Search for Cosmic Strings using SPT Data

Ebtihal M. Abdelaziz
Supervisor: Adam Anderson

SIST 5 minutes, 5 slides

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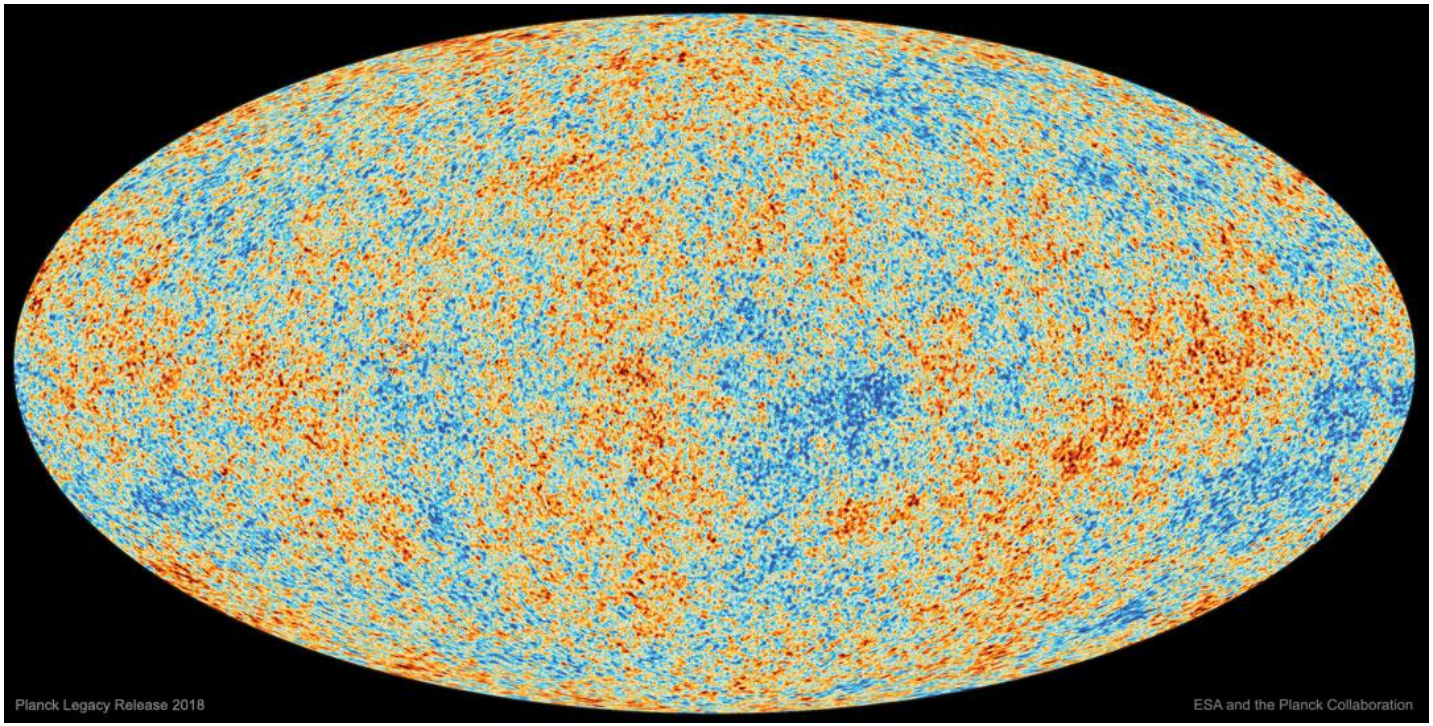
SOUTH POLE TELESCOPE SPT

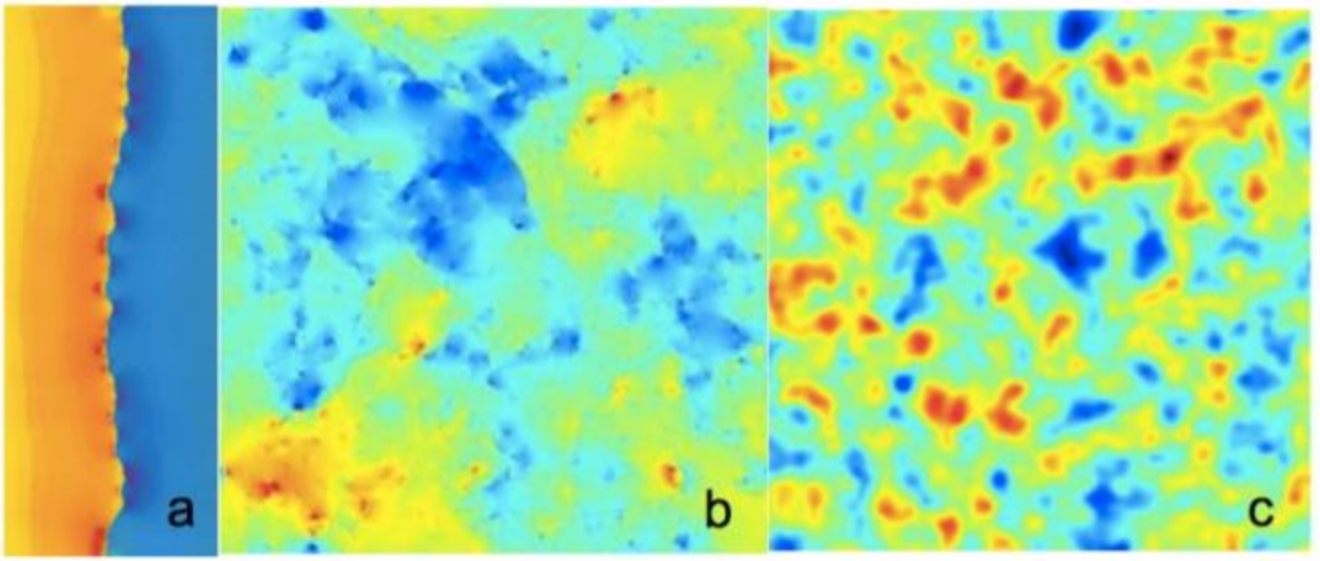
Cosmic Microwave Background

- Formed about 380,000 years after the Big Bang
- Helped us measure cosmic parameters to a great agreement with theory
- CMB maps show fluctuations in temperature or polarization
- It is measured by microwave telescopes such as the South Pole Telescope (SPT)
- Cosmic Strings have been constrained to be less than 10% of the total CMB anisotropy



Cosmic Strings

- Strings are linear topological defects
- Allowed by the standard model of physics
- Have not been detected before
- Possible detection methods include finding their power spectrum and edge detection algorithms



a) a line-discontinuity in CMB temperature caused by a single string on a uniform background (image provided by Proty Wu and Paul Shellard, (J.H.P.Wu PhD thesis, U. of Cambridge, 2000)). b) anisotropy caused by a network of strings alone (0708.1162). c) anisotropy caused by a network of strings with CMB anisotropy (1004.2885).

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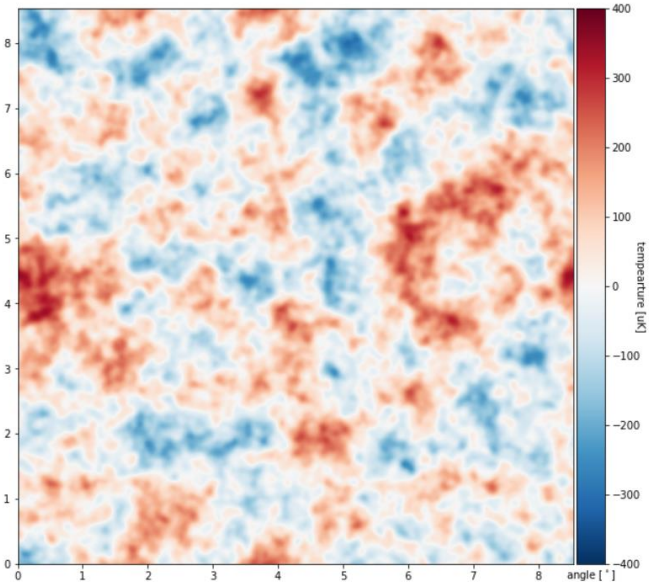
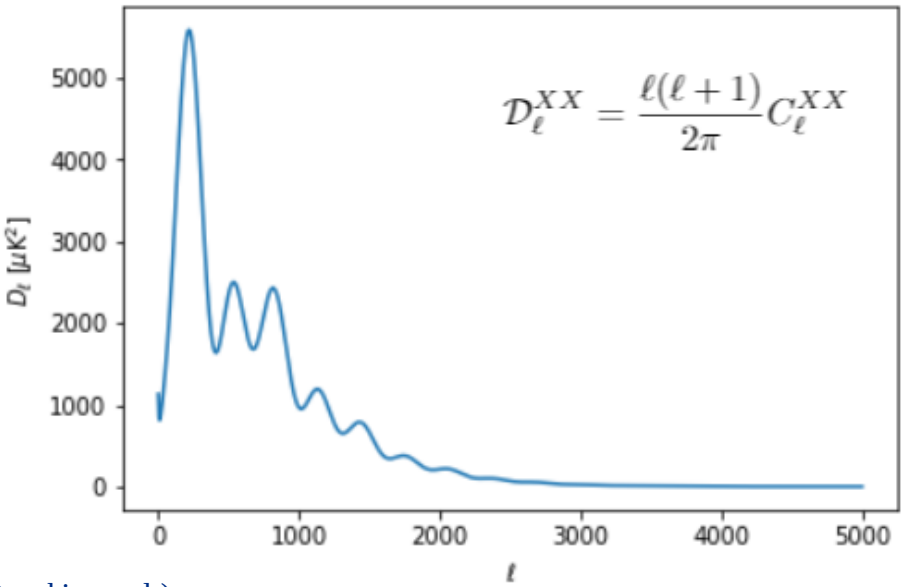
Power Spectrum

(Pictures from CAMB)



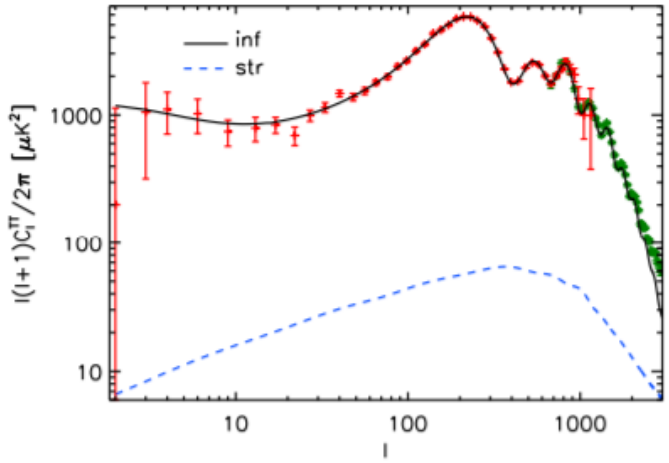
Fourier Transform



Amplitude squared of anisotropies

Angular scale

(Picture from Dvorkin et al.)



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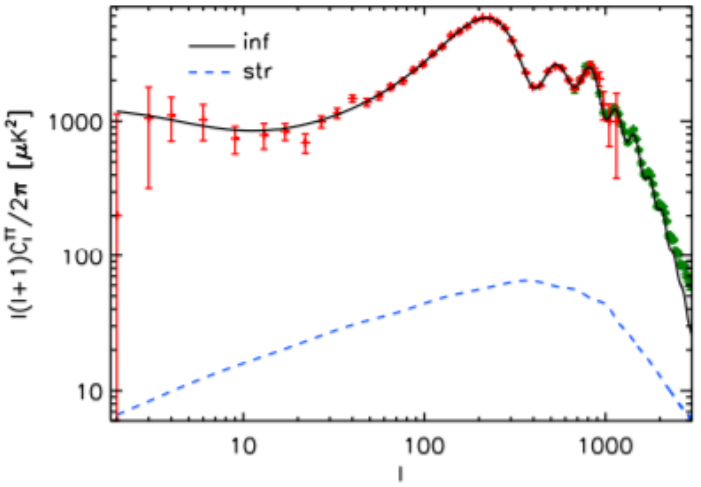
Fisher Forecast

- Tells us about the maximum uncertainties in the values we are trying to measure

$$F_{ij} = \sum_{\ell} \frac{2\ell+1}{2} f_{sky} \mathrm{Tr}\left(\boldsymbol{C}_\ell^{-1}(\theta) \frac{\partial \boldsymbol{C}_\ell}{\partial \theta_i} \boldsymbol{C}_\ell^{-1}(\theta) \frac{\partial \boldsymbol{C}_\ell}{\partial \theta_j} \right)$$

$$\mathbf{C}_\ell \equiv \begin{pmatrix} C_\ell^{TT} + N_\ell^{TT} & C_\ell^{TE} & C_\ell^{Td} \\ C_\ell^{TE} & C_\ell^{EE} + N_\ell^{EE} & 0 \\ C_\ell^{Td} & 0 & C_\ell^{dd} + N_\ell^{dd} \end{pmatrix}$$

$$\sigma_i \equiv \sigma(\theta_i) = \sqrt{(\mathbf{F^{-1}})_{ii}}$$



(Picture from Dvorkin et al.)

References

1. Physics Today 68, 3, 28 (2015); doi: 10.1063/PT.3.2718
2. M. Landriau and E. Shellard, Phys.Rev. D83, 043516 (2011), 1004.2885.
3. A. A. Fraisse, C. Ringeval, D. N. Spergel, and F. R. Bouchet, Phys.Rev. D78, 043535 (2008), 0708.1162.
4. Dvorkin C, Wyman M, and Hu W. 2011. "Cosmic String Constraints from Wmap and the South Pole Telescope Data." *Physical Review D - Particles, Fields, Gravitation and Cosmology* 84 (12). https://doi.org/10.1103/PhysRevD.84.123519.

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