OBSERVATIONAL COSMOLOGY

Problem sheet 8 – SZ effect
Due date: 02.07.2019

(a) Plot the spectrum of the thermal SZ effect for a galaxy cluster with Comptonization parameter $y = 10^{-4}$. To be precise, plot the change in specific intensity ΔI (in units of MJy/sr) against frequency (in GHz).
(Hint: Use $T_{\rm CMB} = 2.7255$ K and $I_0 = 2(k_{\rm B}T_{\rm CMB})^3/(hc)^2 = 270.33$ MJy/sr. Neglect the relativistic corrections, i.e. the temperature dependent term in the frequency function.)

(b) Again plot the tSZ spectrum, but this time showing the change in the CMB brightness temperature (i.e. $\Delta T_{\rm CMB}$, in units of μK) against frequency.

(c) Find the frequency where the tSZ signal becomes zero, either analytically or graphically.

(d) Assume this cluster is moving *towards* you with a velocity 300 km/s with respect to the CMB rest frame. What will be the newly obtained frequency where the combined SZ signals will be zero? To get the cluster optical depth, assume it to be isothermal, with temperature $k_{\rm B}T_e = 5$ keV.