Exercise	1	2	3	Total
100%	6	6	6	18
Points				

Extragalactic Astronomy and Cosmology

Homework 8 - Lecture 19 - multiple component Universe

Due date: November 16

1 The Future of our Universe

The most likely cosmology describing our own Universe has a flat geometry with a matter density of $\Omega_{m,0} \simeq 0.3$ and a cosmological constant with $\Omega_{\Lambda,0} = 0.7$. What will the values of Ω_m and Ω_Λ be when the Universe has expanded to be five times its present size? Use an approximation suggested by this result to find the late-time solution to the Friedmann equation for our Universe. What is the late-time value of the deceleration parameter q ?

2 Density parameter as a function of redshift

Show that in a spatially-flat cosmology which considers matter and cosmological constant the density parameter evolves as

$$\Omega_m(z) = \Omega_{m,0} \frac{(1+z)^3}{1 - \Omega_{m,0} + (1+z)^3 \Omega_{m,0}} \tag{1}$$

3 Friedmann equation for a four-component Universe

Suppose that the Universe contains *four* different contributions to the Friedmann equation, namely radiation, non-relativistic matter, a cosmological constant, and a (hypothetical) component for which the density parameter evolves proportional to $fraca^2 2$. Write down the Friedmann equation for this Universe. Which of those components would you expect to dominate the Friedmann equation at early times, and which at late times? Give reasons for your answer!

Hint: This is not an exercise to write down a lot of equations but to think about