ELECTRODYNAMICS
PROBLEM SET 10
due May 3^{rd}, before class

I. UNIFORMLY MOVING CHARGE

On the first homework you calculated the field due to a charge moving with constant velocity by taking the Coulomb field and boosting it. Use the retarded fields computed in class to arrive at the same result. Does the electric field point towards the present position of the charge or to the position previously occupied by the charge at the "retarded time " $t = R/c$?

II. BREMSSTRAHLUNG

A *nonrelativistic* particle of charge Ze, mass m and kinetic energy E makes a head-on collision with a fixed central force field of finite range. The interaction is repulsive and described by a potential $V(r)$ that becomes larger than E at some finite distance r_{min}.

a) The particle, stopped by the force field, radiates. Show that the total power radiated is given by

$$W = \frac{4}{3}\frac{Z^2e^2}{m^2c^3}\sqrt{\frac{m}{2}}\int_{r_{min}}^{\infty}\left|\frac{dV(r)}{dr}\right|^2\frac{dr}{\sqrt{V(r_{min})-V(r)}}. \tag{1}$$

b) If the potential has the Coulomb form $V(r) = Z'Ze^2/r$ show that the total power radiated is

$$W = \frac{8}{45}\frac{Zmv_0^5}{Z'c^3}. \tag{2}$$

III. CLASSICAL ATOMS ARE UNSTABLE

The classical model of an atom has an electron in a circular orbit around the nucleus. Classically, the electron should radiate, loose energy and fall into the nucleus. *Estimate* how long it would take for an electron to fall into a nucleus.