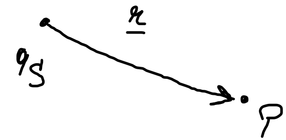
$$\underline{E}(P) = \frac{\underline{F}(P)}{q_0}$$

$\underline{F}(P)$ → forza sulla carica di prova

q_0 ← carica di prova

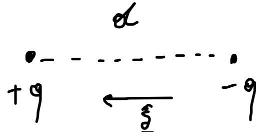
Vale il pr. di sovrapp. per $\underline{E}$

Per una singola carica sorgente q_S



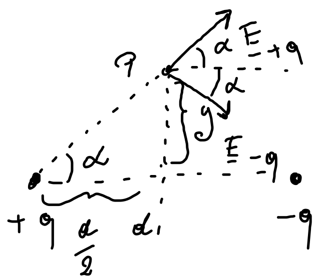
$$\underline{E}(\underline{r}) = \frac{1}{4\pi\varepsilon_0}\frac{q_S}{r^2}\hat{\underline{r}}$$

Dipolo



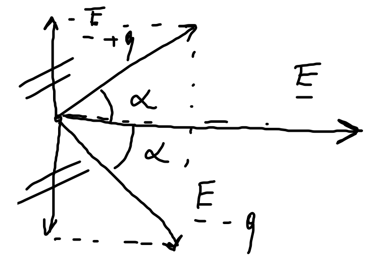
Vettore dipolo $\vec{p} = d\,q\,\hat{\underline{s}}$

Punto P sull'asse del dipolo



$$\underline{E}(P) = \underline{E}_{+q}(P) + \underline{E}_{-q}(P)$$

↑ pr. sovrapp.

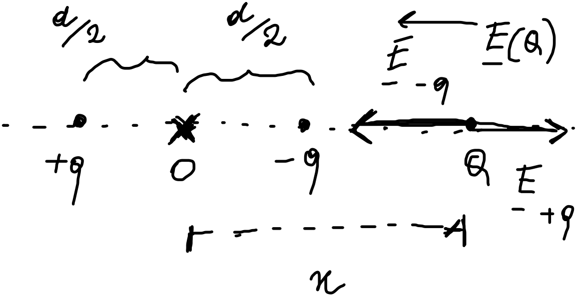


$$|\underline{E}_{+q}| = |\underline{E}_{-q}|$$

$$|\underline{E}|(P) = 2\,|\underline{E}_{+q}|\cos\alpha \qquad \text{dist}(P, +q) = \sqrt{\frac{d^2}{4} + y^2} \qquad \cos\alpha = \frac{d/2}{\left(\frac{d^2}{4} + y^2\right)^{\frac{1}{2}}}$$

$$= \cancel{2} \cdot \underbrace{\frac{1}{4\pi\varepsilon_0}\frac{q}{\left(\frac{d^2}{4} + y^2\right)}}_{|\underline{E}_{+q}|} \frac{d/\cancel{2}}{\left(\frac{d^2}{4} + y^2\right)^{\frac{1}{2}}} = \frac{1}{4\pi\varepsilon_0}\frac{\overbrace{qd}^{p}}{\left(\frac{d^2}{4} + y^2\right)^{3/2}}$$

$$y \gg d \qquad (y^2)^{3/2} \sim \frac{1}{y^3}$$

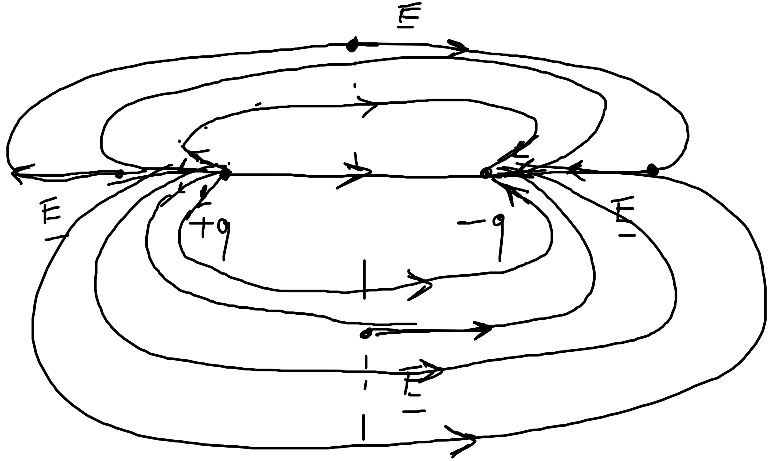


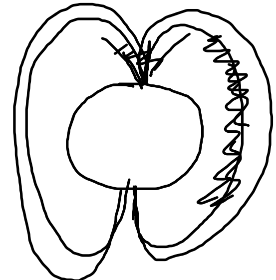
$$\underline{E}(Q) = \underline{E}_{+q}(Q) + \underline{E}_{-q}(Q)$$

pr. sovr.

$$\left|\underline{E}_{+q}(Q)\right| = \frac{1}{4\pi\varepsilon_0}\frac{q}{\left(x+\frac{d}{2}\right)^2} \qquad \left|\underline{E}_{-q}(Q)\right| = \frac{1}{4\pi\varepsilon_0}\frac{q}{\left(x-\frac{d}{2}\right)^2}$$

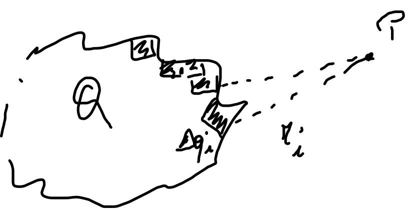
$$\underline{E}(Q) = E_{+q}(Q) - E_{-q}(Q) = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{\left(x+\frac{d}{2}\right)^2} - \frac{1}{\left(x-\frac{d}{2}\right)^2}\right) < 0$$





$Q = 1\ \mu C$ $\qquad e = 1.6 \cdot 10^{-19}\ C$

$\#$ cariche elementari $= \dfrac{10^{-6}}{1.6 \cdot 10^{-19}} \approx 10^{13}$



$$\underline{E}(P) = \sum_{i=1}^{N} \frac{1}{4\pi\varepsilon_0} \frac{\Delta q_i}{r_i^2} \hat{\underline{r}}_i$$

$N \simeq$ diversi miliardi

Introduco la densità volumetrica di carica

$$Q = \sum_{i=1}^{N} \Delta q_i$$

Densità volumetrica di carica

$$\rho = \frac{\Delta Q}{\Delta V}$$

$\Delta Q \rightarrow$ carica in un piccolo volume ΔV

$\Delta V \leftarrow$ piccolo volume

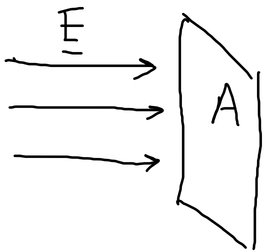
$$\Delta q_i \sim dq = \rho \cdot dV$$

$$\underline{E}(P) = \int \frac{1}{4\pi\varepsilon_0} \frac{\rho \, dV}{r^2} \, \hat{\underline{r}} = \frac{1}{4\pi\varepsilon_0} \int \frac{\rho}{r^2} \, \hat{\underline{r}} \, dV$$

Volume che contiene la carica

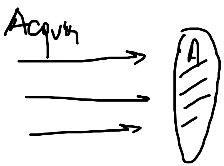
Teorema di Gauss

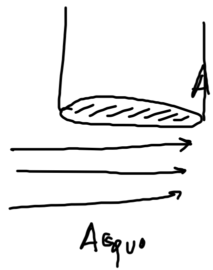
Flusso di un vettore ($\underline{E}$) attraverso una superficie



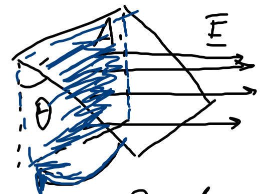
Linee di campo ⊥ alla superficie

$$\phi = E \cdot A \qquad [\phi] = \frac{N}{C} \cdot m^2$$





Per una superficie inclinata

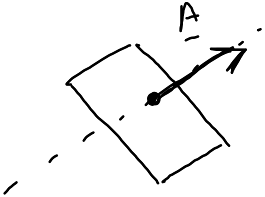


$$\phi \overset{def}{=} \underline{E} \cdot A \cdot \cos\theta$$

$\underline{E}$

$$\underline{c} \cdot \underline{d} = c\, d \cos\theta$$

Vettore area :

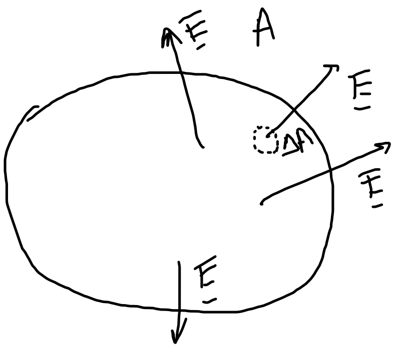


modulo: valore dell'area

Direzione: $\perp$ alla superficie } Versore normale alla sup. $\underline{\hat{n}}$

Verso: uscente

$$\underline{A} \overset{def}{=} A \cdot \underline{\hat{n}}$$



$$\phi = EA\cos\theta = \underline{E} \cdot \underline{A} \qquad \underline{E} \text{ uniforme}$$

Considero un'area ΔA_i (al limite infinitesimo) su cui $\underline{E}$ è uniforme

$$\Delta\phi = \underline{E}_i \cdot \Delta\underline{A}_i \qquad \phi = \lim_{N \to +\infty} \sum_{i=1}^{N} \underline{E}_i \cdot \Delta\underline{A}_i$$

$$\phi = \sum_{i=1}^{N} \Delta\phi = \sum_{i=1}^{N} \underline{E}_i \cdot \Delta\underline{A}_i = \int_{\text{area totale}} \underline{E} \cdot d\underline{A}$$