ASSIGNMENT 5, due date April 3rd, 2013

Let us consider flat Universe with radiation ($T_0 = 2.726\ K$), three types of relativistic neutrinos, and dust-like matter. $H_0 = 70\ km/s/Mpc$.

1. Estimate the comoving scale of the peak in the matter density fluctuations power spectrum. Use Mpc^{-1} units

2. What should be the amplitude of the decaying mode of density perturbations of the scale that enters horizon at matter-radiation equality relative to the growing mode, in order decaying and growing mode be equal at the present time ?

3. What is the comoving size of sound horizon at $T = 3000\ K$ epoch ? How much of then will fit in the circumference of the present day horizon ?

4. We have derived the equation for density perturbations in pressureless matter, that is valid even if there are other uniformly distributed components

$$\ddot{\delta} + 2H\dot{\delta} - \frac{3}{2}H^2\Omega_m(t)\delta = 0 \tag{1}$$

   We call the 'growing' mode the one that grows fastest, or decays slowest. Write the general solution when the Universe is dominated by radiation, with matter being subdominant again, $\Omega_m(t) \ll 1$, assuming that scale of the perturbation is shorter than the radiation Jeans length.