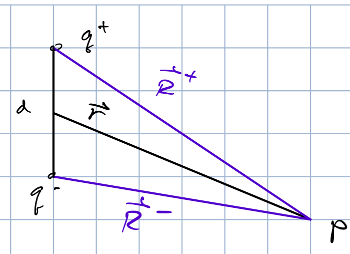

$$\varphi(\vec{r},t) = \left(\frac{q_0}{4\pi\epsilon_0}\right)\cdot\left(\frac{\cos[\omega(t-R_+/c)]}{R_+} - \frac{\cos[\omega(t-R_-/c)]}{R_-}\right)$$

$$R_\pm = r^2 \mp rd\cos\theta + \left(\frac{d}{2}\right)^2$$

$$\frac{1}{R_\pm^2} \simeq \frac{1}{r}\left(1+\frac{d}{2r}\cos\theta\right)$$

$$\cos[\omega(t-R_\pm/c)] \longrightarrow \cos[\underbrace{\omega(t-r/c)}_{\equiv\alpha} \pm \underbrace{\frac{\omega d}{2c}\cos\theta}_{\equiv\beta}]$$

$$\cos[\omega(t-R_\pm/c)] \simeq \cos\alpha\cos\beta \mp \sin\alpha\sin\beta$$

using $\frac{\omega d}{c} \ll 1$, $\beta \to 0$ & $\cos\beta \to 1$ & $\sin\beta \to \beta$

$$\cos[\omega(t-R_\pm/c)] \simeq \cos\alpha \mp \beta\sin\alpha$$

$$\varphi(\vec{r},\theta,t) = \left(\frac{q_0}{4\pi\epsilon_0}\right)\left(\frac{1}{r}\right)\left\{(\cos\alpha-\beta\sin\alpha)\left(\frac{d}{2r}\cos\theta+1\right)+(\cos\alpha+\beta\sin\alpha)\left(\frac{d}{2r}\cos\theta\right)\right\}$$

$$= \left(\frac{q_0}{4\pi\epsilon_0}\right)\left(\frac{1}{r}\right)\cdot\left(\frac{d}{r}\cos\alpha\cos\theta - 2\beta\sin\alpha\right)$$

$$= \left(\frac{q_0}{4\pi\epsilon_0}\right)\cdot\left(\frac{d\cos\theta}{r}\right)\left(\frac{\cos\alpha}{r} - \frac{\omega}{c}\sin\alpha\right) \qquad \alpha = \omega(t-r/c)$$

factor out a $1/r$, $\frac{\omega}{rc} \gg 1$ by radiation $\longrightarrow$ sin dominates

$$\varphi(\vec{r},\theta,t) = \left(\frac{\overset{q\cdot d}{p_0}}{4\pi\epsilon_0}\right)\cdot\left(\frac{\omega}{c}\right)\cdot\left(\frac{\cos\theta}{r}\right)\cdot\sin[\omega(t-r/c)]$$

vector potential: $I(t) = \frac{dq(t)}{dt}\hat{z} = -q_0\omega\sin(\omega t)\hat{z}$

$$\vec{A}(\vec{r},t) = \frac{\mu_0}{4\pi}\int_{-d/2}^{d/2}\frac{-q_0\omega\sin(\omega t)}{R_\pm}\hat{z}$$

$$\vdots$$

$$= \frac{-\mu_0 p_0\omega}{4\pi r}\sin(\omega t_r)\hat{z}$$

$$\vec{A}(\vec{r},\theta,t) = -\left(\frac{\mu_0 p_0\omega}{4\pi r}\right)\sin[\omega(t-r/c)]\left(\cos\theta\,\hat{r} + \sin\theta\,\hat{\theta}\right)$$

$$\vec{E}(\vec{r}, \theta, t) = -\left(\frac{\mu_0 p_0 \omega^2}{4\pi}\right) \cdot \left(\frac{\sin\theta}{r}\right) \cdot \cos(\omega t_r)\ \hat{\theta}$$

$$\vec{B}(\vec{r}, \theta, t) = -\left(\frac{\mu_0 p_0 \omega^2}{4\pi c}\right) \cdot \left(\frac{\sin\theta}{r}\right) \cos(\omega t_r)\ \hat{\phi}$$

$$\vec{S} = \frac{1}{\mu_0}\left[\vec{E} \times \vec{B}\right] = \frac{\mu_0}{c}\left[\left(\frac{p_0 \omega^2}{4\pi}\right)\left(\frac{\sin\theta}{r}\right) \cos(\omega t_r)\right]^2 \hat{r}$$

$$\langle \vec{S} \rangle = \left(\frac{\mu_0 p_0^2 \omega^4}{32\pi^2 c}\right) \cdot \underbrace{\left(\frac{\sin^2\theta}{r^2}\right)}_{\text{sync } f^n}\ \hat{r}$$

$$\langle P \rangle = \frac{\mu_0 p_0^2 \omega^4}{12\pi c}$$