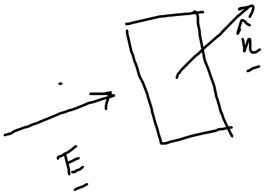
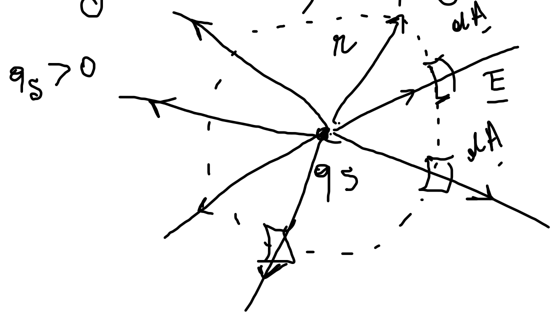


$$\phi(\underline{E}) = \underline{E} \cdot \underline{A} \qquad \underline{A} = \begin{cases} \text{modulo: } A \\ \text{direzione: } \hat{n} \\ \text{e verso} \end{cases}$$

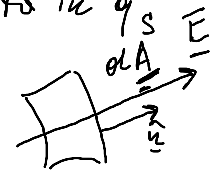
$\underline{E}$ é cost sulla sup.

$$\phi(\underline{E}) = \int_{\text{superficie}} \underline{E} \cdot d\underline{A}$$

Carica sorgente q_s ; superficie: una sfera di raggio r centrata in q_s



$$\phi(\underline{E}) = \int_{\text{sup}} \underline{E} \cdot d\underline{A}$$



$d\underline{A} = dA\,\hat{\underline{n}}$ $\qquad \underline{E} \parallel \hat{\underline{n}}$ $\qquad dA \perp$ al raggio

$\underline{E} \cdot d\underline{A} = \underline{E} \cdot \hat{\underline{n}}\, dA$ $\qquad \underline{E}$ lungo raggio

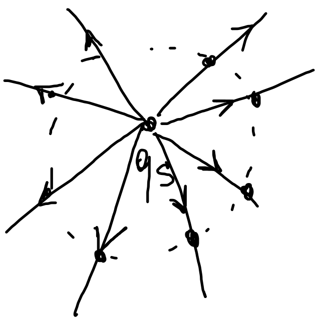
$= E\, dA$

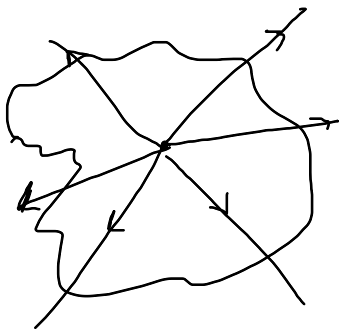
$$\Phi(\underline{E}) = \int_{\underbrace{\text{sfera}}_{\text{sup. della sfera}}} \underline{E}\, dA = E \int_{\text{sfera}} dA = E\, 4\pi r^2 = \frac{q_s}{\cancel{4\pi}\varepsilon_0 \cancel{r^2}} \cancel{4\pi r^2} = \frac{q_s}{\varepsilon_0}$$

$$\underline{E} = \frac{1}{4\pi\varepsilon_0} \frac{q_s}{r^2} \hat{\underline{r}}$$

$$|\underline{E}| = \frac{q_s}{4\pi\varepsilon_0 r^2}$$

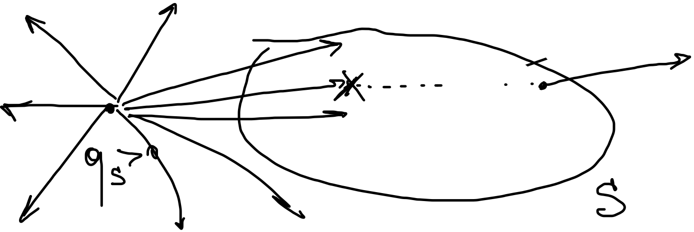
$\Phi(\underline{E})$ rappresenta quante linee di campo attraversano la superficie





$\Phi(\underline{E}) = q_s/\varepsilon$
vero per sup. chiusa di forma arbitraria

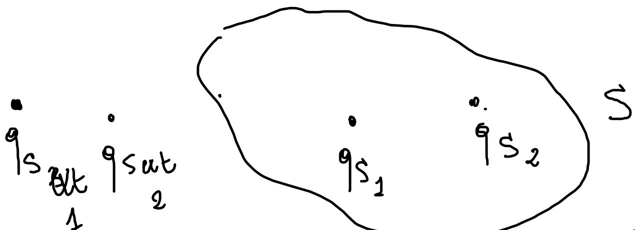
Carica esterna alla sup. chiusa



solo carica est

$$\Phi(\underline{E}) = 0$$

$$\Phi(\underline{E}_{TOT}) = ?$$



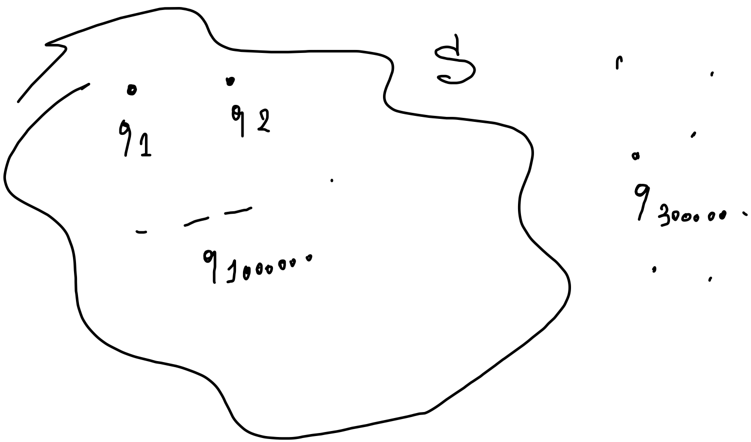
$$\underline{E}_{TOT} = \underline{E}_{q_{s_1}} + \underline{E}_{q_{s_2}} + \dots + \underline{E}_{q_{s\,ext_1}} + \underline{E}_{q_{s\,ext_2}} + \dots$$

$$\Phi(\underline{E}_{TOT}) = \Phi(\underline{E}_{q_{s_1}}) + \Phi(\underline{E}_{q_{s_2}}) + \dots + \cancel{\Phi(\underline{E}_{q_{s\,ext_1}})} + \cancel{\Phi(\underline{E}_{q_{s\,ext_2}})} + \dots$$

$$= \overbrace{\frac{q_{s_1}}{\varepsilon_0} + \frac{q_{s_2}}{\varepsilon_0} + \dots}^{q_{int}}$$

Fissata una sup. geometrica di forma arbitraria date un certo numero di cariche sorgenti

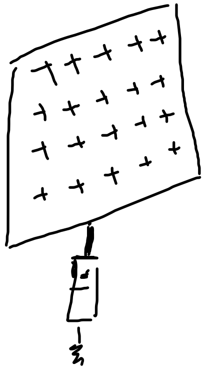
$$\int_S \underline{E} \cdot d\underline{A} = \frac{q^{int}}{\varepsilon_0}$$

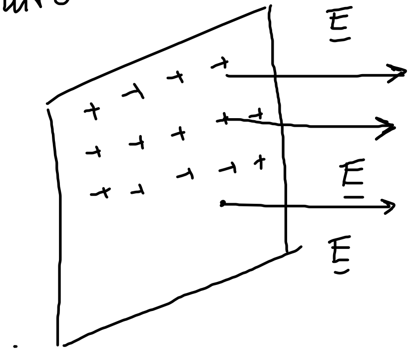


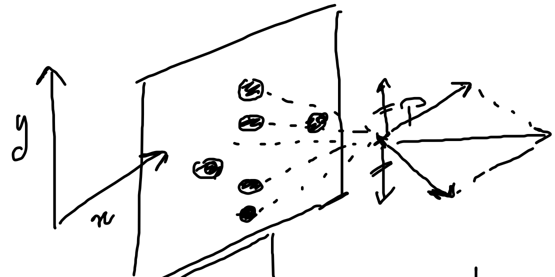
$$\Phi(\underline{E}) = \frac{q_1 + q_2 + \ldots q_{1000000\ldots}}{\varepsilon_0}$$

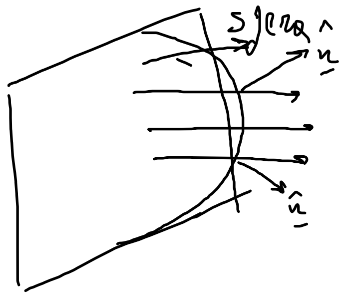
es Piano carico indefinito

$\underline{E}$ è ⊥ piano uscente

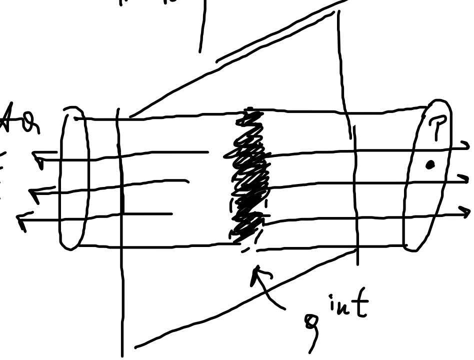








brutta scelta



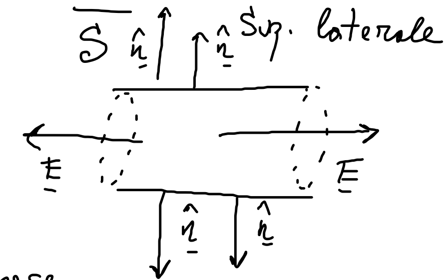
buona scelta

Uso th. Gauss per il cilindro mostrato prima

$$\int_{\text{Cilindro}} \underline{E} \cdot d\underline{A} = \frac{q^{int}}{\varepsilon_0} = \frac{\sigma \cdot A_{base}}{\varepsilon_0}$$

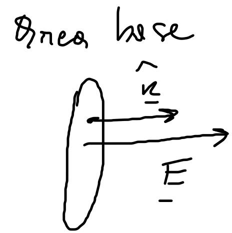
Introduco $\sigma \overset{def}{=} \frac{Q}{S}$

E ? $\Phi(\underline{E})$



$$\int_{\text{Cilindro}} \underline{E} \cdot d\underline{A} = \int_{\text{Area base}} \cdot 2 + \cancel{\int_{\text{Sup. laterale}}} = 0$$

$$= 2 \int_{\text{Area base}} E\, dA = 2E \int_{\text{Area base}} dA = 2 E A_{base}$$

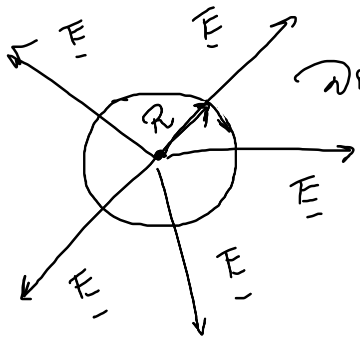


$$\underline{E} \cdot d\underline{A} = \underline{E} \cdot \hat{\underline{n}}\, dA$$
$$= E\, dA$$

$$2E\cancel{A_{base}} = \frac{\sigma \cdot \cancel{A_{base}}}{\varepsilon_0} \; ; \; E = \frac{\sigma}{2\varepsilon_0}$$

$r_N \sim 10^{-15}\, m \qquad r_e \sim 10^{-10}\, m$

- Calcolo del $\underline{E}$ di una sfera uniformemente carica



Noto $\rho = \frac{Q}{\frac{4}{3}\pi R^3}$

$Q \rightarrow$ carica totale nella sfera

$\frac{4}{3}\pi R^3 \rightarrow$ volume sfera

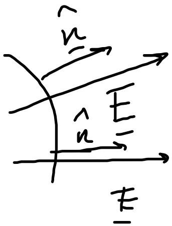
ρ: densità volumetrica di carica

Sup. di Gauss: sup. sferica di raggio r

$\underbrace{\text{dentro la sfera carica}}_{r<R}$ $\qquad$ $\underbrace{\text{fuori dalla sfera carica}}_{r>R}$

$$\int_{\text{sfera}} \underline{E}\cdot d\underline{A} = \int_{\text{sfera}} E\,dA = E\int_{\text{sfera}} dA = E\cdot \underbrace{4\pi r^2}_{\text{sup. sfera di raggio } r}$$

$\underline{E} \parallel \hat{\underline{n}}$ ↳ E cost sulla sfera



$$\underline{E}\cdot d\underline{A} = \underline{E}\cdot\hat{\underline{n}}\,dA = E\,dA$$

Q^{int} →
- $r > R$: Tutta la carica $\quad E 4\pi r^2 = \dfrac{Q}{\varepsilon_0} \;\Rightarrow\; E = \dfrac{Q}{4\pi r^2 \varepsilon_0}$
- $r < R$: Solo un "pezzetto" ???

$$E 4\pi r^2 = \frac{Q^{int}}{\varepsilon_0}$$