In this project you will compute the power spectrum of CMB lensing.

1. Find an expression in the literature for the CMB lensing power spectrum $C_L^{\kappa\kappa}$, given the matter power spectrum $P(k, z)$, under the Limber approximation. First, compute this integral using completely your own code: you can use the fitting formulae for the matter power spectrum from Eisenstein and Hu 1998, and for the redshift-dependent growth factor $D_1(z)$ you can integrate an ordinary differential equation (e.g. Dodelson textbook).

2. Now, compute the same integral at high precision using the $P(k, z)$ and growth factor from the CAMB library (i.e. perform your own Limber integral, but use $P(k, z)$ and $D_1(z)$ from CAMB). It is probably easiest to use the python wrapper to this library. For a scale L of your choice make a plot of the various terms, either vs z or comoving distance χ.

3. Make a plot of your final spectra, together with the 2015 data from the Planck satellite.

4. For the precise (CAMB-based) spectrum, try changing the parameters A_s, $\Omega_m h^2$ and m_ν – look at what happens qualitatively. At what point for each of these parameters does it look (by eye) like the Planck data are no longer a good fit? Add these perturbed curves to your original curve. In a separate panel, plot the CMB temperature power spectrum for these same values of the cosmological parameters, together with the Planck temperature power spectrum data.

5. (Bonus – if time) Try adding in the corrections for nonlinear growth in $P(k, z)$ by turning on the so-called “Halofit” corrections. Note that this scales the matter power spectrum in a redshift-dependent way, so you will most likely now need CAMB to write out the power spectrum at a range of redshifts.