The University of Manchester

Polarised Galactic filaments

M. Vidal*, R. D. Davies, C. Dickinson.

Jodrell Bank Centre for Astrophysics, School of Physics and Astronomy, University of Manchester, Manchester M13 9PL, UK
* mvidal@jb.man.ac.uk

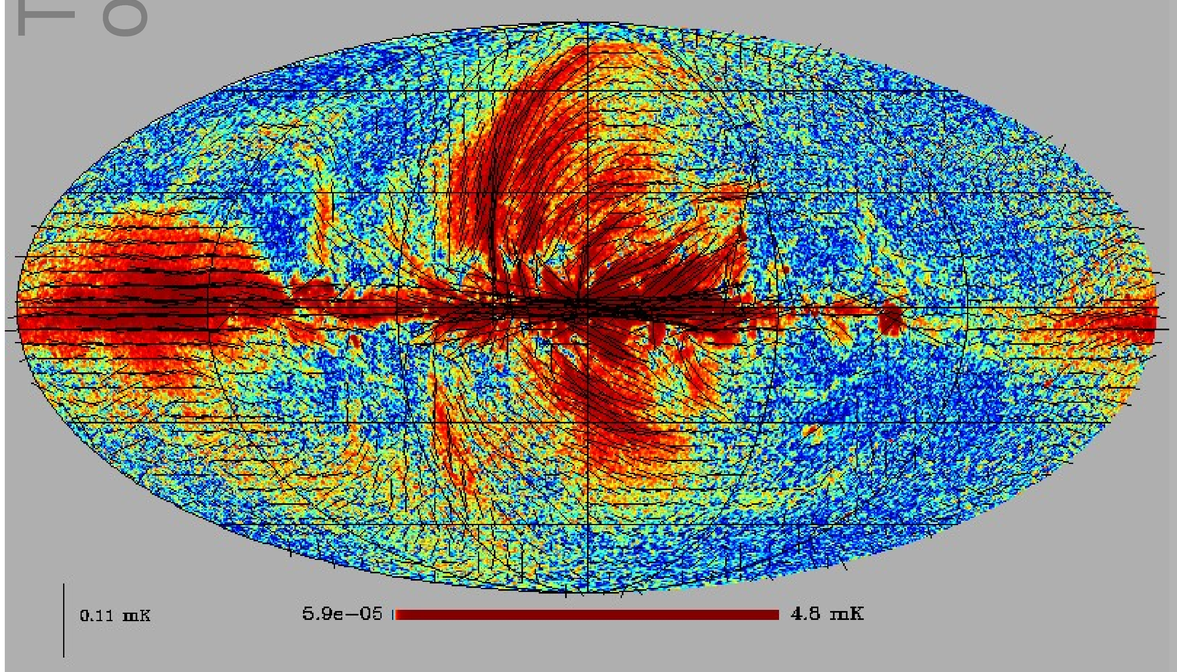

*Figure 1: WMAP f*ull sky map of polarisation intensity at 23 GHz. What is the nature of the filamentary structure we see? The vectors show the direction of the magnetic field, orientated parallel to the filaments.

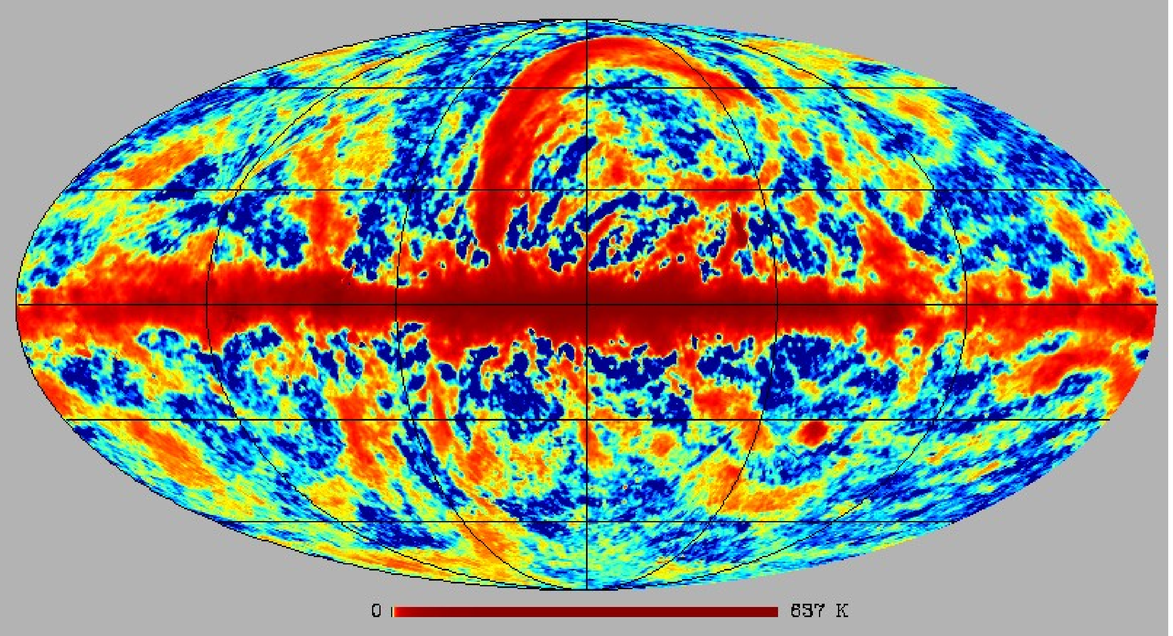

Figure 2: 408 MHz continuum map, filtered to remove the diffuse emission. By removing the emission on angular scales bigger than 5 deg, we can recognize a number of features visible on polarisation at 23 GHz.

The characterisation of the polarised anisotropy of the CMB is one of the current challenges of observational cosmology. Several groups are trying to detect primordial B-modes, a polarisation signal in the CMB which could confirm the inflationary paradigm and quantify the energy scale of the inflation.

The expected cosmological signal is order of magnitudes smaller than the Galactic radiation, so understanding and characterising this local emission becomes critical. *WMAP* provided us with a stunning view of the polarised sky, revealing a filamentary structure running mostly perpendicular to the Galactic plane (Fig. 1). These polarised features trace the Galactic magnetic field across the sky. The direction of the magnetic field in all these filaments is tangential to their extension.

The nature of these structures is not completely clear. Different interpretations had been proposed: local shell-like objects powered by OB associations, old supernova remnants, a population of highly-relativistic electrons illuminating magnetic field lines, or jets produced in a Galactic nucleus outburst.

Some of these filaments are well known from low frequency maps, such as the North Polar Spur, the main arc-shape feature in Fig. 1. Fig. 2 shows a filtered version of the 408 MHz map. The diffuse emission was subtracted to enhance the small-scale features. A number of the structures that we see in polarisation on Fig. 1 appear well defined in the filtered continuum 408 MHz map.

As a case study, we have considered the two filaments shown on Fig. 3. They are visible in the filtered 408 MHz also and one of them in emission at 21 cm. We have calculated the spectral index between 23 GHz and 33 GHz using T-T plots which have the advantage of being insensitive to absolute offsets in the data. We found values of -2.6 and -3.0 for filament 1 and 2 respectively between 23 and 33 GHz, consistent with diffuse synchrotron radiation but with significantly different spectral indices.

MV acknowledges the funding from Becas Chile.
CD acknowledges an STFC Advanced Fellowship and an ERC IRG grant under the PF7.

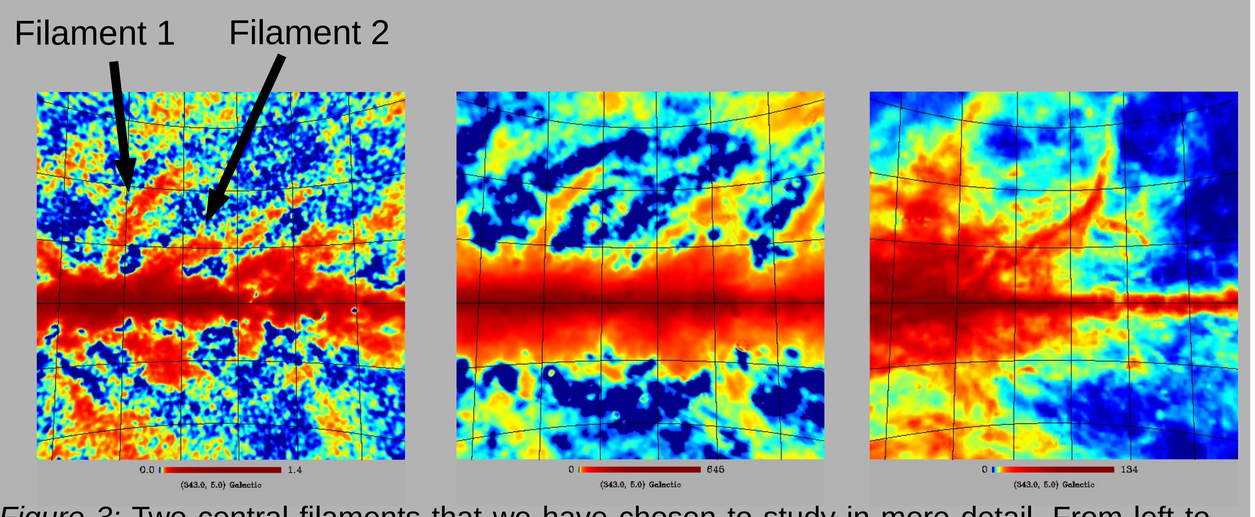

Figure 3: Two central filaments that we have chosen to study in more detail. From left to right are the *WMAP* 23 GHz polarisation intensity map, our filtered version of the 408 MHz map and a HI velocity which might help to estimate kinematic distances to some of these features.

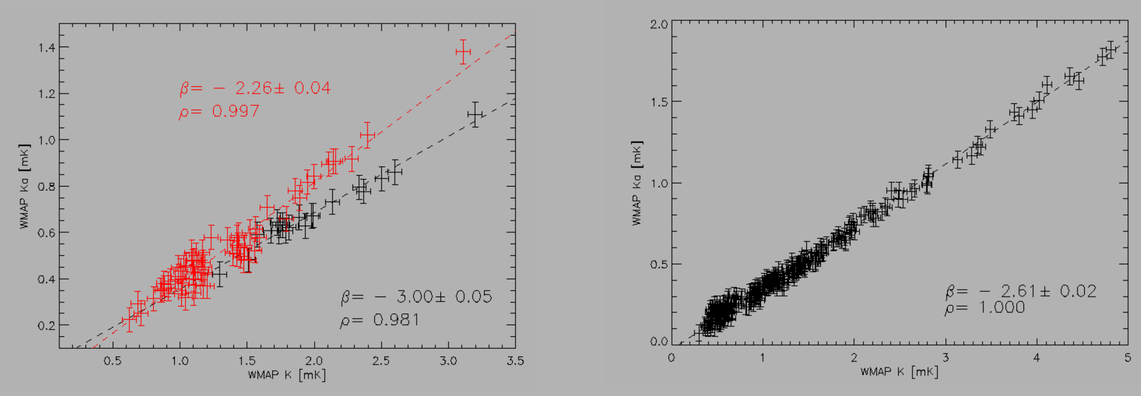

Figure 4: T-T plots of the two filaments marked in Fig. 3. On the left is filament 1. The black points corresponds to the first 10 deg in Galactic latitude closer to the Galactic plane. The following 10 deg are plotted in red, which sample an area coincident with a large HII region, this explains the flattening of the spectra. On the right is the T-T plot for the filament 2. ρ denotes the correlation coefficient.

We also have estimated the polarisation fraction of these two filaments as the ratio between the WMAP 23 GHz polarisation amplitude and a extrapolation of the filtered 408 MHz map showed in Fig. 2 to 23 GHz, assuming a spectral index of -2.7. We found that both filaments are highly polarised, ~30%, a similar value to the polarisation fraction of the North Polar Spur.

We are studying correlation between the polarised filaments and HI maps. The determination of the distance to these high Galactic latitude features is essential and the 21 cm velocity maps could help on this. *Planck* data will certainly help also to constrain the observational parameters in order to stablish the true nature of the filamentary structure.