The CMB power spectrum

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Abstract. I compute the CMB power spectrum using all previous parts in the project.

0.1 Introduction

In this project I am following the algorithm presented in Callin (2005)[1] for simulating the cosmic microwave background. This is the final part of the project.

In the first part I set up the background cosmology of the universe, and made a function that could find the conformal time as a function of x. In the second part I computed the electron fraction, electron density, optical depth and visibility function for times around and during recombination. The third part use the two previous to compute the density perturbations, and velocities of dark matter and baryons. This also included the temperature multipoles Θ_l.

This final part combines all of these quantities to compute the final CMB power spectrum.

As previously done I will continue building on the skeleton code provided.

0.2 Equations

Transfer function

$$\Theta_l(k, x = 0) = \int_\infty^0 \tilde{S}(k, x) j_l[k(\eta_0 - \eta)]dx, \tag{1}$$

where j_l is the spherical Bessel functions, and S is the source function defined

$$\tilde{S}(k, x) = \tilde{g}\left[\Theta_0 + \Psi + \frac{1}{4}\Pi\right] + e^{-\tau}[\Psi' - \Phi'] - \frac{1}{k}\frac{d}{dx}(\mathcal{H}\tilde{g}v_b) + \frac{3}{4k^2}\frac{d}{dx}\left[\mathcal{H}\frac{d}{dx}(\mathcal{H}\tilde{g}\Pi)\right]. \tag{2}$$

The only variable not explained earlier in this equation is $\Pi = \Theta_2 + \Theta_0^P + \Theta_2^P$, which contatin two not previously used variables Θ_0^P, and Θ_2^P. These two are related to the polarization of the temperature multi poles. Since we chose to not include polarization and neutrinos in the last part of the project, these two can be set to zero, which means that for our case $\Pi = \Theta_2$.

0.3 Implementation

0.4 Conclusions

Unfortunately time did not allow me to use a Metropolis algorithm to estimate the values of the various cosmological parameters. This is something I will have to do on my own time afterwards. This is unfortunate as this would have been the icing on the cake.

0.5 References

[1] P. Callin, astro-ph/0606683

0.6   Source code

The source code for the function made for computing the high resolution source function in evolution_mod.f90 is included as well as the file cl_mod.f90 file used for computing the final power spectrum is included for inspection. This file depends on all files previously used in the three earlier parts of the project.