Anisotropic Temperature Correlation Function

(Work in progress)

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Challenges New Physics in Space
April 2009
Campos do Jordão

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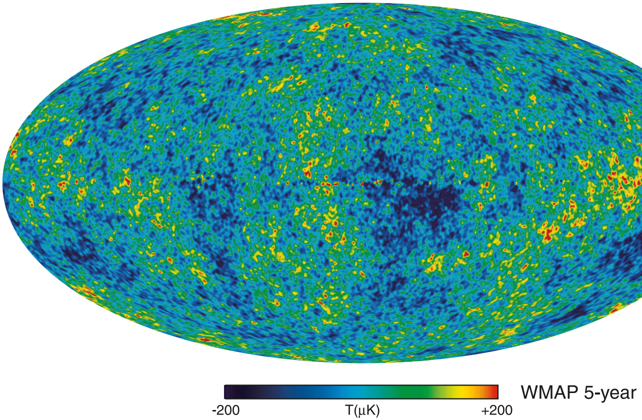
Here it is:



...Precisely, we'd like to find out more about some of its anomalies, like:

- The low multipole alignments
- North/South and the Cold Spot asymmetries
- The low power in the quadrupole C_2
- Any statistically significant deviation from isotropy and/or gaussianity

Why is this a challenge?

In its simplest realization, i.e, single field inflation, the temperature of the universe is a gaussian random event... So any deviation of it could tell us more about the primordial universe.

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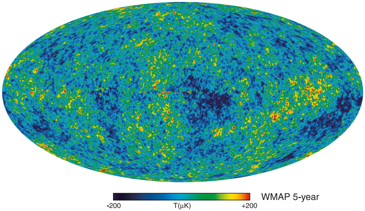

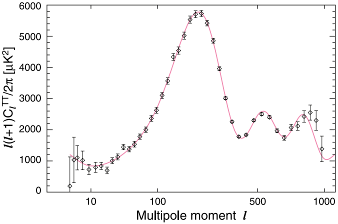

The temperature and its two-point function are defined by

$$\Delta T = \Sigma_{\ell,m}\, a_{\ell,m} Y_{\ell,m}\,, \qquad C(\mathbf{n}_1, \mathbf{n}_2) = \langle \Delta T(\mathbf{n}_1) \Delta T(\mathbf{n}_2) \rangle$$

The universe is statistically isotropic if and only if

$$C(\mathbf{n}_1, \mathbf{n}_2) = \Sigma_\ell (2\ell + 1) C_\ell P_\ell(\mathbf{n}_1 \cdot \mathbf{n}_2)/4\pi\,, \qquad C_\ell = \frac{1}{2\ell + 1} \Sigma_\ell |a_{\ell,m}|^2$$

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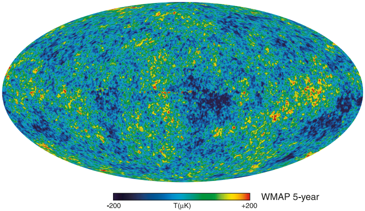

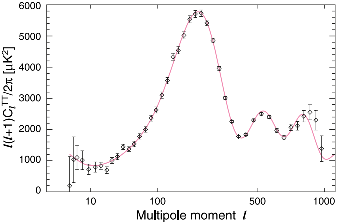

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If it is not isotropic, what can it be?

Virtually anything! So it is important to analyze the problem in as much an independent manner as possible. For example:

- Pullen & Kamionkowski (2008) introduced a simpler version of it

$$C(\boldsymbol{n}_1, \boldsymbol{n}_2) : S^2 \rightarrow \mathbb{R}$$

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Angular-planar correlation function

Motivated by recent analysis (Copi *et.al* 2005), which suggest that the ecliptic and/or the galactic planes may be important in CMB analysis, we consider

$$C(\boldsymbol{n}_1, \boldsymbol{n}_2) = C(\boldsymbol{n}_1 \cdot \boldsymbol{n}_2) + C(\boldsymbol{n}_1 \times \boldsymbol{n}_2)$$

which can be expanded as

$$C(\boldsymbol{n}_1, \boldsymbol{n}_2) = \Sigma_{\ell,l,m}\, \mathcal{C}_\ell^{lm} P_\ell(\cos\vartheta) Y_{l,m}(\theta, \phi)$$

In this way we can define a rotationally invariant angular-planar power spectrum statistics

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Some statistics...

The first model we would like to test with the angular-planar estimator is the gaussian and isotropic model itself. Using...

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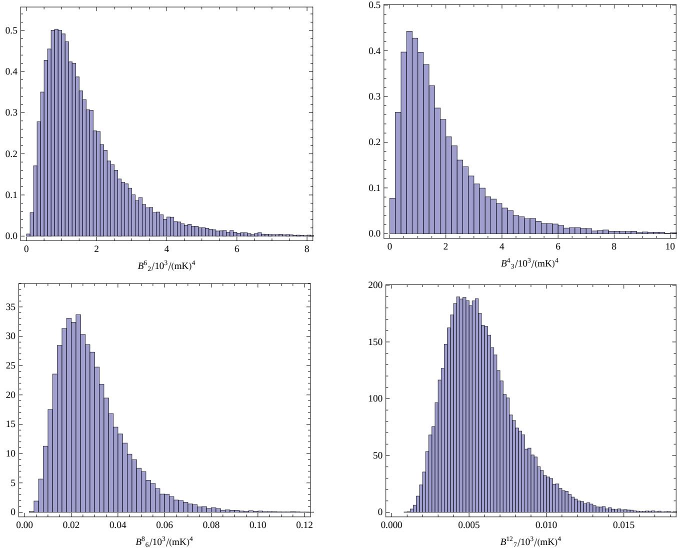
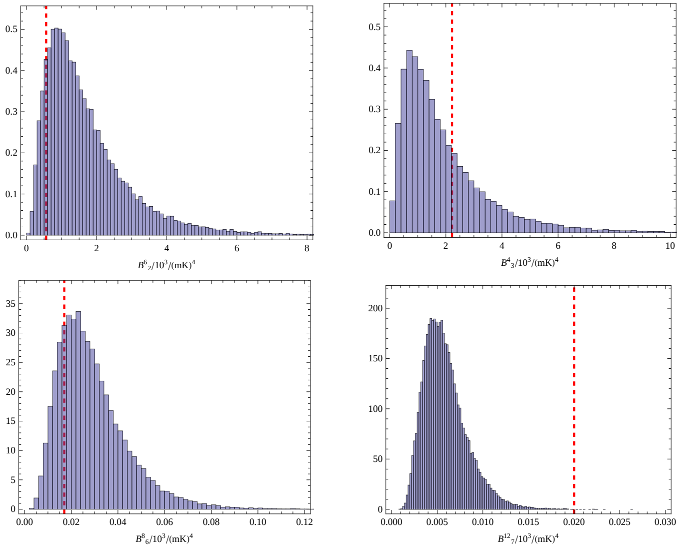


Now, we would like now to compare it to the Wmap 5yr data...



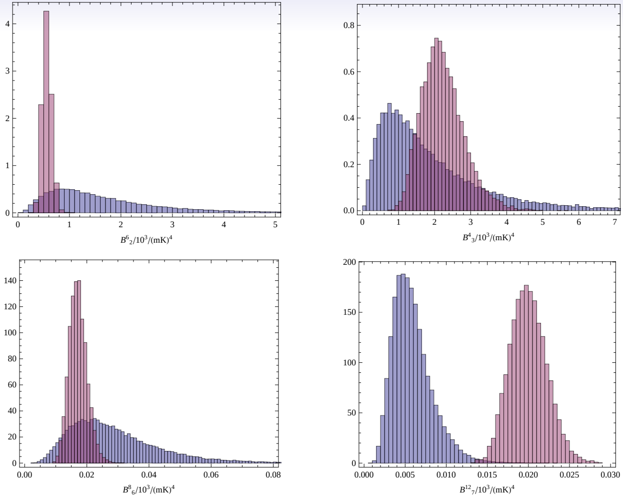
Rigorously, we need to consider the CMB measurement errors as random variables:

$$\Delta T_{\rm map}(\boldsymbol{n}) = \Delta T_{\rm CMB}(\boldsymbol{n}) + \text{statistical and istrumental errors}$$

In order to estimate the errors, we took the mean and deviation of the following various data set

- Third year data: ILC and HILC with different sky-cuts (KQ75 and KQ85)
- Five year data: ILC and HILC with different sky-cuts (KQ75 and KQ85)

So, we will suppose that statistical and instrumental errors are gaussian random variables, with means and variances defined by these data set.



The probabilities of observing such values are

$$P_<(B_2^6) = 14.2\%,\ P_<(B_6^8) = 29\%,\ P_>(B_3^4) = 31\%,\ P_>(B_7^{12}) = 0.037\%$$

Partial Conclusions

We have build an estimator able of quantifying angular and planar correlations of the CMB, which is:

- unbiased, minimum-variance and rotationally invariant
- model independent

This work is still in progress. In particular, we haven't checked the effect of different masks in our final probabilities.

...the exact role of gaussianity and statistical isotropy in the CMB anomalies is still unknown, and a well defined distinction between these two properties is still a major challenge.

Acknowledgements

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and the audience.

Thank you!