CLASSICAL ELECTRODYNAMICS II

Homework Set 9

November 21, 2014

1. A particle of mass m and charge q moves in a laboratory through a static external magnetic field, where $\mathbf{B}$ is parallel to the z axis. Determine x, y, z, and t as functions of the proper time τ.

   Hint: Use the equations of motion,

$$\begin{aligned} \frac{d\mathbf{p}}{dt} &= q(\mathbf{E} + \frac{\mathbf{v}}{c} \times \mathbf{B}) \ , \\ \frac{d\mathcal{E}}{dt} &= q\mathbf{v} \cdot \mathbf{E} \ , \end{aligned}$$

   where $\mathbf{p} = m\mathbf{v}\gamma$ is the relativistic momentum and $\mathcal{E} = mc^2\gamma$ is the relativistic energy.

2. An electromagnetic wave with frequency ω and propagation vector $\mathbf{k}$ impinges normally on a mirror, which is moving with velocity $\mathbf{v}$ relative to frame S. Determine the frequency of the reflected wave in frame S.

   Hint: Consider the reflection from frame S$'$, the rest frame of the mirror and note that $(\omega/c,\mathbf{k})$ transforms like a 4-vector.