Department of Physics, IIT Kanpur

Tutorial Problem Set-8

PHY103 HCV/SMT **22st Sept 2015**

1. Two large plane charge sheets having surface charge densities σ_0 and $-\sigma_0$ are superposed on each other in $x-y$ plane.

(a) Find the electric and magnetic fields at a point with $z>0$ in the given frame S.

(b) Find the surface charge density σ'_+ of the positive charge sheet as seen from the frame S' moving with respect to S at velocity $v\hat{i}$.

(c) Assuming that the negative charge sheet moves with respect to S' with a velocity $-V\hat{i}$, write the surface charge density of the negative sheet in the frame S'.

(d) Write the electric and magnetic fields in the frame S' with at points $z'>0$, using the charge density and the current density calculated in S'.

(e) Using the field transformation equations write the electric and magnetic fields in S' from those in S.

(f) Comparing the magnetic field found in (c) and (d) find the expression for V.

(The general equation for velocity addition for motion along $x-x'$ axis is $V=\frac{v_1+v_2}{1-v_1v_2/c^2}$. This ensures that in no frame any object can go faster than c)

More problems

1. A particle moves on the x-axis with velocity u_1 as seen from a frame S'. Consider two events: The particle crossing the point x1' at time t1' and then crossing x2' at time t2'. Find the coordinates and times of occurrence of these events in frame S using Lorentz Transformation equations. Find velocity of the particle as seen from S. As usual, S' moves with respect to S with velocity v in positive x-direction.

2. Consider two line charges, with linear charge densities +λ and –λ , lie along the x-axis. The positive line move at velocity v in +x-direction and the negative line moves at velocity v in –x direction. All this is in the frame S. A point charge q is placed at (0,0,y).

(a) Find the force F on q as seen in the frame S.

(b) Write the fields in the frame S' and the force F' on the particle using Coulomb's law and Biot-Savart law.

(c) Write the force transformation equation in the given situation.