Physics 262 Early Universe Cosmology

Homework 4

Assigned April 22

Due April 28 11pm (uploaded on canvas)

Clarifications added 4/26/21in blue

4.1) For the following three cases, express the Friedmann eqn purely in terms of a, $\dot{a}$, and constants. Integrate (analytically) to get an expression for $a(t)$. For the first two, use the convention $a(0)=0$. In each case, give your answer in terms of t_0 and a_0 $(=a(t_0))$.

i) A flat universe containing only Relativistic Matter

ii) A flat universe containing only Non-relativistic matter.

iii) A flat universe containing only ρ_Λ

4.2) The equation of sate for dark energy is often parameterized by the expression

$$w(a) = w_0 + w_a(1-a) \qquad (1.1)$$

Derive an analytic expression for the dark energy density $\omega_Q(a)$ in terms of $\omega_{Q,0}$, w_0 and w_a. For this problem we are taking $a(t_0)=1$

Note: As we will discuss later in class, there are different ideas about what drives the cosmic acceleration. One of them is a cosmological constant (the subject of problem 4.1.iii), another is a fluid called "quintessence" which can take on different equations of state (the subject of problem 4.2)