Physics 390: Homework set #7

Due Friday April 6, 2007

Reading: Tipler & Llewellyn, Chapter 13 (1-5), Chapter 14 (3-8)[1]

Questions:

1. Discuss some ways by which we could distinguish antineutrons from neutrons. For example: how would an antineutron beta-decay? What effect would a magnetic field have on a beam of antineutrons? Could a nucleus capture an antineutron?

2. Some theorists have suggested that certain constants of nature may not really be constant—they may vary slightly with time. Suppose that the fine-structure constant $\alpha = e^2/4\pi\epsilon\hbar c$ changed by some fraction over a period of 10^{10} years. What kind of experiment can you think of to test this hypothesis?

3. Use the physical constants G, $\hbar$, and c, together with dimensional analysis, to construct a quantity with the dimensions of time. This is the *Planck time*. Construct corresponding quantities with the dimensions of mass and length—the *Planck mass* and *Planck length*, respectively. Evaluate these quantities numerically. In some sense these are the "natural" units for time, mass, and length.

Problems: Chapter 13: 6, 10, 14, 27, 28, 32, 49
Chapter 14: 8[2], 21, 23

[1]The reading and problems from Chapter 14 are available online at
http://bcs.whfreeman.com/tiplermodernphysics4e/content/cat_010/Ch14toSect14-8.pdf
http://bcs.whfreeman.com/tiplermodernphysics4e/content/cat_010/Ch14SummaryProblems.pdf

[2]The book has a wrong formula. It should be $m_1 - m_2 = -2.5 \log(f_1/f_2)$