

In the name of God

Department of Physics
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ADVANCED TOPICS IN MODERN COSMOLOGY

Exercise Set 12

(Date Due: 1393/02/30)

1. Using, continuity equation, Euler equation, Entropy conservation, in an expanding universe show that in comoving coordinate

$$\ddot{\delta}_k + 2H\dot{\delta}_k + \left(\frac{k^2 v_s^2}{a^2} - 4\pi G\bar{\rho} \right) \delta_k = \frac{\sigma}{\bar{\rho}a^2} \delta S_k$$

Then for $\lambda > \lambda_J$ and with adiabatic perturbation solve δ_k as a function of a . (Hint: suppose that $\delta_k(a_{CMB}) \sim 10^{-6}$)

2. Show that in expanding universe for $\lambda < \lambda_J$:

$$\delta_k \sim a^{-1/2} \exp\left(\pm i v_s k \int dt' a(t')^{-1}\right)$$

3. Show that for potential we have;

$$\ddot{\delta}_{\phi_k} + 3H\dot{\delta}_{\phi_k} + \left(\frac{\ddot{a}}{a} - \frac{1}{2} \frac{\dot{a}^2}{a^2} - \frac{3}{2} K \right) \delta_{\phi_k} + k^2 v_s^2 \delta_{\phi_k} = 0$$

Good luck, Movahed
