Physics 323, Spring Quarter 2016
Electrodynamics: Homework Assignment 5

(a) Turn in all problems and clearly note all constants and assumptions you use.
(1-point penalty each otherwise)
(b) Use 8½ x 11 paper & staple
(1-point penalty each otherwise)
(c) Due May 5 either 9:00 am in class or 8:45 am in the instructor's mailbox;
late homework gets 0.

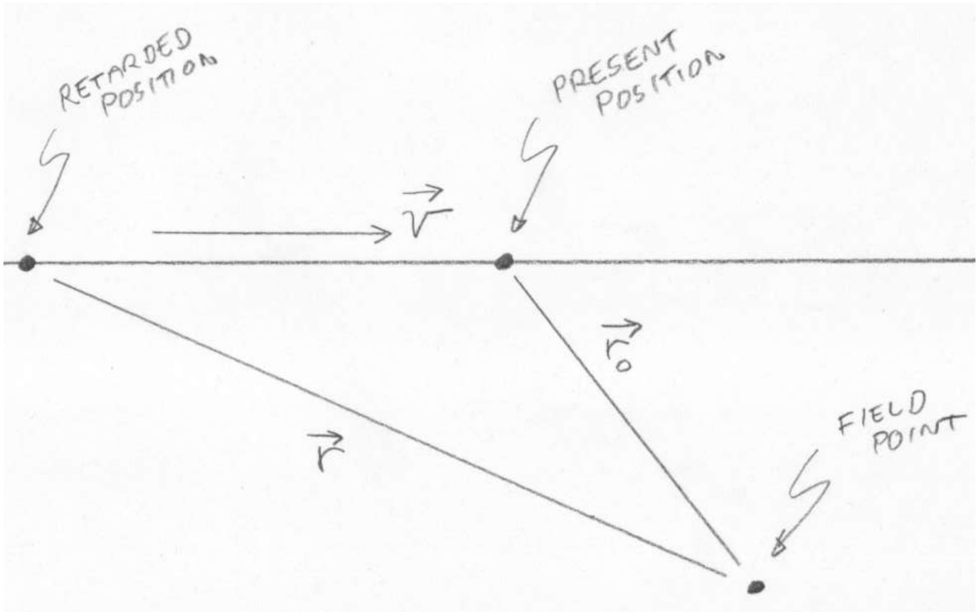
1. Recall for waveguides we had separated the fields into longitudinal and transverse parts and in Maxwell's Equations we had also separated the ∇ operator into longitudinal and transverse parts. We then found one of Maxwell's equations becomes the equation

$$\hat{k}\times\left(-\nabla_t B_z+\frac{d}{dz}B_t\right)=\hat{k}\times\left(-\frac{-i}{c^2}\omega\hat{k}\times\mathbf{E}_t\right).$$

where $\hat{k}$ is along the waveguide axis. (This is a generalization of one or more of the equations of Griffiths Equation 9.179.)
a. Derive this equation.
b. Find which, of any of the equations in Griffiths Equations 9.179 are contained in the above equation.

2. In class we studied a charge moving with constant velocity **v**, as shown below. The usual Liénard-Wiechert denominator is $d=r-(\mathbf{r}\bullet\mathbf{v}/c)$, which is as usual in terms of the retarded position. Interestingly, we found we could write this denominator (and hence the potentials and fields) in terms of the particle's present position $\mathbf{r}_o$

$$d=\left\{r_0^2-(\mathbf{r}_0\times\mathbf{v}/c)^2\right\}^{1/2}$$; derive this expression.



3. For the point charge moving in problem 2, imagine you evaluate electric flux leaving a sphere containing the charge. This is a famous problem.
a. Does the electric flux leaving the sphere depend on the radius of the sphere?
b. What do you expect the electric flux leaving the sphere to be? Explain.
c. From the electric field (Griffiths Equation 10.75) directly evaluate the electric flux leaving the sphere.

4. Consider an short oscillating electric dipole. The two charges are separated by a short distance s and the charges oscillate back and forth as $Q(t) = Q_0 e^{i\omega t}$.
a. What's the current I(t)?
b. What's the dipole moment p(t)?
c. What's the vector potential in terms of the retarded dipole moment $[p]_R$?
d. In the "far field" (distances much greater than the wavelength or spacing between the charges) what's the divergence of vector potential? You can write this in terms of the retarded dipole moment.
e. In the "far field" what's the scalar potential?

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