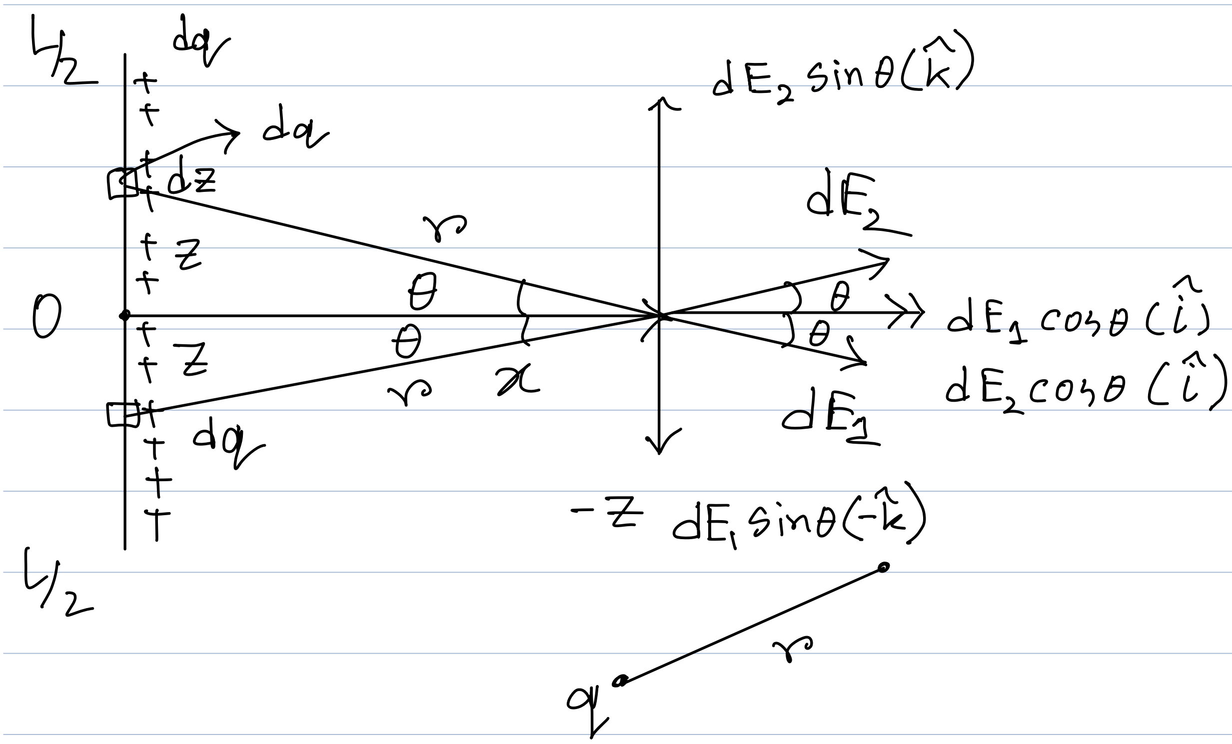
Important Calculation



$$E = \int_0^{L/2} dE_1 \cos\theta\,\hat{i} + \int_{-L/2}^{0} dE_2 \cos\theta\,\hat{i}$$

$$E = \left(\int_{-L/2}^{0} dE_2 \cos\theta + \int_0^{L/2} dE_1 \cos\theta \right) \hat{i}$$

$$= \left(-\int_{L/2}^{0} dE_2 \cos\theta + \int_{0}^{L/2} dE_1 \cos\theta \right) \hat{i}$$

$$= \left(\int_{0}^{L/2} dE_2 \cos\theta + \int_{0}^{L/2} dE_1 \cos\theta \right) \hat{i}$$

$$= \left(\int_{0}^{L/2} dE \cos\theta + \int_{0}^{L/2} dE \cos\theta \right) \hat{i}$$

$dE = dE_1 = dE_2$

$$= 2 \int_{0}^{L/2} dE \cos\theta \, \hat{i}$$

$$= 2 \int_{0}^{L/2} \frac{1}{4\pi\epsilon_0} \frac{dq}{r^2} \cos\theta$$

$\lambda = \frac{dq}{dz}$

$$dq = \lambda\, dz$$

$$= 2\int_0^{L/2} \frac{1}{4\pi\epsilon_0}\frac{\lambda\, dz}{r^2}\cos\theta$$

$$=2\int_0^{\theta_0} \frac{1}{4\pi\epsilon_0}\frac{\lambda\, x \sec^2\theta\, d\theta}{x^2\sec^2\theta}\cos\theta$$

$$\frac{x}{r} = \cos\theta$$

$$r = \frac{x}{\cos\theta}$$

$$r^2 = \frac{x^2}{\cos^2\theta}$$

$$r^2 = x^2\sec^2\theta \quad \text{—(i)}$$

$$= \frac{2\lambda}{4\pi\epsilon_0 x}\int_0^{\theta_0} \cos\theta\, d\theta$$

$$= \frac{2\lambda}{4\pi\epsilon_0 x}\sin\theta \Big|_0^{\theta_0}$$

$$= \frac{2\lambda}{4\pi\epsilon_0 x}\sin\theta_0$$

$$= \frac{2\lambda}{4\pi\epsilon_0 x}\frac{L/2}{\sqrt{(L/2)^2+x^2}}$$

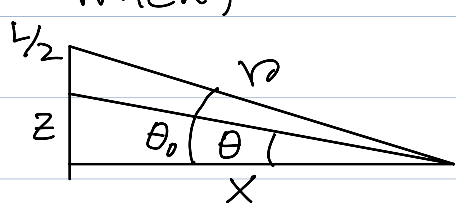
$$\frac{z}{x} = \tan\theta$$

$$\Rightarrow z = x\tan\theta$$

$$\Rightarrow \frac{dz}{d\theta} = x\sec^2\theta$$

$$\Rightarrow dz = x\sec^2\theta\, d\theta$$

when,



$z=0,\ \theta=0$

$$= \frac{\lambda}{4\pi\epsilon_0}$$

$$\sin\theta_0 = \frac{L/2}{r}$$

$$r = \sqrt{(L/2)^2 + x^2}$$

$$= \frac{q}{4\pi\epsilon_0 x\sqrt{(L/2)^2 + x^2}}$$

$$\lambda = q/L$$

$$q = \lambda L$$

$$x \gg L$$

$$= \frac{q}{4\pi\epsilon_0 \sqrt{x^2\left(\frac{(L/2)^2}{x^2} + 1\right)}}$$

$$\downarrow$$

$$0$$

$$= \frac{q}{4\pi\epsilon_0 x^2}$$

$$x \ll L \Rightarrow ?$$

L = 10L