Physics 122: Practice Problem of the Day

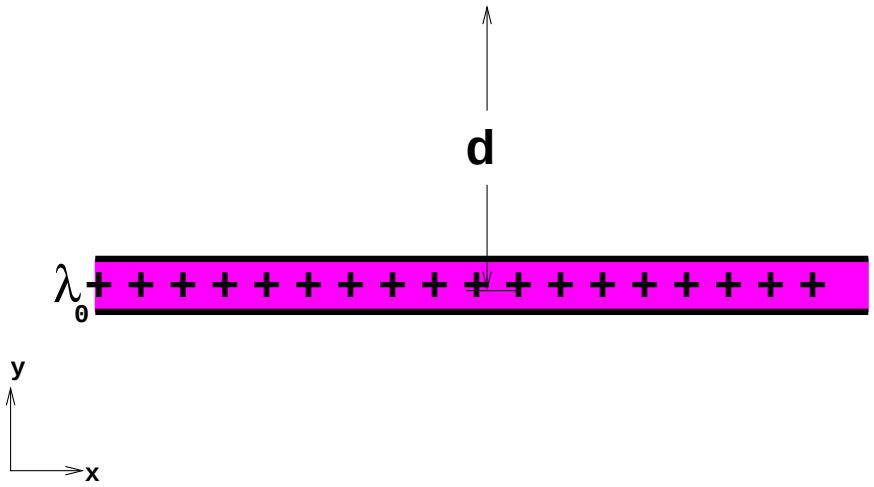
Problem #11: Calculating $\vec{E}$ by Direct Integration of Coulomb's Law

Monday February 9, 2009

This is Coulomb's Law in differential form:

$$d\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{dq}{r^2}\hat{r}$$

Consider a line of infinite charge with linear charge density λ_0 as shown here:



Show by **direct integration** of the expression above that the magnitude of the electric field at a distance d from the line of charge is given by:

$$E = \frac{\lambda_0}{2\pi\epsilon_0 d}$$

Hints: for the above problem, do not skip steps. Use the coordinate system given. Use symmetry to argue that all but one of the components of the field must be zero. Also recognize that the function you are integrating over is "even" in the x-coordinate. Finally take some care with the trigonometry to establish the best parametrization and limits for this integral.