Differential Geometry (and Relativity) - Summer 2014

Homework 7, Sections II.6 and II.7

Due Tuesday, July 5 at 11:20

Write in complete sentences!!! *Explain* what you are doing and convince me that you understand what you are doing and why.

II.6.3. The radius of our galaxy, the Milky Way, is about 5×10^4 light years (one light year $\approx 9.45 \times 10^{17}$ cm). Can a person, in theory, travel from the center to the edge of our galaxy in a normal lifetime? Explain, using either time dilation of length contraction.

II.6.4. μ-mesons at rest have an average lifetime of about 2.3×10^{-6} sec. These particles are produced high in the Earth's atmosphere by cosmic rays. Suppose a μ-meson is created and travels downward with speed $\beta = 0.99$. How far will it travel before disintegrating?

II.6.5. At the end of this section, we deduced relativistic length contraction from time dilation. Show conversely, that if length contraction is assumed, time dilation follows. You can again describe this in terms of trains and platforms.

II.7.3. The observer in frame S finds that a certain event A occurs at the origin of his coordinate system, and that a second event B occurs 2×10^{-8} sec later at the point $x = 1200$ cm, $y = z = 0$ cm. (a) Is there an inertial frame observer S' for whom these two events are simultaneous? (b) If so, what is the speed and direction of motion of S' relative to S? (c) Verify that the proper distance $\Delta\sigma$ between A and B is the same in both coordinate systems.

"Theorem." Suppose inertial frame S' has velocity β_1 relative to inertial from S. Suppose that inertial from S'' has velocity β_2 relative to S'. *Use the Lorentz transformation* to prove that the velocity of S'' relative to S is $\beta = \dfrac{\beta_1 + \beta_2}{1 + \beta_1\beta_2}$. **Note.** If we take $\beta_1 = \beta_2 = 1$, then we get $\beta = 1$. This, again, illustrates the constancy of the speed of light.