PHYS 942 homework assignment #04

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PHYS 942
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Names ($\leq$3, write clearly): _____

Due: Wednesday, November 13, at the lecture. **Show all your steps!**

1. (*40 points*) A weather radar wave is scattered by a raindrop of radius a such that $ka << 1$, i.e., the long wavelength limit applies. The raindrop has a real dielectric constant ϵ and a small real conductance σ such that the skin depth δ is large compared to the radius a. The incident wave is plane polarized in the vertical direction.

   (a) Calculate the total absorption cross section, defined as the ratio of absorbed power over incident power flux. The former is given by the Poynting flux into the raindrop, but be careful to use the total fields in that calculation, i.e., the sum of incident and scattered fields. This is a somewhat lengthy calculation with up to quadruple cross products. However, clever application of Poynting's theorem can make this calculation much easier!

2. (*20 points*) Show that two consecutive Lorentz transformations in the same direction with velocity v_1 and v_2, respectively, are equivalent to a single transformation with $v = (v_1 + v_2)/(1 + v_1 v_2/c^2)$. Show this in two ways:

   (a) By using the explicit addition formula.

   (b) By using the boost parameter and the 4x4 L.T. transformation matrix.

3. (*40 points*) Seeing versus observing:

   (a) In the following, assume β=0.9. A rod of length L'=10 m is aligned with, and moving along the x-axis towards you at speed v. You, the observer, are located slightly above the x-axis so you can see both ends of the rod (Note: *seeing* means that a photon arrives at your eye.)

   (i) What is the rod's length L that you *observe*? How would you measure it?

   (ii) What is the rod's length L_s^+ that you *see*? Why is it different from (i)? (The effect is called *abberation*).

   (iii) What length L_s^- would you *see* if the rod moves away from you at speed v?

   (iv) How would (ii) and (iii) turn out if Galilean relativity applied?