Homework problems 2

Group II

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Problem No 4.15

Dark Energy equation of state from quintessence

In quintessence model with potential \( V(\phi) = \frac{1}{2} m^2 \phi^2 \), find the present value of the dark energy equation of state parameter \( w \) as function of the present value \( \phi(t_0) = \phi_0 \). Choose the present value \( \phi \) in such a way that \( w_0 = 0.9 \), and find \( w(z) \) as function of redshift at \( 2 > z > 0 \). Take the values \( \Omega_\phi \equiv \Omega_\Lambda = 0.73 \), \( \Omega_m = 0.27 \) and make use of the fact that the scalar field changes slowly at the present epoch.

Problem No 5.4

Chemical potential

Estimate the value of the chemical potential for u-quark at temperature 1 GeV.

Problem No 6.6

Hydrogen abundances at recombination

Find relative equilibrium abundances of hydrogen atoms at 2s- and 2p-levels at temperature \( T_{eq} = 0.33 \) eV. Disregard higher levels in this calculation.