Physics 853 Quiz #2 - Friday, Sep. 17, 2010

1. Two lights flash at space-time points x_1 and x_2. An observer with four-momentum p measures the distance between the flashes. Express the distance in terms of Lorentz scalars constructed from x_1, x_2 and p.

2. Consider a particle living in a one-dimensional world and interacting with the zero$^{\text{th}}$ component of a vector potential and obeying the Klein-Gordon equation,

$$(i\partial - eA)^2\phi = m^2\phi,$$

and the vector potential is $eA = (V_0, 0, 0, 0)$, with

$$V_0 = \begin{cases} 0, & x < 0 \\ 3m, & x > 0. \end{cases}$$

Let the particle incoming from the left have momentum $p_x \to 0$.

(a) Solve for solutions, i.e., find p', B and C for solutions of the form

$$\phi(x) = \begin{cases} e^{ipx} + Be^{-ipx}, & x < 0 \\ Ce^{ip'\cdot x}, & x > 0 \end{cases}.$$

(b) What are the charge densities and currents on each side? For the charge densities, find the average over a long distance (neglect oscillating pieces).