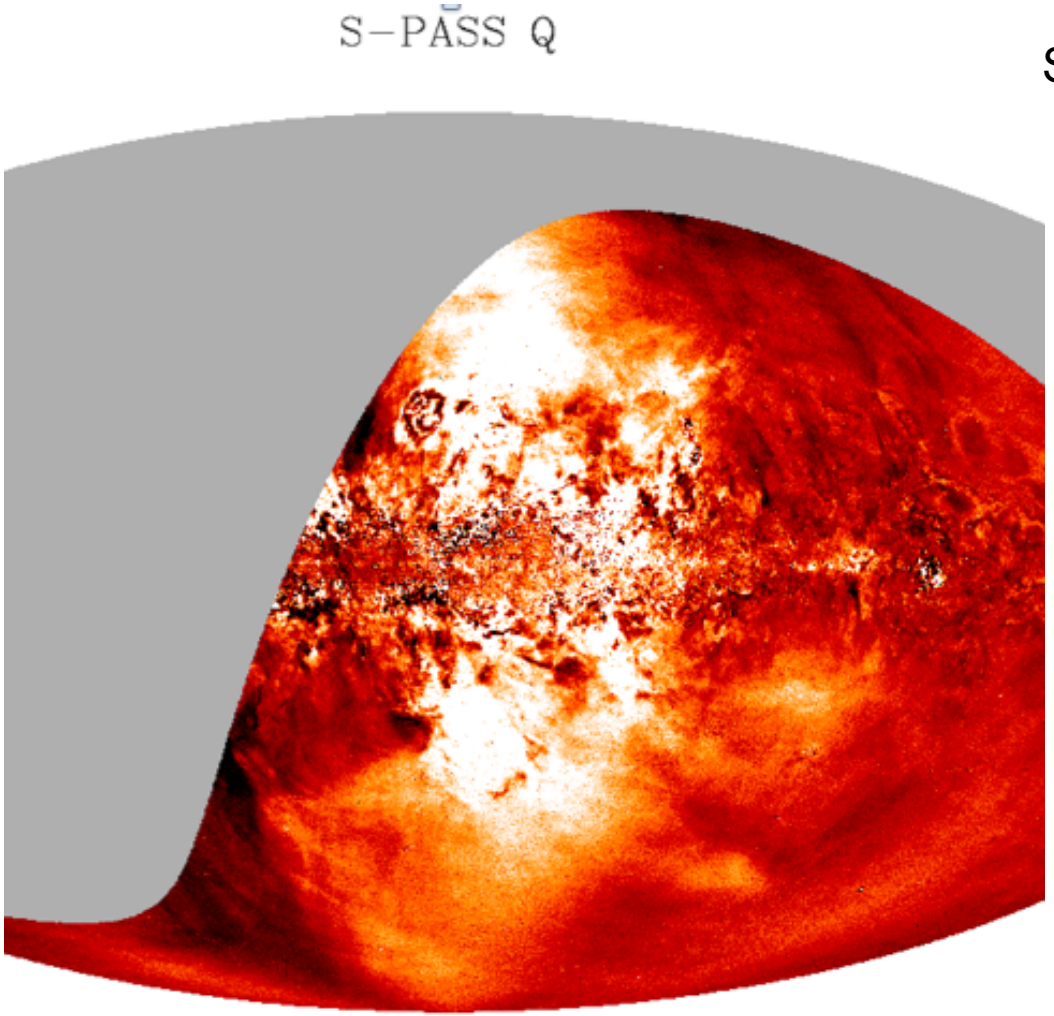
- To study Galactic magnetic structure
- 300 – 4000 MHz
  - RM res = 4 rad/m^2
  - max-scale = 400 rad/m^2

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
  - 2400-3000 MHz (4000?)

Galactic plane: depolarization

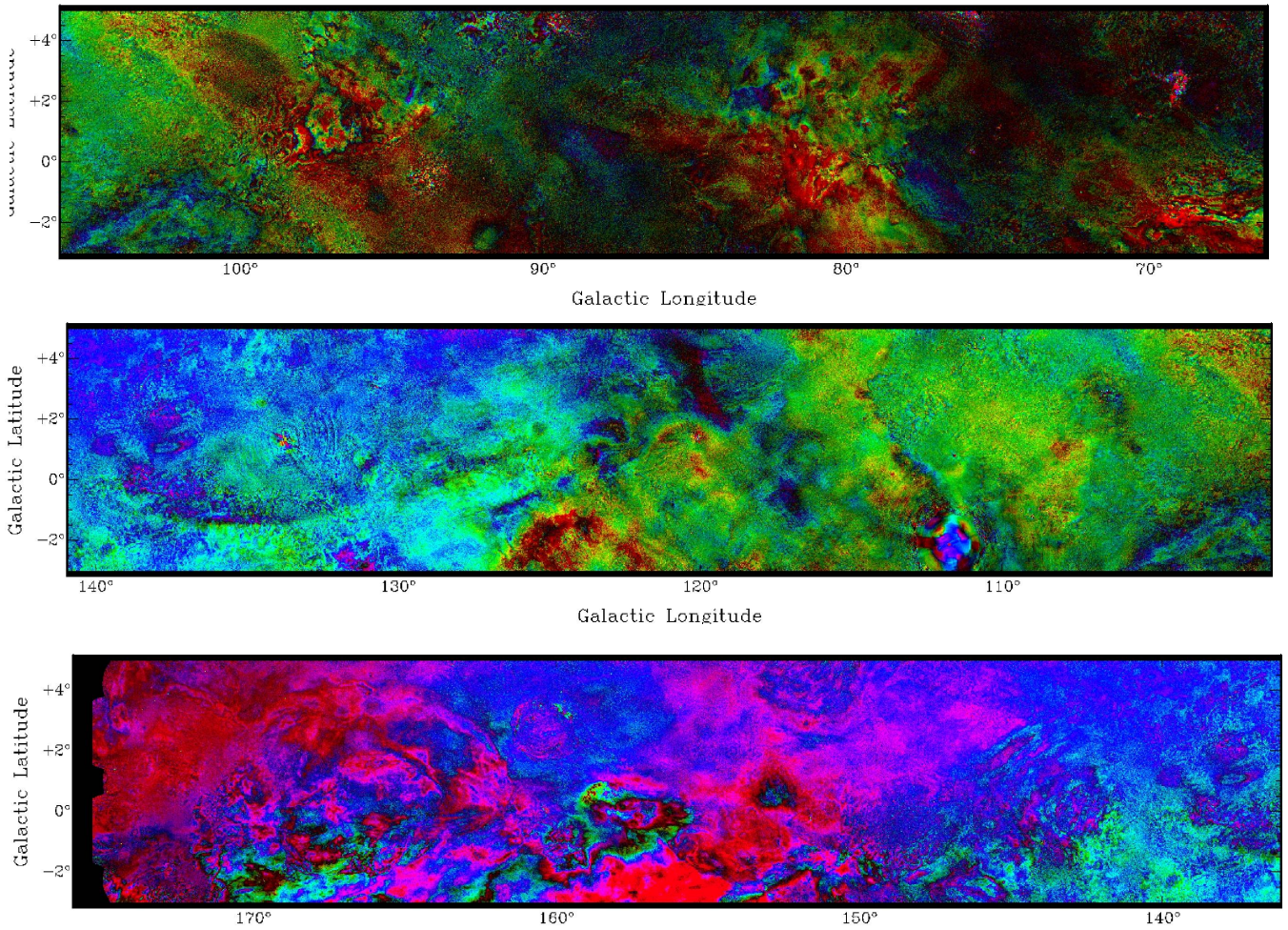


S-PASS 2.3 GHz

Galactic plane: higher frequencies

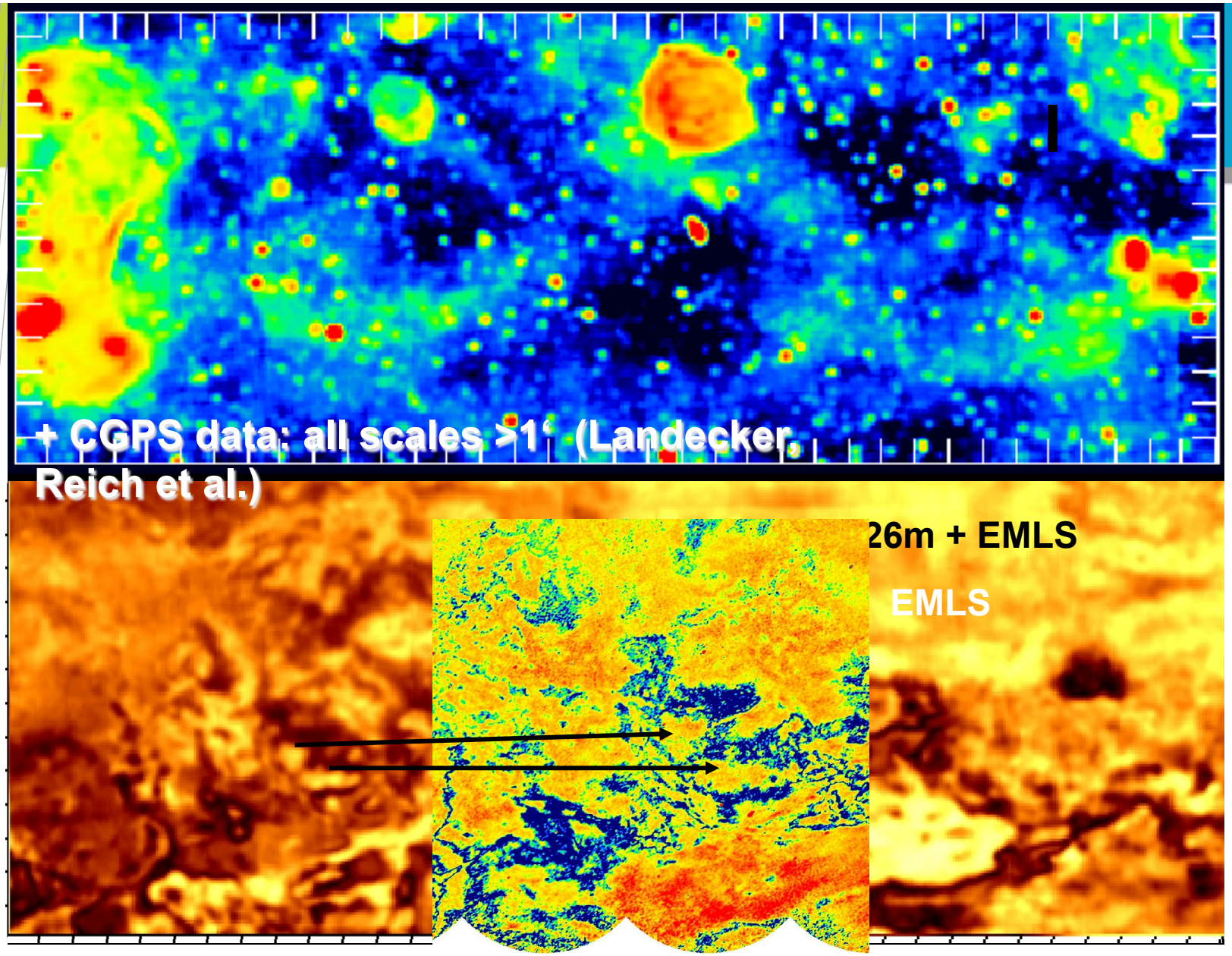
- Inner Galaxy and Galactic plane still depolarized at 2.3 GHz
- Need to go to higher frequencies
- At least 5-6 GHz
- Component separation: 4-12 GHz
  - Total intensity:
    - Two components: synchrotron and free-free
    - Free-free emission leads emission budget on the plane at high frequencies
  - Polarization => synchrotron
  - 4-12 GHz => precise frequency behaviour
  - Able to discriminate the two components

CGPS: 1.4 GHz, small angular scales (1')



- Brightness => polarized intensity
- Colour => polarization angle

Landecker et al. 2010, A&A


+ CGPS data: all scales >1‘ (Landecker, Reich et al.)
26m + EMLS
EMLS

ASKAP: large scale component.

- ASKAP
  - Frequency range: 700-1800 MHz
  - Interferometer
  - Large scale component missing
  - need for single dish data

Large scale component for ASKAP.

- ASKAP
  - Frequency range: 700-1800 MHz
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Summary (1)

- Galactic magnetic field structure

- 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 (3000?)

Summary (2)

- Galactic Plane structure and magnetic field structure
  - Mapping Inner Galaxy and Galactic Plane at 5-6 GHz (at least)
  - Weeker signal and smaller beam

    => sensitivity

    => Broadband
  - 4-12 GHz to separate synchrotron and free-free components (Total Intensity)

- ASKAP
  - Large-scale component for ASKAP observations
  - 700-1800 MHz

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Thank you