Physics 390: Homework set #7

Due Thursday December 9, 2004

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. Even though no fractionally-charged particle has ever been observed to pass through a particle detector, we say we have "discovered" quarks. What, in your opinion, constitutes a scientific discovery? Does the discovery of quarks stand up to these criteria? Argue your case.

3. 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?

4. 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, 28, 33, 49
Chapter 14:   8, 21, 23

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[1]The reading and problems from Chapter 14 are available online at
http://bcs.whfreeman.com/tiplermodernphysics4e/.