

ASTR340 (Fall 2018) Homework 5

The Hot Big Bang

(Due at the start of class on the 13th November 2018)

1. FMC Q11.9
2. FMC Q12.3
3. FMC Q12.6
4. Muons have a mass of $M=1.9 \times 10^{-28}$ kg. Using the formula given in the class, calculate the threshold temperature for muons.
5. A typical human being is comprised of large amounts of hydrogen and oxygen (which are combined to form water), in addition to carbon and nitrogen (which are crucial elements in most organic molecules). Iron is a small but critical component of the molecules in our blood. In addition, many of us wear small amounts of silver or gold, which are heavy elements whose nuclei are much heavier than that of iron. Which one of these elements originated in the big bang? How did the other elements come to exist? In particular, what phenomenon is associated with the production of silver and gold?
6. In recent years, a tremendous amount of effort has gone into measuring the abundance of Deuterium (D) in the Universe. Why is this? You might find it useful to refer to the abundance-density diagram from the “Where did the elements come from?” class notes and consider the effects of measurement uncertainty on any conclusions regarding the inferred baryon density.
7. Protons are slightly less massive than neutrons. Why is this a necessary condition for allowing neutrons to decay into protons? Can you think of a good reason why neutrons should not completely decay and turn into pure radiation [Hint: for the first part of this question, you should think about the energies involved and the relevance of Einstein’s mass-energy conversion formula. For the second part, you’re on your own.]