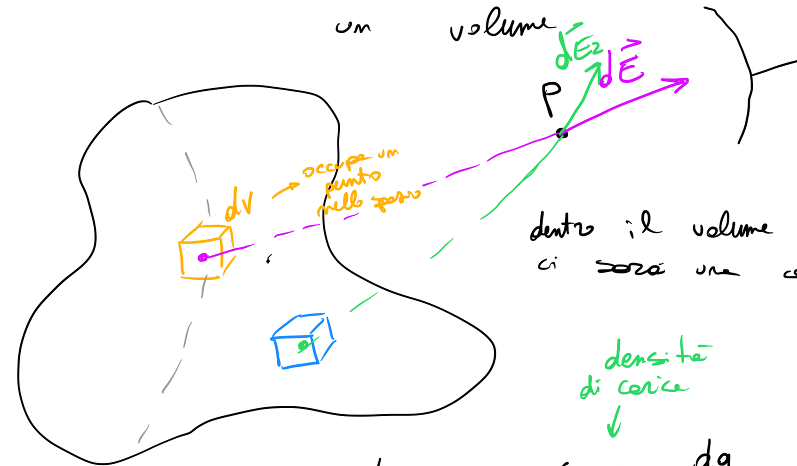
L.2

SOVRAPPOSIZIONE

VOLUME

distribuzione di cariche continue che occupano un volume



dentro il volume dV ci sarà una carica dQ

$$\vec{E}_P = \int_V d\vec{E} = \int_V \frac{1}{4\pi\varepsilon_0}\frac{dq}{r^2}\hat{r} = \boxed{\int_V \frac{1}{4\pi\varepsilon_0}\frac{\rho\, dV}{r^2}\hat{r}}$$

integrale di volume

$$\int_V dV = \int dx \int dy \int dz$$

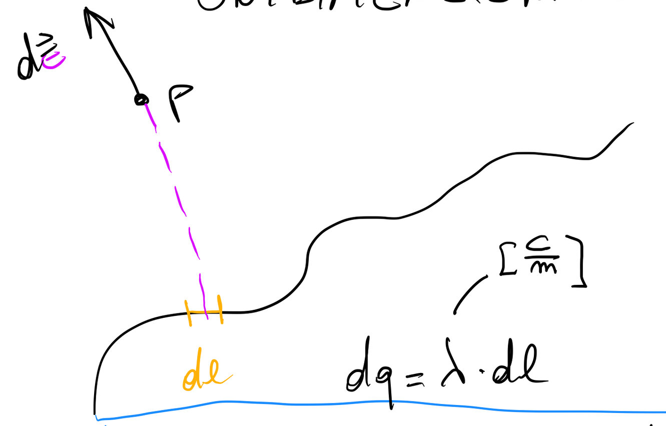
densità di carica

$$V \longrightarrow \rho(x,y,z) = \frac{dq}{dV} \rightarrow dq = \rho\, dV$$

$\left[\frac{C}{m^3}\right]$

se $\rho(x,y,z) = cost$
$\Downarrow$
Q è costante

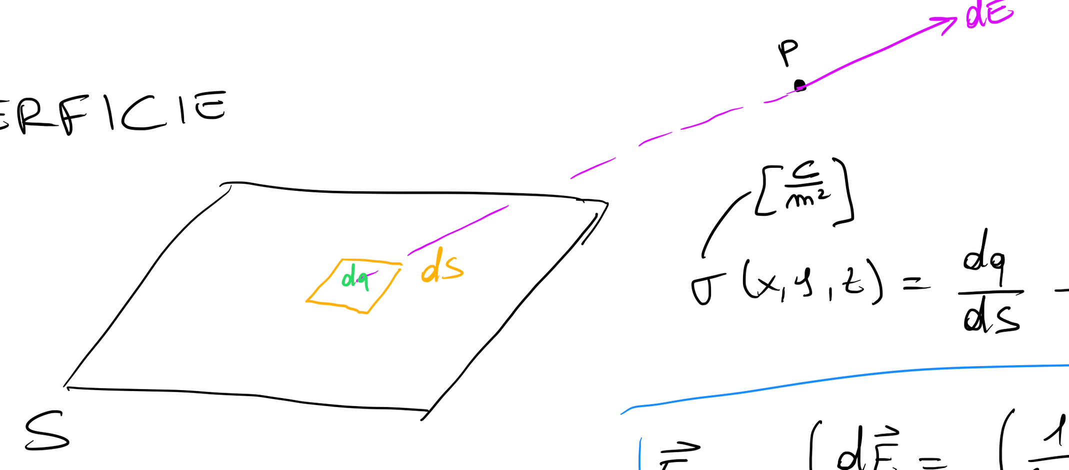
UNIDIMENSIONALE



$$dq = \lambda \cdot dl \qquad \left[\frac{C}{m}\right]$$

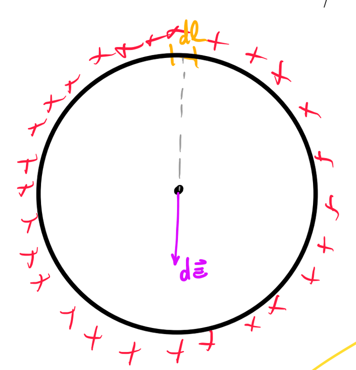
$$\boxed{\vec{E} = \int_L d\vec{E} = \int_L \frac{1}{4\pi\varepsilon_0}\frac{\lambda\, dl}{r^2}\hat{r}}$$

SUPERFICIE



$$\sigma(x,y,z) = \frac{dq}{ds} \rightarrow dq = \sigma\, ds \qquad \left[\frac{C}{m^2}\right]$$

$$\boxed{\vec{E}_P = \int_S d\vec{E} = \int_S \frac{1}{4\pi\varepsilon_0}\frac{\sigma\, ds}{r^2}\hat{r}}$$



$Q > 0$

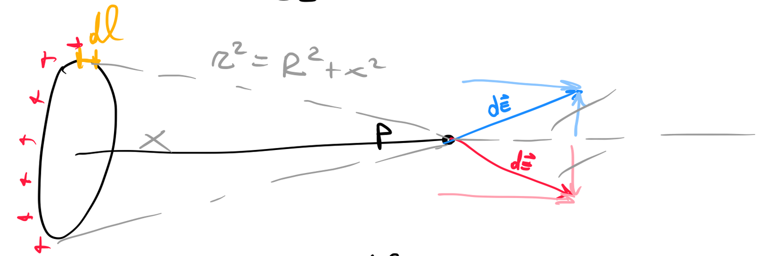
$$\lambda = \frac{Q}{2\pi R} = cost$$

[raggio

integrale su un percorso chiuso

$$\oint d\vec{E} = 0 \text{ per simmetria}$$

punto che esce

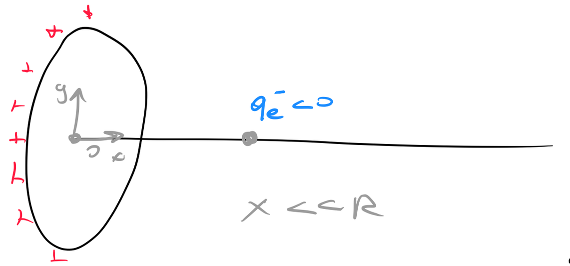


$$\oint \frac{1}{4\pi\varepsilon_0}\frac{\lambda\, dl}{r^2}\cos\theta \rightarrow \frac{\lambda}{4\pi\varepsilon_0}\oint \frac{dl}{r^2}\cos\theta$$

$$\frac{\lambda}{4\pi\varepsilon_0 r^2}\oint dl \cos\theta \qquad = \cos\theta = \frac{x}{\sqrt{R^2+x^2}}$$

$$\frac{\lambda\cos\theta}{4\pi\varepsilon_0 (R^2+x^2)}\underbrace{\oint dl}_{2\pi R} \rightarrow \frac{1}{2\varepsilon_0}\frac{\lambda R x}{(R^2+x^2)^{3/2}}$$

ES



$$F = q_e\vec{E} = -|q_e|\cdot\vec{E}$$

τ per arrivare al centro dell'anello

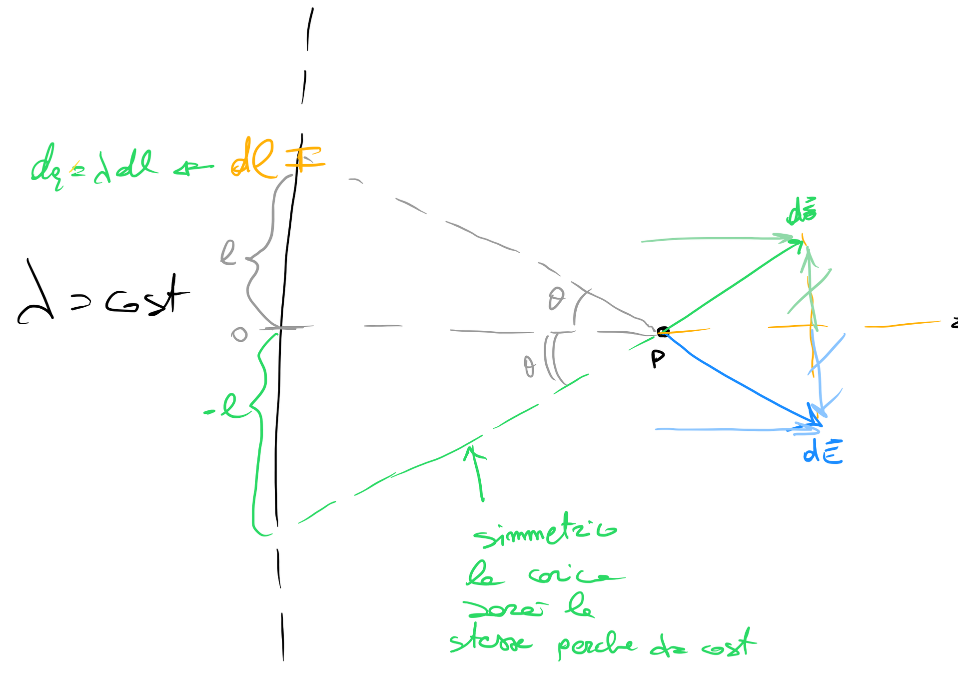
$$\vec{F} = m\vec{a}$$

$$m_e\ddot{x} = -|q_e|\cdot\frac{1}{2\varepsilon_0}\cdot\frac{\lambda R x}{(x^2+R^2)^{3/2}}$$

$$m\ddot{x} = \frac{-|q_e|}{2\varepsilon_0}\cdot\frac{\lambda x}{R^2} \rightarrow \ddot{x} = -\underbrace{\left(\frac{|q_e|\lambda}{2\varepsilon_0 R^2 m_e}\right)}_{\omega^2} \rightarrow \ddot{x} = -\omega^2 x$$

MOTO ARMONICO
$\Downarrow$

$$\tau = \frac{T}{4} = \frac{2\pi}{4\omega} = \frac{\pi}{2\omega}$$



$\Rightarrow$ Considero solo i contributi lungo l'asse x

$$d\vec{E}_x = \left[\frac{1}{4\pi\varepsilon_0}\frac{\lambda\, dl}{r^2}\right]\cdot\cos\theta$$

$$E_P = \int_{l,b} \frac{1}{4\pi\varepsilon_0}\cdot\frac{\lambda\, dl}{r^2}\cos\theta = \frac{\lambda}{4\pi\varepsilon_0}\int \frac{dl}{\underset{x^2+l^2}{\overset{\|}{r^2}}}\cos\theta = \frac{\lambda}{4\pi\varepsilon_0}\int_{l,b}\frac{dl\cos\theta}{r^2}$$

$r\cdot\cos\theta = x$
$r\sin\theta = l$

$$\operatorname{tg}\theta = \frac{l}{x} \rightarrow \frac{d\operatorname{tg}\theta}{d\theta}\cdot d\theta = \frac{1}{x}dl$$

!!! RIGUARDARE CAMBIO DI VARIABILE

$$\rightarrow E_P = \frac{\lambda}{4\pi\varepsilon_0}\int \frac{x}{\cos^2\theta}\cdot\frac{\cos\theta}{x^2}\cdot\cos\theta^2 = \frac{\cos\theta}{x}$$

$$= \frac{\lambda}{4\pi\varepsilon_0 x} = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}}\cos\theta \rightarrow \frac{\lambda}{4\pi\varepsilon_0 x}\cdot\sin\theta\Big|_{-\frac{\pi}{2}}^{\frac{\pi}{2}} = \frac{\lambda}{2\pi\varepsilon_0 x}$$

nella direzione del versore x