Physics 323, Spring Quarter 2015
Electrodynamics: Homework Assignment 8

Turn in all problems and clearly note all constants and assumptions you use. (1-point penalty each otherwise)

Due 9:00 am Thursday May 28

1. In a colliding-beam accelerator, electrons and positrons collide head-on with each other at an interaction point. The particles have speed 0.6 c. Suppose the annihilation products consist solely of photons.
a. Show there must be two or more photons in the final state.
b. In the case where two photons are emitted, show that the photons are back-to-back with equal energies (in the lab frame).
c. In the case where two photons are emitted, find the energy of each photon, find the wavelength of the photons (in the lab frame).

2. (simple) The energy of an electron is twice its rest mass (rest energy).
a. Find the electron's boost factor γ and the velocity factor β.
b. Find the electron's velocity factor β for the case where its momentum is its rest mass (times c).

3. A photon has energy 0.2 GeV with velocity in the x-direction. A second photon with energy 0.1 GeV has velocity in the y-direction.
a. What's the total energy of the photons?
b. What's the total momentum of the photons?
c. Suppose these two photons annihilated to create a single particle in the final state. Find the mass of this single particle.
d. Find the direction this single particle's velocity.
e. Find the single particle's velocity factor β.

4. A laser near Earth beams light in the direction of Earth. It emits red light with intensity 10^{20} photons/second (in the laser's frame). At some initial time, the laser is at rest (relative to the Earth frame).
a. It the initial time, what's laser power detected at the Earth? Assume the light travel time is small.
b. What's the recession velocity of the laser (in the Earth's frame) after 10 years (laser time) elapsed from the initial time? Assume the laser's rest mass is 10 kg.
c. After those 10 years have elapsed, what's the laser power detected at Earth? (Ignore the light transit time).
d. Suppose you are the observer on Earth: show that the decreasing power detected over time is consistent with energy conservation.

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