Token 655 586

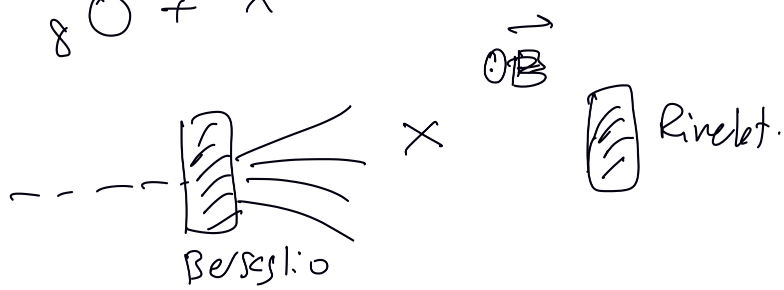
Rutherford

e^-: Thompson 1897

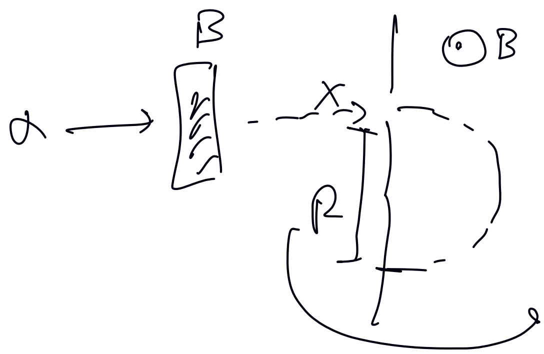
e^-, N, α

protone: Rutherford 1918

$$\alpha + {}^{14}_{7}N \longrightarrow {}^{17}_{8}O + X$$



X carica. $\Rightarrow$ spettroscopia di massa.



$$\vec{F} = m\vec{a} = q(\vec{v} \times \vec{B})$$

$$a = \frac{q}{m} vB$$

$$\propto \frac{q}{m}$$

$\frac{q}{m}$ compatibile con ione H^+

$$\alpha + {}^{14}_{7}N \rightarrow {}^{17}_{8}O + p$$

Trasmutazione nucleare

Chadwick 1931 $\longrightarrow$ Scoperta del neutrone.

$$\alpha + {}^{9}_{4}Be \longrightarrow {}^{12}_{6}C + X$$

Li

B

caratteristiche di X

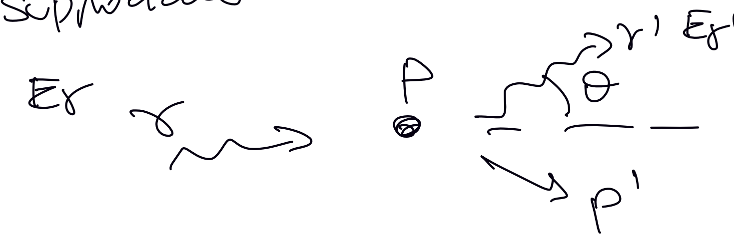
- neutra
- non ionizzante
- molto penetrante

Ipotesi:

- fotoni $X \equiv \gamma$
- nuove particelle con massa m

supponiamo $\alpha + Be \rightarrow C + \gamma$

$\hookrightarrow \gamma + p \longrightarrow \gamma + p$



$K_p = 5$ MeV

$$E_{\gamma'} = \frac{m_p}{E_{p'}} \frac{E_\gamma}{1 - \frac{p_{p'}}{E_{p'}} \cos\theta}$$

$\gamma \rightsquigarrow \circ\, p \qquad \gamma' \rightsquigarrow \quad \circ \longrightarrow p' \, (p'_p, E_p')$

$$E_{\gamma'} = \frac{m_p}{E_{p'}} \frac{E_\gamma}{1 + \frac{p_{p'}}{E_{p'}}}$$

$E_{p'} = m_p + K'_p \qquad K'_p \simeq 5$ MeV dalle misure

$E_{\gamma'} \cong 0.9\, E_\gamma$

$E_\gamma + \cancel{m_p} = E_\gamma' + \cancel{m_p} + K_p'$

$\alpha + Be \Rightarrow C + \gamma$

non può avere 50 MeV

$\Rightarrow \quad E_\gamma - E_\gamma' = K_p'$

$\underbrace{0.1\, E_\gamma} = 5\text{ MeV} \Rightarrow E_\gamma \simeq 50\text{ MeV}$

$\Rightarrow$ non era possibile

$\Rightarrow$ Chadwick $\quad \alpha + {}^{9}_{4}Be \to {}^{12}_{6}C + \underbrace{n}$

$\dfrac{|m_n - m_p|}{m_p} \simeq 10\%$

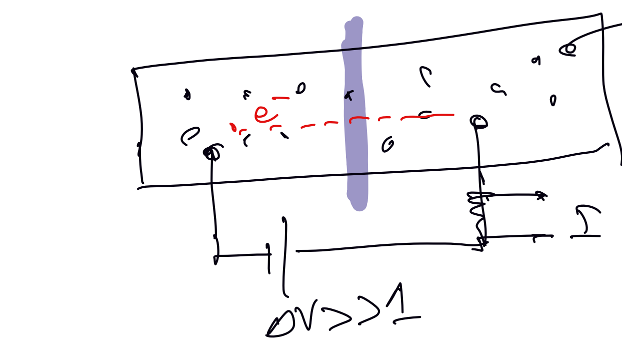
$m_p = 938.3$ MeV

$m_n = 939.6$ MeV

$\dfrac{\Delta m}{m} \simeq 1‰$

$\gamma, \alpha, p, n, e^-$

<u>scoperta dell'elettrone</u> Thompson 1897 Nobel 1906



gas.

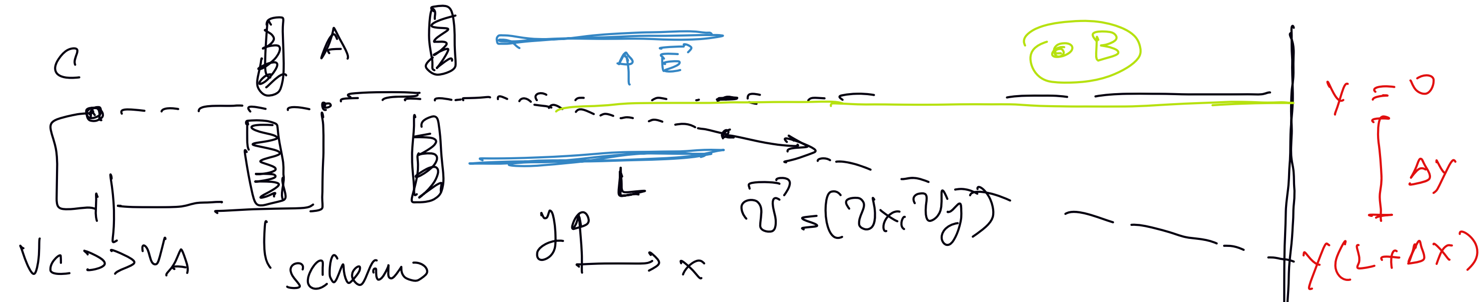
param. sotto controllo.

- ΔV
- tipo di gas
- pressione del gas ⇒ n

Variando param ⇒ misurare I

schermo ⇒ non passa corrente.

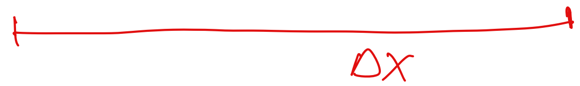
variazione corrente I con $\vec{B}$ ⇒ particella carica.



$$m a_y = qE$$

$$a_y = \frac{q}{m} E$$

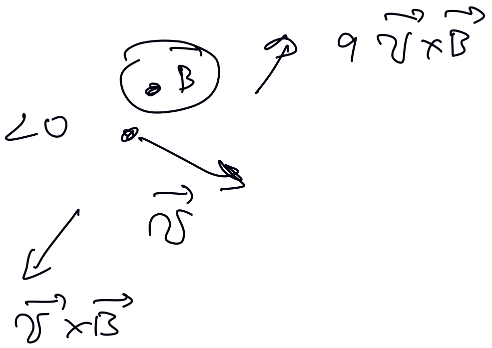
$$\begin{cases} a_x = 0 \\ a_y = \frac{q}{m} E \end{cases}$$



$$v_y(L) = a_y \cdot \Delta T = \frac{q}{m} E \frac{L}{v_x}$$

$$L = v_x \Delta T \Rightarrow \Delta T = \frac{L}{v_x}$$

$q<0$



$$\vec{F} = q(\vec{v}\times\vec{B} + \vec{E}) = 0$$

$$q(v_x B + E) = 0. \Rightarrow \boxed{v_x = \frac{E}{B}}$$

$$y(L+\Delta X) = \frac{q}{m} E L \frac{B^2}{E^2}\left(\frac{L}{2} + \Delta X\right)$$

determinati dallo sperim.

$\Rightarrow$ stimare $\frac{q}{m}$ per un configurazione.

Ripetere misure $\begin{cases} \text{- diversi gas} \\ \text{- diverse pressioni} \\ \text{- diversi } \Delta V \end{cases}$ $\Rightarrow \frac{q}{m}$ invariante

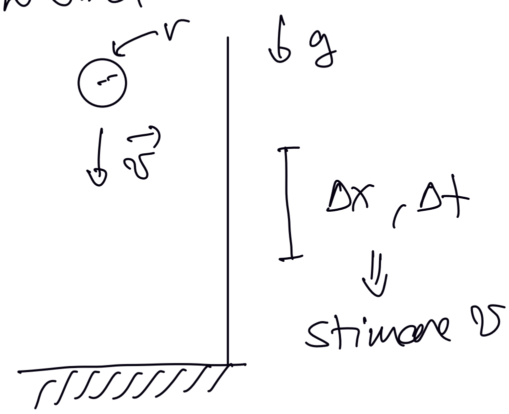
Thompson: $\frac{q}{m} = 1.76 \times 10^{11}\ C \cdot Kg^{-1}$ $\quad q<0$

$$\vec F = m\vec a = q(\vec E + \vec v \times \vec B)$$

⇒ per poter misurare m ⇒ serve misura indip. di q

<u>Esperimento di Millikan</u> 1909 Nobel 1923

olio nebulizzato



misura di q

ρ: densità dell'olio

$$m = \frac{4\pi}{3}\rho r^3$$

$$F = mg - 6\pi\eta r v_0 = 0$$

↳ coeff di viscosità

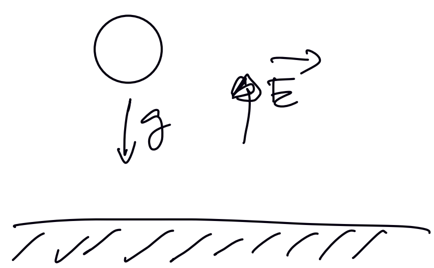
v_0: vel. limite

r: raggio della sfera.

$$\Rightarrow \quad mg = 6\pi\eta r v_0$$

$$\frac{\cancel{4}^{2}\cancel{\pi}}{3}\rho r^{\cancel{3}\,2} g = \cancel{6}^{3}\cancel{\pi}\eta \cancel{r} v_0 \quad \Rightarrow \quad r = \sqrt{\frac{9}{2}\frac{\eta v_0}{\rho g}}$$

misura di v_0 ⇒ stima di r



Accendo campo elettrico.
(nuova configurazione)

$$F = ma = mg - 6\pi\eta r v_1 - qE = 0$$

$$q = \frac{1}{E}(mg - 6\pi\eta r v_1)$$

$(6\pi\eta r) \to$ ricavare da v_0 (dalla prima config.

$$6\pi\eta r = \frac{4\pi}{3} \rho g \frac{1}{v_0} r^2$$

$$q = \frac{1}{E} 6\pi r \eta (v_0 - v_1)$$

$r = \sqrt{\frac{9}{2} \frac{\eta v_0}{\rho g}}$

v_0: $E = 0$

v_1: $E \neq 0$

r: stimato da v_0.

E: noto

misure di $q \pm \delta q$

- variare r
- variare materiale

Millikan: ha visto $q = \#_{\substack{\text{intero} \\ \mathbb{N}}} e$

$e = 1.59 \times 10^{-19}$ C

in accordo entro 1% con valore attuale.

combinando Millikan + Thompson

$m = 0.911 \times 10^{-30}$ kg

$= 0.511$ MeV

e^-, p, n, α, γ, nuclei (ioni)

$\beta = \frac{P}{E}$ $\quad \beta\gamma = \frac{E}{m}$

- misure di $|\vec{p}|$
- misure di E
- misure di q