no mo' sicko mode

$$\left(\nabla^2 - \frac{1}{c^2}\partial_t^{\,2}\right)\Psi(\vec r, t) = -f(\vec r\,', t')$$

$$G_r(\vec r, \vec r\,')$$

Obtained potentials:

$$\varphi(\vec r, t) = \frac{1}{4\pi\epsilon_0}\int \frac{\overbrace{\rho(\vec r\,', t_r)}^{\delta(t'-t_r)}}{R}\, d\tau'$$

$$\vec A(\vec r, t) = \frac{\mu_0}{4\pi}\int \frac{\vec J(\vec r\,', t_r)}{R}\, d\tau'$$

$$\vec E(\vec r, t) = -\nabla\varphi - \partial_t \vec A \qquad \vec B = \vec\nabla \times \vec A$$

$$\partial_{t_r} = \partial_t \qquad t_r = t - |R|/c$$

$$\nabla\left(\frac{1}{|\vec R|}\right) = -\frac{\hat R}{|\vec R|^2} \qquad \vec\nabla\varphi = \frac{1}{4\pi\epsilon_0}\int_{V'} \underbrace{(\nabla\rho)\frac{1}{R}}_{} + \rho\,\underbrace{\vec\nabla\left(\frac{1}{R}\right)}_{}\, d\tau'$$

$$\nabla(|\vec R|) = -\frac{\hat R}{|\vec R|^2}$$

$$\vec\nabla\rho(r, t_r) = (\partial_t\rho)\cdot\vec\nabla(t_R) = -\frac{1}{c}(\partial_t\rho)\hat R$$

$$\vec\nabla\varphi = \frac{1}{4\pi\epsilon_0}\int_{V'}\left[\underline{-\frac{1}{c}\partial_t(\rho)}\cdot\frac{\hat R}{|\vec R|} - \underline{\rho\cdot\frac{\hat R}{|\vec R|^2}}\right]d\tau'$$

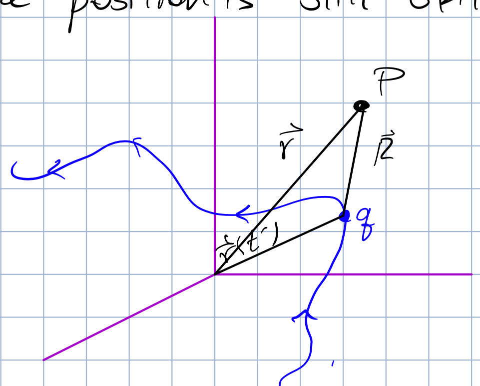
$$\partial_t\vec A = \frac{1}{4\pi\epsilon_0}\cdot\underline{\frac{1}{c^2}}\cdot\int_{V'} \underline{\partial_t(\vec J)\cdot\frac{1}{|\vec R|^2}}\, d\tau'$$

$$\vec E(\vec r, t_r) = \frac{1}{4\pi\epsilon_0}\int_{V'}\left[\frac{\rho(\vec r\,', t_r)}{\underline{|\vec R|^2}}\cdot\hat R + \frac{\partial_t(\rho(\vec r\,', t_r))}{\underline{c|\vec R|}}\cdot\hat R - \frac{\partial_t(\vec J(r, t_r))}{\underline{c^2|\vec R|}}\right]d\tau'$$

$$\vec B(\vec r, t_r) = \frac{\mu_0}{4\pi}\int_{V'}\left[\frac{\vec J(\vec r\,', t_r)}{|\vec R|^2} + \frac{\partial_t(\vec J(r, t_r))}{c\cdot|\vec R|}\right]\times\hat R\, d\tau'$$

Jemifenko's Equations

source position is still stationary, but can change



$$\vec r\,' \rightarrow \vec r\,'(t)$$

$$t'' = t' - t + |\vec R|/c$$

$$dt'' = dt'\left(1 + \frac{1}{c}\frac{d|\vec R|}{dt'}\right)$$

$$\varphi(\vec{r},t) = \frac{q}{4\pi\epsilon_0}\int_{-\infty}^{\infty} \frac{\delta(t'-t_r)}{|\vec{r}-\vec{r}'|}\,dt'$$ ← potential due to moving charge

$$= \frac{q}{4\pi\epsilon_0}\int_{-\infty}^{\infty} \frac{\delta(t'-t+|\vec{R}|/c)}{|\vec{r}-\vec{r}'|}\,dt'$$

$$\frac{d}{dt'}(|\vec{R}|) = \frac{d}{dt'}(|\vec{r}-\vec{r}'|) = \frac{d}{dt'} f(x_i', t')$$

$$= \frac{d}{dx_i'}(f(x_i',t'))\cdot\frac{d}{dt'}(x_i')$$

$$= \left[\sum_i \partial_{x_i'}(|\vec{r}-\vec{r}'|)\right]\frac{dx_i'}{dt'}$$

gradient wrt primed coords

perspective of particle

$$= \nabla'(|\vec{R}|)\cdot\frac{d\vec{r}'}{dt'}$$

$$\vec{\beta} \equiv \vec{v}/c$$

$$\frac{1}{c}\cdot\frac{d|\vec{R}|}{dt'} = -\frac{\vec{R}}{|\vec{R}|}\cdot\vec{\beta}$$

$$dt'' = dt'\left(1 - \frac{\vec{R}\cdot\vec{\beta}}{|\vec{R}|}\right)$$

$$dt' = \left(\frac{|\vec{R}|}{|\vec{R}|-\vec{R}\cdot\vec{\beta}}\right)dt''$$

$$\varphi(\vec{r},t) = \frac{1}{4\pi\epsilon_0}\int \frac{\delta(t'')}{\cancel{|\vec{R}(t')|}}\cdot\frac{\cancel{|\vec{R}|}}{|\vec{R}|-\vec{\beta}\cdot\vec{R}}\,dt''$$

$$t''=0 \longrightarrow t' = |\vec{R}|/c$$

$$\varphi(\vec{r},t) = \left(\frac{q}{4\pi\epsilon_0}\right)\cdot\frac{1}{|\vec{R}(t')| - \vec{\beta}(t')\cdot\vec{R}(t')}\Bigg|_{t''=0}$$

$$\varphi(\vec{r},t) = \left(\frac{q}{4\pi\epsilon_0}\right)\cdot\frac{1}{|\vec{R}(t_r)| - \vec{\beta}(t_r)\cdot\vec{R}(t_r)}$$

$$\vec{A}(\vec{r},t) = \left(\frac{\mu_0}{4\pi}\right)\frac{q\vec{v}}{|\vec{R}(t_r)| - \vec{\beta}(t_r)\cdot\vec{R}(t_r)}$$

$$\vec{A}(\vec{r},t) = \frac{1}{c}\,\vec{\beta}\cdot\varphi(\vec{r},t)$$