

# Giant Rings in the CMB Sky

Nissan Itzhaki

Based on 1005.3923 with [E. Kovetz](#) and [A. Ben-David](#)

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which does not appear to be connected with any of the CMB “anomalies”.

Goals of the talk:

1. Present a new CMB “anomaly” at large scale (giant rings).
2. Point out a connection with the bulk flow.
3. Suggest an explanation to the giant rings, bulk flow and relation between them.

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Are there unusual giant rings in the CMB sky?

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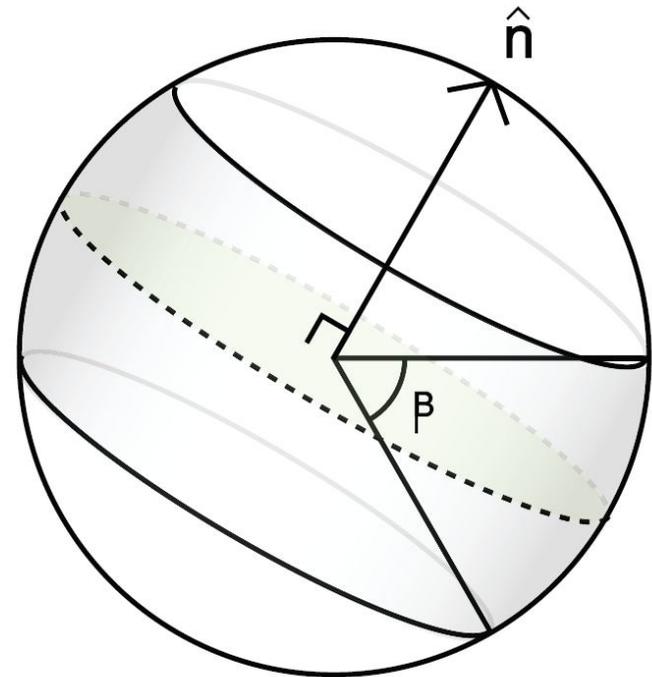
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To answer this question we define the following **ringscore**

$$R(\beta, \hat{n}) = \int_{\frac{\pi-\beta}{2}}^{\frac{\pi+\beta}{2}} d(\cos \theta) \tilde{T}^2(\theta, \hat{n}),$$

Fix  $\beta$  and search for the maximum as a function of  $\hat{n}$ .

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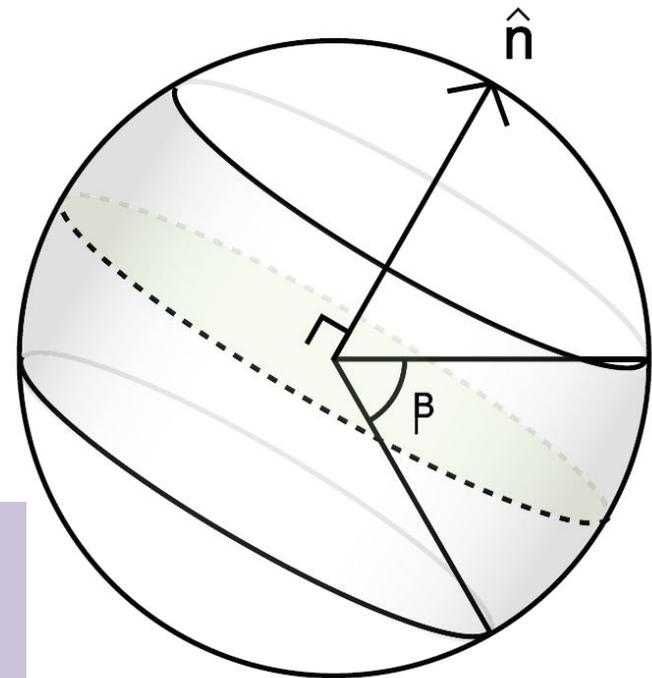
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This score measures how much the rings deviates from random behavior as a function of  $\hat{n}$ .



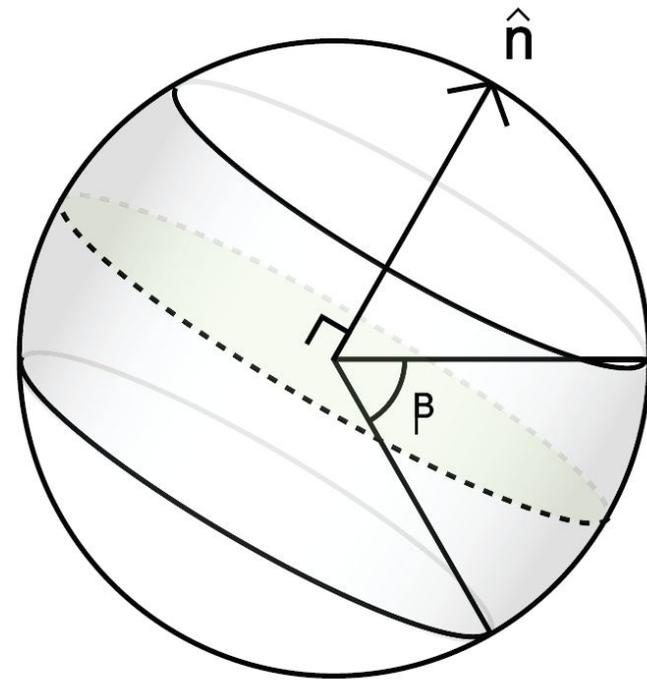
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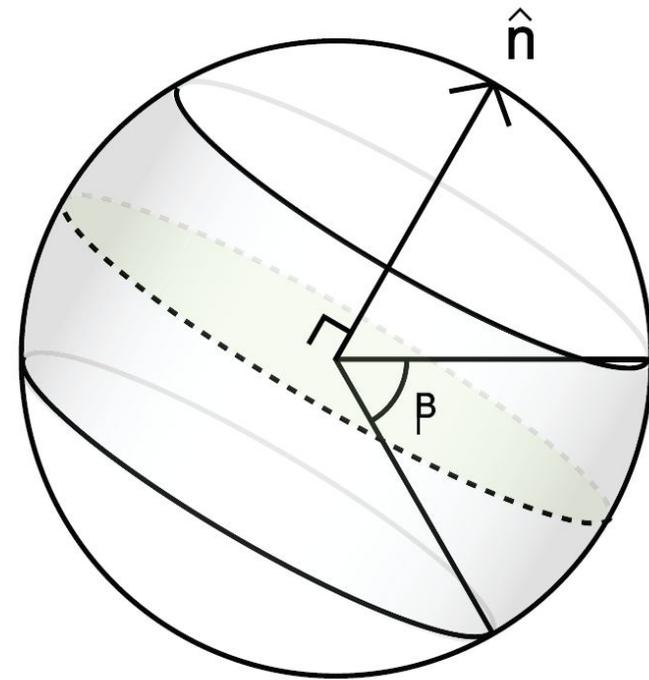
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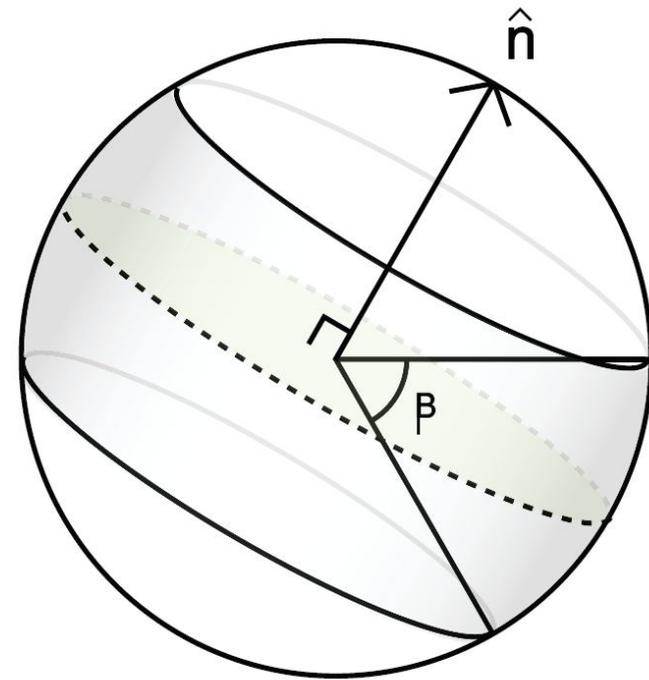
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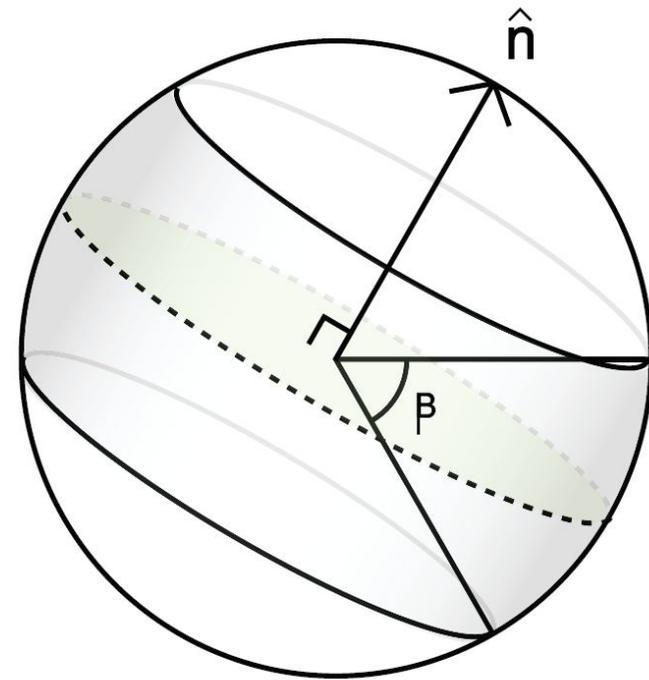
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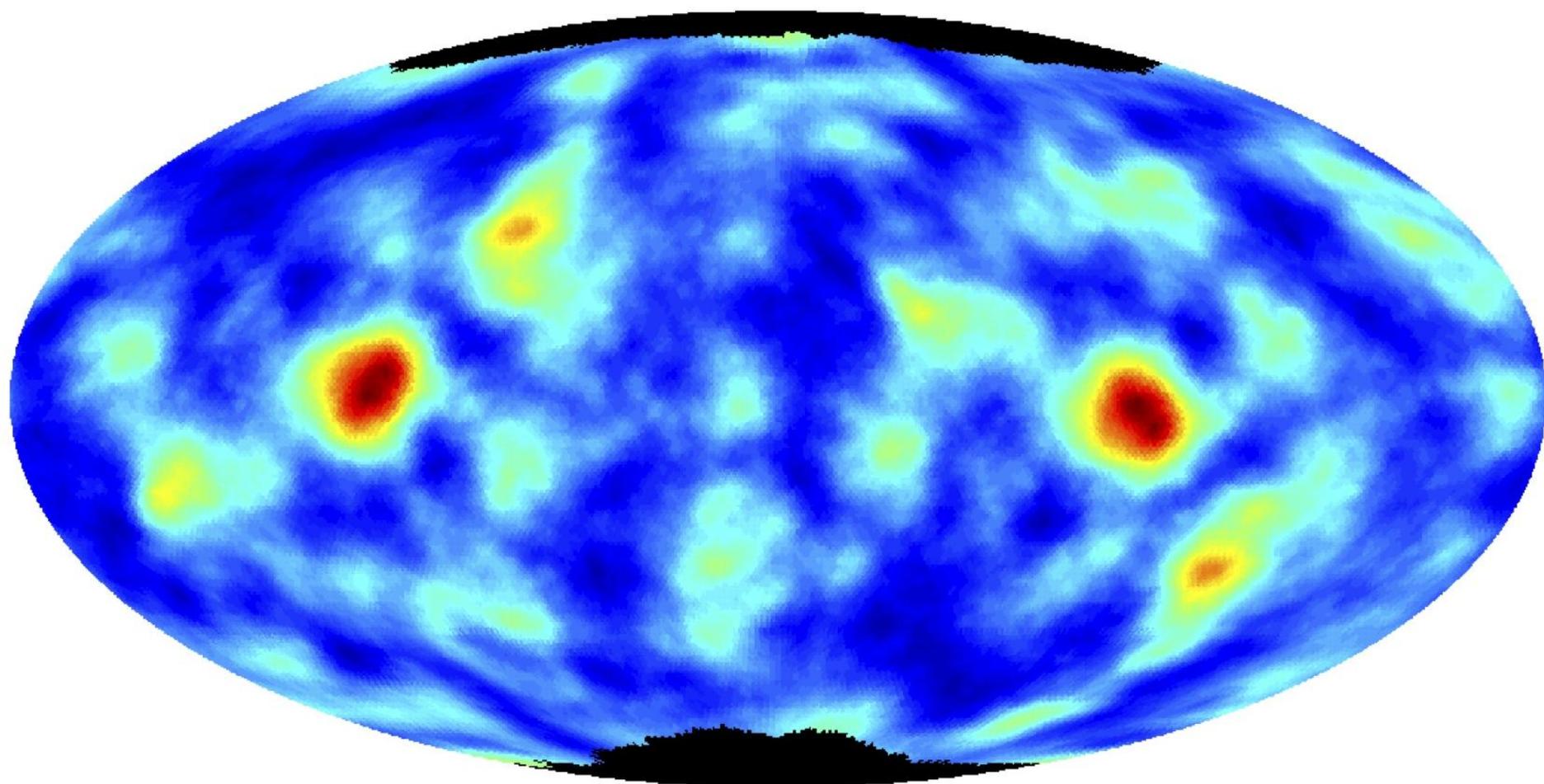
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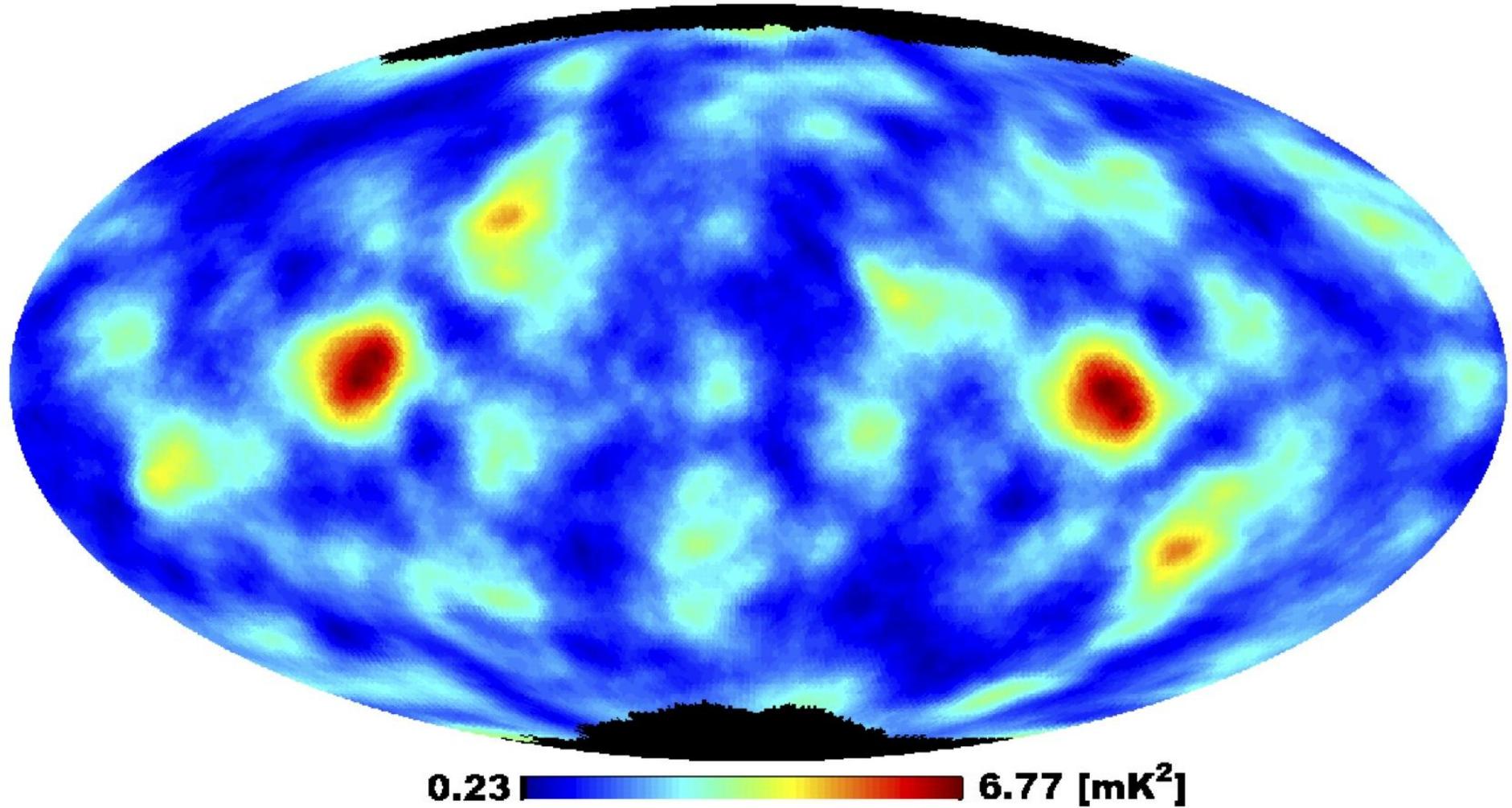
- To have statistical significance  $\beta$  cannot be **too small**.
- Since we are masking the galactic plane (we use the KQ75 which mask 29% of the WMAP7 sky)  $\beta$  cannot be **too large** either.
- Taking a nice round value that is not too large or small  $\beta = \pi/3 = 60^\circ$

we get the following **ringscore map**:

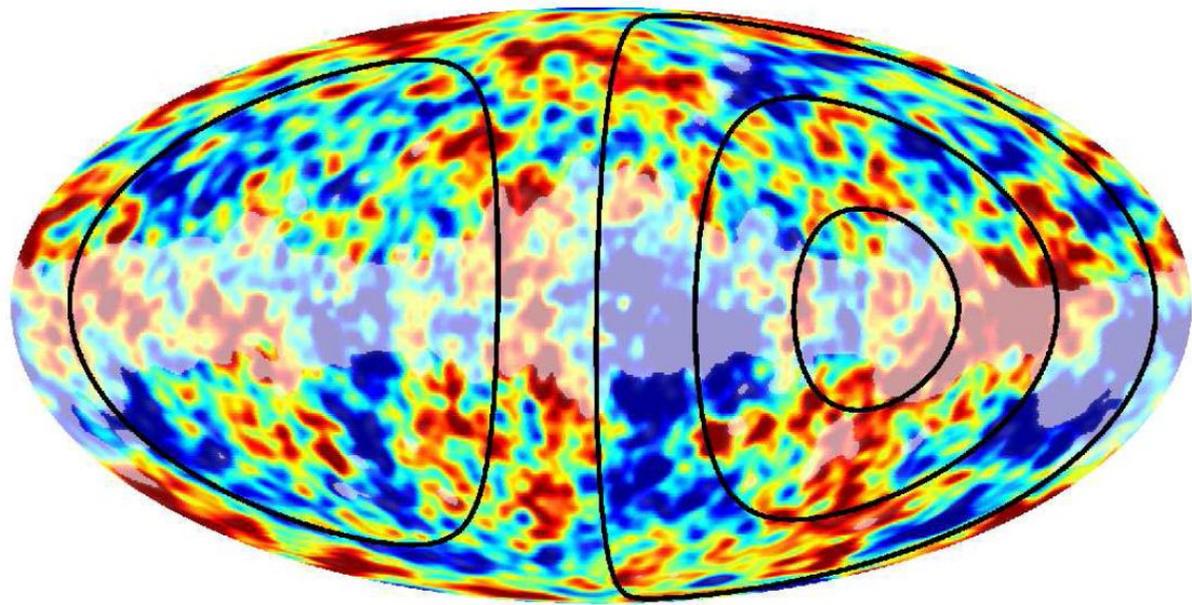


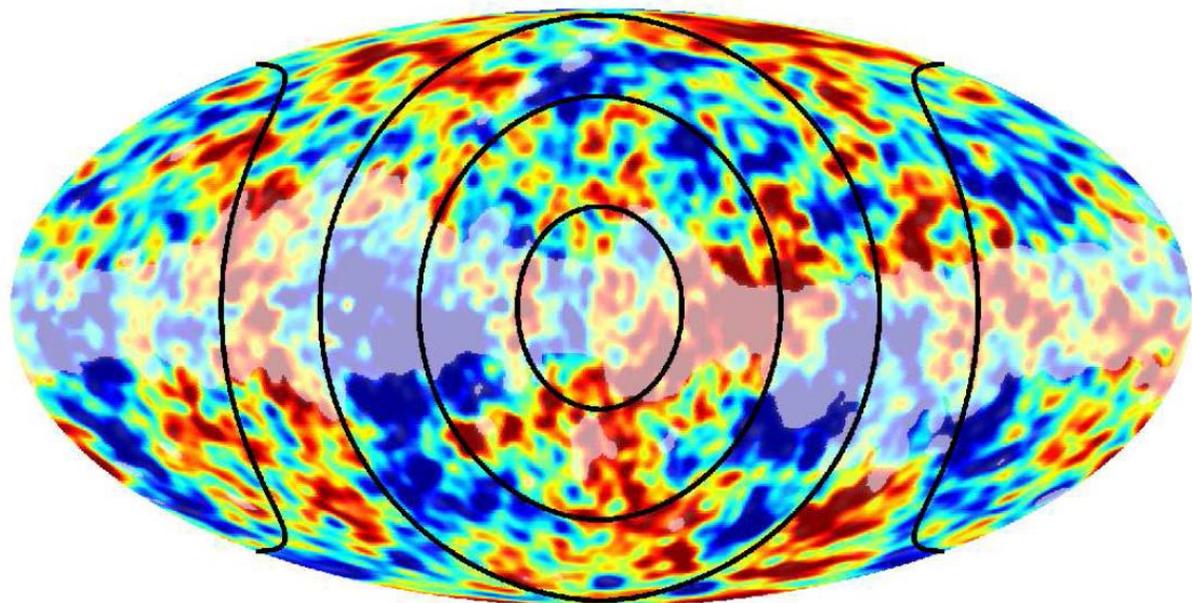
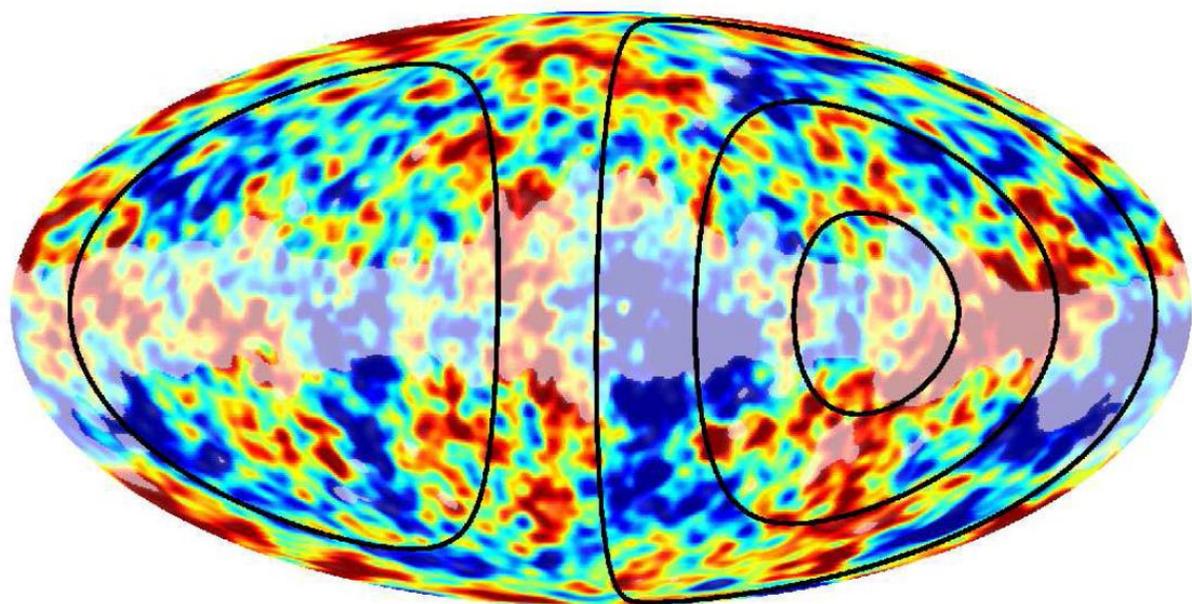


0.23 |  | 6.77 [mK<sup>2</sup>]



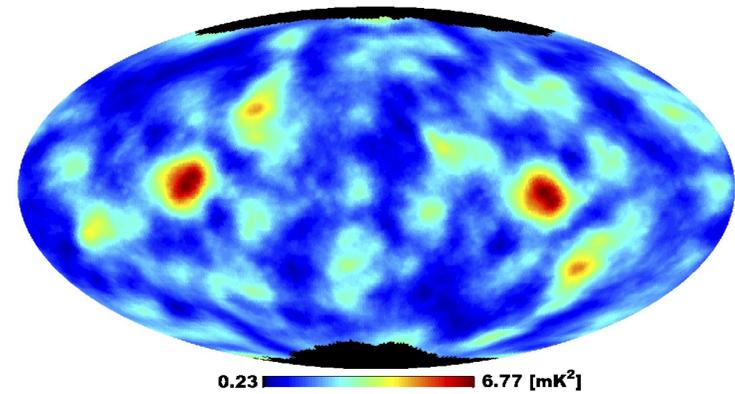
We see that there is a clear peak which can even be seen on the original ILC map:





There are some interesting features to this map and its peak:

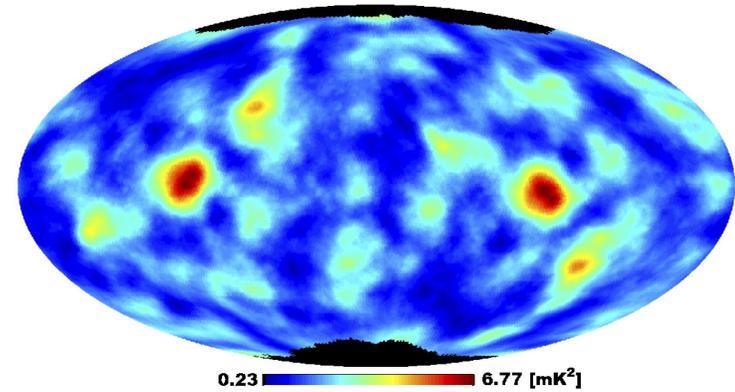
1. The location of the peak at  $(276^\circ, -1^\circ)$  is almost insensitive to  $\beta$ .



This direction might indeed be special.

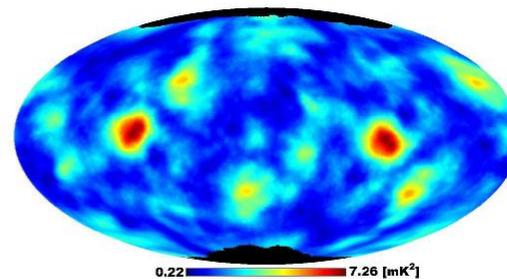
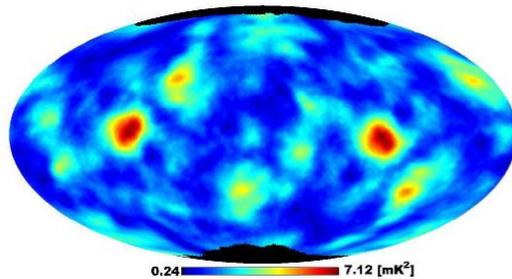
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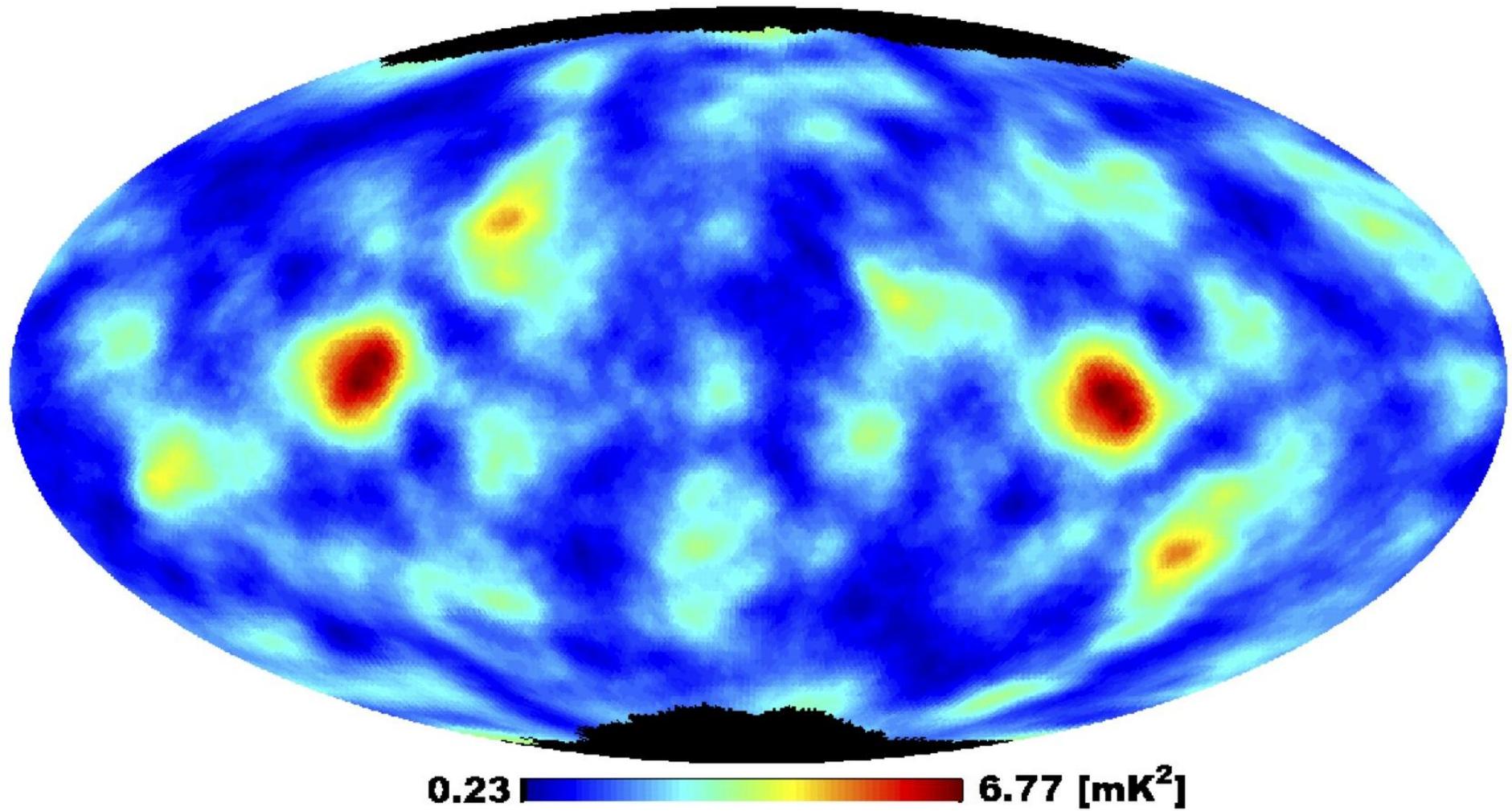
2. The V band and W band maps look almost the same



The direction is special at the cosmological level

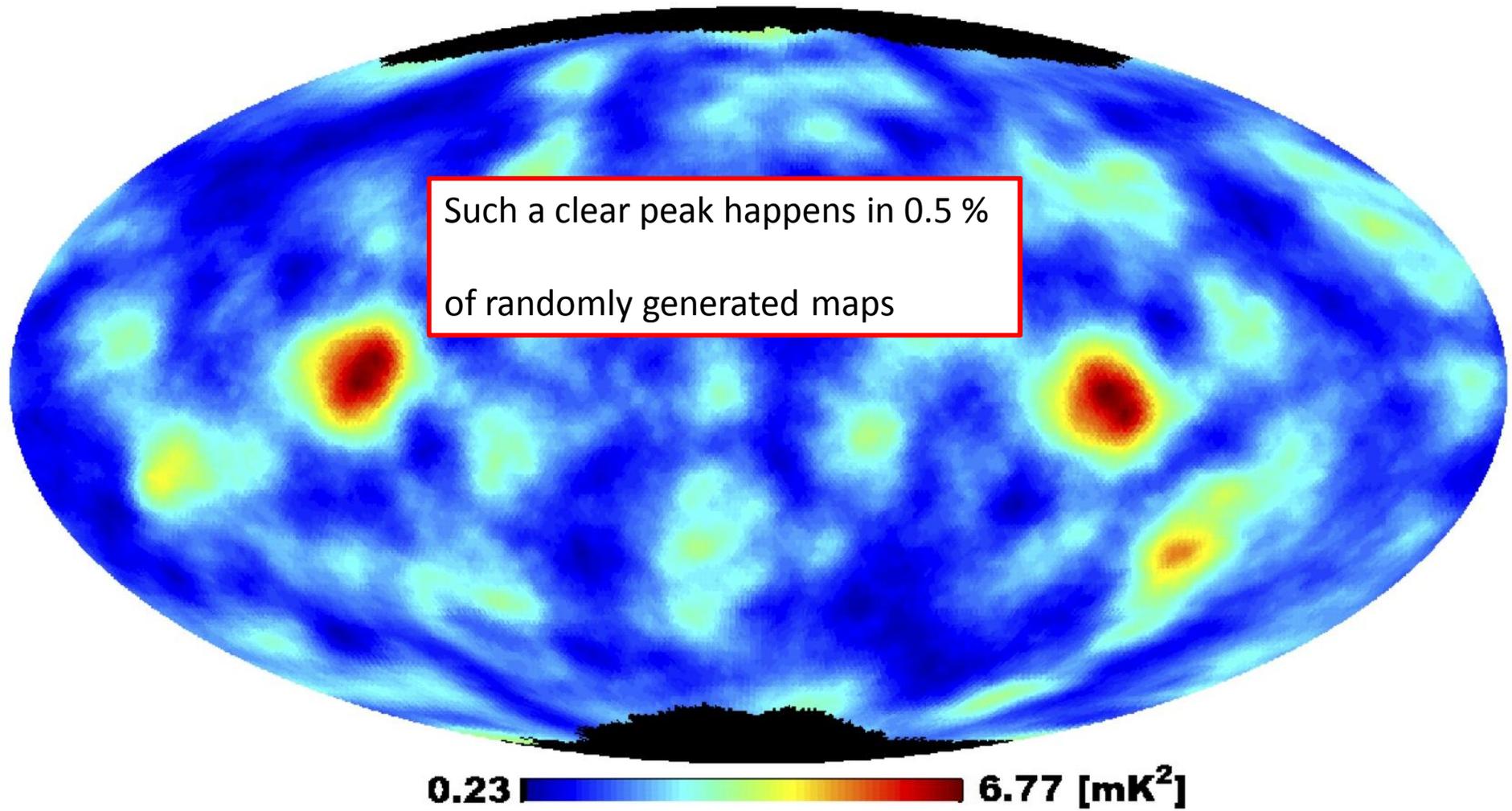
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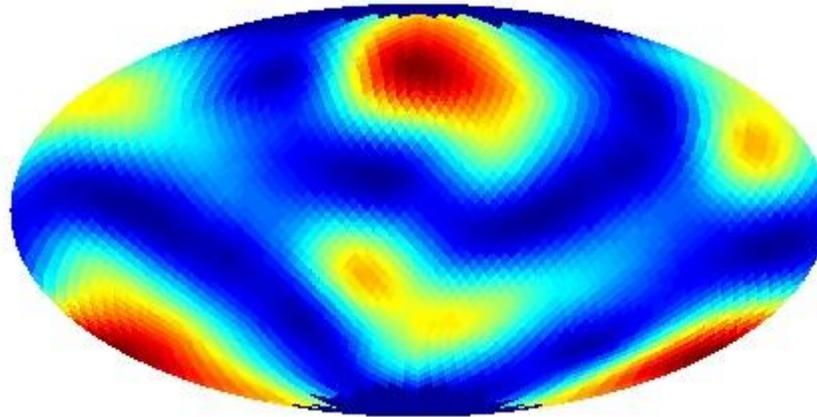
What is the statistical significance of this peak?



The rings are not due to local ( $z < 0.3$ ) structures

- Francis and Peacock estimated the ISW effect of local structures.
- We used their results to generate

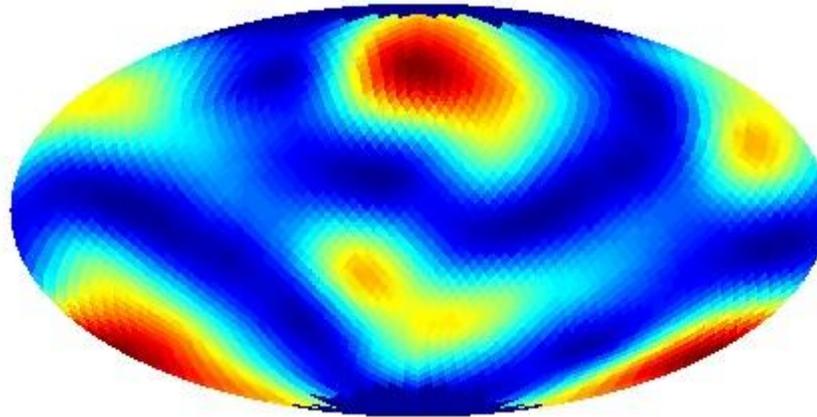
a local ringscore map:



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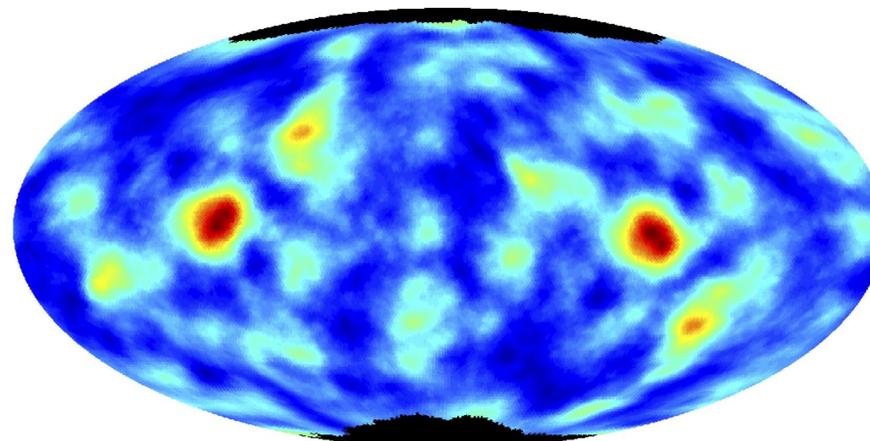
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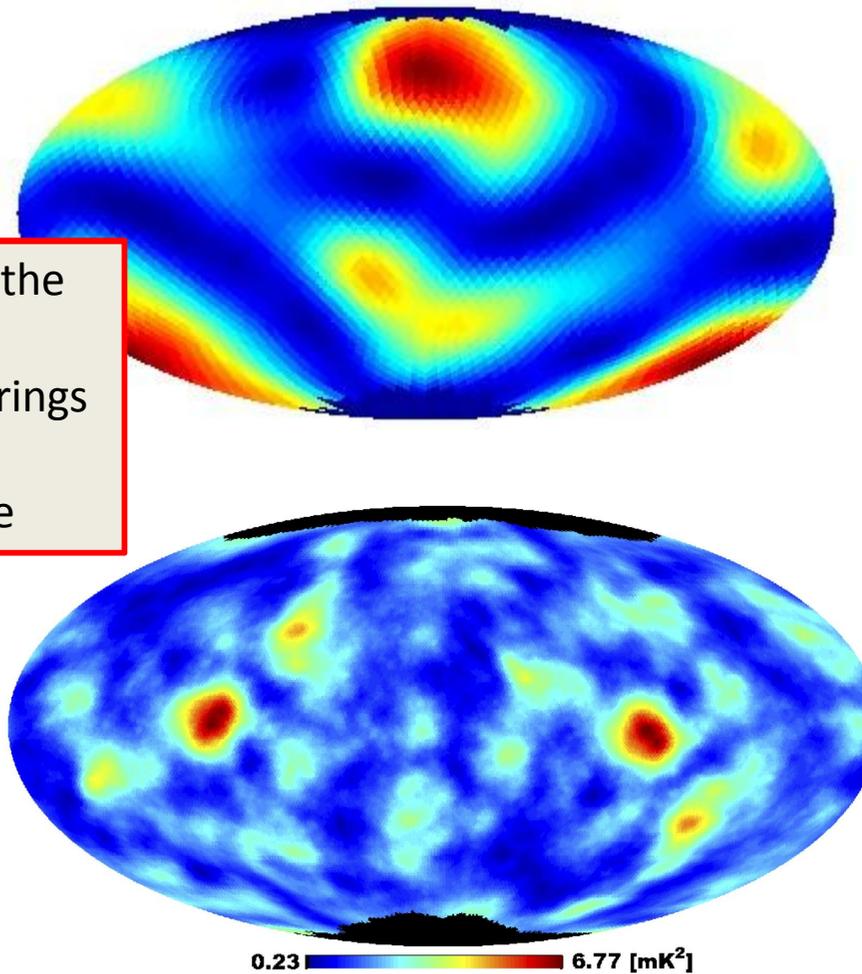
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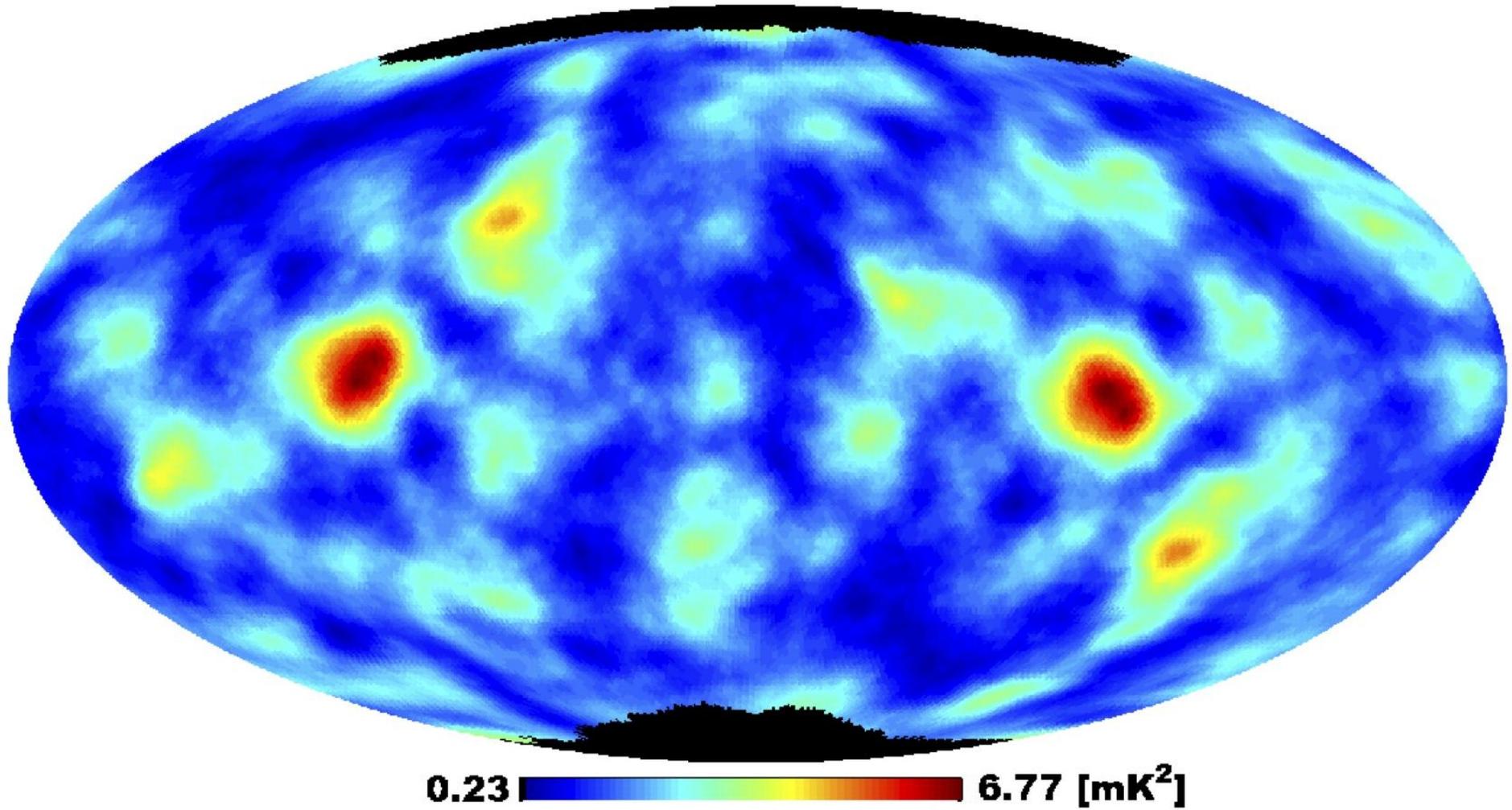
This indicates that the origin of the giant rings is a far away source

which doesn't look at all like

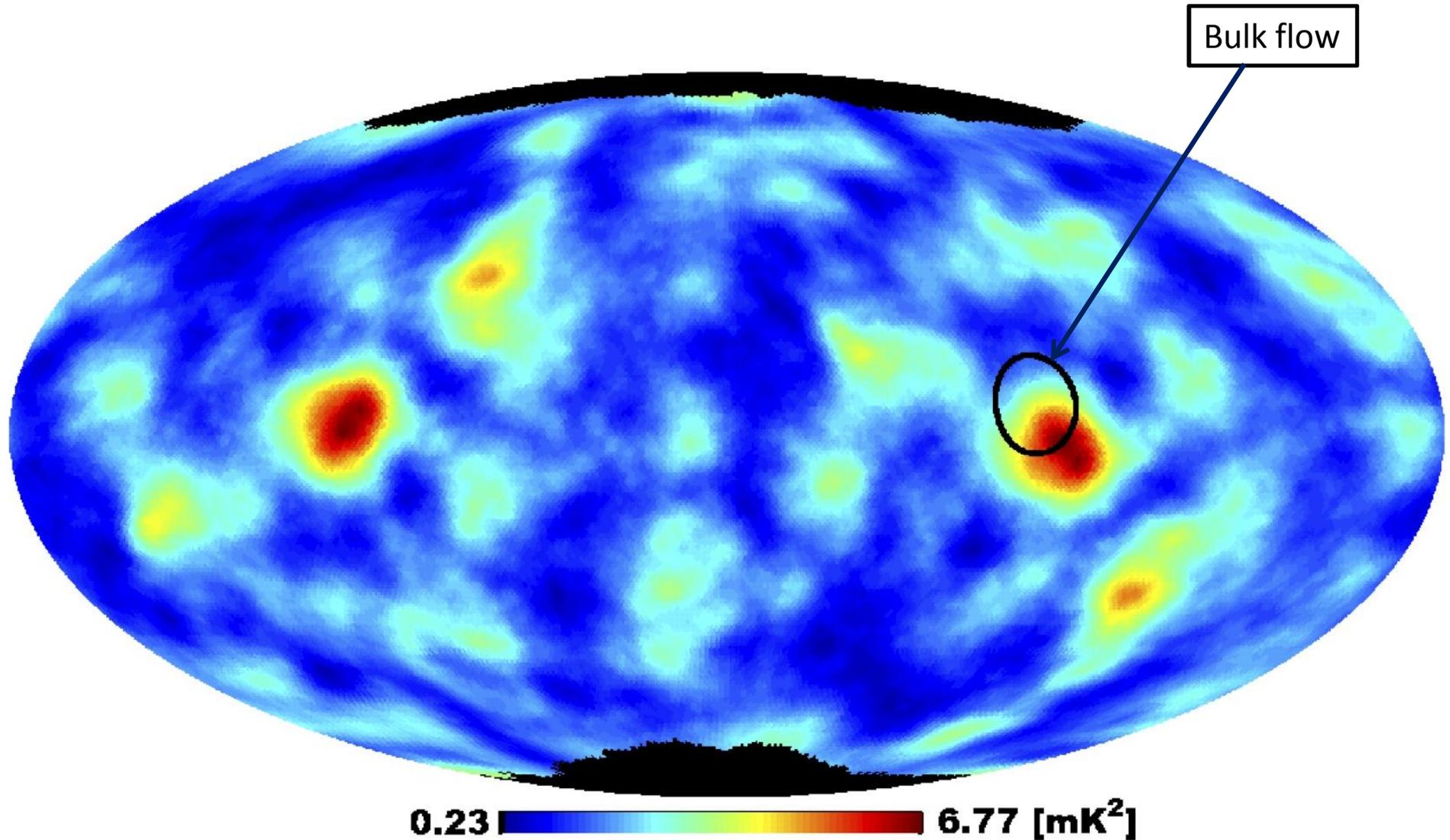
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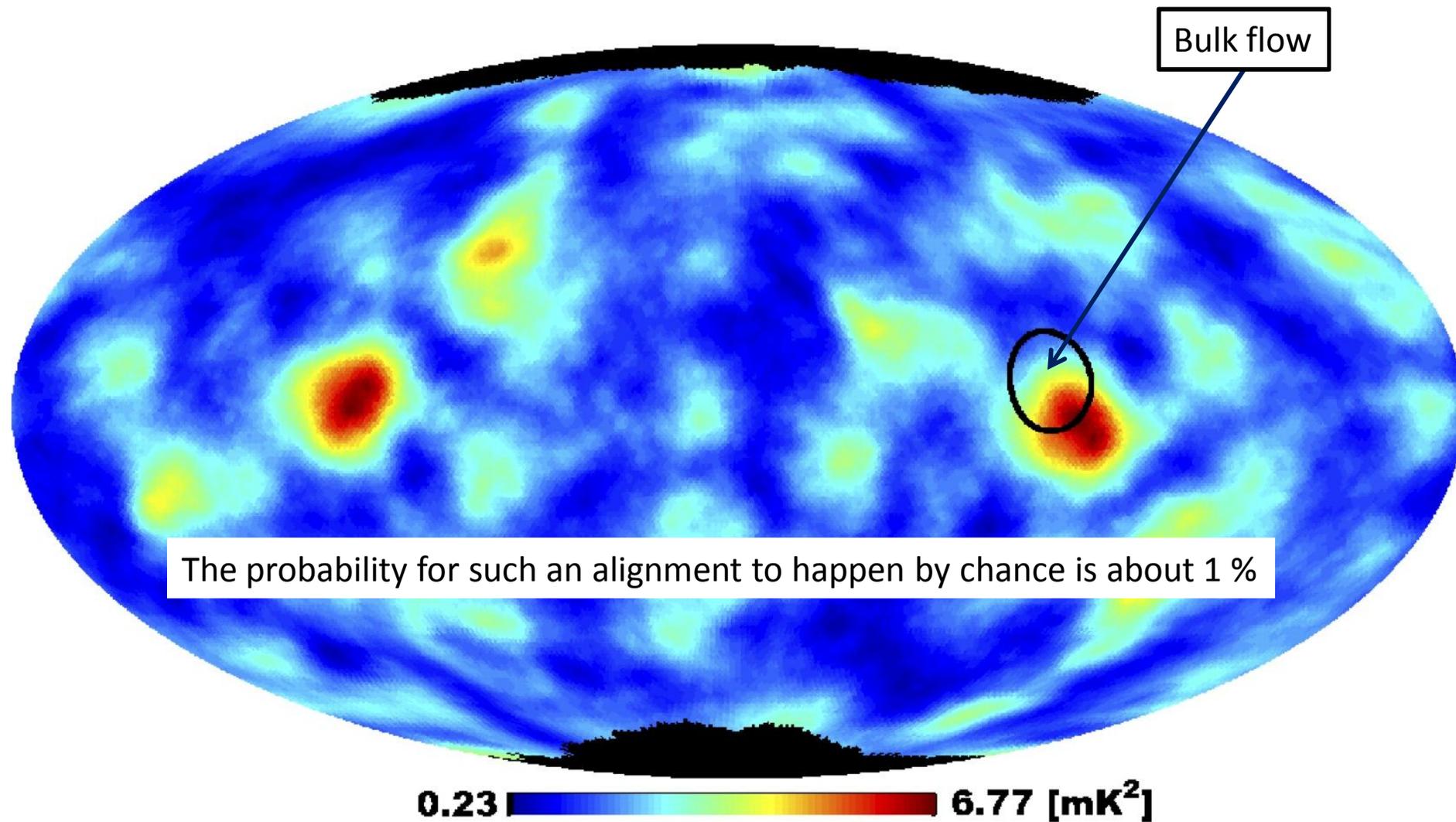


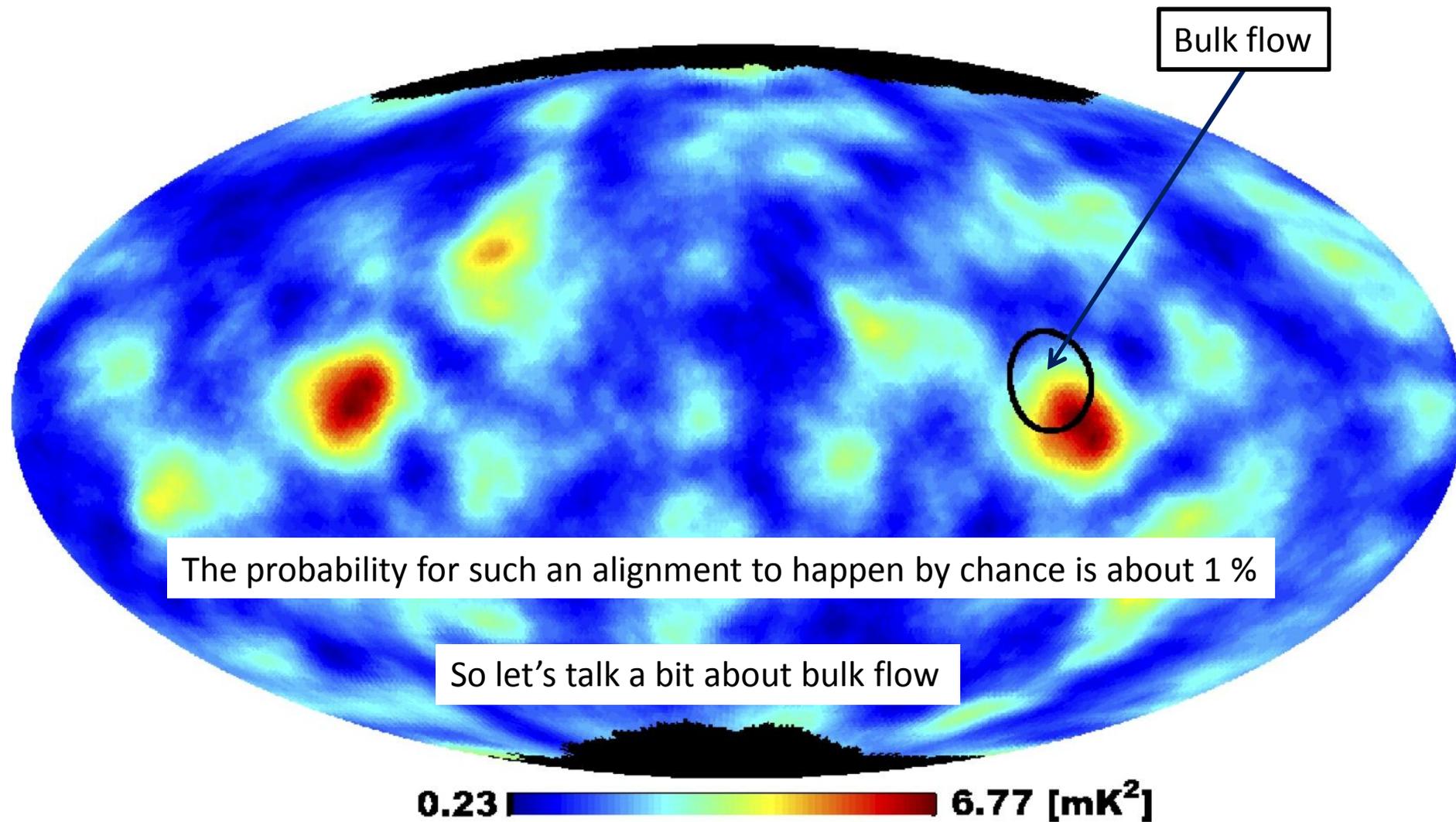
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The rms of the BF  
can be calculated.

Theory :

1. For  $\sim 100h^{-1}$  Mpc

about  $\sim 110 \text{ km s}^{-1}$

2. Drops like  $1/r$

## What one finds is quite different:

(Watkins, Feldman, Hudson, 0809.4041; Lavaux, Tully, Mohayaee, Colombi, 0810.3658)

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The probability of this happening by chance is 0.5%

If one is not ready to give up on statistical isotropy than a way to explain this is to relax the  $\Lambda$ CDM assumption that there is a single power spectrum that fixes all observables :  $\Phi \neq \Psi$  .

And adopt a DGP-like model in which the PV power spectrum is larger at large distances.

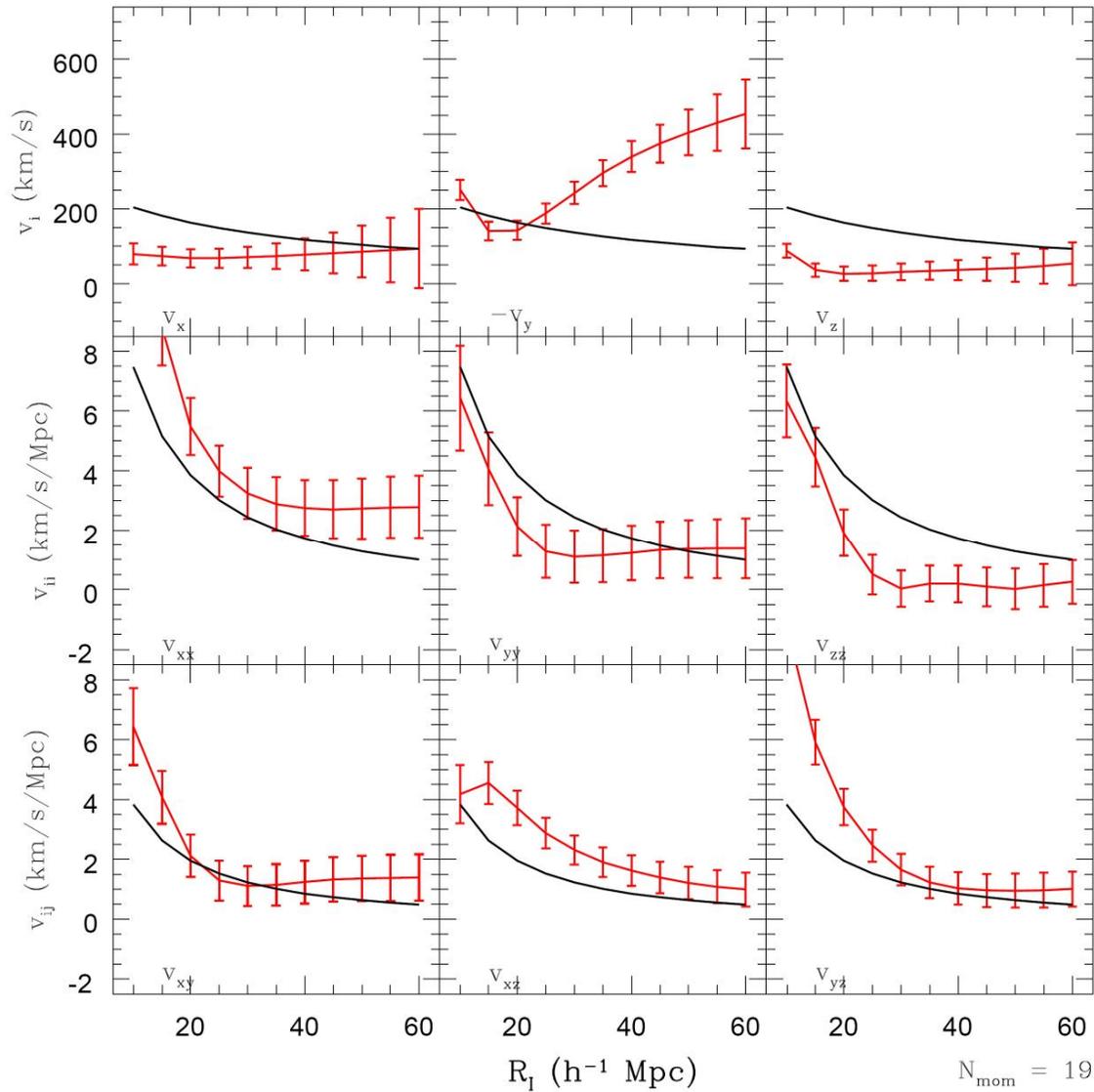
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This was possible in 2008 but seems very unlikely today:

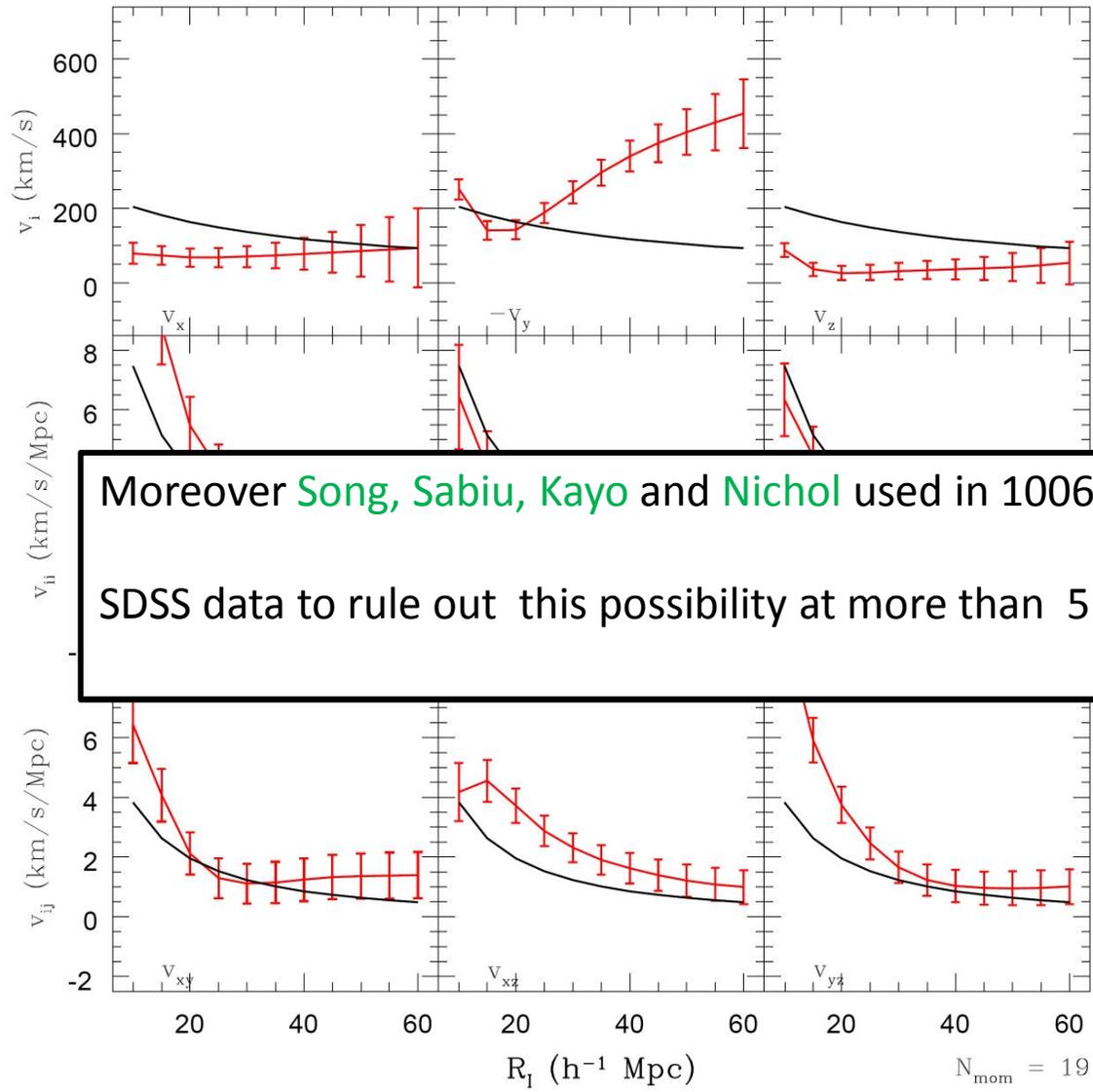
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Moreover Song, Sabiu, Kayo and Nichol used in 1006.4630 the SDSS data to rule out this possibility at more than  $5\sigma$



We are left with the possibility that there is a far away **cosmic defect** that generates the observed bulk flow.

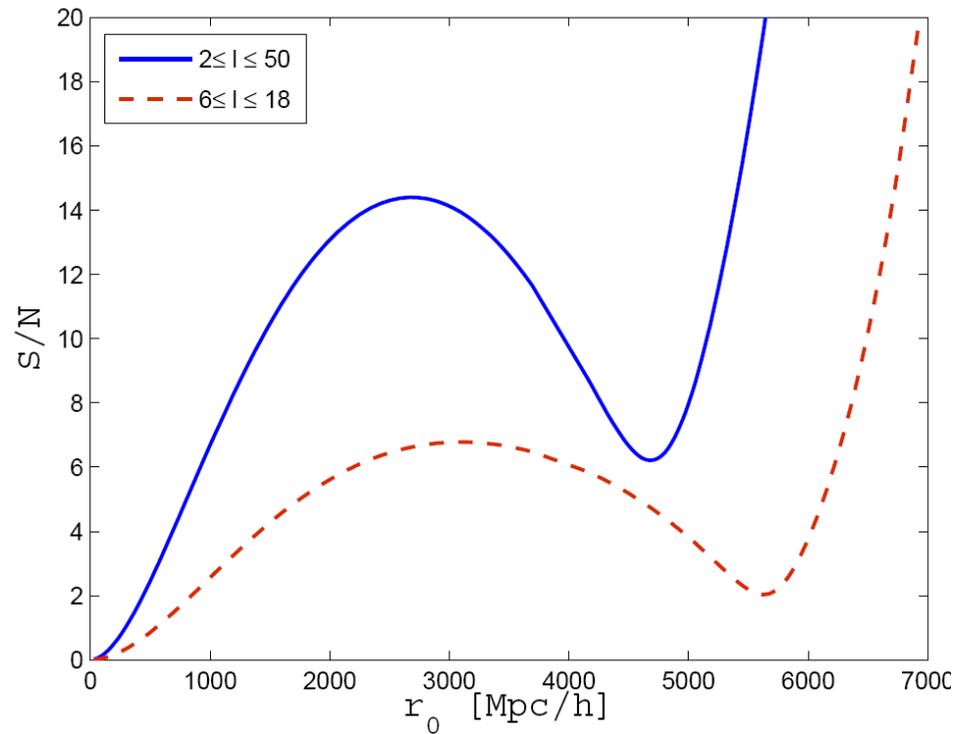


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In **0807.3216** I showed that some stringy models of inflation have exactly this property:  
Pre inflationary particles, that are essential to resolve some problems in the model,  
provide the seed for anomalously large structures.

About a year later [0911.2100](#) with [A. Fialkov](#) and [E. Kovetz](#) we studied the cosmological imprints of these giant structures.

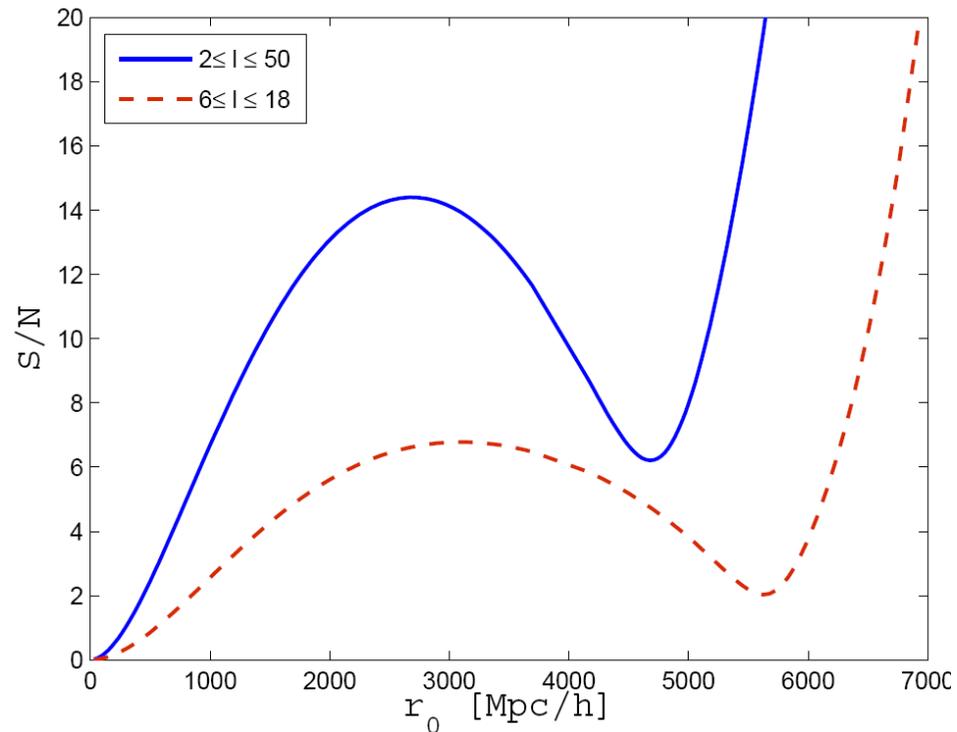
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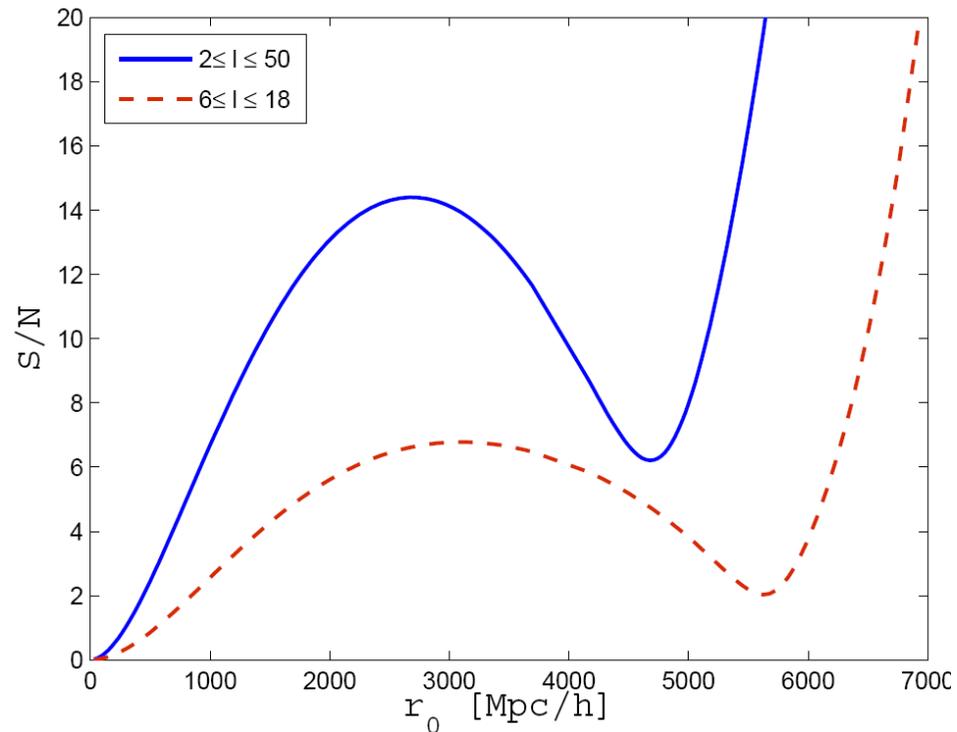
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What kind of imprints  
should we look for?



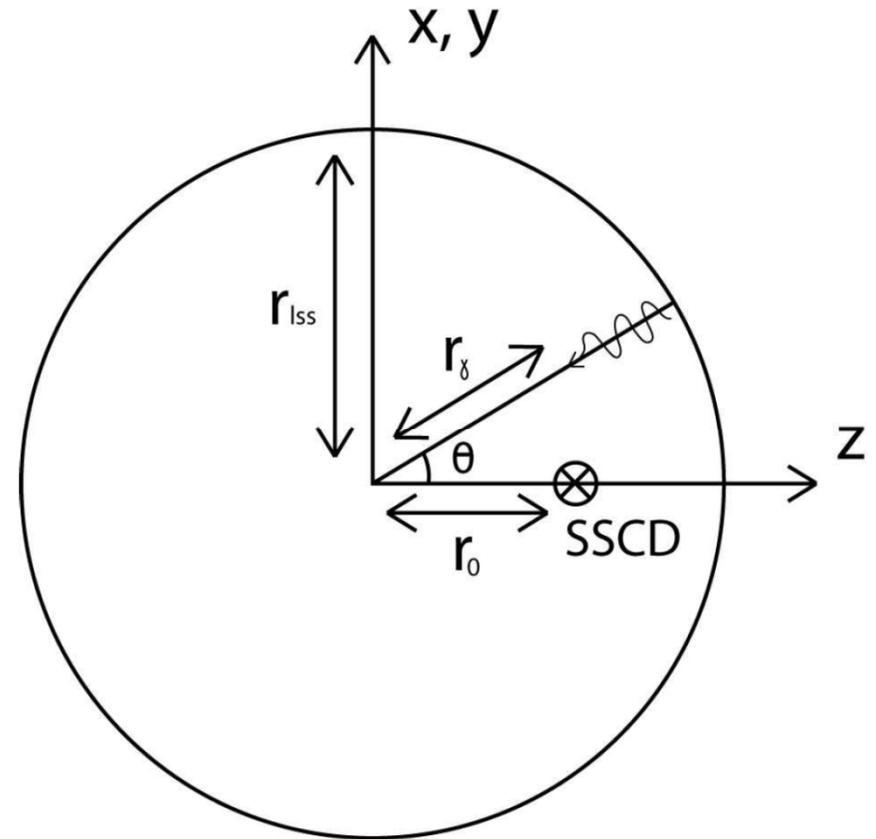
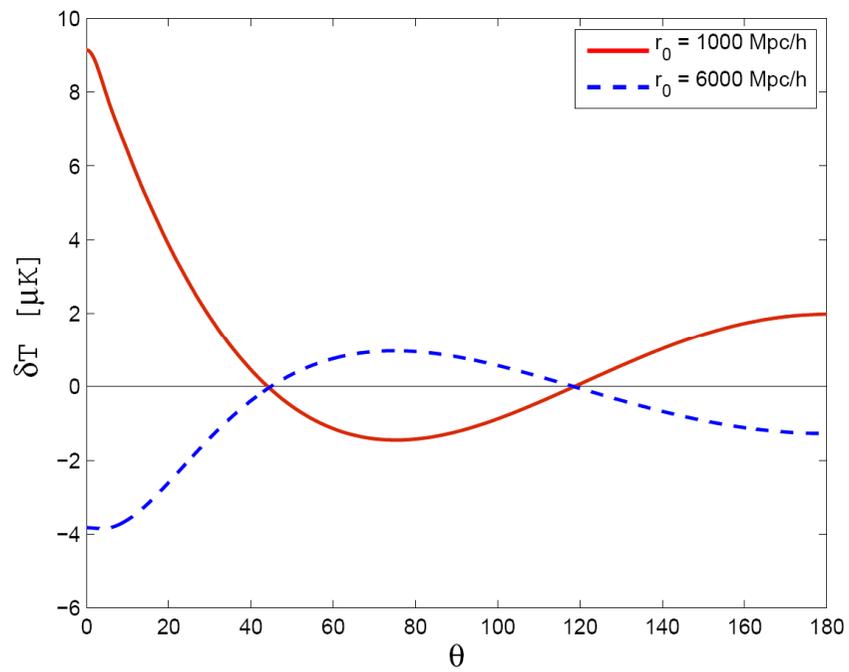
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The distinct imprint:

GIANT RINGS in the CMB sky that  
are aligned with the peculiar velocity.



- A cosmic defect seeded by a pre-inflationary particle can explain two  $1/200$  features that are aligned at  $1/100$ .

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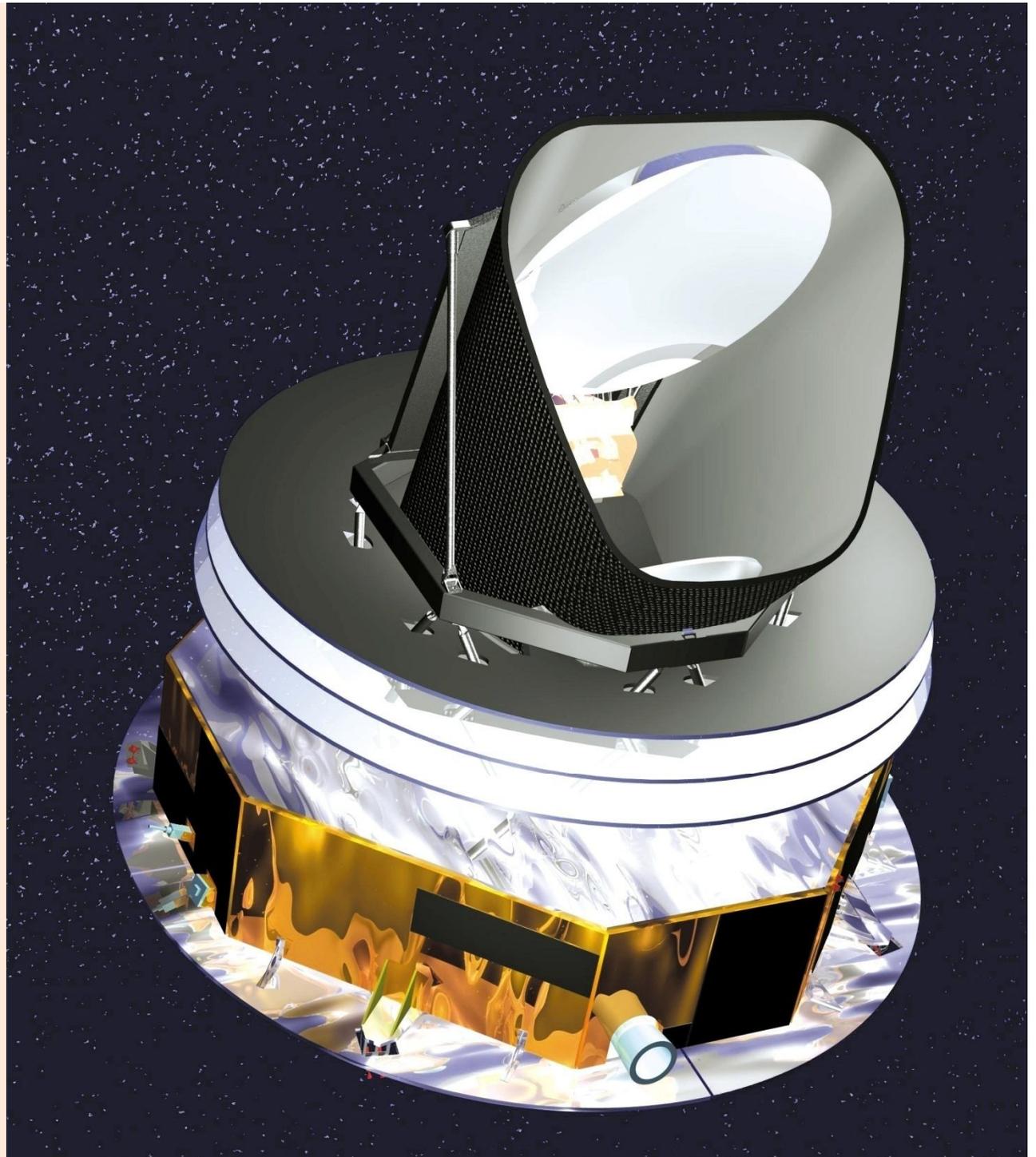
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- I'm not aware of other explanation to the giant rings, bulk flow and their alignment.

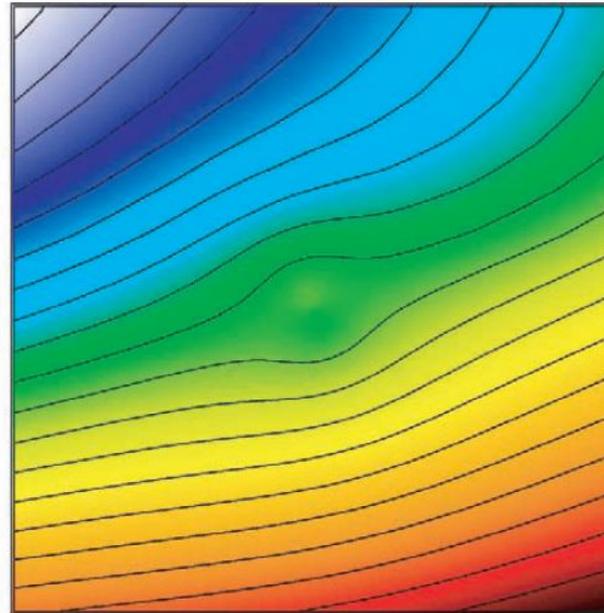
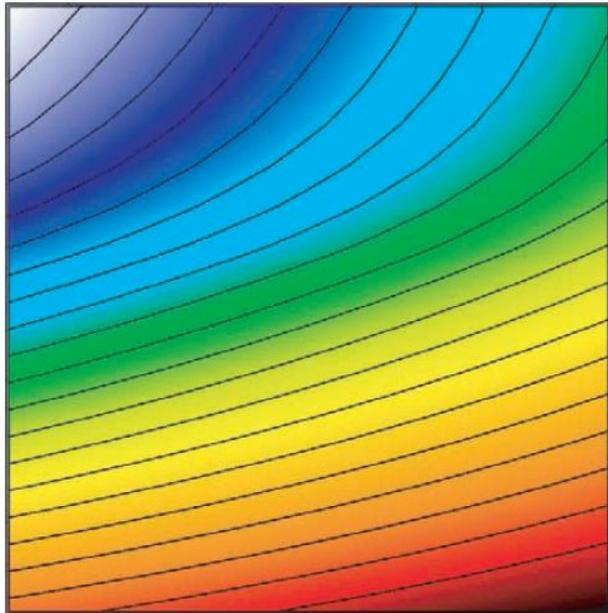
Our scenario has other distinct predictions that will be tested by Planck.



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This is how an ordinary GWL of the CMB looks like



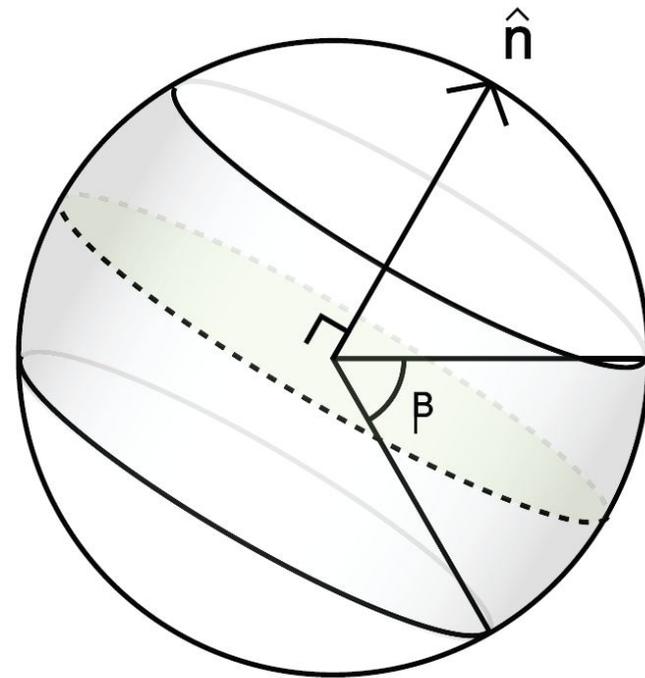
Taken from the  
Planck blue book

- The weak gravitational lensing of such a cosmic defect is very different than that of ordinary structures.

In our case the signal is spread all over the sky.

- One needs to define a WGL ringscore and see if it points in the same direction.

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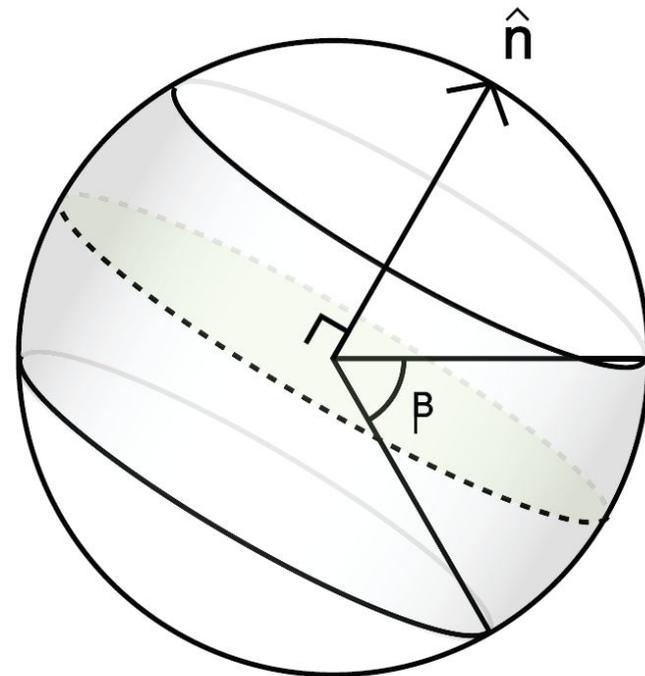


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Our calculation so far indicate that the WGL ring score is fairly weak but detectable.

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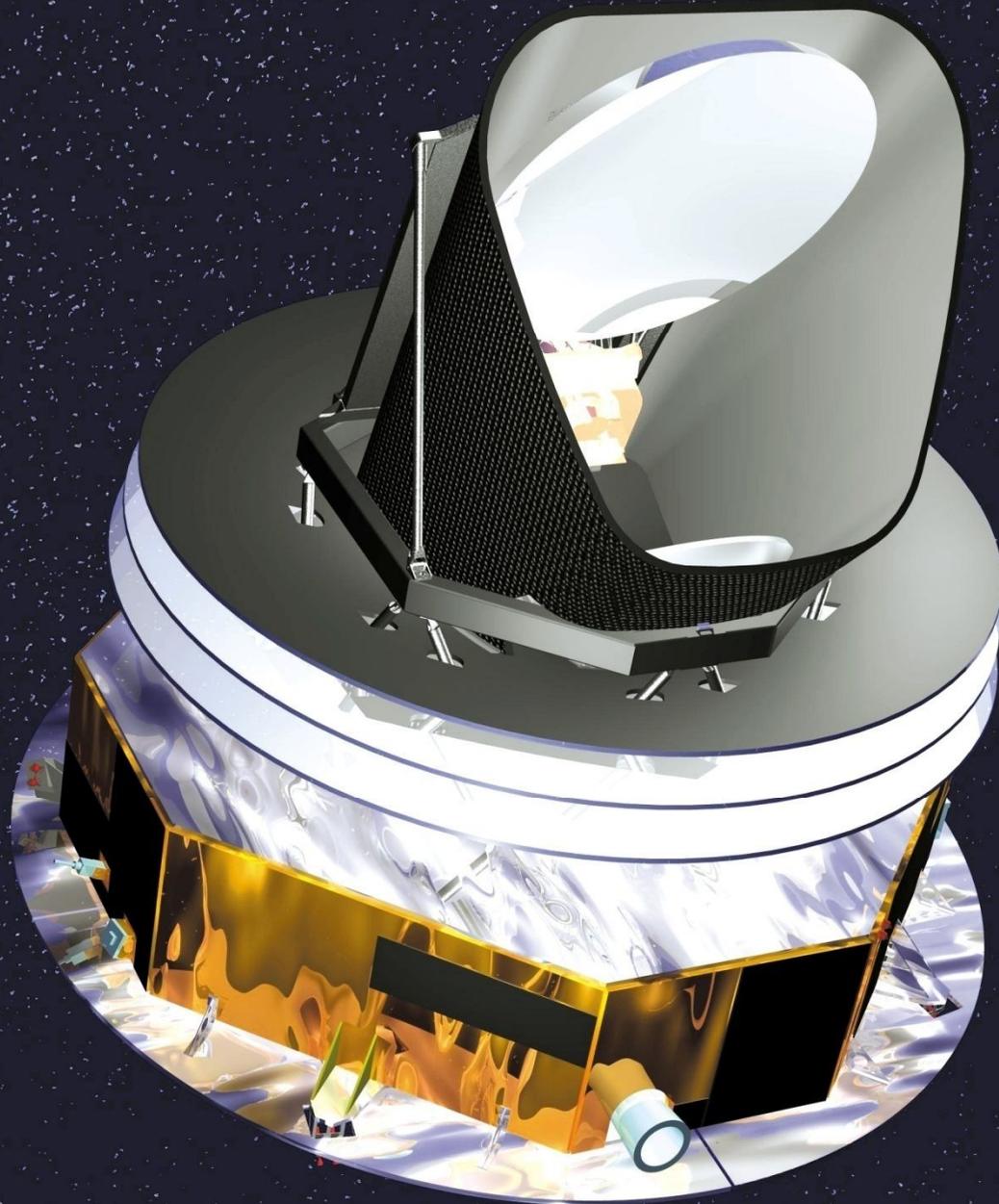
- Polarization:

right now it is not clear if there is a clear signal because of reionization.

Our scenario has other distinct predictions that will be tested by Planck.

1. Weak gravitational lensing.
2. kSZ measurement of PV.
3. Polarization.

Should be fun



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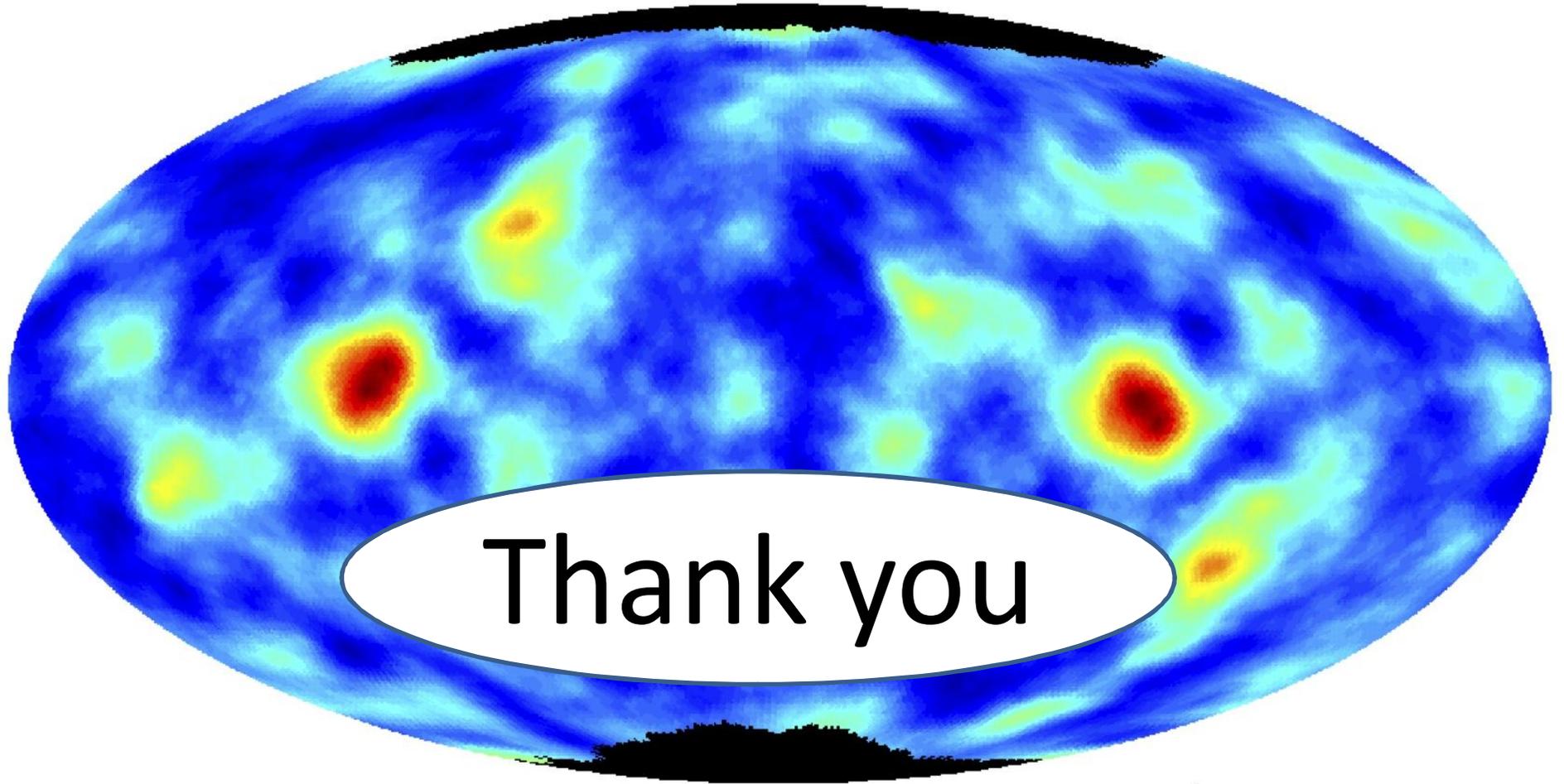
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2. These rings are aligned with a different anomaly – the bulk flow.
3. A pre-inflationary particle can explain the giant rings, bulk flow and their alignment (I'm not aware of other explanation).
4. If indeed a PIP is responsible to these anomalies than there are other predictions that will be tested by Planck.



Thank you













