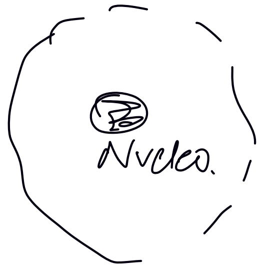
Token 655 586

Rutherford

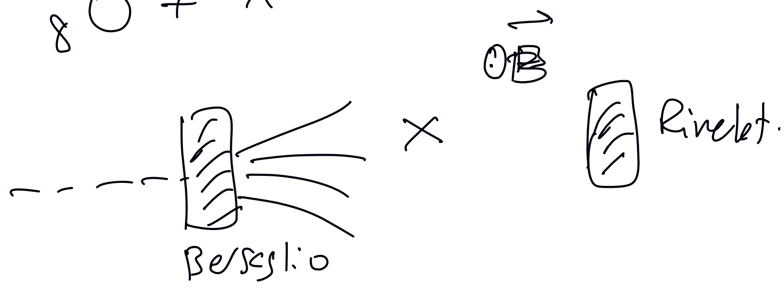


e^-: Thompson 1897

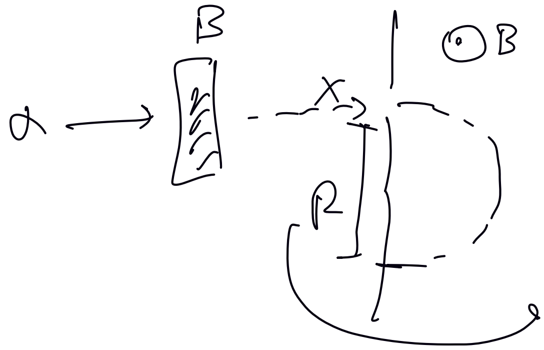
e^-, N, α

protone: Rutherford 1918

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



X carica. $\Rightarrow$ spettroscopia di massa.



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

$$a = \frac{q}{m} v B$$

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

$\frac{q}{m}$ 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

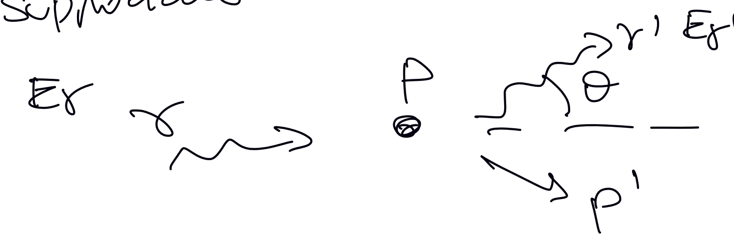
- neutra
- non ionizzante
- molto penetrante

Ipotesi:

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

Supponiamo $\alpha + Be \to C + \gamma$

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



$K_p = 5$ MeV

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

γ $\bullet$ p $\qquad$ γ' $\bullet \longrightarrow p' \, (p'_p, E_p')$

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

$E_p' = m_p + K_p'$ $\qquad$ $K_p' \simeq 5$ MeV dalle misure

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

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

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

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 $\quad \alpha + {}^{9}_{4}Be \rightarrow {}^{12}_{6}C + n$

$$m_p = 938.3\text{ MeV}$$
$$m_n = 939.6\text{ MeV}$$

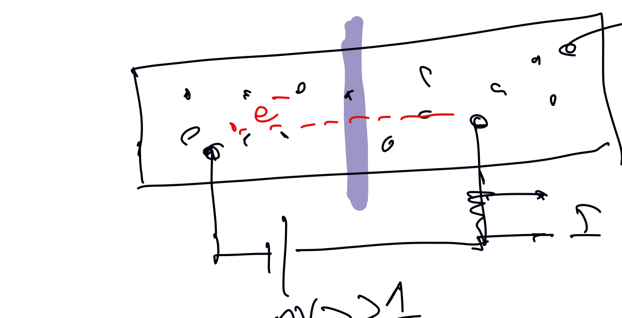
$$\frac{|m_n - m_p|}{m_p} \simeq 10\%$$

$$\frac{\Delta m}{m} \simeq 1‰$$

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

<u>scoperta dell'elettrone</u>

Thompson 1897 Nobel 1906



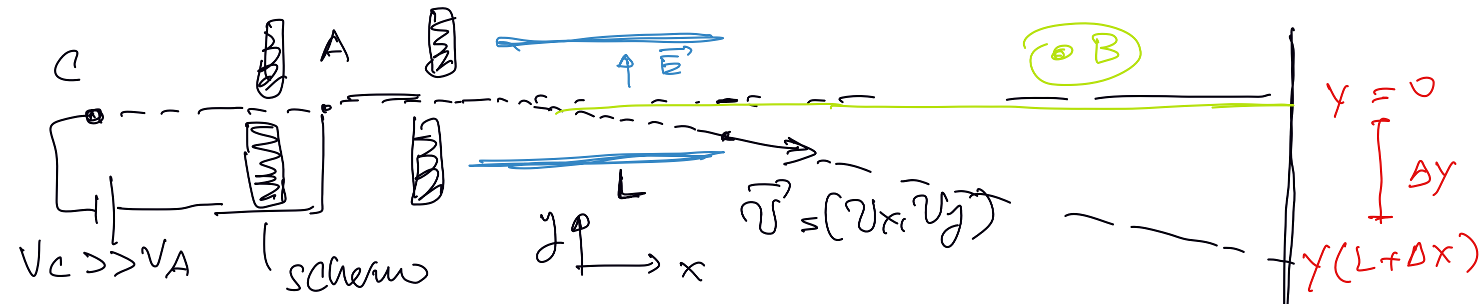
param sotto controllo.

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

variando param ⇒ misurare I

schermo ⇒ non passa corrente.

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



$m a_y = qE$

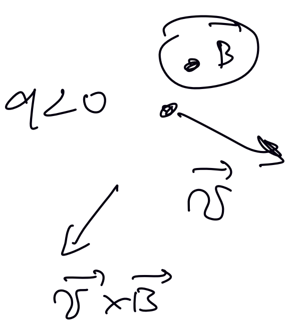
$a_y = \frac{q}{m}E$

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

Δx

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

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



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

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

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

determinati dallo sperim.

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

Ripetere misure
- diversi gas
- diverse pressioni
- diversi ΔV

$\Rightarrow \frac{q}{m}$ invariante

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

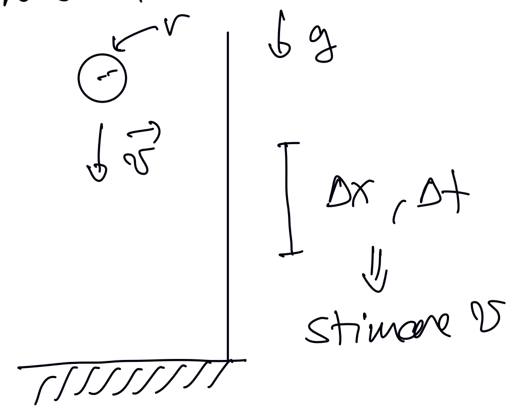
$$\vec{F} = m\vec{a} = q(\vec{E} + \vec{v} \times \vec{B})$$

$\Rightarrow$ per poter misurare m $\Rightarrow$ serve misura indip. di q

Esperimento di Millikan

1909 Nobel 1923

olio nebulizzato



misura di q

ρ: densità dell'olio

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

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

↳ coeff. di viscosità

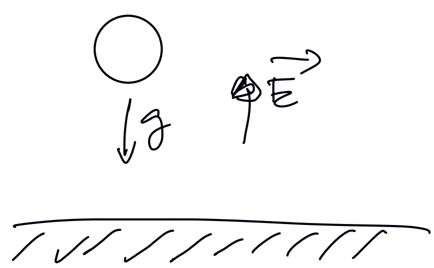
v_0: vel. limite

r: raggio della sfera.

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

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

misura di v_0 $\Rightarrow$ stima di r



Accendo campo elettrico.
(nuova configurazione)

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

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

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

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

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

E → noto

$6\pi r\eta$ → stimato da v_0.

v_0 → $E = 0$

v_1 → $E \neq 0$

misure di $q \pm \delta q$

- variare r
- variare materiale

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

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

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)

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

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