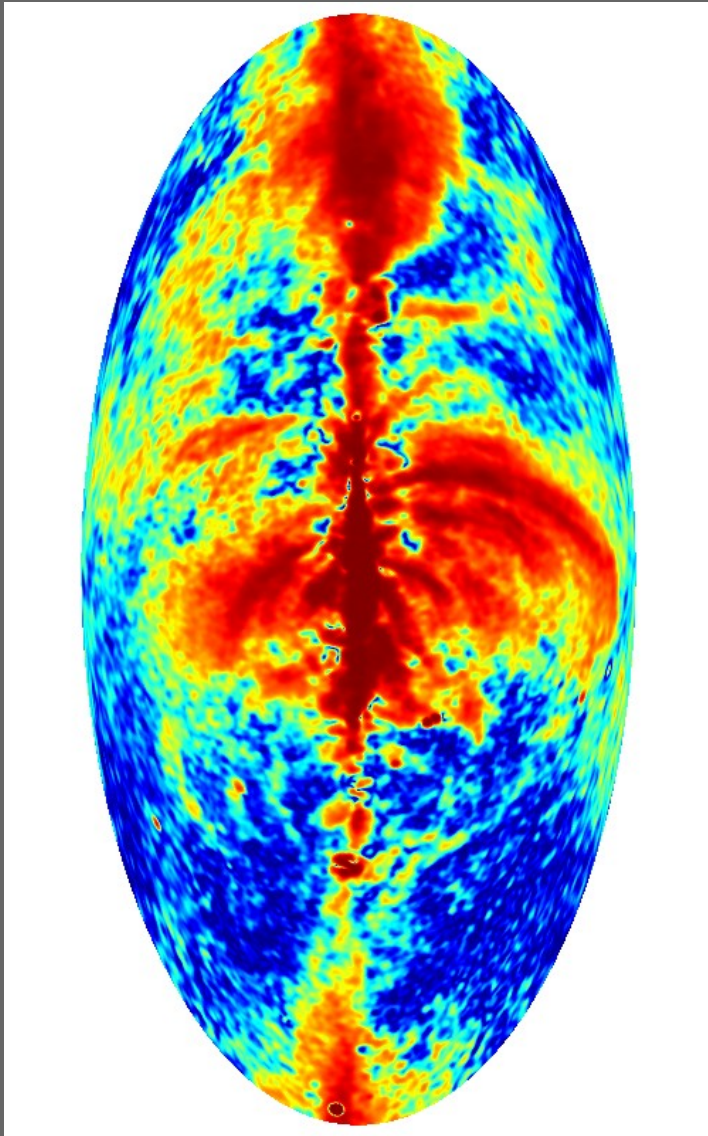


# Polarised filaments with WMAP data

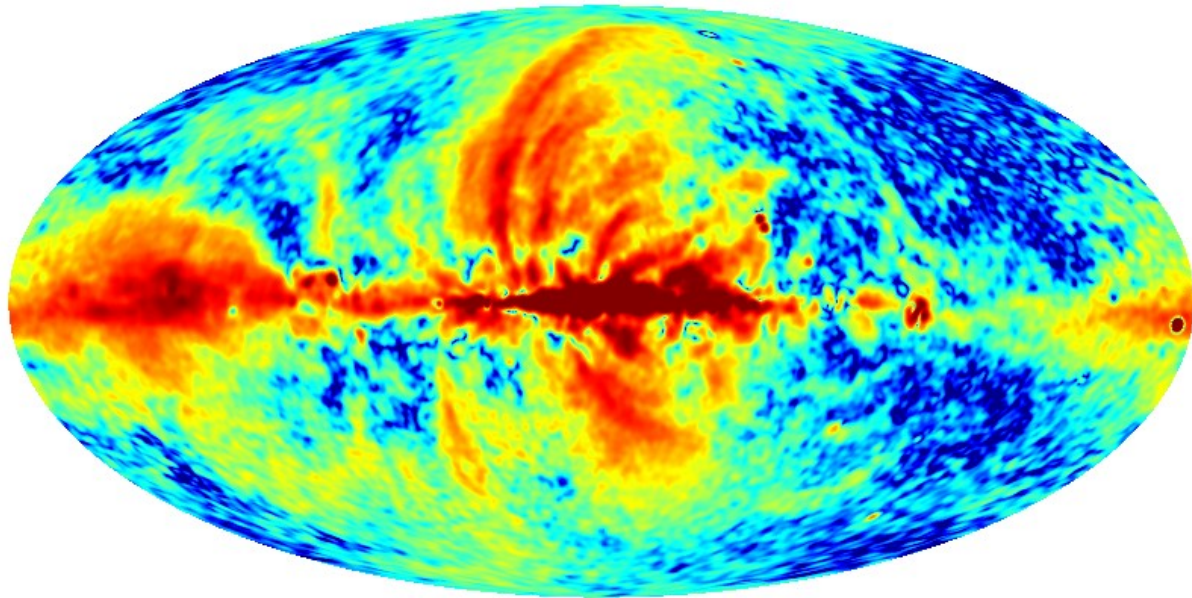
Matias Vidal

Jodrell Bank Centre for Astrophysics



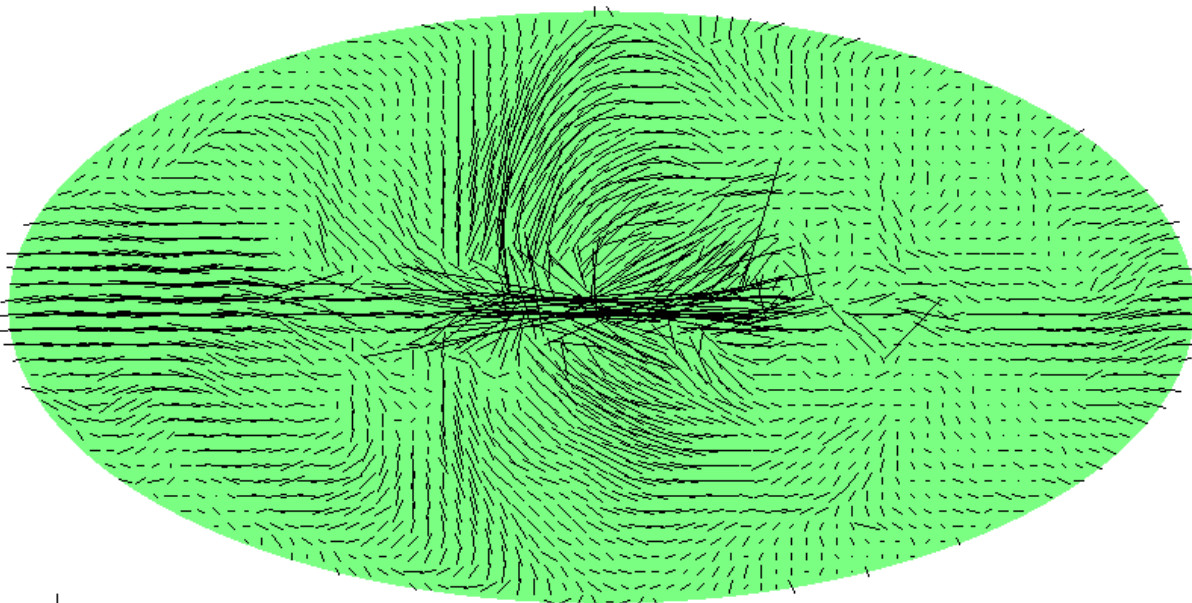
Maybe about the same age??

WMAP-K Pol. Amp.  $2^\circ$  resolution




-2.8  -0.84 Log ()

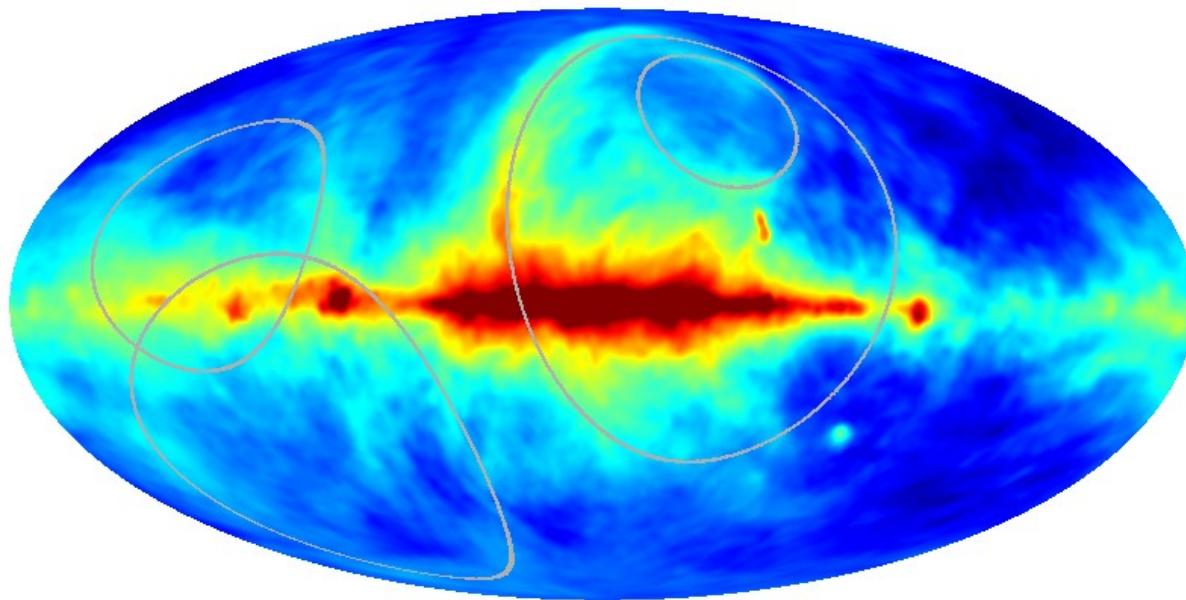
WMAP-K B-field vectors



0.090

0.90  1.1

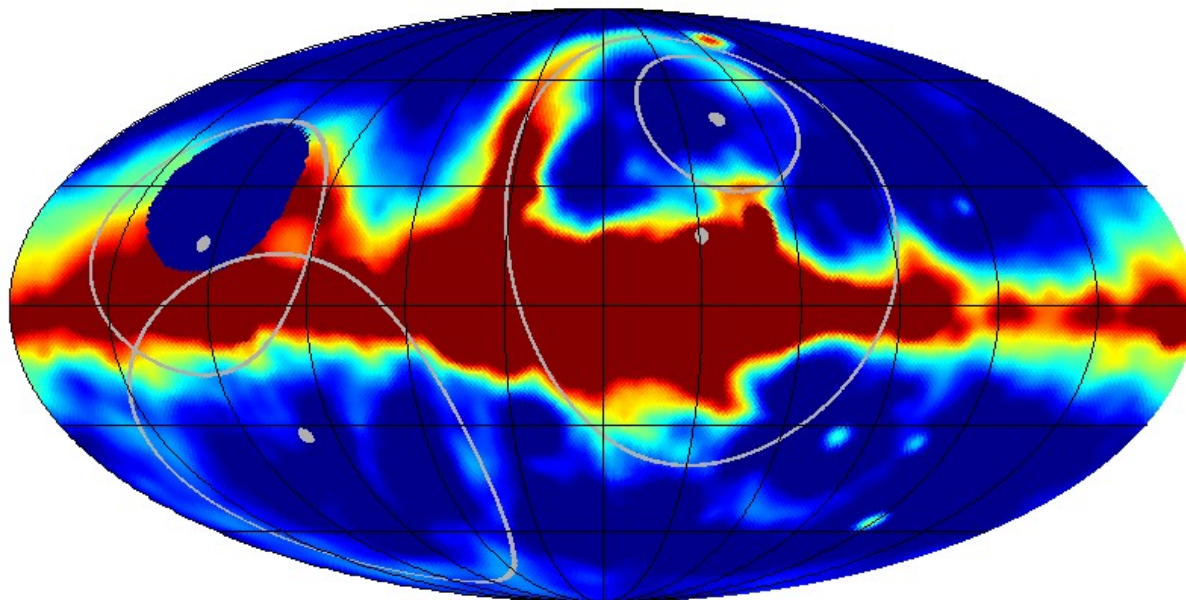
- Radio loops are the largest structures in the sky
- Most of the polarised emission at high  $b$  comes from these structures ( $\nu \lesssim 70$  GHz)
- Highly coherent
- Maps the (local?) Galactic magnetic field.
- Small depolarisation at high  $b$



“Old” loops,  
know since 60's

1.1  2.2 Log ( )

45 MHz



408 MHz  
Haslam

45 MHz  
Guzman et al. (2012)

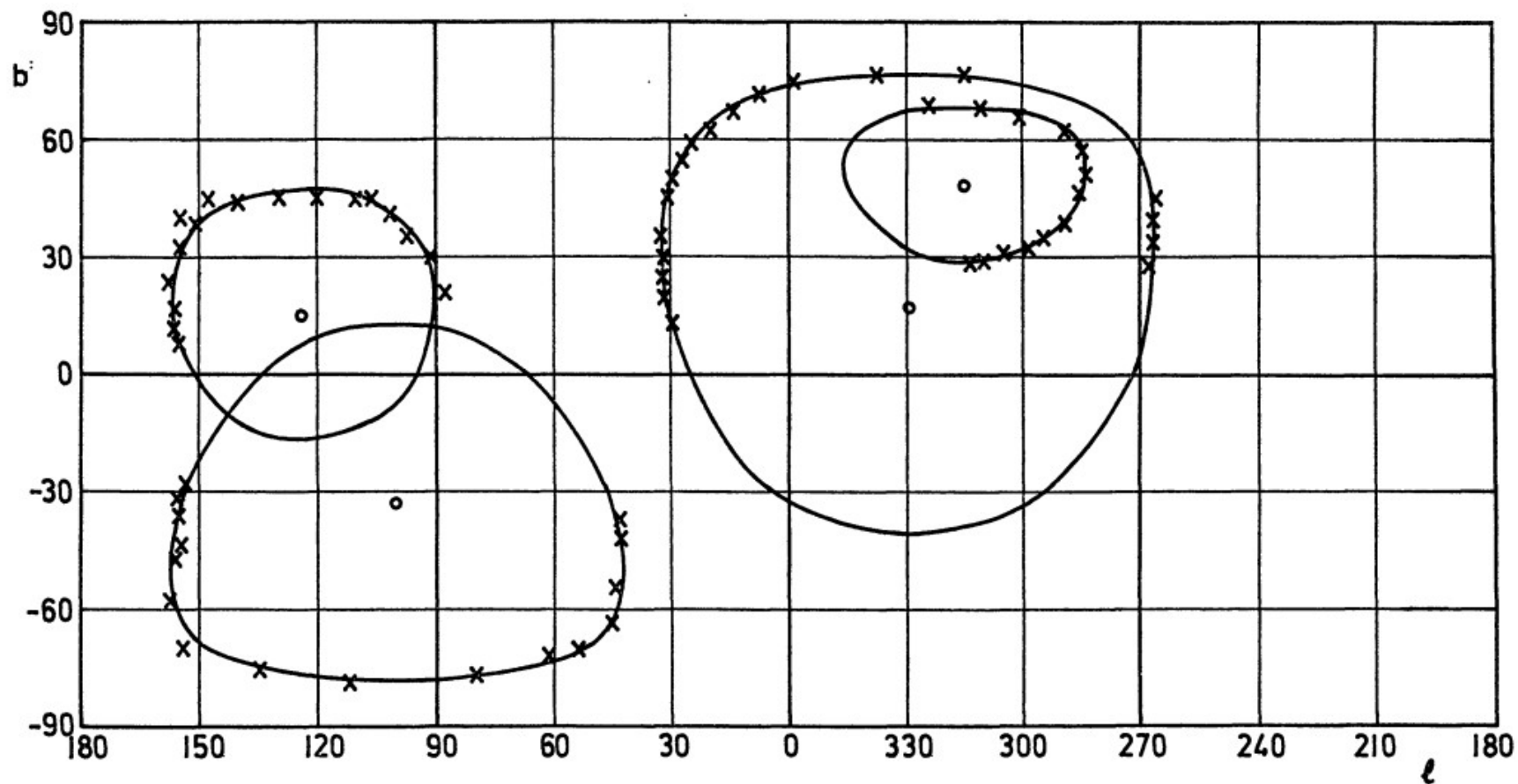
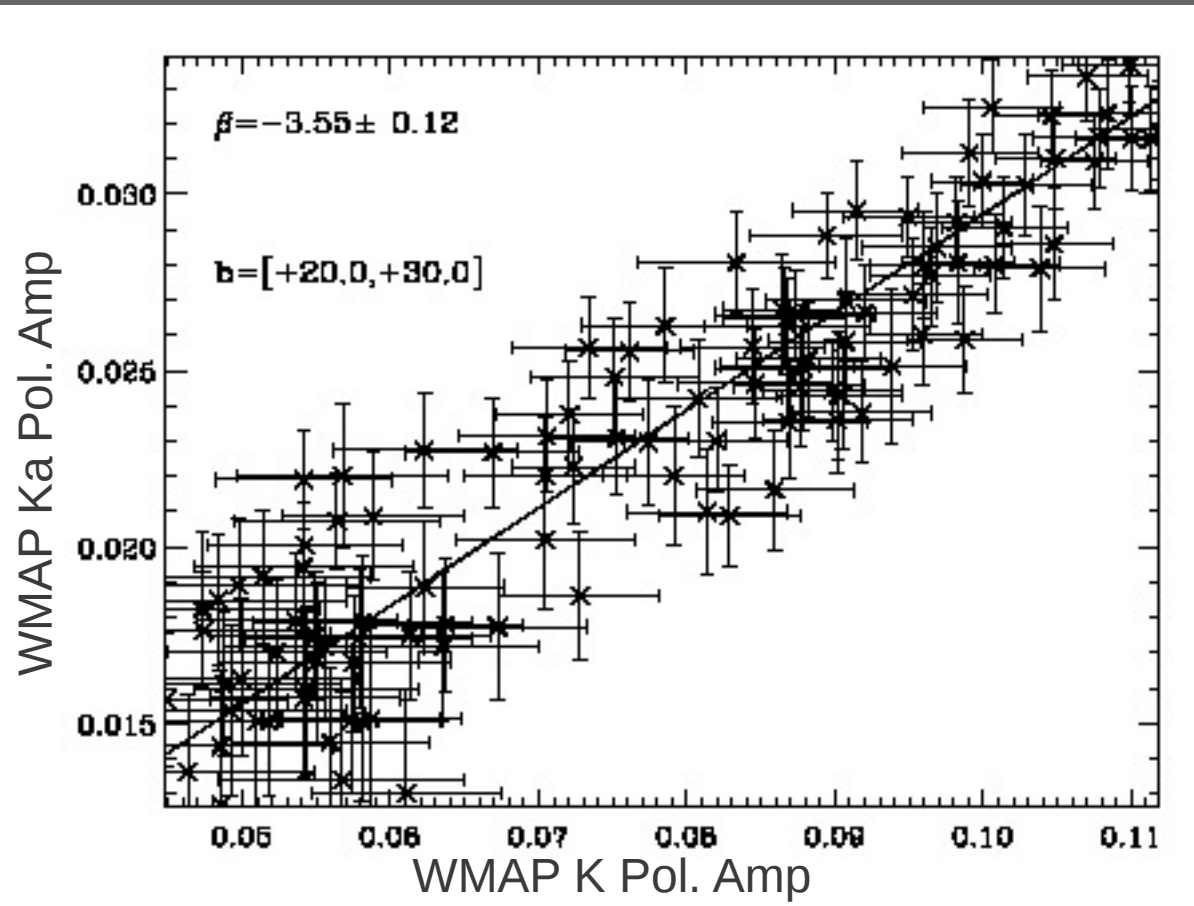


Table 1. *The small circle parameters of the galactic loops*

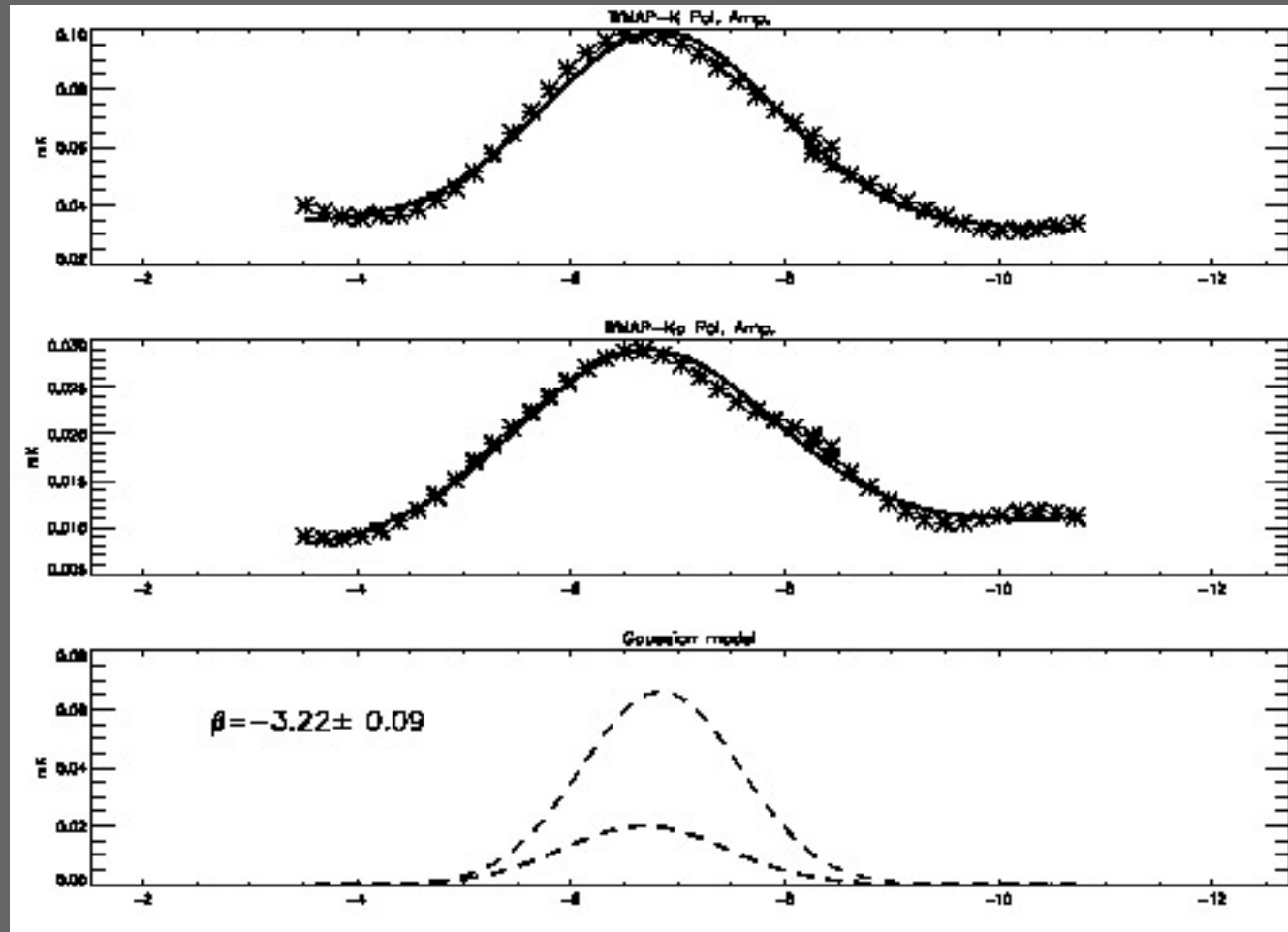
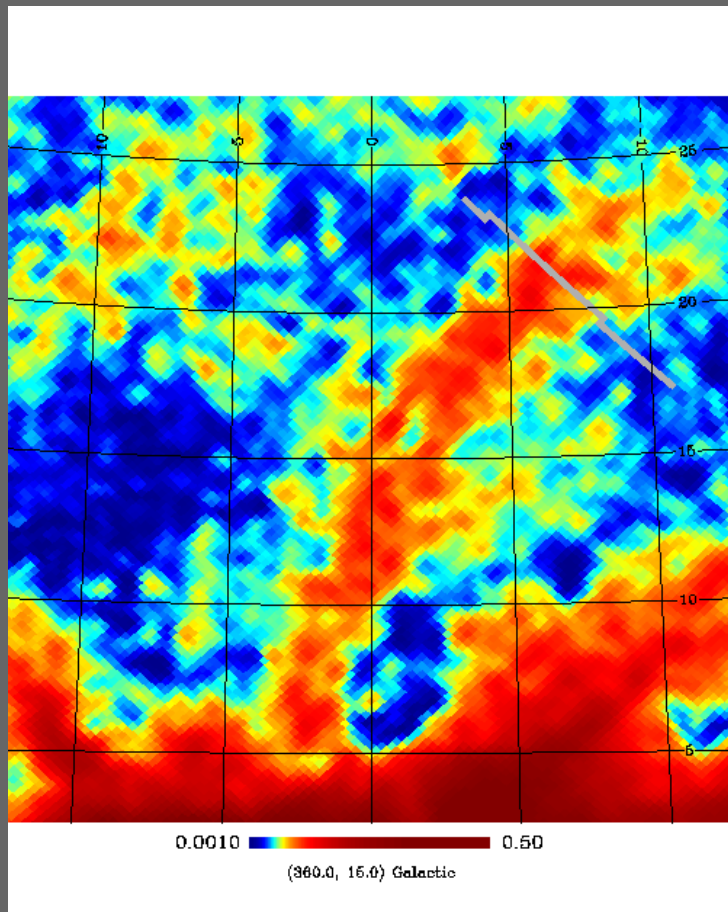
Object	$l$ (centre)	$b$ (centre)	Diameter	R. M. S. Deviation	Arc Length
Loop I	$329^\circ \pm 1.5$	$+17.5 \pm 3^\circ$	$116^\circ \pm 4^\circ$	0.9	$155^\circ$
Loop II	$100^\circ \pm 2^\circ$	$-32.5 \pm 3^\circ$	$91^\circ \pm 4^\circ$	1.1	$150^\circ$
Loop III	$124^\circ \pm 2^\circ$	$+15.5 \pm 3^\circ$	$65^\circ \pm 3^\circ$	1.7	$180^\circ$
Loop IV	$315^\circ \pm 3^\circ$	$+48.5 \pm 1^\circ$	$39.5 \pm 2^\circ$	0.8	$190^\circ$

# Polarisation Spectral indices



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

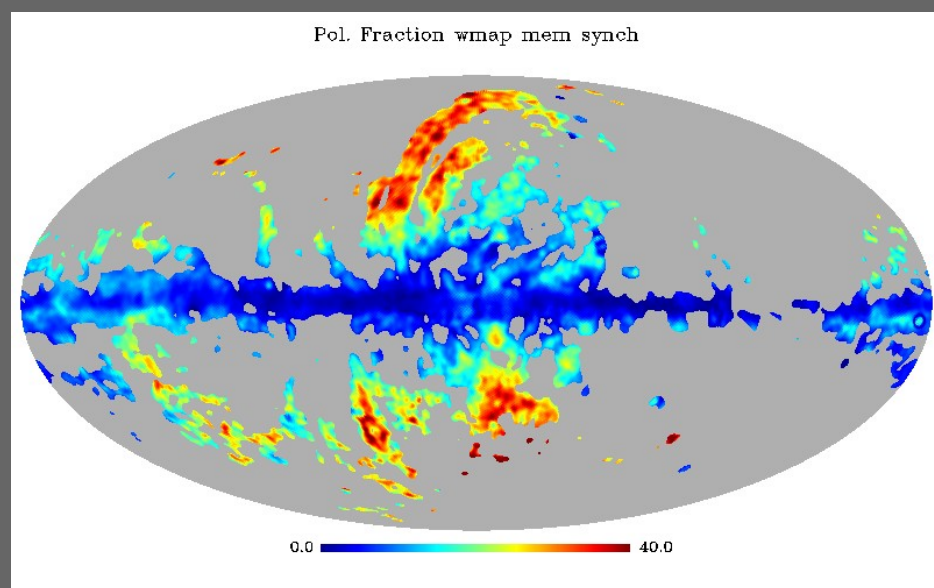
# Spectral indices



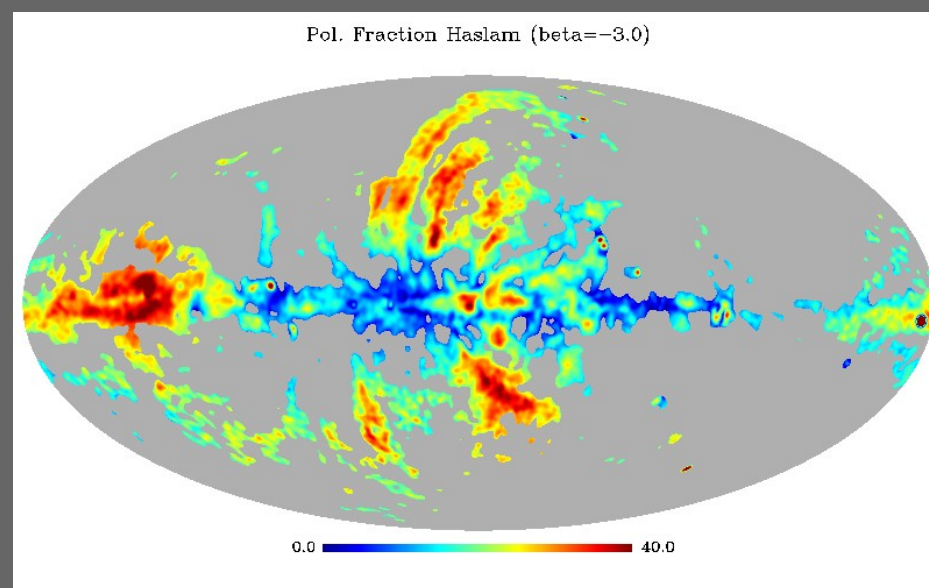
Similar results as with T-T plots

# 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



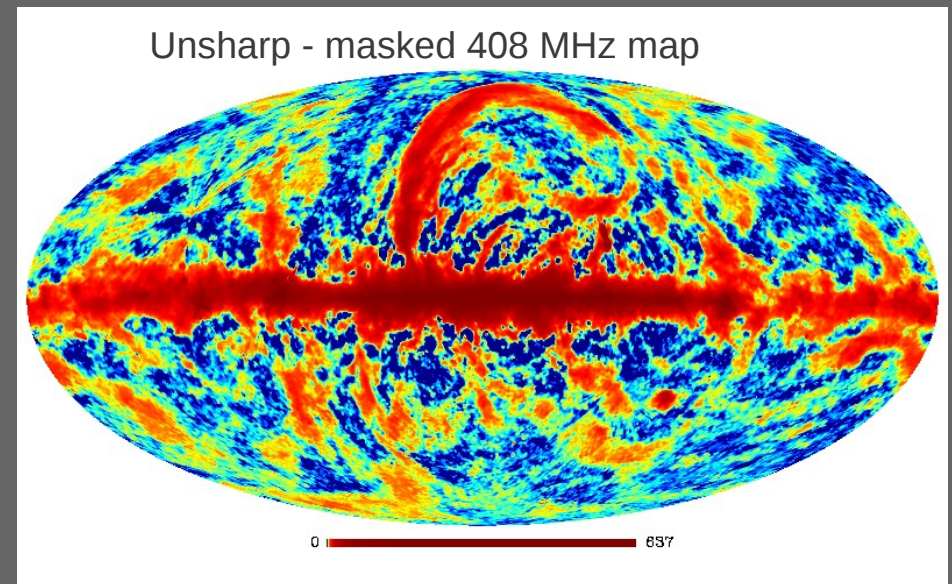
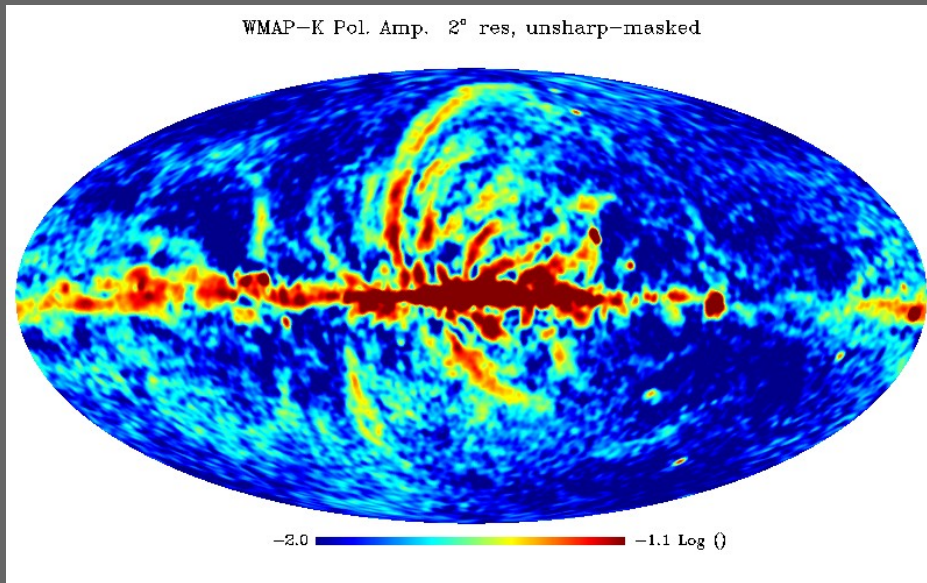
Extrapolating a free-free subtracted 408 MHz map to 23 GHz

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



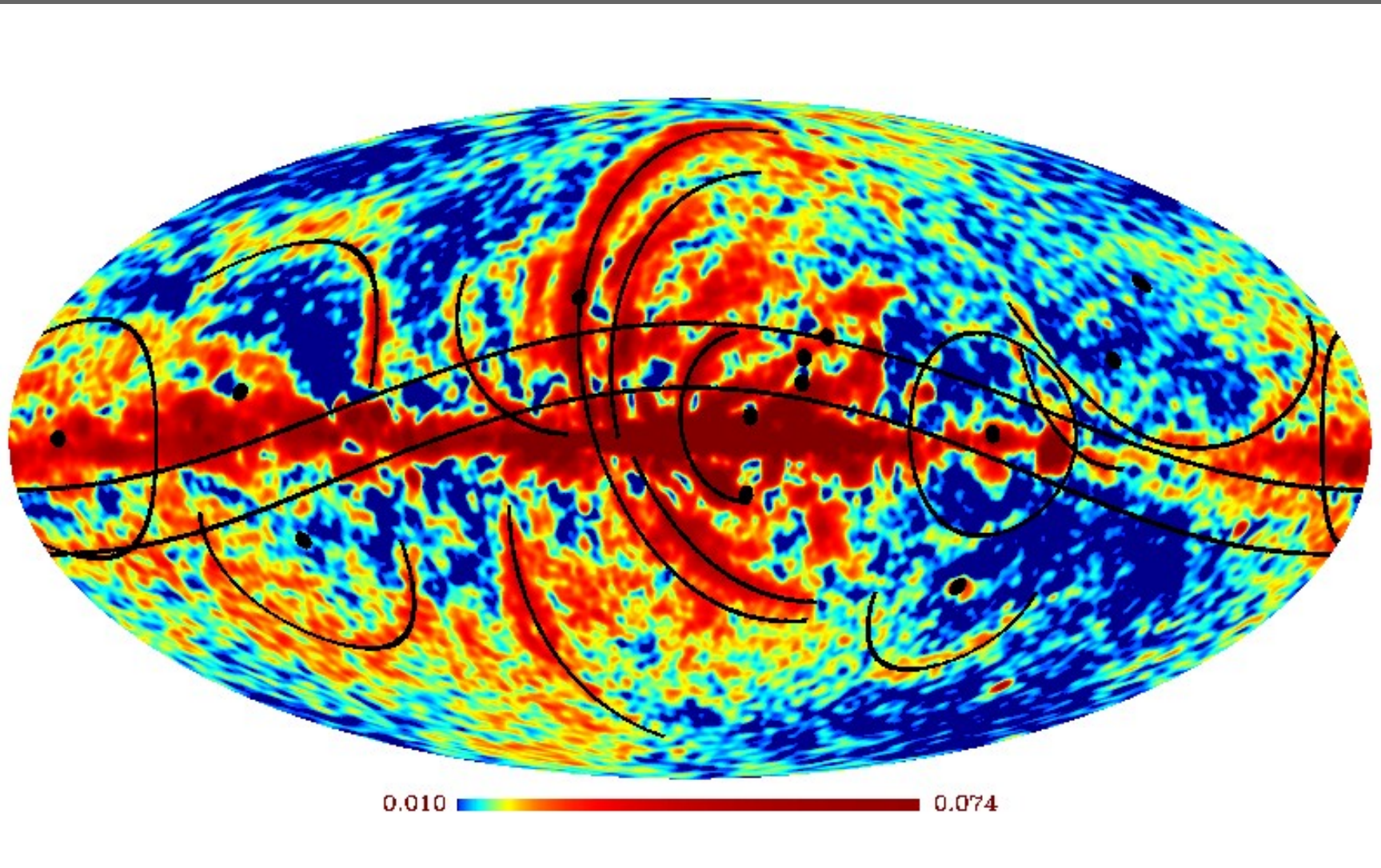
# Geometry

Filaments are easily visible in polarisation.  
Not total power.

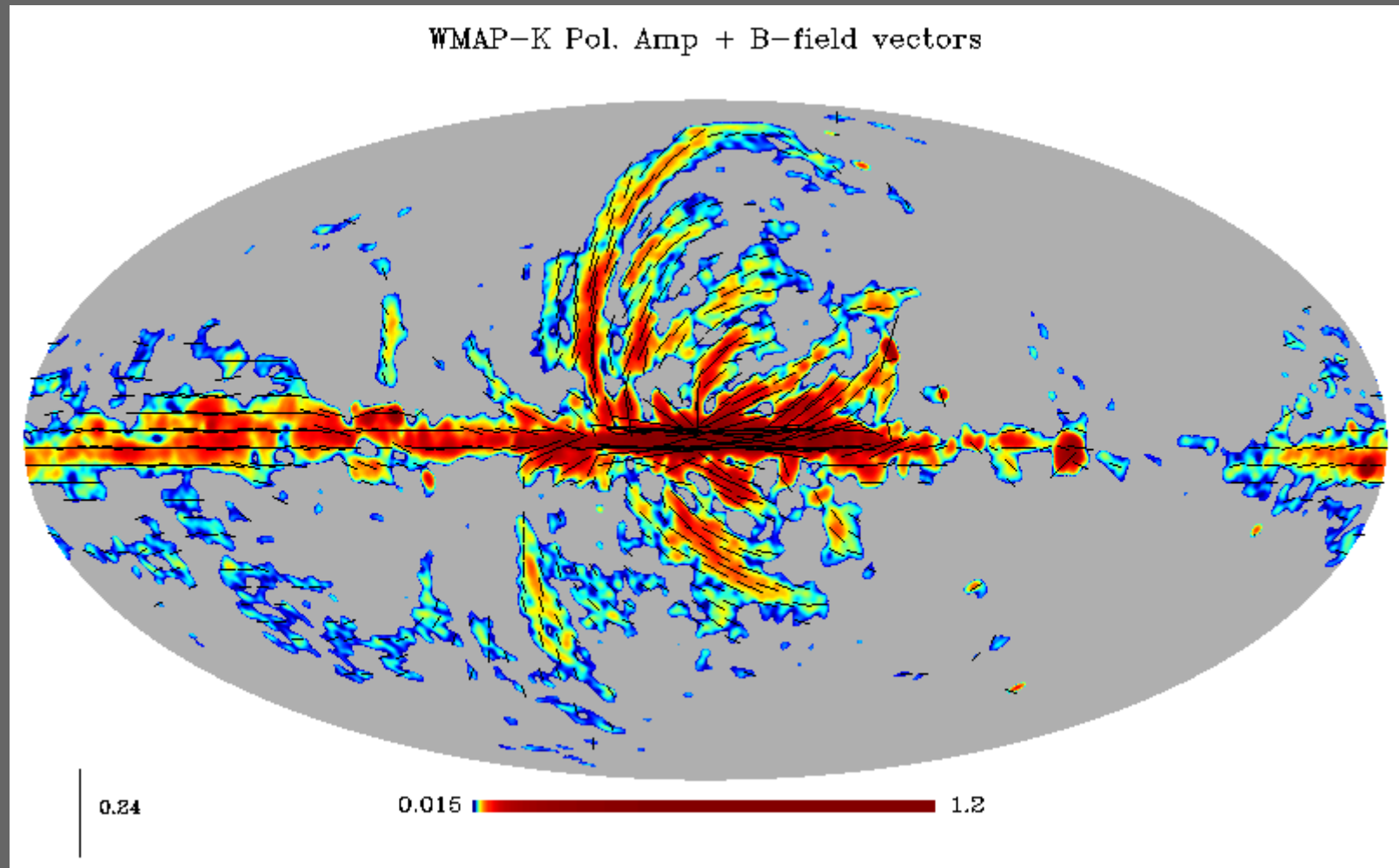


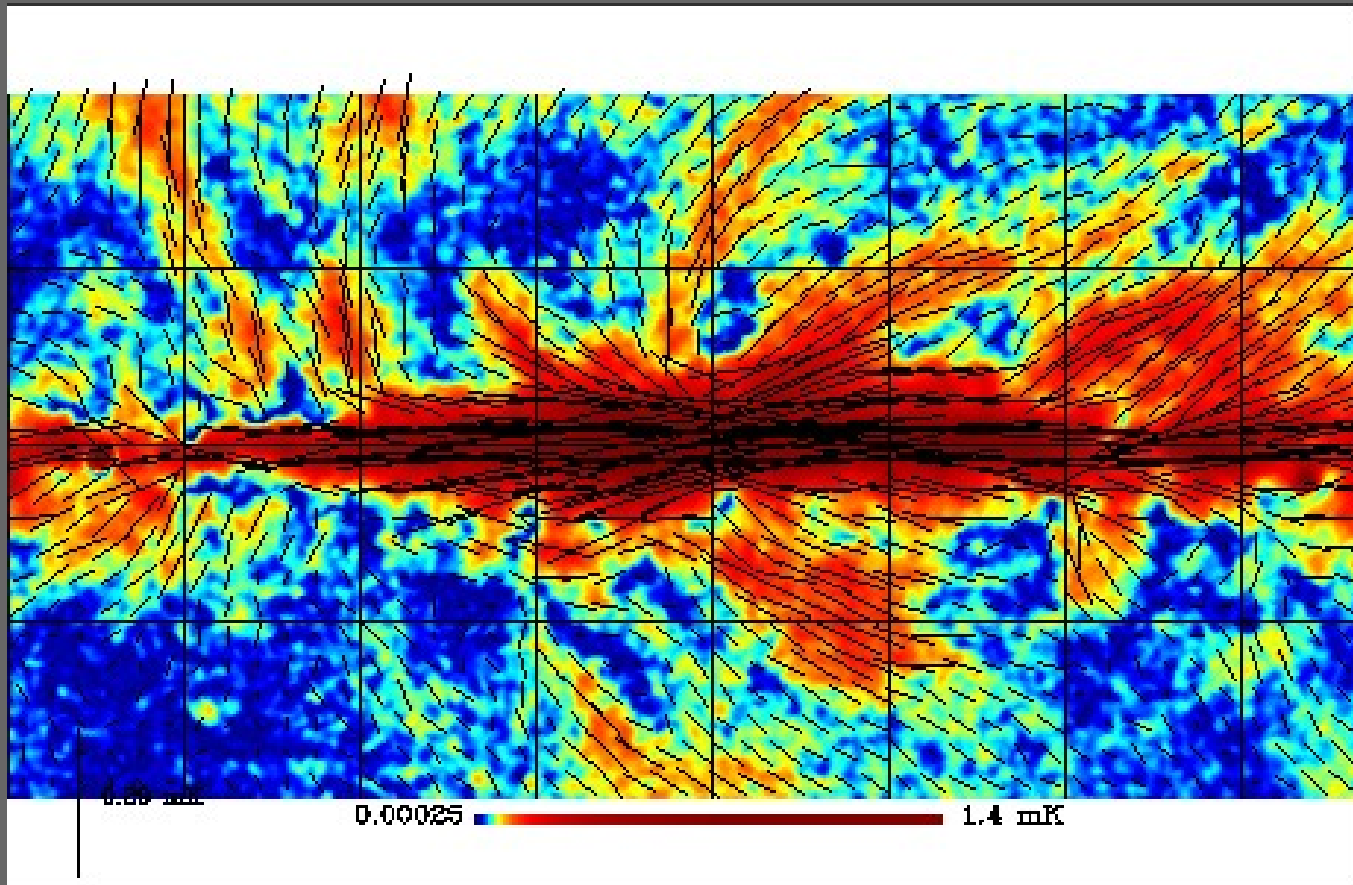
Unsharp mask to remove diffuse large scale emission  
and highlight the filaments in total intensity maps.

Most of these features follow small circles in the sky



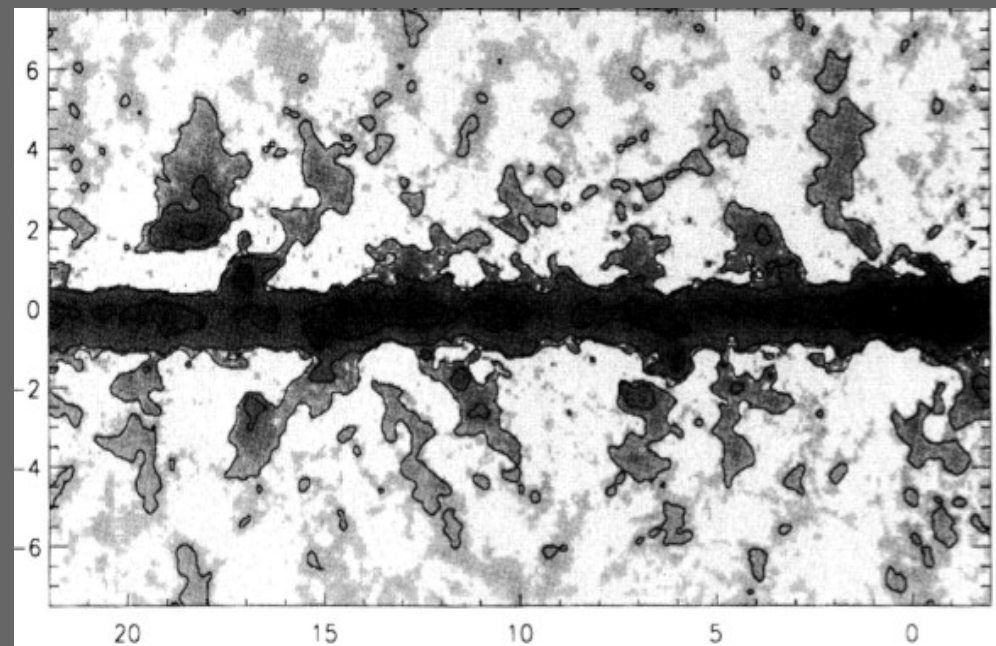
Magnetic field vectors are parallel to the filaments.  
Very different from CMB!!



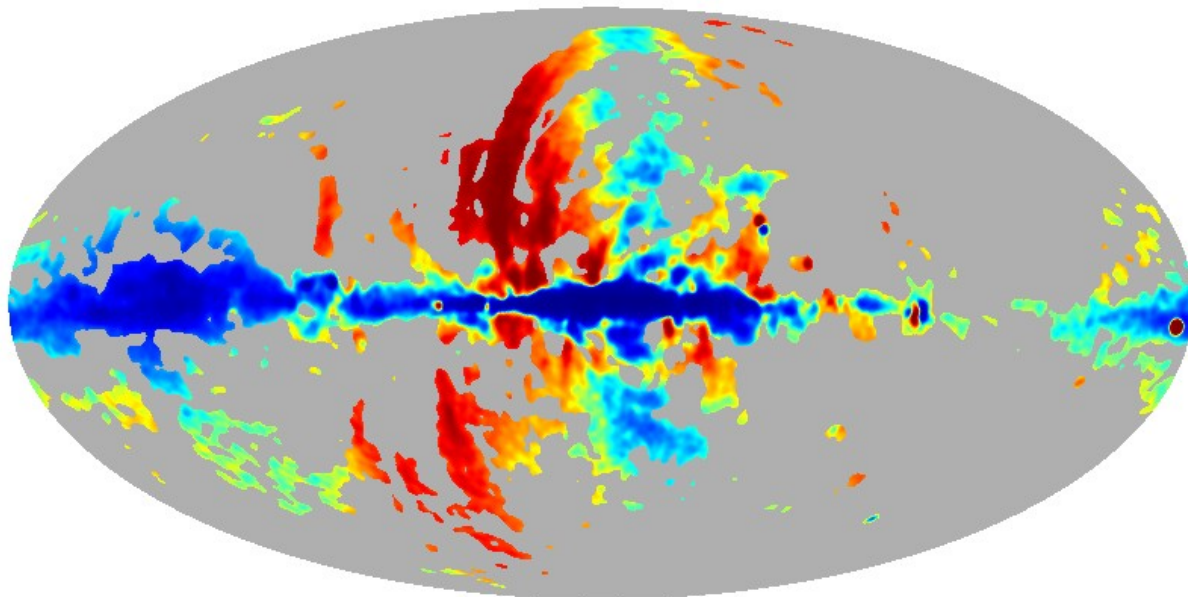


Many filaments coming out from the plane!

Similar structures in different data sets

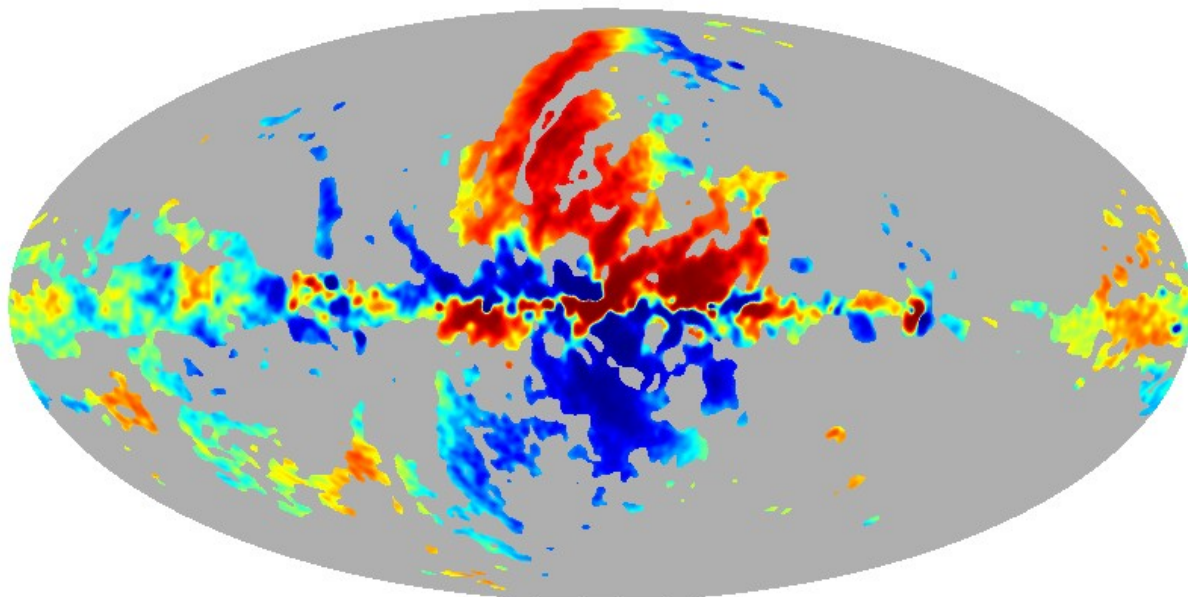


WMAP-K Stokes Q



-0.95 1.1

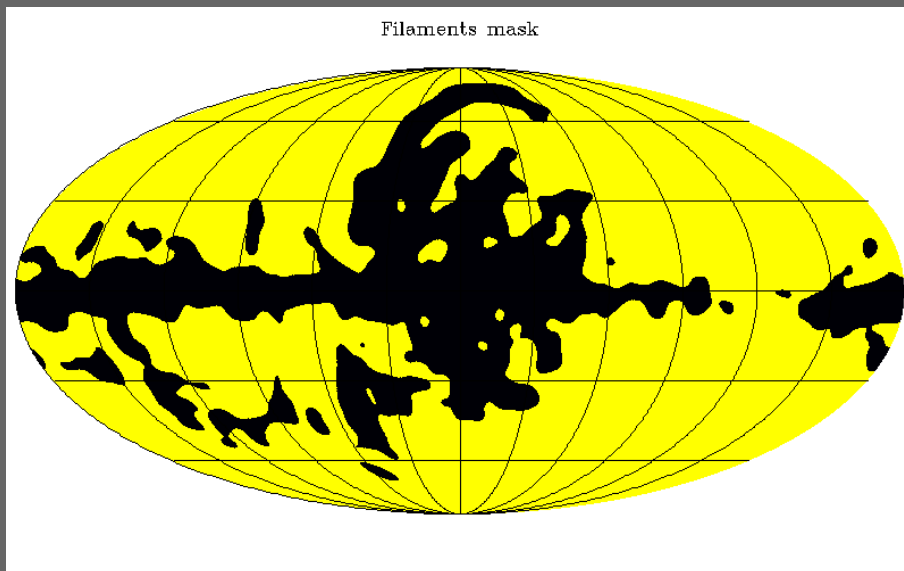
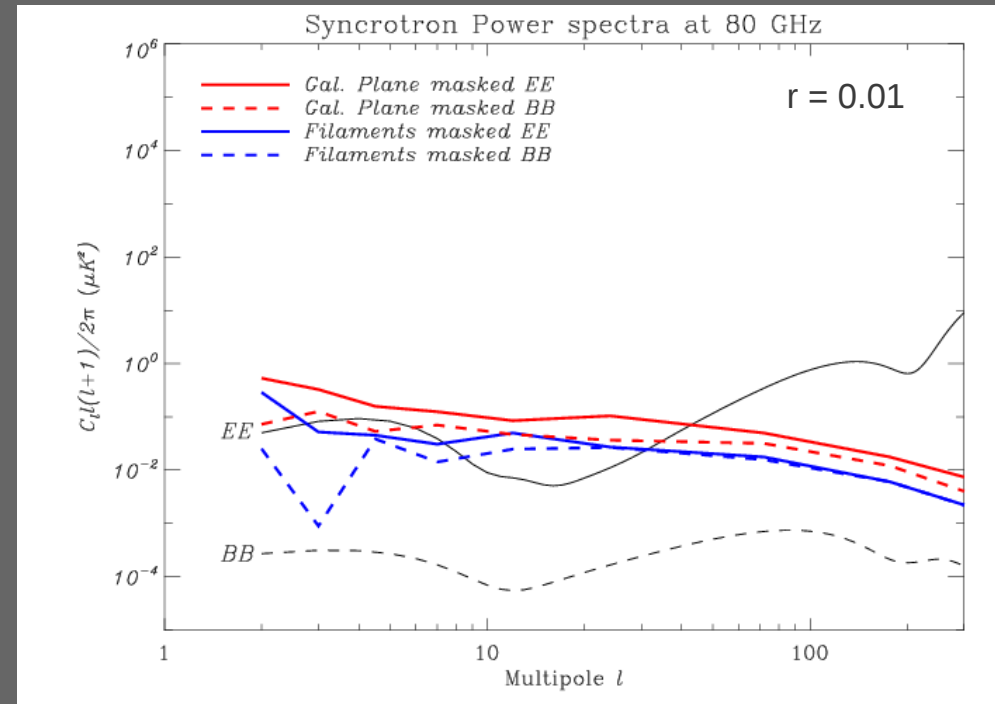
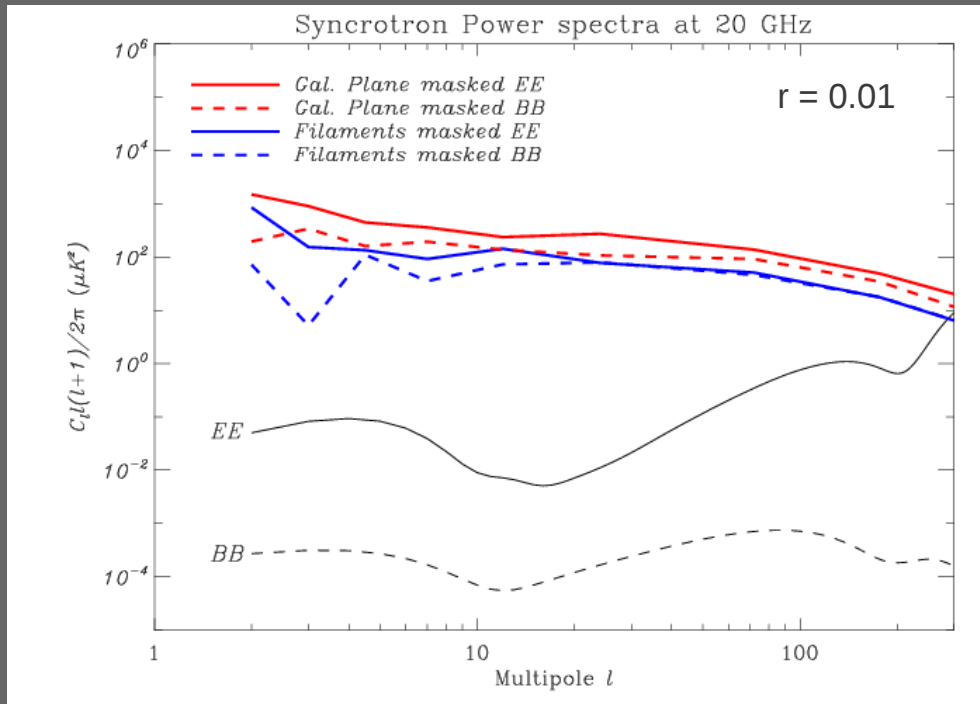
WMAP-K Stokes U



-0.28 0.44

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.

~ 5x on EE for  $l \lesssim 10$

~ 130x 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.