AY C10/L&S C70U **Name:** _____
Fall 2018
Worksheet 9
10/30/2018

This worksheet goes into more detail on cosmology and the expanding Universe. There are 2 pages (including this cover page) and 3 questions. Accuracy is definitely desired, but effort and clear physical reasoning are far more important than the final answer.

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1. In this question, we will investigate some aspects of the expanding Universe. Suppose that the Universe is expanding at a rate of H_0. At the present time, the Universe has a normal matter density of ρ_0, a dark matter density of ρ_{DM} and a cosmological constant of λ_0. Assume for the moment that H_0 is a constant.

   (a) Suppose that the Universe expands at a constant rate of H_0, for some time τ. After this time, **find the factors** by which the following quantities have changed:

      i. mass density

      ii. dark matter density

      iii. dark energy density

      iv. wavelength of photons from the most distant galaxies

   (b) **Look at** the drawing at the wall of Campbell 121 facing the lobby (you can step outside if you would like). **Reproduce** it below, and **describe** what it shows.

(c) **Use your results** from part (a) to explain the drawing that you made in part (b).

2. From your plot in the previous question, **use your plot** to find the regions where astronomers making observations with Hubble's law would give an age of the Universe that is **larger** or **smaller** than the actual age.

3.