Physics 390: Homework 1

This homework is due, in class, on **Friday, January 16**.

For full credit, show all your working.

1. **Relativity:**

   (a) A spaceship leaves the Earth and flies at 99% of the speed of light (in a straight line) to another planet 100 light years away. How long does it take to make the trip from the point of view of (i) an observer who stays home on Earth and (ii) a crew member on board the ship?

   (b) Cosmic rays, which are protons traveling through space, have been detected on Earth with kinetic energies as high as 10^{20} electron volts. From the point of view of such a particle, about how long does it take to cross the galaxy from one side to the other? (The diameter of the galaxy is about 100 000 light years and the mass of the proton is 1.67×10^{-27} kg.)

2. Problem 3-8 from Tipler & Llewellyn.

3. **Wien's law:** Given Planck's radiation law,

$$u(\lambda) = \frac{8\pi hc\lambda^{-5}}{e^{hc/\lambda kT} - 1},$$

   we can derive Wien's law.

   (a) Differentiate to show that the wavelength of maximum radiation λ_m depends on temperature as $\lambda_m = b/T$ for some constant b.

   (b) Calculate the constant b to two significant figures and state its units. It may be useful to know that the solution to the equation $5e^{-x} + x = 5$ is $4.965\ldots$

4. Problem 3-15 from Tipler & Llewellyn, parts (a) and (c) only.

5. Problem 3-47 from Tipler & Llewellyn.