Homework 5

Due: Wednesday October 27th 2021, at class time

Always justify your answers and show your work.

1. Give a definition of the following terms, in less than 6 lines of text. Be as precise and clear as possible.

   (a) Equalization epoch of matter and radiation.

   (b) Fossil ionization left after recombination.

   (c) Velocity dispersion of a galaxy cluster.

2. If the Universe contains a generic combination of matter, radiation, curvature, and a dark energy component with negative pressure given by $p = w\epsilon$, what is the condition for the expansion to accelerate? What is this condition when the component with negative pressure dominates over all others?

3. Suppose the Universe is spatially flat and contains a single component with pressure p and energy density ϵ, obeying the equation-of-state with a unique parameter w: $p = w\epsilon$.

   Does the angular diameter distance always increase with redshift, or does it reach a maximum value? If a maximum value is reached, what redshift is it reached at and what is this maximum value?

   Give your answer as a function of w.