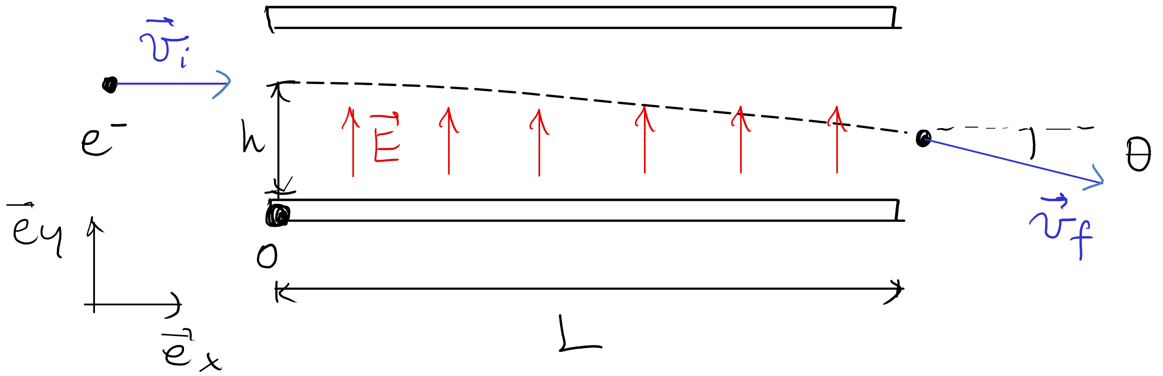
Esempio : moto di una particella carica in un campo elettrico costante



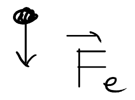
elettrone e^- $q = -e$

$\vec{E} = \text{cost}$

gravità trascurabile

$\Rightarrow \theta = ?$

Forze : $\vec{F}_{el} = q\vec{E}$ Diagramma corpo libero :



II Newton : $\sum \vec{F} = m\vec{a}$

$$q\vec{E} = m\vec{a}$$

$$\vec{a} = \frac{q}{m}\vec{E} \quad \Rightarrow \text{ moto unif. accelerato}$$

$$\vec{v}_f = \vec{v}_i + \vec{a}(t_f - t_i) \qquad \vec{r}_f = \vec{r}_i + \vec{v}_i(t_f - t_i) + \frac{1}{2}\vec{a}(t_f - t_i)^2$$

Componenti cartesiane : Condizioni iniziali : $t_i = 0$

$$\vec{a} = \frac{q}{m}E\,\vec{e}_y \qquad \vec{E} = E\,\vec{e}_y \qquad E \equiv |\vec{E}| > 0$$

$$\vec{r}_i = 0\,\vec{e}_x + h\,\vec{e}_y = h\,\vec{e}_y$$

$$\vec{v}_i = v_{ix}\,\vec{e}_x + 0\,\vec{e}_y = v_{ix}\,\vec{e}_x$$

Leggi orarie:

$$v_{fx}\vec{e}_x + v_{fy}\vec{e}_y = v_{ix}\vec{e}_x + \frac{qE}{m}(t_f - t_i)\vec{e}_y$$

$$\begin{cases} v_{fx} = v_{ix} \\ v_{fy} = \frac{qE}{m}(t_f - t_i) \end{cases}$$

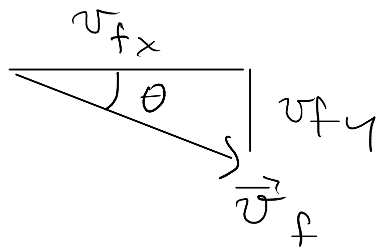
$$x_f\vec{e}_x + y_f\vec{e}_y = h\vec{e}_y + v_{ix}(t_f - t_i)\vec{e}_x + \frac{1}{2}\frac{qE}{m}(t_f - t_i)^2\vec{e}_y$$

$$\begin{cases} x_f = v_{ix}(t_f - t_i) \\ y_f = h + \frac{1}{2}\frac{qE}{m}(t_f - t_i)^2 = h - \frac{1}{2}\frac{eE}{m}(t_f - t_i)^2 \end{cases}$$

Tempo di uscita: $(t_f - t_i)$

$$t_f - t_i = \frac{L}{v_{ix}} \rightarrow v_{fy} = \frac{qE}{m}\frac{L}{v_{ix}}$$

$$\tan\theta = -\frac{v_{fy}}{v_{fx}} = -\frac{qEL}{m v_{ix}^2} = \frac{eEL}{m v_{ix}^2}$$



$$\tan\theta = \frac{\sin\theta}{\cos\theta} = \frac{v_{fy}}{v_{fx}}$$

$$\theta = \arctan\left(\frac{eEL}{m v_{ix}^2}\right) \qquad \text{es: } \left[\frac{eEL}{m v_{ix}^2}\right] = 1$$

devo cambiare segno per avere $\theta > 0$

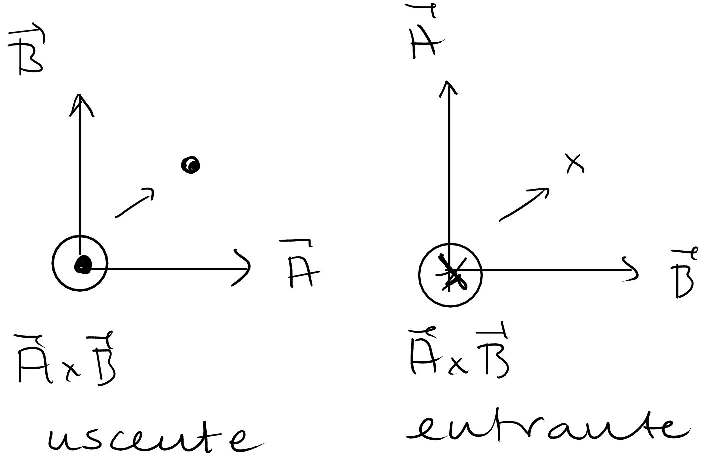
3. Interazioni magnetiche

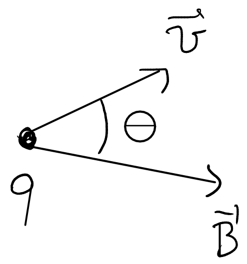
~1200 poli +/−, N/S

~1700 misure quantitative

~1800 campo magnetico

Maxwell → campo EM





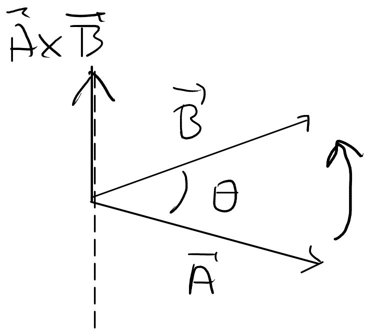
$|\vec{F}_m| \sim |q\vec{v}|$

$|\vec{F}_m| \sim |\vec{B}|$ ← campo magnetico

$|\vec{F}_m| \sim |\sin\theta|$

Prodotto vettoriale $\vec{A}\times\vec{B}$

Prodotto scalare $\vec{A}\cdot\vec{B} = |\vec{A}||\vec{B}|\cos\theta$



- direzione: $\vec{A}\times\vec{B} \perp \vec{A},\vec{B}$
- modulo: $|\vec{A}\times\vec{B}| = |\vec{A}|\cdot|\vec{B}|\cdot\sin\theta$
- verso: regola della mano destra

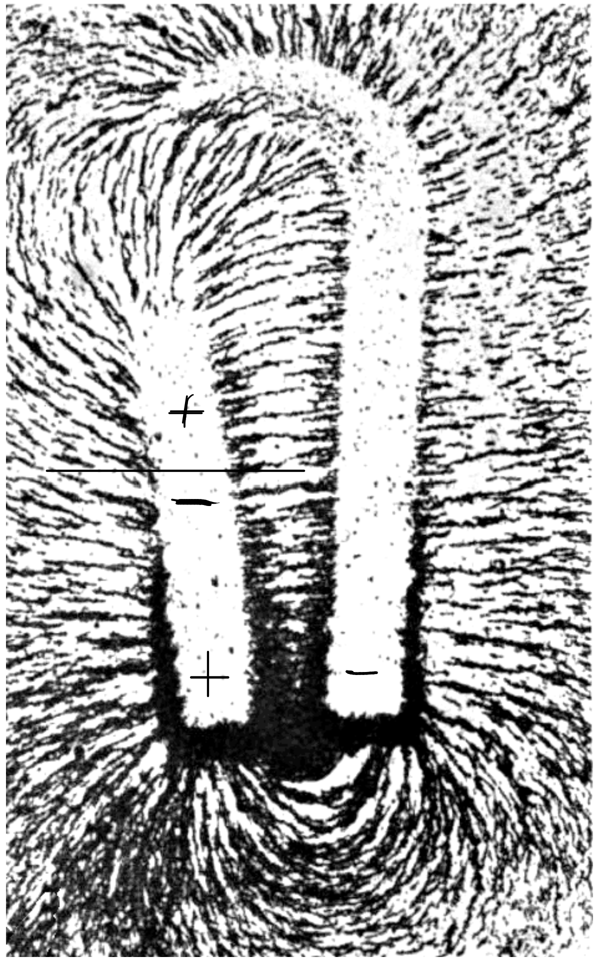
$\vec{B}\times\vec{A} = -\vec{A}\times\vec{B}$

$\vec{F}_m = (q\vec{v})\times\vec{B}$ forza di Lorentz

Tesla

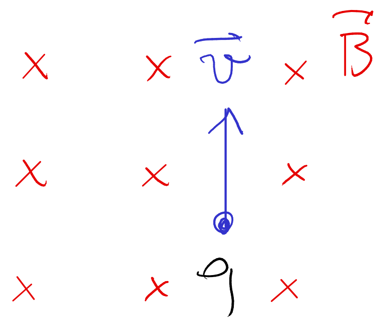
↓

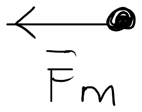
SI: $\dfrac{Ns}{Cm} \equiv T$



Aghi di ferro deflessi dal campo magnetico di un ferro di cavallo

Esempio: moto di una particella carica in un campo magnetico costante





carica $q > 0$

massa m

$\vec{B} = \text{cost}$

$$\vec{F}_m = q\vec{v} \times \vec{B}$$

II Newton: $\Sigma \vec{F} = m\vec{a}$

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

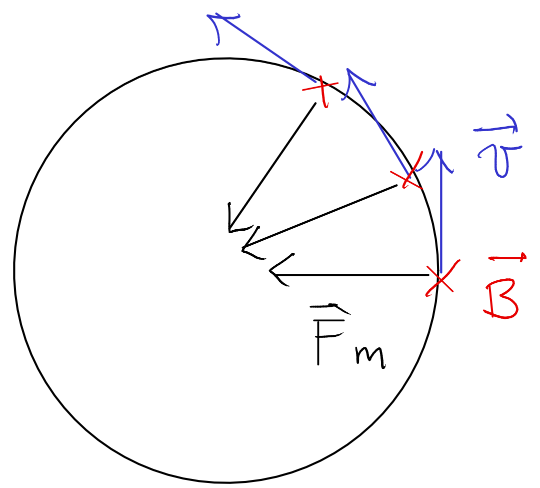
$$|\vec{a}| \equiv a_c = \frac{|\vec{v}|^2}{r}$$

raggio circonferenza

$$|q||\vec{v}||\vec{B}| = m a_c$$

$$q|\cancel{\vec{v}}||\vec{B}| = m\frac{|\vec{v}|^{\cancel{2}}}{r}$$

$$r = \frac{m|\vec{v}|}{q|\vec{B}|}$$



$$\left.\begin{array}{l} \vec{F}_m \perp \vec{v} \Rightarrow \vec{a} \perp \vec{v} \\ |\vec{F}_m| = \text{cost} \Rightarrow |\vec{a}| = \text{cost} \end{array}\right\} \text{moto circolare unif.}$$

periodo: $2\pi r = |\vec{v}|\tau \Rightarrow \tau = \dfrac{2\pi r}{|\vec{v}|} = \dfrac{2\pi m}{q|\vec{B}|}$

4. <u>Interazione forte</u> → responsabile della stabilità dei nuclei

nucleo atomo = protoni + neutroni

protoni ↓ +e

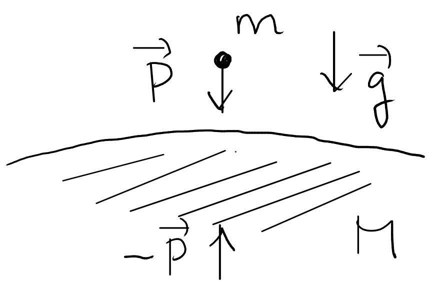
neutroni ↓ 0

5. <u>Interazione debole</u> → responsabile del decadimento radio attivo

FORZE MACROSCOPICHE

Risultante di una moltitudine di forze fondamentali tra particelle elementari

1. Peso



$\vec{p} = m\vec{g}$

III Newton: $\vec{p}^{(m)} = -\vec{p}^{(M)}$

2. Forza elastica → piccola deformazione di un corpo macro

Es.: molla