Electrodynamics, spring 2003

Exercise 13 (only on Thu 8.5.)

1. According to the Abraham and Lorentz model, the self-force experienced by a charged particle is
$$\mathbf{F} = \frac{q^2}{6\pi\epsilon_0 c^3}\frac{d^2\mathbf{v}}{dt^2}$$
Express $\mathbf{F}$ in terms of the velocity $\mathbf{v}$ and the magnetic field $\mathbf{B}$ for a particle on a circular orbit in a uniform field at a non-relativistic velocity.
2. A charged particle (mass m, charge q) enters the half-space $x > 0$ at $t = 0$ with a velocity $v_0\mathbf{e}_x$. There is uniform magnetic field $B_0\mathbf{e}_z$ (transverse to the initial velocity vector) in the region $x > 0$. Solve the relativistic equation of motion. Radiation losses can be ignored. Tip: consider first qualitatively how a non-relativistic particle would move.
3. Solve the relativistic equation of motion of a particle (mass m, charge q) in a uniform electric field $\mathbf{E} = E_0\mathbf{e}_x$ with initial conditions $\mathbf{r}(t = 0) = 0$ and $\mathbf{v}(t = 0) = v_0\mathbf{e}_y$. Compare the result with the non-relativistic case. Radiation losses can be ignored.
4. The Hamiltonian of a charged particle in an electromagnetic field is $H(\pi, \mathbf{r}, t) = (1/2m)(\pi - q\mathbf{A}^2 + q\phi)$. Show by a direct calculation that canonical equations of motion yield the familiar Newtonian equation.

Return answers until Tuesday 6.5. at 14 o'clock.

Obs. Exercise groups only on Thursday 8.5.

The second exam (välikoe) is on Thursday, May 15, at 10.00-14.00 (in D101). Topics: sections 9-16 of the lecture notes and exercises 8-13. However, section 14 (radiating systems, "säteilevät systeemit") is excluded.

On Monday, May 5, we will go through what we have learned during the second half of the course.
On Thursday, May 8, Rami Vainio will give a tutorial presentation on space plasma physics (in Finnish). The lecture starts at 10 o'clock and lasts for about one hour.