

Particle Astrophysics, 171.697

Problem Set 8

Due: First class of week 9

1. Calculate the mean-free path of a photon to Thomson scattering as a function of redshift before recombination and then plot (or sketch) the ratio Γ/H , where Γ is the scattering rate and H the expansion rate, as a function of time t .
2. Calculate (using, at least roughly, the current best values for the various relevant cosmological parameters) the sound horizon at the surface of last scatter. What comoving wavenumber does this correspond to? What angle does this distance subtend on the CMB sky? What multipole moment ℓ does this correspond to?
3. (Problem 14 in Weinberg's cosmology book) Consider the equations for scalar fluctuations in Newtonian gauge in a universe containing only cold dark matter. Find the two solutions of the coupled equations for Φ_q and δu_q . (You can normalize these solutions any way you like, but keep it simple.) For each solution, calculate \mathcal{R}_q , $\delta\rho_q$, and ζ_q . Do not make any assumptions about the magnitude of the wave number.