Phys 3330 Electricity & Magnetism II
Spring 2017
Assignment #9 - due Monday May 8th 2017

Relativity

1. Define the transformation matrix by $\mathbf{r}_4' = \mathbf{L}\,\mathbf{r}_4$ and

$$\boldsymbol{L} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & \gamma & i\frac{\gamma v}{c} \\ 0 & 0 & -i\frac{\gamma v}{c} & \gamma \end{bmatrix}$$

   and the reverse transformation matrix **L**' which is the same as **L** but with the opposite sign for v. Show that **LL**' = **1**, the unit matrix which has 1's along the diagonal, and 0's elsewhere.

2. Find the determinant of the matrix **L**.

3. Show that dx' dy' dz' d(ict)' = dx dy dz d(ict). Hint: evaluate the Jacobian. This shows that not only do the two observers agree on the 4 dimensional radius they also agree on a 4 dimensional volume.

4. Starting with the formula for the velocity transformation, show that if O is looking at a photon moving with a speed u = c, then O' also measure the speed as u' = c.

5. Relative to the Earth an object is moving with a speed u<c. Starting with the velocity transformation, can a moving observer (v≠0) ever measure the speed of the object as being greater than the speed of light (u'>c)?

6. You are traveling in a spacecraft which is moving with a velocity relative to the Earth equal to ¾c parallel to the ground below you. You fire a missile with a speed of ½c relative to the spacecraft. What is the speed of the missile relative to the Earth
   a. If you fire the missile in the same direction as you are moving?
   b. If you fire the missile in the opposite direction to the direction you are moving?
   c. If you fire the missile perpendicular to the direction you are moving?