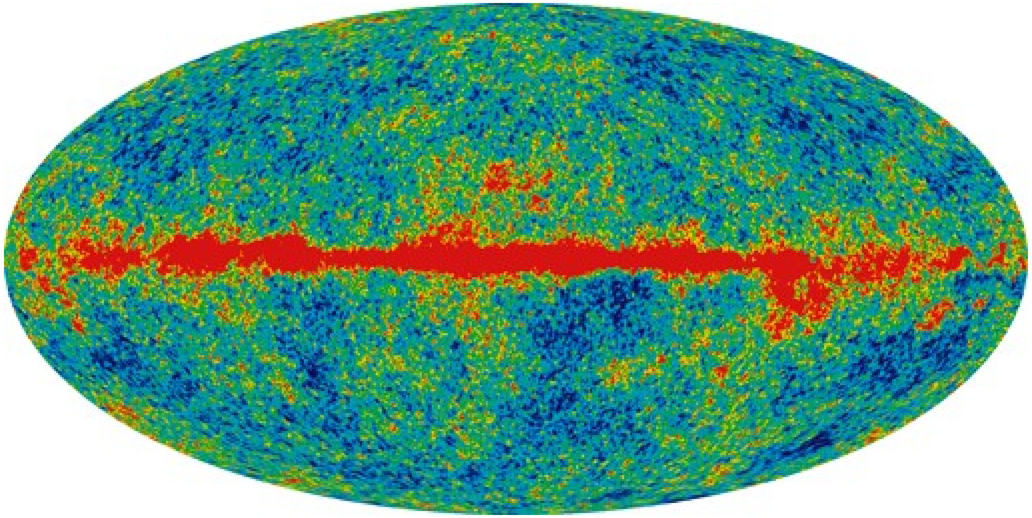
Faraday Depth as a diagnostic of galactic foreground contamination of CMB maps

Martin A. K. Hansen
Discovery Center
Niels Bohr Institute
University of Copenhagen

In collaboration with: W. Zhao, A. Frejsel, P. D. Naselsky, J. Kim and O. V. Verkhodanov

Foreground cleaning of CMB maps

Foreground cleaning of CMB maps is of very great importance for precision cosmology.



V-band and galactic foreground signal.

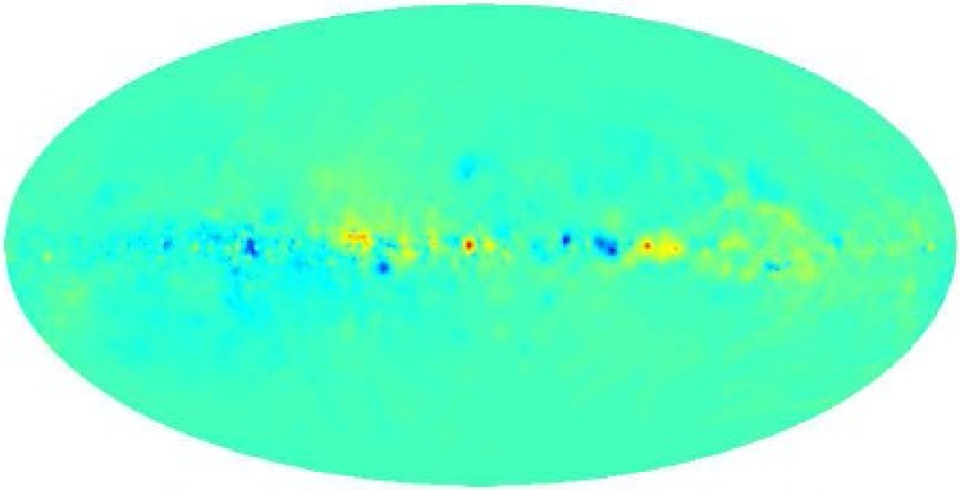
We have looked into the possible foreground contamination at high galactic latitude, due to the galactic magnetic field and thermal electron density.

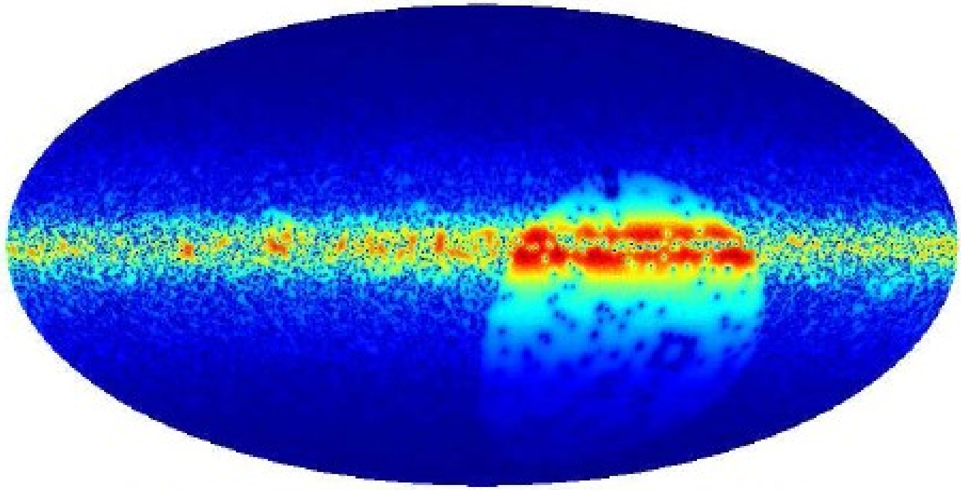
The galactic Faraday depth

$$\Phi(r_0) = \frac{e^3}{2\pi m_e^2 c^4} \int_{r_0}^{0} dr n_e(r) B_e(r)$$

The Faraday depth is dependent on the line of sight component of the magnetic field, as well as the thermal electron density.

Faraday depth Introduced by Oppermann et al. 2011. (ArXiv: 1111.6186).
Sky maps created by Oppermann et al., via the NRAO VLA SKY Survey, and other sources.

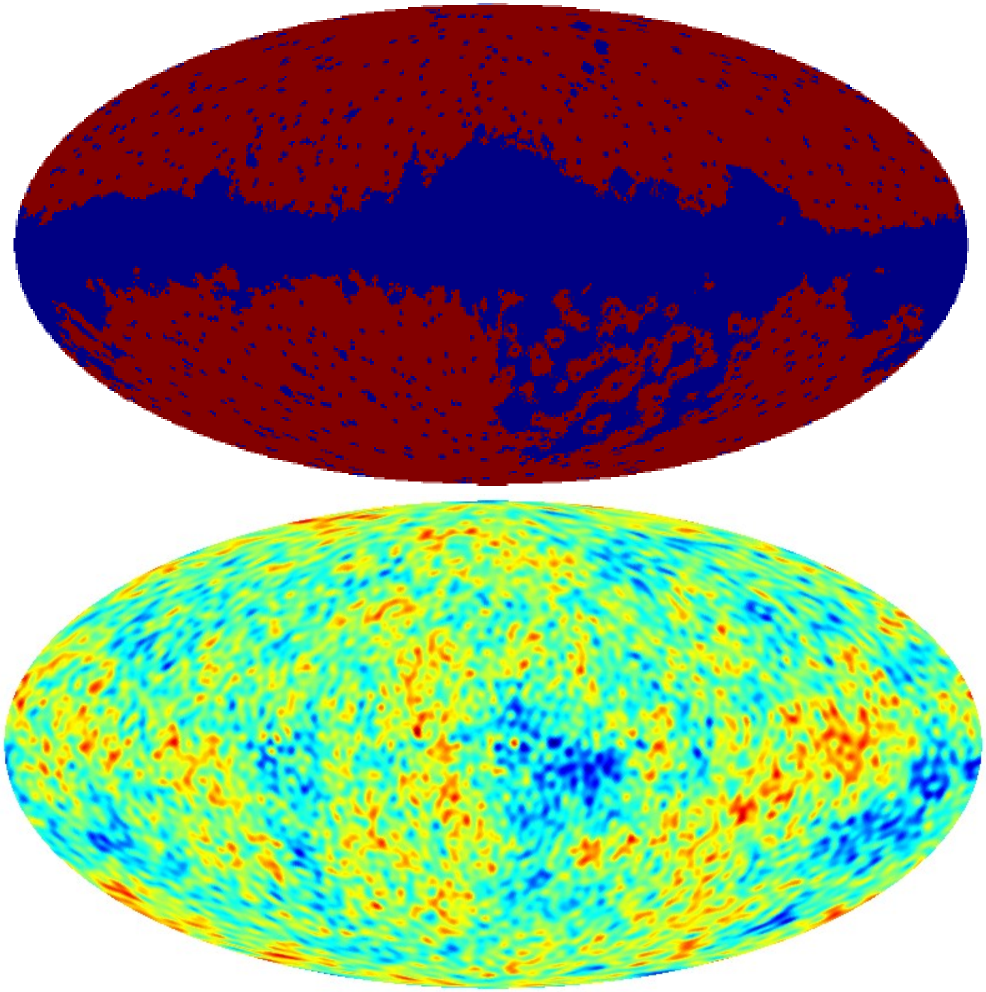




Top: The galactic Faraday depth
Bottom: The corresponding map of errors

Masking and correlation test

The mask is a combination of the KQ75 mask, and the areas in the Faraday depth map with more than 2 sigma uncertainty.

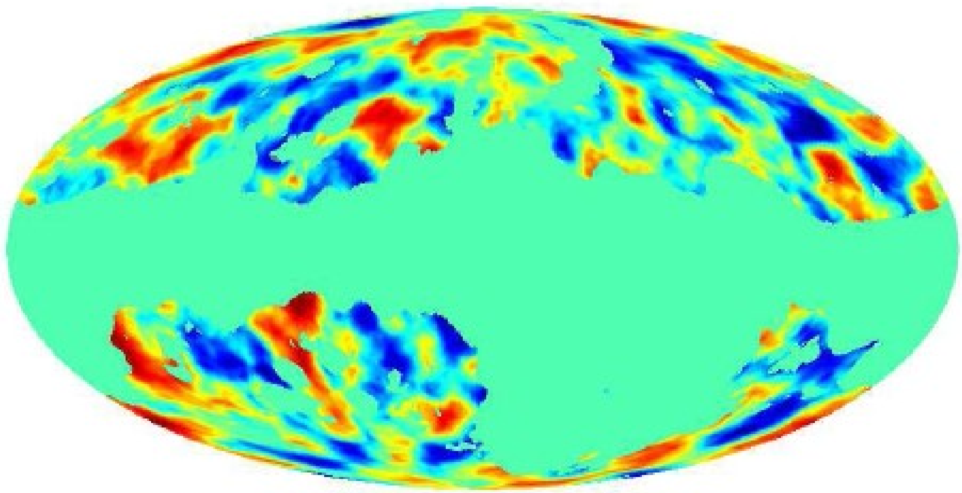


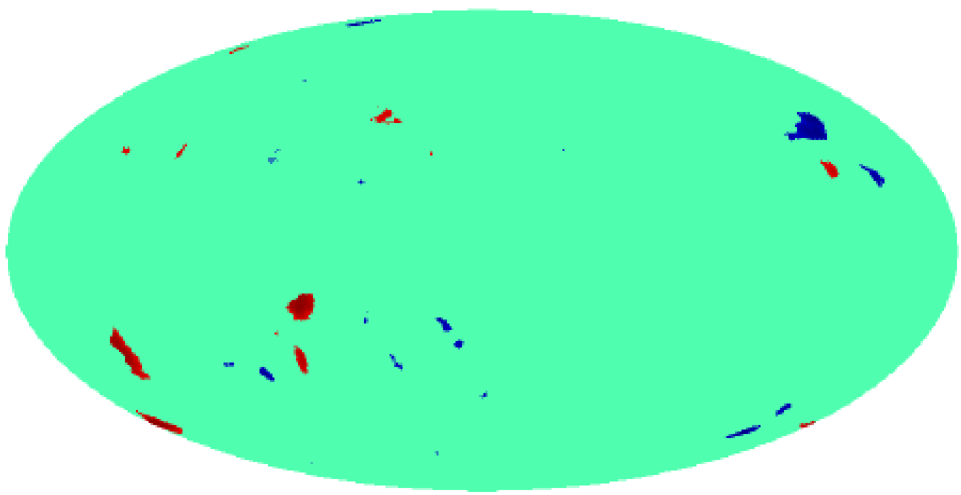
Top: KQ75P1 mask
Bottom: The ILC 7 year map

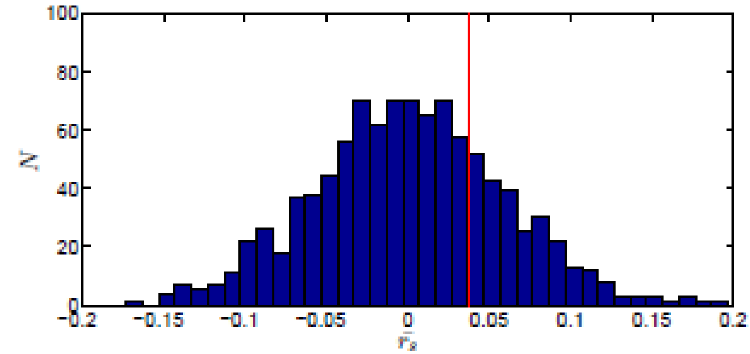
$$r_s(l,b,R) = \frac{\sum_{i \in C}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i \in C}(x_i - \bar{x})^2 + \epsilon}\sqrt{\sum_{i \in C}(y_i - \bar{y})^2 + \epsilon}},$$

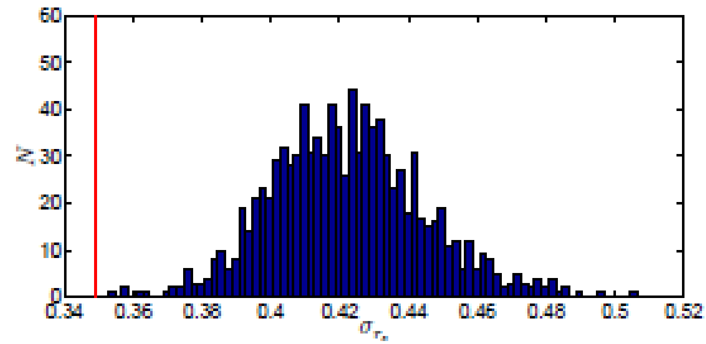
The correlation test investigates the average correlation in a circle with radius R, around a location l,b.

Results of the correlation test







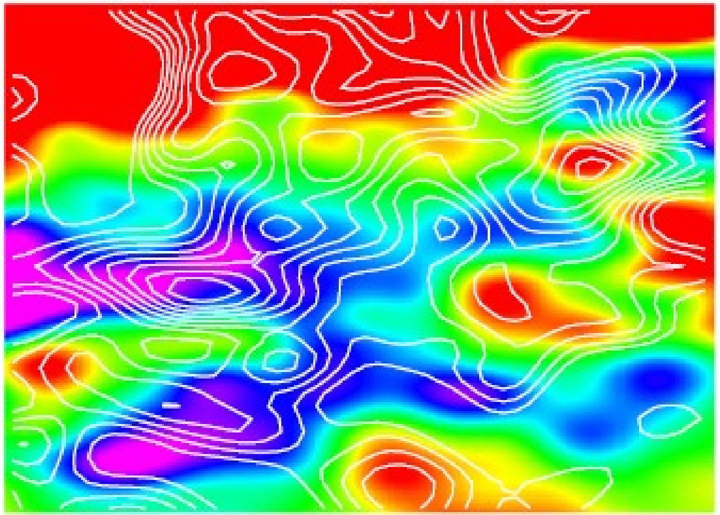


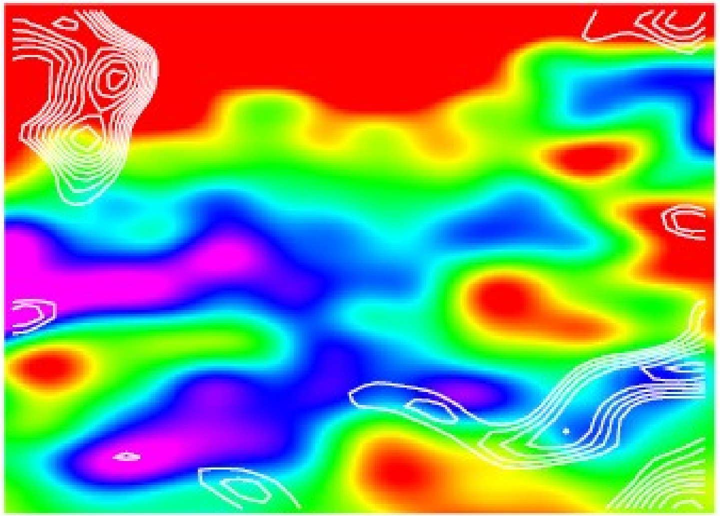
We simulated 1000 CMB maps, and compared them to the Faraday depth map.
Top: mean value of r_s
Bottom: standard deviation

Extremely low standard deviation!

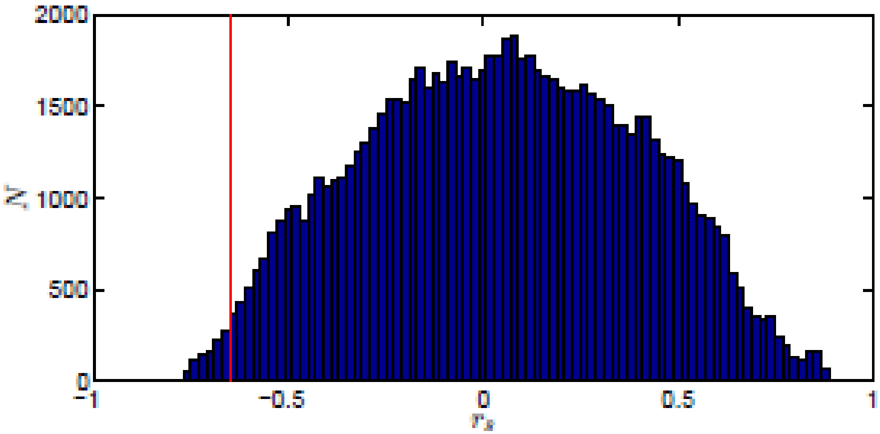
Top: correlation for R=5 deg.
Bottom: map of areas with more than 2 sigma deviation

The correlation in the Cold Spot area





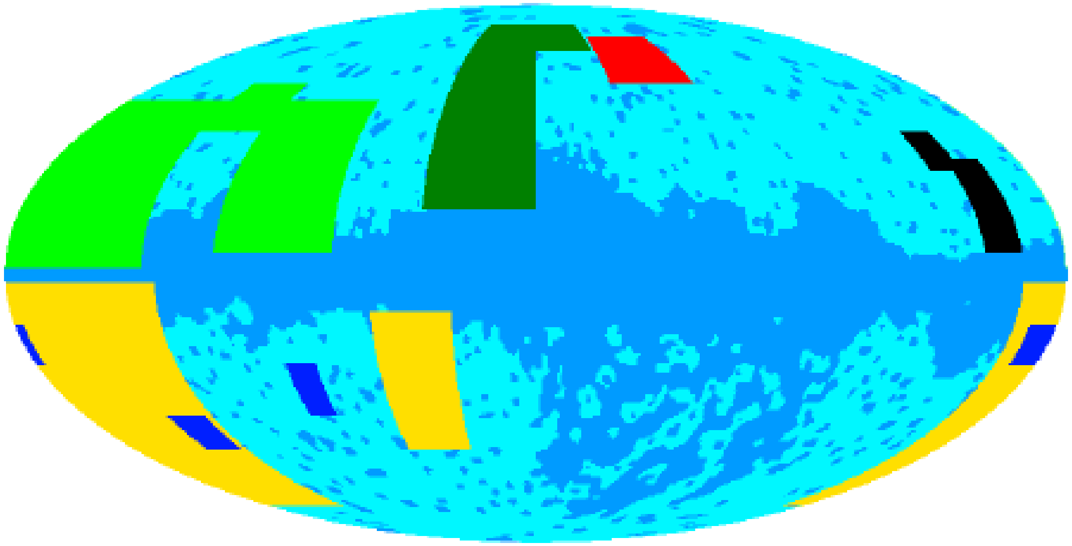
Top: positive CMB isolines (white)
Bottom: Negative CMB isolines (white)
Background: Faraday depth.
Region is just south of cold spot



The location around the CS, compared to the rest of the correlation map. R=5 deg.

Correlation in the Galactic radio loops

The galactic radio loops are loop-like structures visible in the radio band. They are probably the remnants of old supernovae. The loops outlines the ensuing shock front.



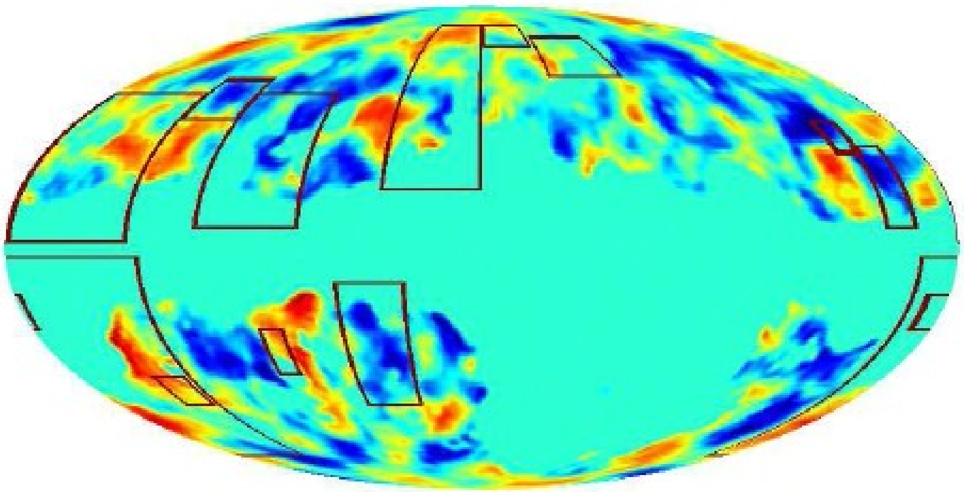
Dark Green: loop 1, Yellow: loop 2, Light green: loop 3, Red: loop 4, Blue: loop5, Black loop 6. The locations of the radio loops are taken from Borka, 2007 (MNRAS 376, 634)

$$r_l = \frac{\sum_{i\in L}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i\in L}(x_i - \bar{x})^2 + \epsilon}\sqrt{\sum_{i\in L}(y_i - \bar{y})^2 + \epsilon}}$$

Correlation test is similar to the previous one, except we now look at the entire loop area, and not a circle around a location.

Results for the Galactic radio loops

Loop		Smooth 1° r_l	Smooth 1° S	Smooth 5° r_l	Smooth 5° S	Smooth 10° r_l	Smooth 10° S
Loop I	A	0.534	15	0.737	8	0.807	5
	B	0.760	5	0.888	10	0.961	17
Loop II	A	-0.323	93	-0.409	89	-0.456	85
	B	0.335	9	0.377	10	0.401	14
Loop III	A	0.283	7	0.445	7	0.573	6
	B	0.108	37	0.553	19	0.903	5
	C	0.127	35	0.328	29	0.615	21
Loop IV	A	0.330	33	0.392	43	0.447	50
Loop V	A	0.999	46	-0.675	54	-0.996	54
	B	0.068	48	0.600	28	0.930	1
	C	0.208	51	0.259	51	0.165	54
Loop VI	A	-0.0311	49	0.119	49	0.649	40
	B	0.049	50	0.233	46	0.692	27



The locations of the Galactic radio loops on the correlation map for R=5deg.

S is the amount of simulations with higher correlation value (out of 100 sims).
We also attempted several levels of smoothing.

It will be interesting to test this with improved data of the Faraday depth, as well as the coming data from Planck

Questions?

Co-authors:
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