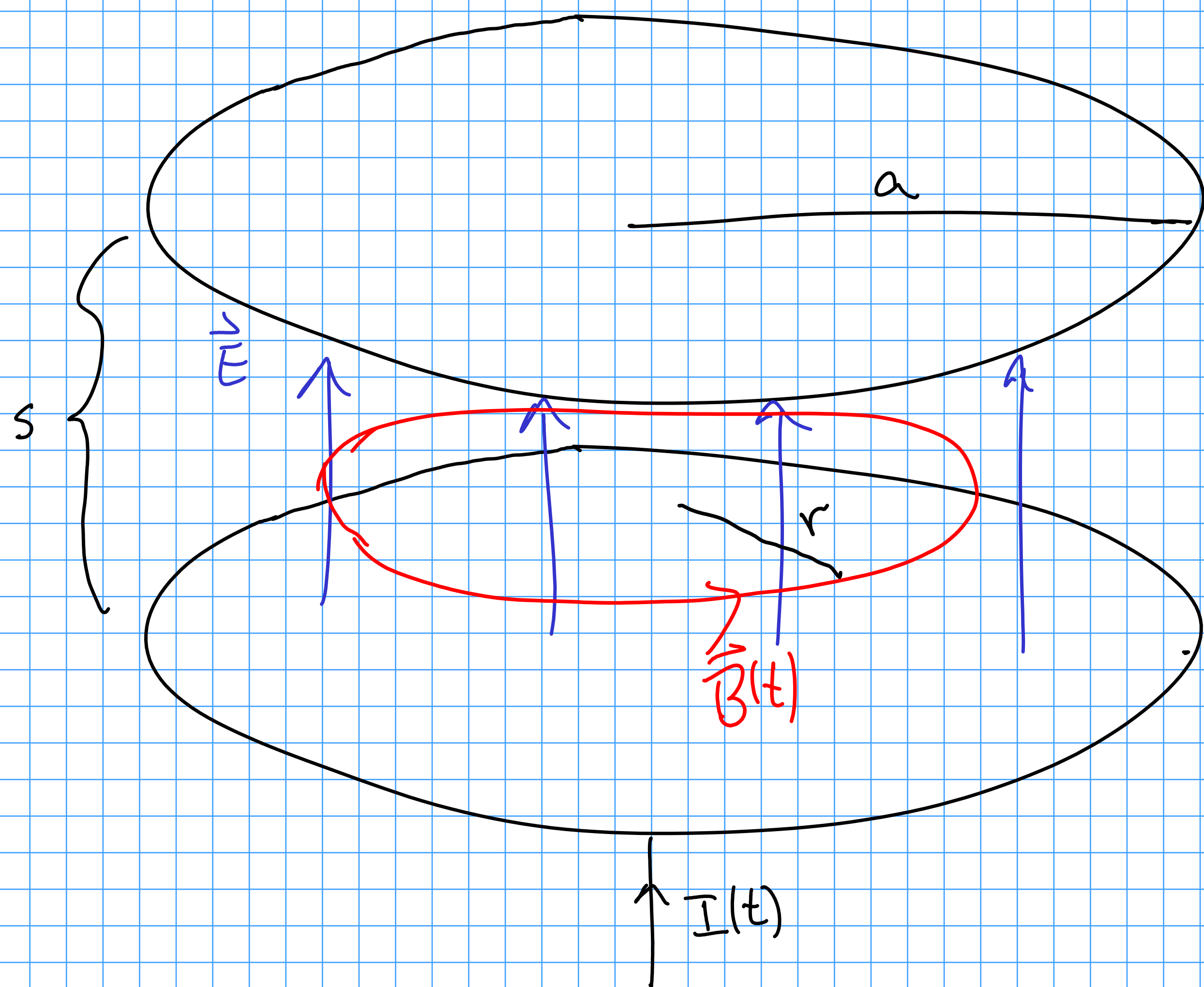
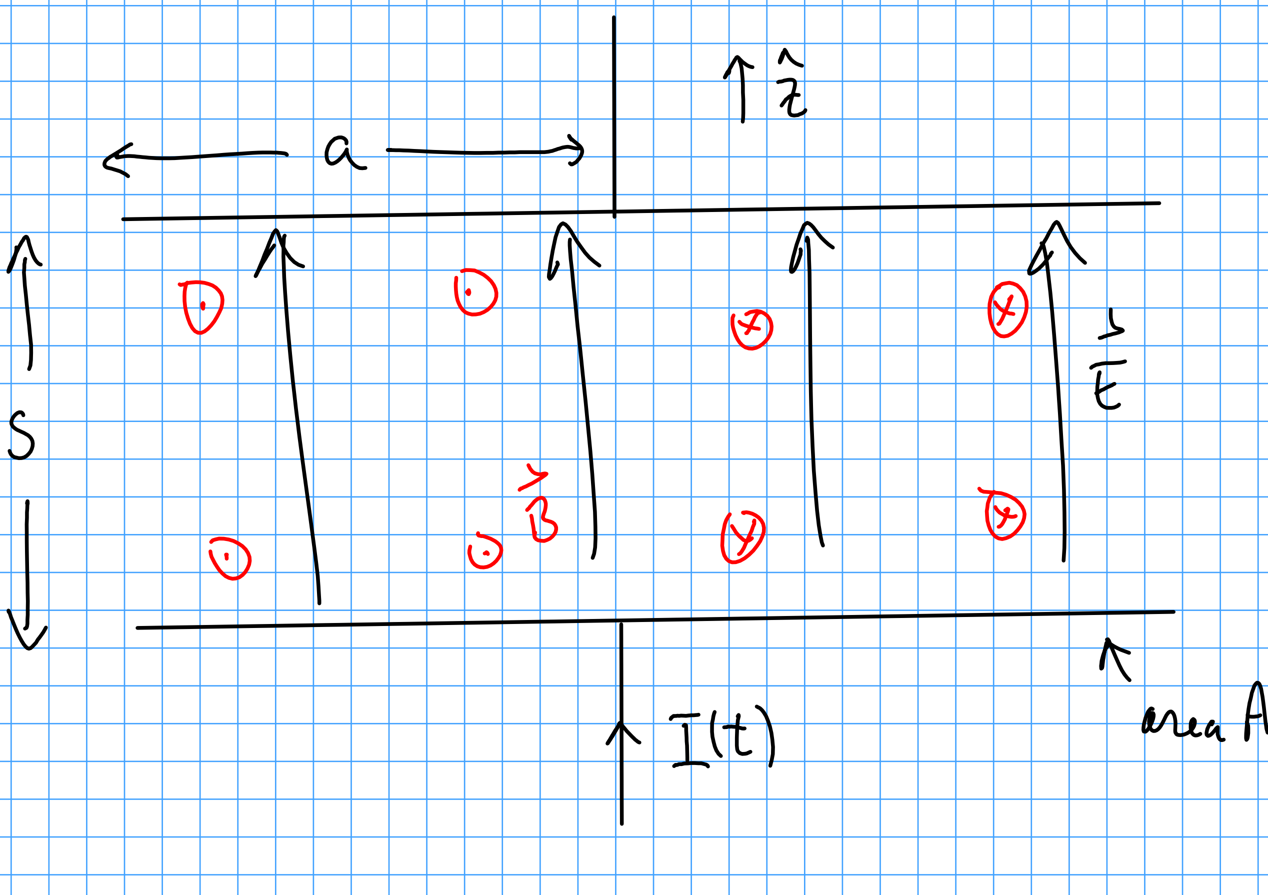
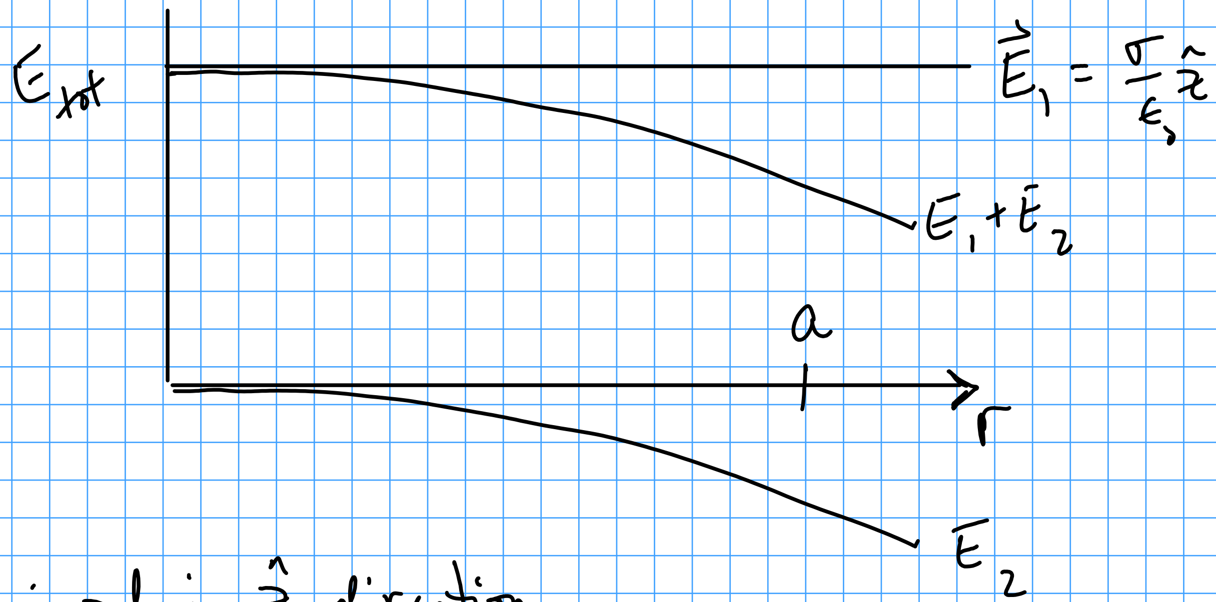


a
s
$\vec{E}$
r
$\vec{B}(t)$
I(t)



$\hat{z}$
a
S
$\vec{B}$
$\vec{E}$
I(t)
area A

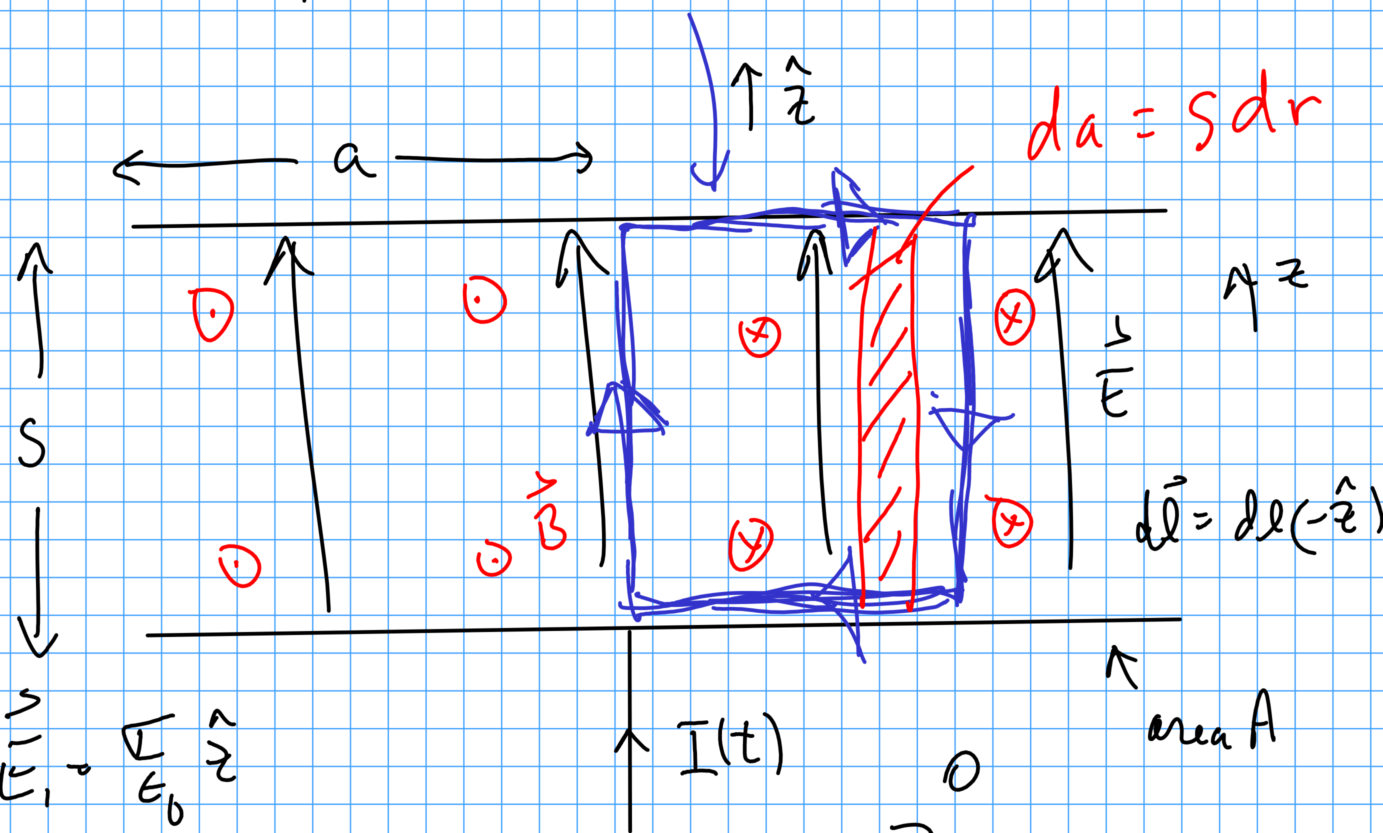


E is only in $\hat{z}$ direction

$$\boxed{\vec{B}_1 = \frac{\mu_0 I}{2\pi}\frac{r}{a^2}\hat{\varphi}}$$

B is only in $\hat{\varphi}$ direction

Faraday's law $\qquad \oint \vec{E} \cdot d\vec{l} = -\frac{d}{dt} \int \vec{B} \cdot d\vec{a}$



$\vec{E}_1 = \frac{\sigma}{\epsilon_0}\hat{z}$

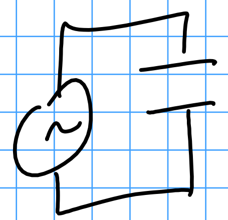
$$\oint \vec{E} \cdot d\vec{l} = \oint(\vec{E}_1 + \vec{E}_2) \cdot d\vec{l} = \cancel{\oint \vec{E}_1 \cdot d\vec{l}}^{\,0} + \oint \vec{E}_2 \cdot d\vec{l}$$

$$\int_{r=0} \vec{E}_2 \cdot d\vec{l}^{\,0} + \int_{\text{down right side}} \vec{E}_2 \cdot d\vec{l} = \int |\vec{E}_2|\, dl \cos 180 = -E_2 s$$

$\hat{z} \quad -\hat{z}$

$$\boxed{\vec{B}_1 = \frac{\mu_0 I}{2\pi} \frac{r}{a^2} \hat{\varphi}}$$

InkSurvey: Derive $\Phi_{B_1} = \int B_1 s\, dr$



$$E_1(t) = E_1 e^{i\omega t}$$

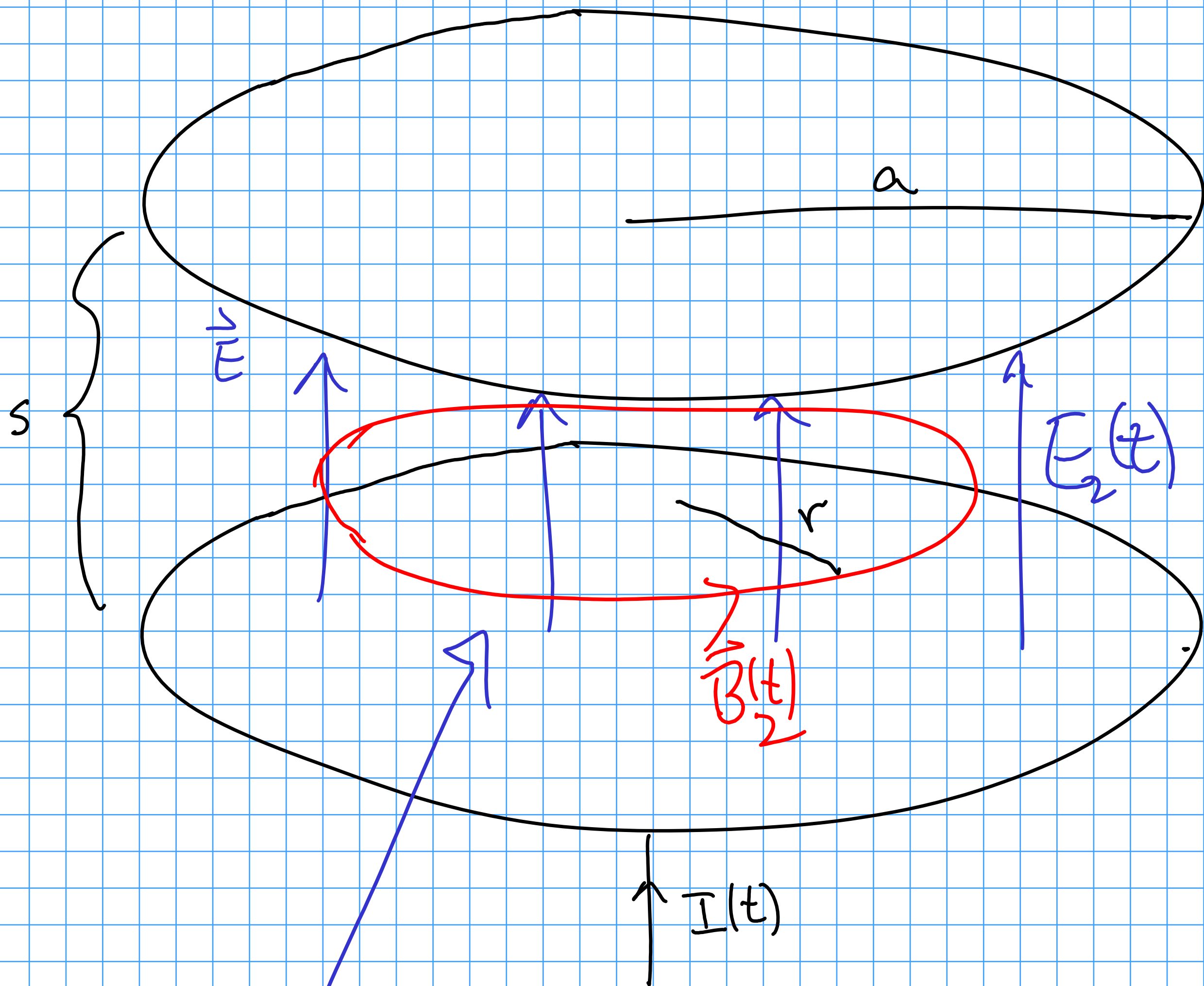
Remember: $B_1 = \frac{\mu_0 I}{2\pi}\frac{r}{a^2}$ & $I = \epsilon_0 \underset{\pi a^2}{\underset{\parallel}{A}} \frac{\partial E_1}{\partial t} = \epsilon_0 A i\omega e^{i\omega t}$

$$-E_2 \cancel{s} = -\frac{d}{dt}\int \frac{\mu_0}{2\pi}\frac{r}{\cancel{a^2}}\epsilon_0 \pi \cancel{a^2}\, i\omega E_1 e^{i\omega t}\cancel{s}\,dr$$

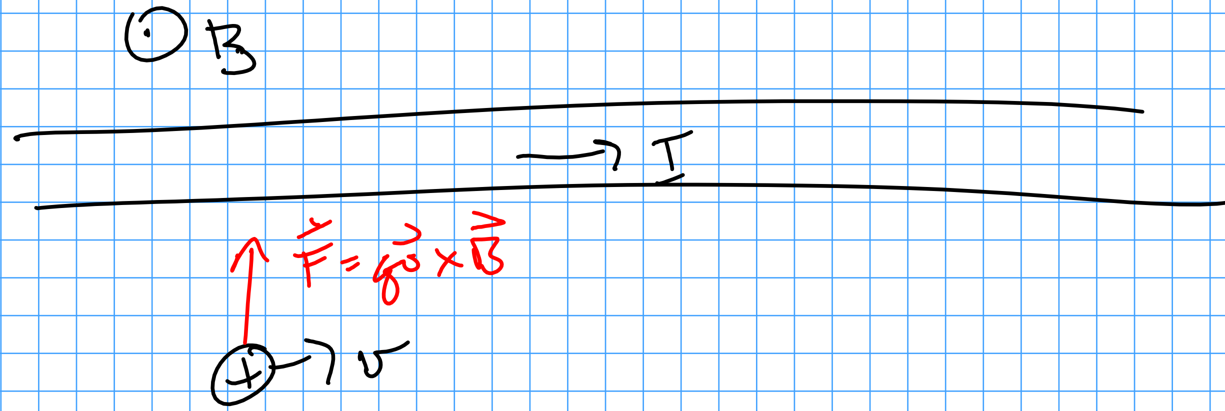
cancel

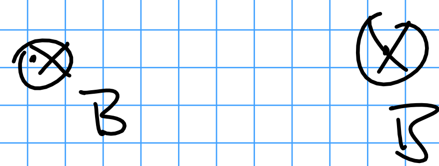
$$E_2 = -\frac{\omega^2 r^2}{4}\mu_0\epsilon_0 E_1 e^{i\omega t}$$

to find B_2 we apply

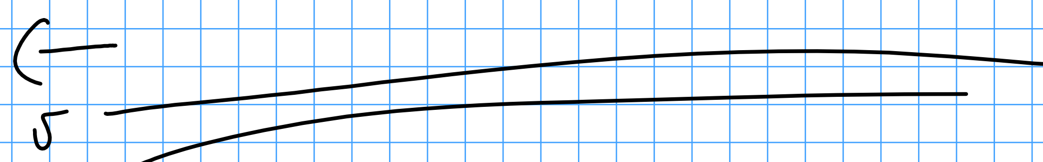


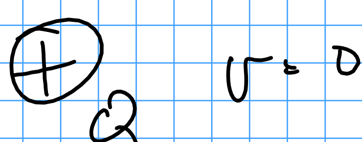
$$\int B_2 \cdot dl = \mu_0 \int \vec{J}_{E_1} \cdot d\vec{a}$$

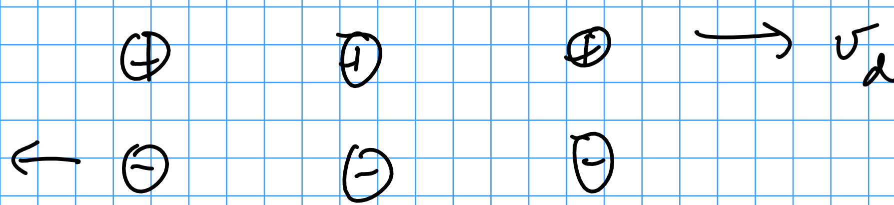


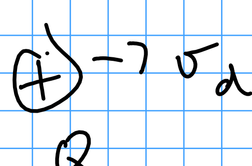


move to the frame of particle



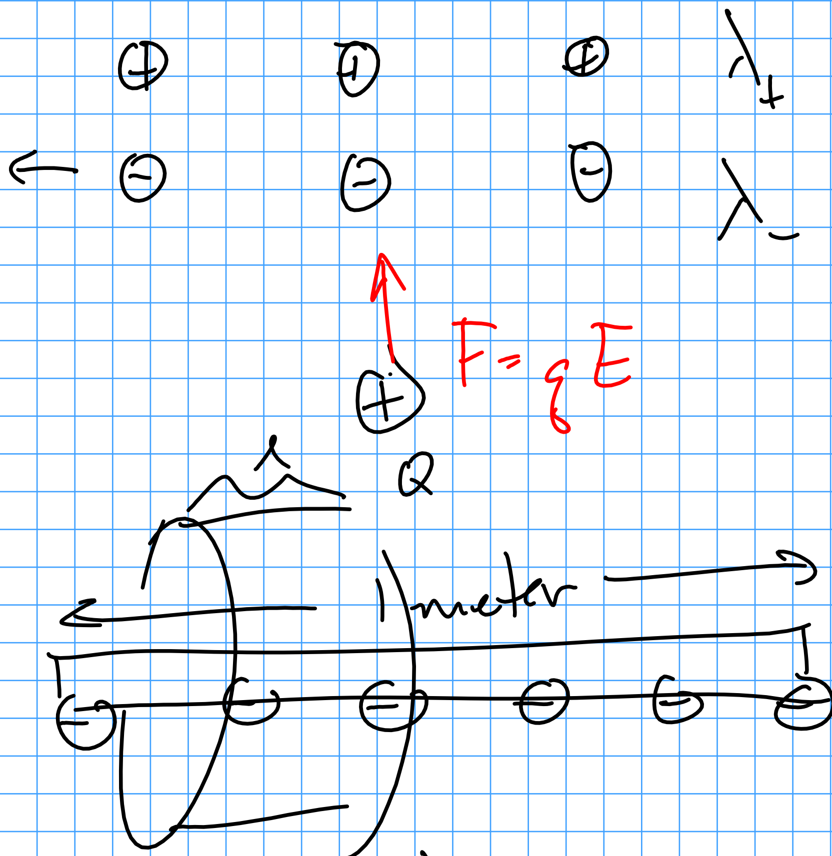






frame of Q

$2v_d$



$|\lambda_-| > |\lambda_+|$

length contraction

$E \ell 2\pi r = \frac{\lambda \ell}{\epsilon_0}$

$E = \frac{\lambda_+}{2\pi r \epsilon_0} + \frac{\lambda_-}{2\pi r \epsilon_0}$