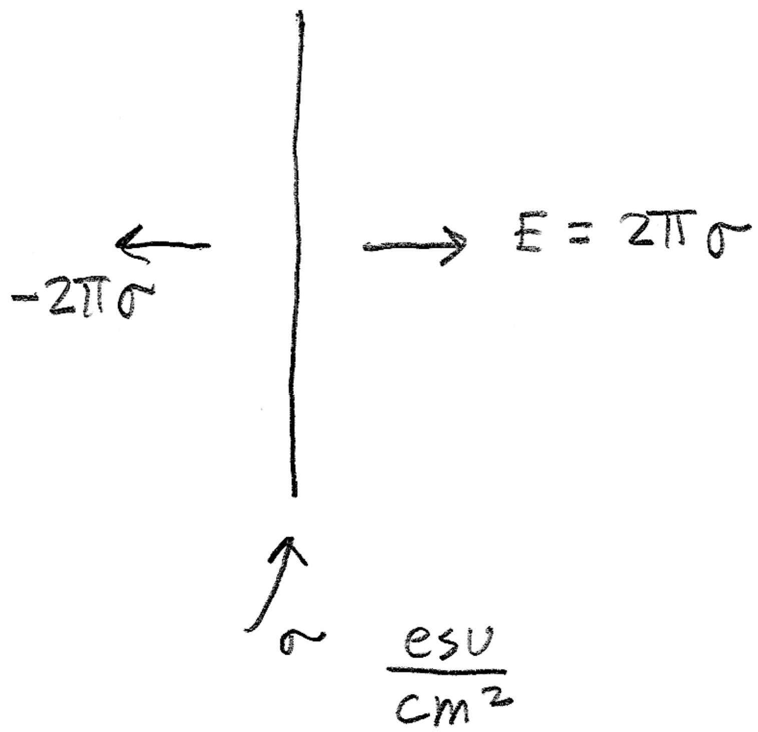
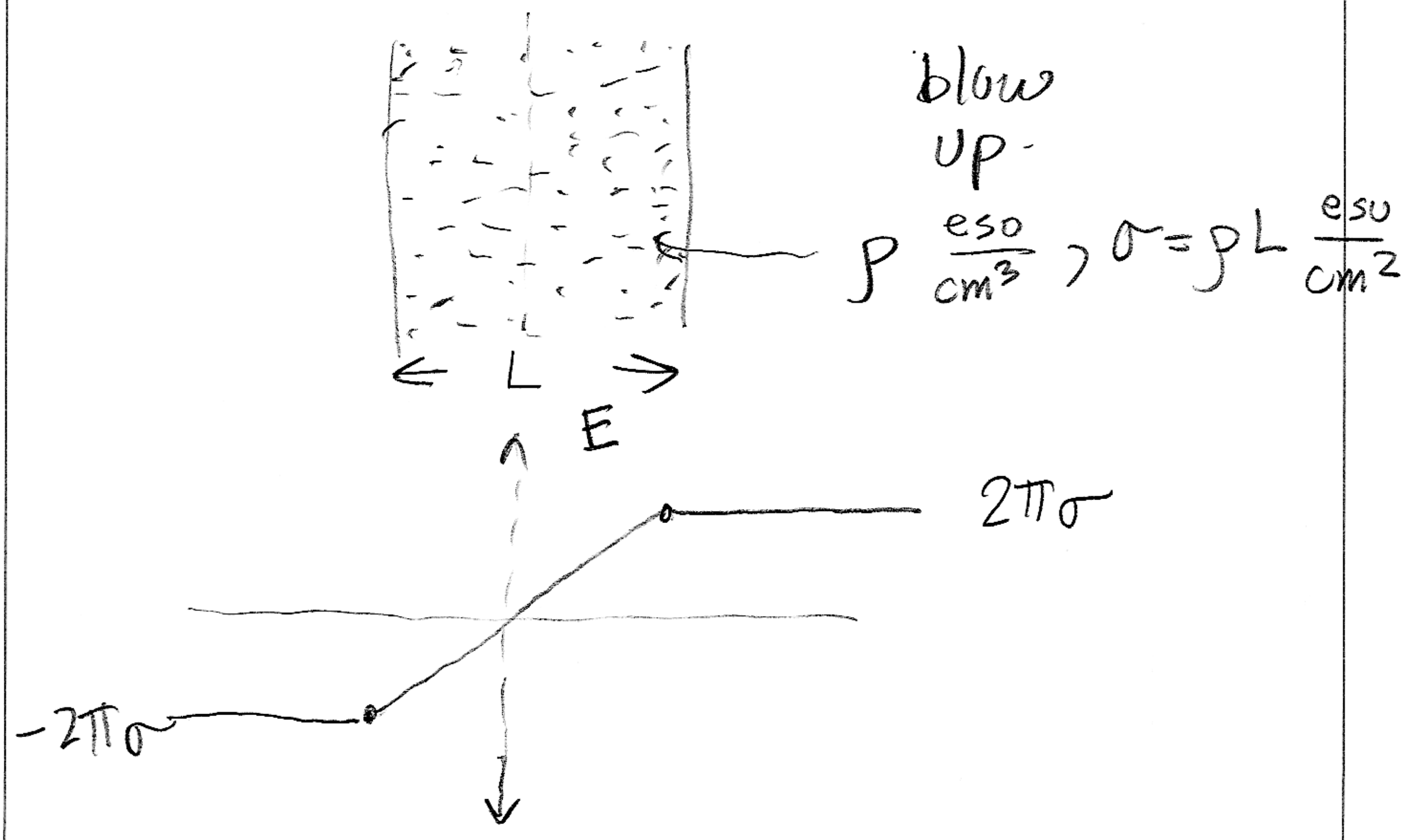
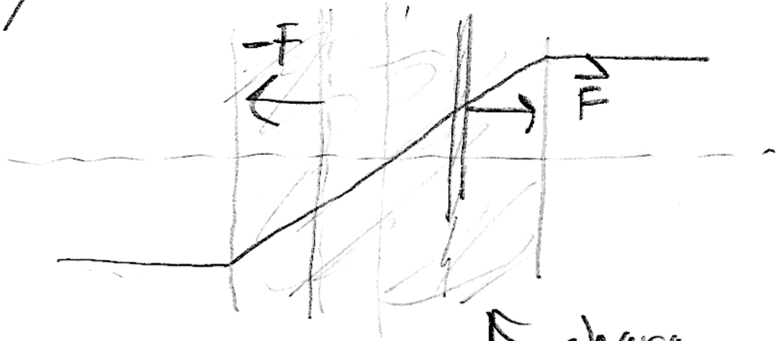
Force on a layer of charge

No external field

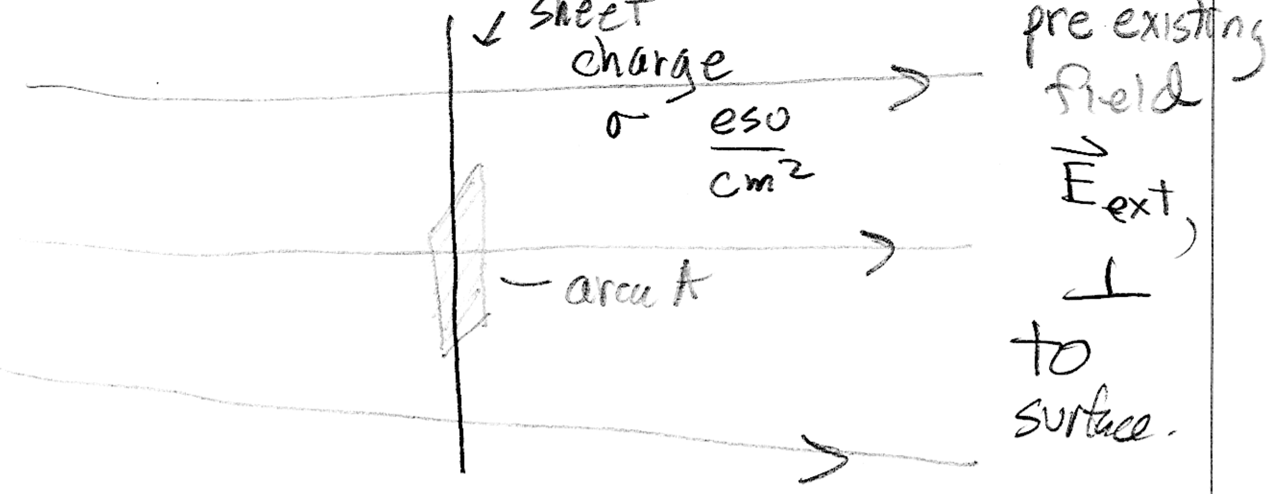


viewed from side



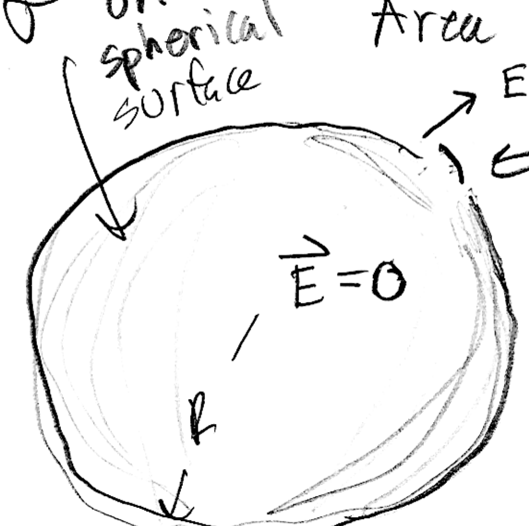


symmetric slices of charge cancel.. no net force. (in plane? yes..)



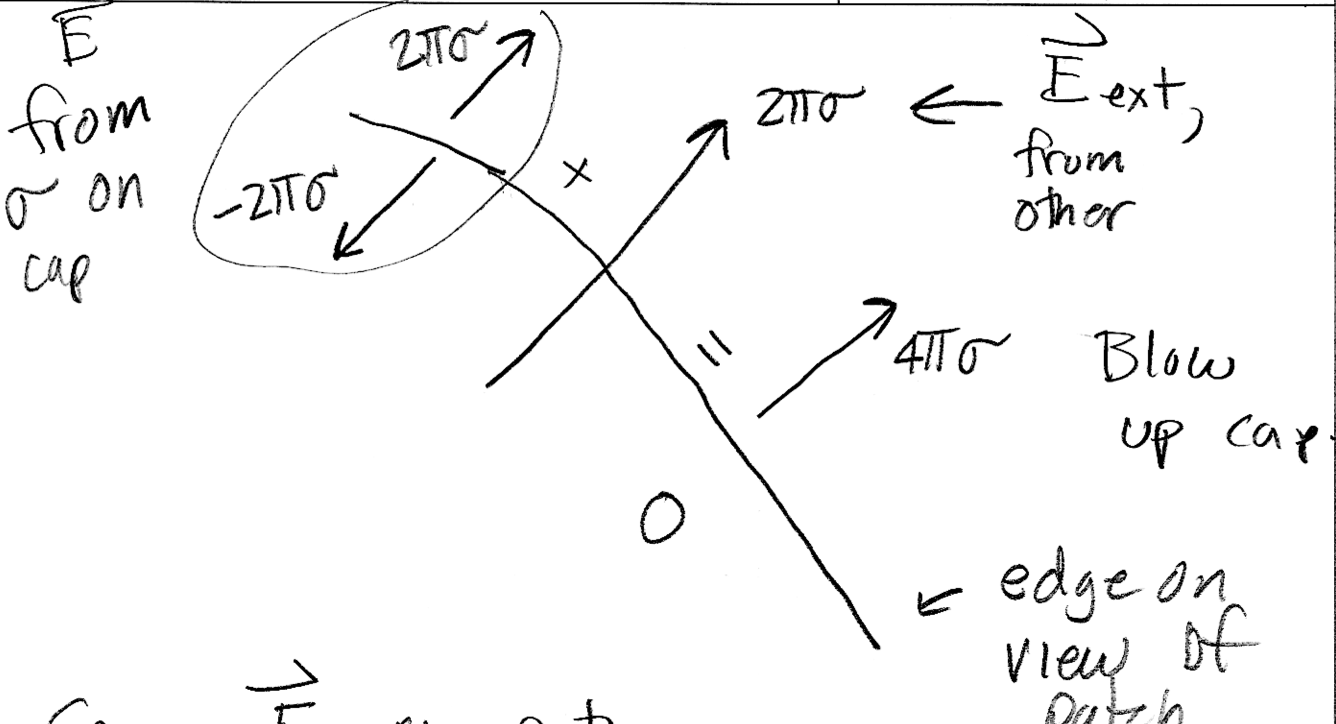
$$\vec{F} = (\sigma \cdot \text{Area}) \cdot \vec{E}_{ext}$$

$$\frac{\vec{F}}{\text{Area}} = \sigma \cdot \vec{E}_{ext}$$



$E = \frac{4\pi R^2 \sigma}{R^2} = 4\pi\sigma$

force on a little "patch", area dA



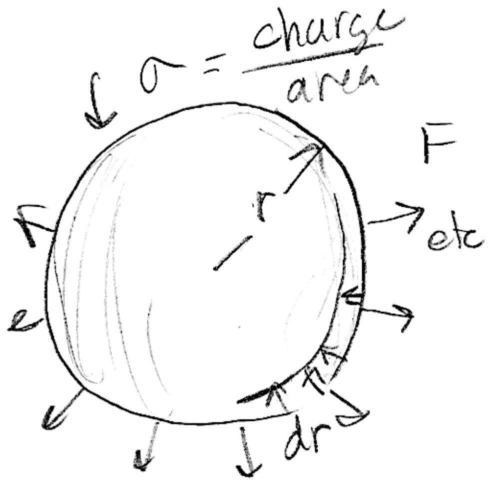
So, $\vec{F}$ on path

$$= (2\pi\sigma) \cdot \sigma \cdot dA$$

$(2\pi\sigma)$ ← "ext" field from other charges

$\sigma \cdot dA$ ← charge on patch

$$= 2\pi\sigma^2 \, dA$$



F(outward)

$$= 2\pi\sigma^2 \cdot (4\pi r^2)$$

now push this together by dr.. you do work.

$$dU = 2\pi\sigma^2 (4\pi r^2 dr)$$

$$E\text{ (surface)} = 4\pi\sigma$$

$$\sigma = \frac{E}{4\pi} \quad \text{(in this case)}$$

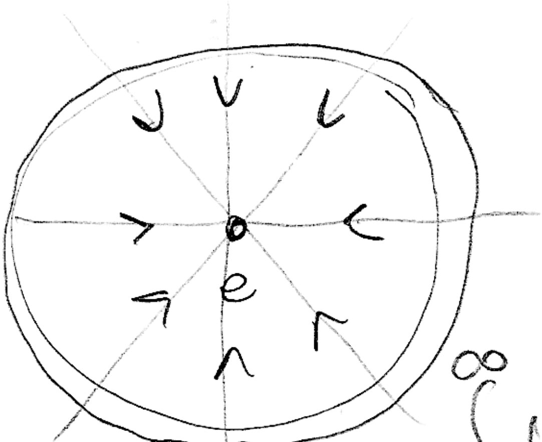
$$dU = 2\pi\left(\frac{E}{4\pi}\right)^2 \quad (dV = 4\pi r^2 dr)$$

$$\boxed{dU = \frac{1}{8\pi} E^2 \, dV}$$

Electric Field is like condensed work.... density of energy from work is....

$$\boxed{\frac{dU}{dV} = \frac{1}{8\pi} E^2}$$

Could a particles mass be due to energy in its electric field?



$$E_r = \frac{-e}{r^2}$$

$$U(r)\,dV = \frac{1}{8\pi}\frac{e^2}{r^4} 4\pi r^2 dr$$

$$= \frac{1}{2}\frac{e^2}{r^2} dr$$

$$\int_{r_0}^{\infty} U(r)\,dV = \frac{1}{2}\frac{e^2}{r_0} = m_e c^2 \,?$$