Polarised filaments with WMAP data

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Maybe about the same age??
Radio loops are the largest structures in the sky.

Most of the polarised emission at high $b$ comes from these structures ($\nu \lesssim 70$ GHz).

- Highly coherent
- Maps the (local?) Galactic magnetic field.
- Small depolarisation at high $b$
“Old” loops, know since 60's

408 MHz
Haslam

45 MHz
Guzman et al. (2012)
Table 1. The small circle parameters of the galactic loops

<table>
<thead>
<tr>
<th>Object</th>
<th>( l ) (centre)</th>
<th>( b ) (centre)</th>
<th>Diameter</th>
<th>R. M. S. Deviation</th>
<th>Arc Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop I</td>
<td>329° ± 1°5</td>
<td>+17°5 ± 3°</td>
<td>116° ± 4°</td>
<td>0'9</td>
<td>155°</td>
</tr>
<tr>
<td>Loop II</td>
<td>100° ± 2°</td>
<td>-32°5 ± 3°</td>
<td>91° ± 4°</td>
<td>1°1</td>
<td>150°</td>
</tr>
<tr>
<td>Loop III</td>
<td>124° ± 2°</td>
<td>+15°5 ± 3°</td>
<td>65° ± 3°</td>
<td>1°7</td>
<td>180°</td>
</tr>
<tr>
<td>Loop IV</td>
<td>315° ± 3°</td>
<td>+48°5 ± 1°</td>
<td>39°5 ± 2°</td>
<td>0°8</td>
<td>190°</td>
</tr>
</tbody>
</table>
Polarisation Spectral indices

- T-T plots in polarisation amplitude
- Steeper than the measured in intensity.
- Similar across the filaments.
Spectral indices

Similar results as with T-T plots
Polarisation fractions

They are not easily visible in WMAP total power => we need to estimate the total power

Using WMAP MEM synchrotron model at 23 GHz

Extrapolating a free-free subtracted 408 MHz map to 23 GHz

Filaments are highly polarised => up to 30 - 40 %
Geometry

Filaments are easily visible in polarisation. Not total power.

Unsharp mask to remove diffuse large scale emission and highlight the filaments in total intensity maps.
Most of these features follow small circles in the sky
Magnetic field vectors are parallel to the filaments.
Very different from CMB!!
Many filaments coming out from the plane!

Similar structures in different data sets
Q & U maps are useful to identify structures that cross the Galactic plane.
Filaments power spectrum

Most of the power away from the plane is on these filaments.

\[ \sim 5x \text{ on EE for } l \leq 10 \]

\[ \sim 130x \text{ on BB for } l \sim 2 \]
Conclusions

- Highly polarised filaments are the main foreground at high Gal. Latitudes

- We can identify them by the field direction and spectral indices.

- Probably all of them are nearby structures related to successive SNe

- Besides the loops, many filaments emerging through the plane.

- Frequencies higher than 100 GHz are safest for CMB.