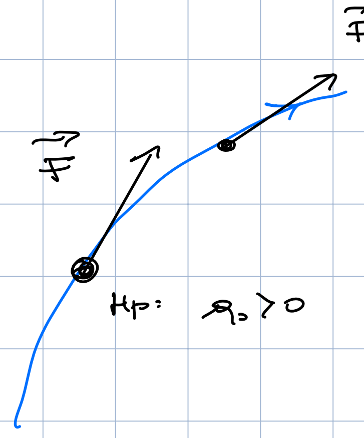
LEGGE DI GAUSS

- rappresentazione di $\vec{E}$ con linee di forza
- significato "fisico" legge di Gauss
- espressione matematica legge di Gauss
- uso della legge di Gauss per calcolare $\vec{E}$

LEGGE DI GAUSS PER $\vec{E}$

- Rappresentazione di $\vec{E}$ con linee di forza

1/

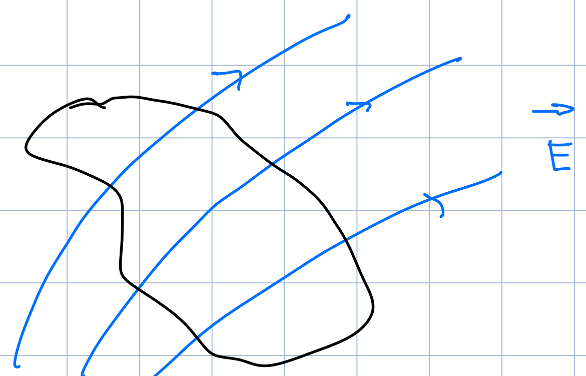


Hp: $q_0 > 0$

2/

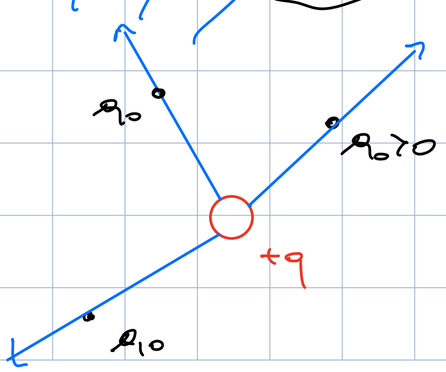
Densità linee di forza $\propto E$

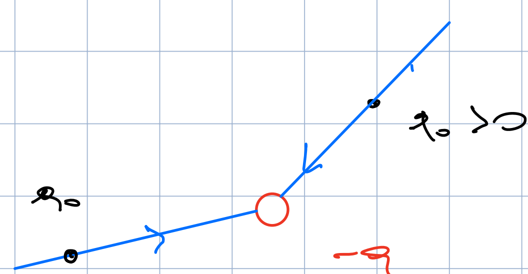
- Linee di forza attraverso superficie chiusa

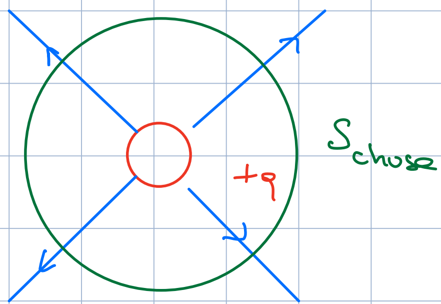


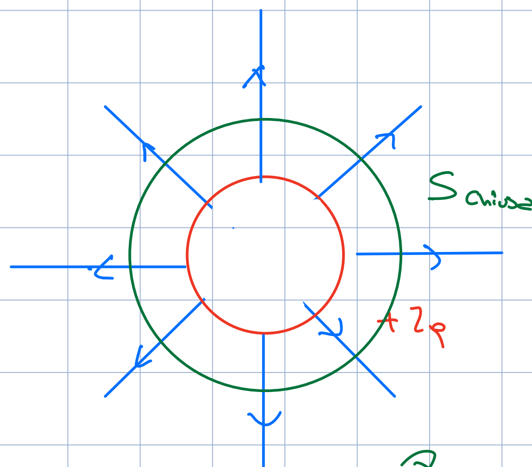
OUT "+"

IN "−"



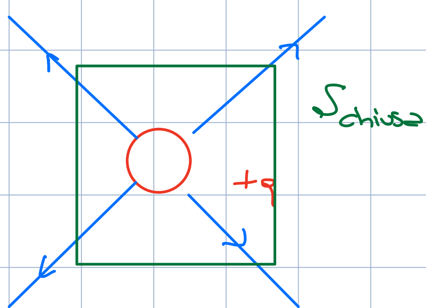


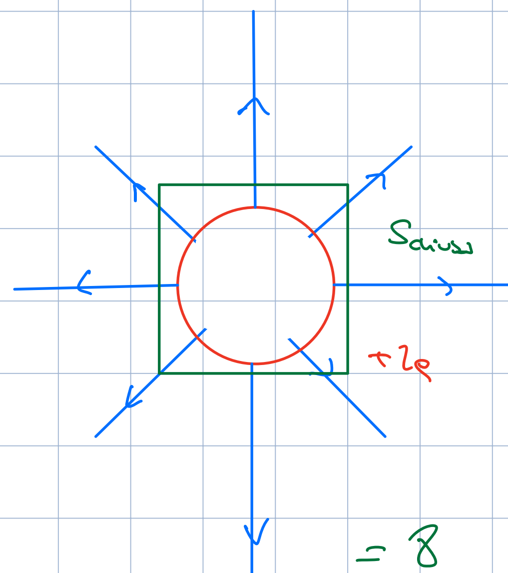




\# linee di forza che attraversano S_{chiusa} $= 4$

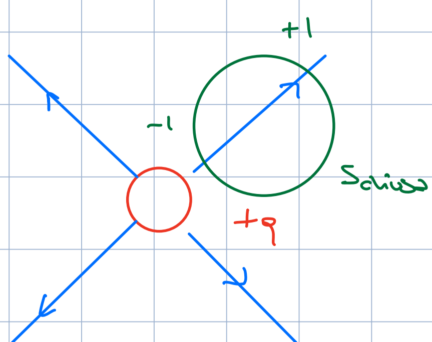
$= 8$

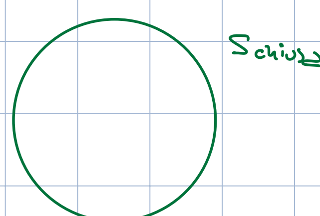




$= 4$

$= 8$

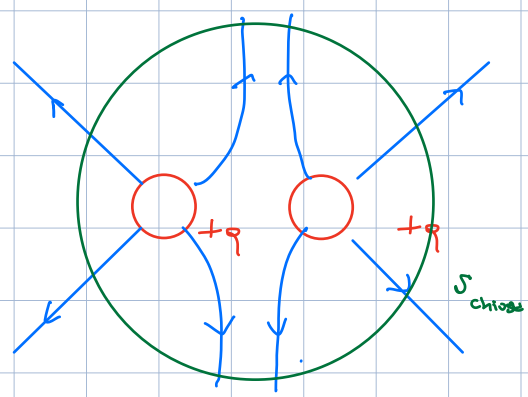




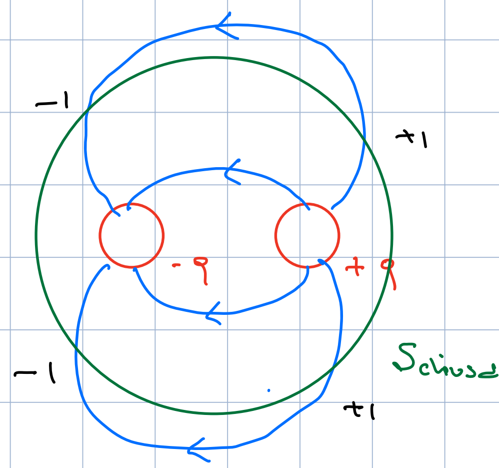
$= 0$

$= 0$

$\boxed{\text{\# linee di } \tilde{E} \text{ attraverso } S_{chiusa} \propto Q_{int}}$ (proporzionale)



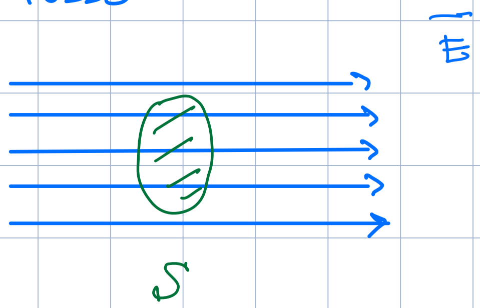
$= 8$

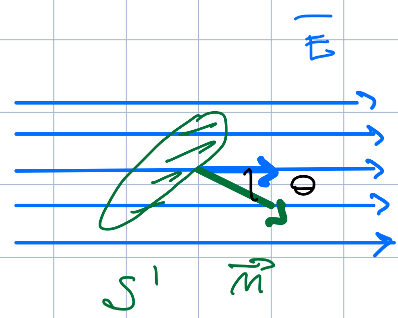


$= 0$

$$\boxed{\begin{array}{l}\#\text{ linee di } \vec{E} \\ \text{attraverso } S_{chiuse}\end{array} \underset{\text{(proporzionale)}}{\propto} \sum_k Q_{k,int}}$$

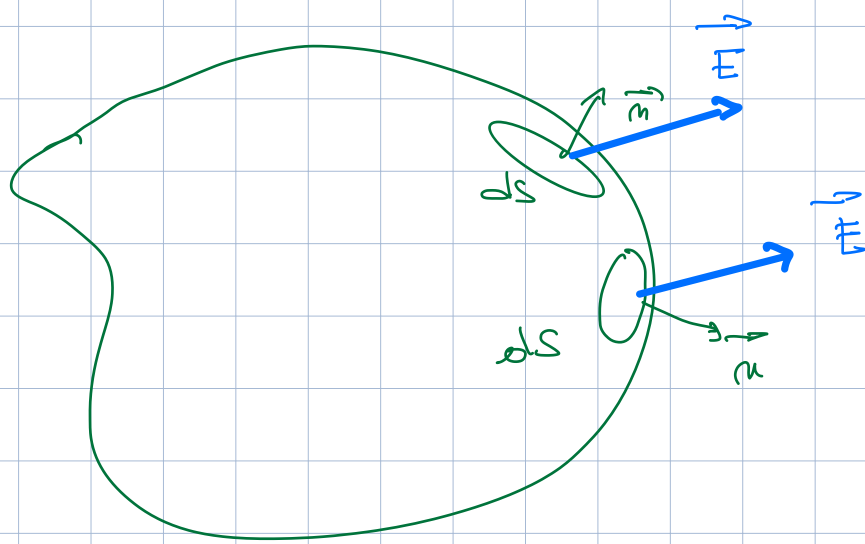
- **Flusso**





$E \, S$ $\qquad$ $E \, S' \cos\theta$

$$\vec E \cdot \vec n \, S$$

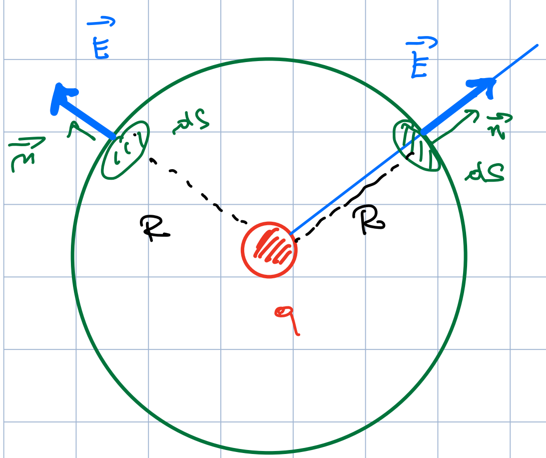


Definizione di flusso di $\vec E$

$$\boxed{\Phi_{\vec E}(S) = \int_S \vec E \cdot \vec n \, dS}$$

- Legge di Gauss per $\vec{E}$

$$\Phi_{\vec{E}}(S_{chiusa}) = \int_{S_{chiusa}} \vec{E}\cdot\vec{n}\, dS = ?\ \sum_k Q_{k,int}$$



$\vec{E} /\!/ \vec{n}$

$$\vec{E}\cdot\vec{n} = E\cdot 1\cdot\cos 0 = E = k_e \frac{q}{R^2}$$

$$E = k_e \frac{q}{R^2}$$

$$\Phi_{\vec{E}}(S_{chiusa}) = \int_{S_{chiusa}} k_e \frac{q}{R^2}\, dS = k_e \frac{q}{R^2} \underbrace{\int_{S_{chiusa}} dS}_{4\pi R^2}$$

$$= k_e \frac{q}{\cancel{R^2}} 4\pi \cancel{R^2} = 4\pi k_e \underbrace{q}_{\sum_k Q_{k,int}}$$

$9\times10^{9}\ Nm^2/C^2$

$$\Phi_{\vec{E}}(S_{chiusa}) = \int_{S_{chiusa}} \vec{E}\cdot\vec{n}\, dS = 4\pi k_e \sum_k Q_{k,int}$$

$$\varepsilon_0 = \frac{1}{4\pi k_e} = 8.854\times10^{-12} \frac{C^2}{N m^2}$$

• Uso della legge di Gauss per calcolo di $\vec{E}$

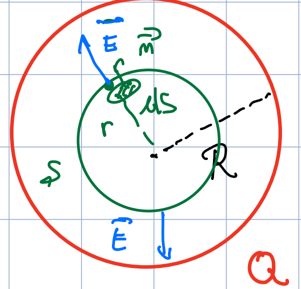
$$\boxed{\Phi_{\vec E}(S_{chiusa}) = \int_{S_{chiusa}} \vec E \cdot \vec n \, dS = 4\pi k_e \sum_k Q_{k,int}}$$

•• <u>Simmetria sferica</u> : Guscio sferico

$\vec E \,//\, \vec n$

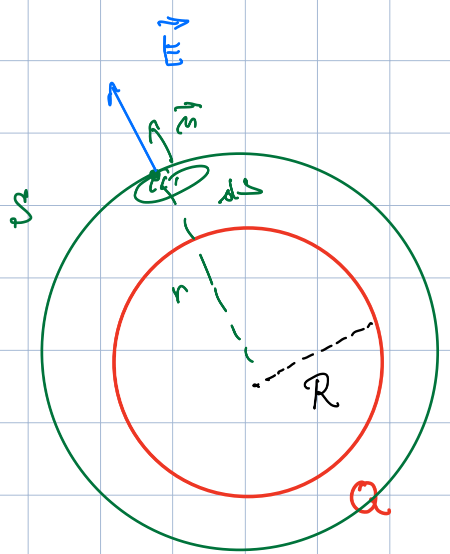
$\vec E \cdot \vec n \, dS = E \, dS$

$\cos\theta = \cos 0 = 1$



$$\Phi_{\vec E}(S_{chiusa}) = \int_{S_{chiusa}} E\, dS = E \int_{S_{chiusa}} dS =$$

$$= E\, 4\pi r^2$$



• <u>$r < R$</u>

$$E\, 4\pi r^2 = 4\pi k_e \sum_k Q_{k,int}$$

$$= 0$$

$$\Rightarrow \boxed{E = 0}$$

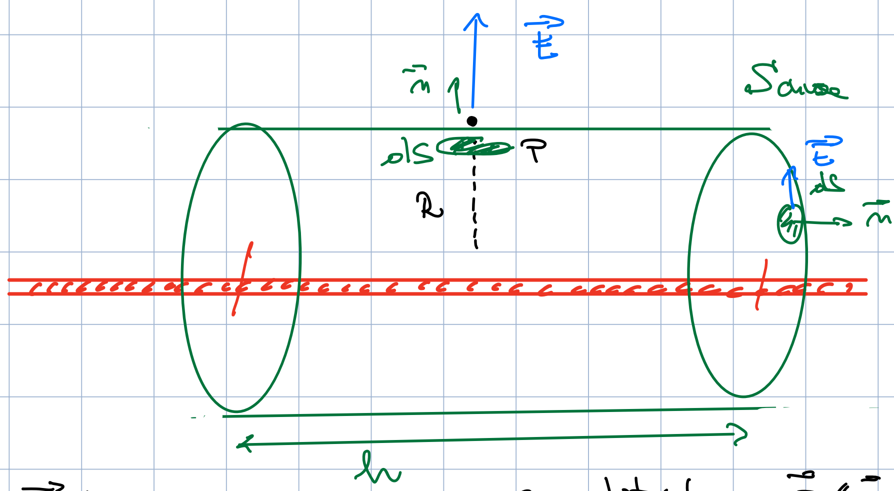
• <u>$r > R$</u>

$$E\, 4\pi r^2 = 4\pi k_e \sum_k Q_{k,int}$$

$$= 4\pi k_e Q$$

$$\Rightarrow \boxed{E = k_e \, Q / r^2}$$

•• Simmetria assiale: distribuzione lineare uniforme



λ densità lineare di carica

$\vec E \cdot \vec n \, dS$

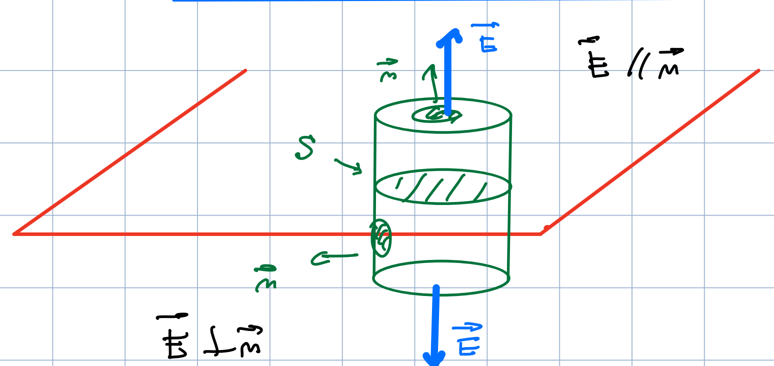
- sup. laterale $\quad \vec E \parallel \vec n \quad \vec E \cdot \vec n = E$
- sup. base $\quad \vec E \perp \vec n \quad \vec E \cdot \vec n = 0$

$$\Phi_{\vec E}(S_{chiusa}) = \int_{S_{laterale}} E\, dS = E \int_{S_{laterale}} dS = E\, 2\cancel{\pi} R \cancel{h}$$

$$= 4\pi k_e \underbrace{\sum_k Q_{k,int}}_{\lambda h} = 4\cancel{\pi} k_e \lambda \cancel{h}$$

$$\boxed{E = 2 k_e \frac{\lambda}{R}}$$

•• Simmetria piana: piano di carica



σ: densità superficiale di carica

$$\Phi_{\vec E} = E\, 2\cancel{S} = 4\pi k_e\, \sigma \cancel{S}$$

$$\boxed{E = 2\pi k_e \sigma}$$