Physics 514, Winter Quarter 2018
Electrodynamics: Homework Assignment 1
Due Jan. 12, 5:00pm either 11:00am in class or 10:45am in the instructor's mailbox.

1. Quick problems involving gauge transformations.
a. Show it's always possible to transform into Coulomb gauge (Jackson eqn 6.21).
b. Show it's always possible to transform into Lorentz (Lorenz) gauge (Jackson eqn 6.14).
c. Show it's always possible to transform into Weyl gauge Φ=0.
d. Show it's always possible to transform into axial gauge **n•A** =0, with constant unit vector **n**.
e. Can there be a gauge with gauge-fixing condition **A**=0? Explain.
f. Demonstrate the restricted gauge transformation (Jackson eqn 6.20) preserves the Lorentz condition (Jackson eqn 6.14).

2. Consider a localized current distribution $\mathbf{J}(\mathbf{r},t) = \mathbf{J_0}(\mathbf{r})e^{-i\omega t}$ oscillating at a nearly monochromatic frequency ω. Show that the resulting magnetic field everywhere consists of a field falling as $1/r^2$ (the "induction" or "reactive" field) in the manner of Jackson eqn 5.14, plus a field falling as 1/r (a "radiation" field). Why did I add the caveat "nearly"? It happens the same is true for the electric field, but it's considerably more difficult to show.

3. Consider the retarded charge density $[\rho(\mathbf{r}',t')]_{\mathrm{ret}}$ appearing in Jackson 6.48. Does the volume integral $\iiint[\rho(\mathbf{r}',t')]_{\mathrm{ret}}\ dv'$ represent the total charge of the system? Explain. Does your reasoning apply to a system consisting of a point charge? Explain.

4. Suppose a uniform and constant surface current starts to flow everywhere on an infinite plane at some time. The current is zero before this time. Using the retarded-potential formalism, find the resulting electric and magnetic fields. (This of course can also be done directly with Maxwell's Equations, in the manner of the Feynman Lectures.)

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