

Due on November 17 24.00

1. **Running of the spectral index.** Assuming slow-roll, calculate $d\varepsilon/d(\ln k)$, $d\eta/d(\ln k)$, and then α_s to leading order in the slow-roll parameters.
2. **Conservation in the super-Hubble limit.**
 - a) Starting from eqs. (9.8) and (9.10), derive eqs. (9.18) and (9.19).
 - b) Show that if $w = v^2$, then $\delta_{\mathbf{k}} = -2\Phi_{\mathbf{k}} = \text{constant}$ is a solution in the long-wavelength limit $k \ll aH$. (You may assume that $a \propto t^n$ with $n > 1/4$ and $v^2 = \text{constant} \geq 0$.)
 - c) Is this the only solution? If so, explain why. If not, is it the dominant solution at late times?
3. **No growth of radiation perturbations.** Assuming there is only radiation ($v^2 = w = \frac{1}{3}$), derive the evolution of $\Phi_{\mathbf{k}}$ and $\delta_{\mathbf{k}}$ in the deep sub-Hubble regime ($k \gg aH$).
4. **Growth of matter perturbations.** Assuming there is only matter ($v^2 = w = 0$), derive the evolution of $\Phi_{\mathbf{k}}$ and $\delta_{\mathbf{k}}$ in the deep sub-Hubble regime ($k \gg aH$).