Due May 28, Thursday

Problem 1 (10 points) Problem 11.6 (Radiation resistance of a magnetic dipole)

Problem 2 (10 points) The Larmor formula (Eq. 11.70) is a non-relativistic approximation to the fully relativistic formula Eq. 11.73 for the radiation caused by the motion of a single charge. Note also that the Larmor formula can be derived by taking the leading order contribution from the perturbation under the condition

$$d \ll \text{``}\lambda\text{''} \ll r.$$

Here, "λ" is c times the typical time scale of the motion of the source particle(s), where the typical time scale can be defined as $\sim \rho/\dot{\rho}$ or $\dot{\rho}/\ddot{\rho}$, etc. In the latter perturbation approach (see your notebook or the content of Section 11.1.4), you may wonder where we have made a non-relativistic approximation. Let us find the answer to this. (a) Does the approximation $d \ll r$ correspond to the non-relativistic approximation? Your answer must be fully explained. (b) How about the approximation $d \ll$ "λ"? Again, you must adequately explain your answer. [Hint: In this case, ρ is a delta function, and so taking its time derivative may seem to lead to an odd result. You can avoid this by deciding to evaluate $\dot{\rho} \equiv \frac{\partial \rho}{\partial t}$ using the charge continuity equation or, equivalently, using insights gained by the integration by parts technique after the direct differentiation. Note: the approximations that we are concerned with here are referred to as approximations 1 and 2 in the textbook.]

Problem 3 (10 points) Problem 11.8 (Radiation by discharging a capacitor)

Problem 4 (10 points) Problem 11.9 (Rotating dipole, revisited)

Problem 5 (10 points) Problem 11.12 (Electron in a gravitational field)

Problem 6 (10 points) Problem 11.16 (Synchrotron radiation pattern)

Problem 7 (10 points) Problem 11.28 (Radiation from a sheet of current)