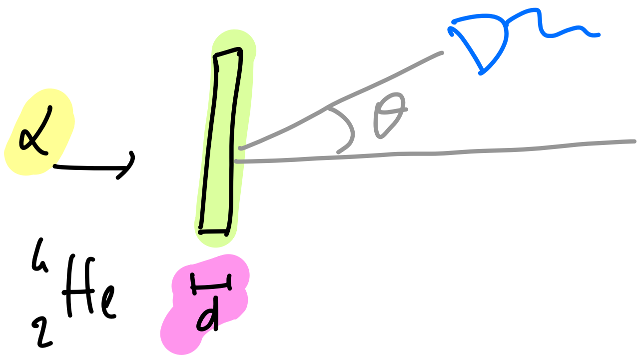
SCATTERING RUTHERFORD QUANTISTICO



$$T_\alpha = \frac{p_\alpha^2}{2m_\alpha} \equiv \frac{p^2}{2m} \simeq 5.5\ \text{MeV}$$

$$m_\alpha < 4 m_p$$

$$m_\alpha \sim 3.7\ \text{GeV}$$

$$\beta = \frac{p}{E} = \frac{\sqrt{2mT}}{T+m} \sim 0.05$$

il processo è

$$\alpha + N \to \alpha + N$$

misuro il numero di "reazioni" nell'unità di tempo

PARTICELLE INCIDENTI AL SEC.

DENSITA' DI BERSAGLI

$$\frac{dN_r}{dt} \propto \frac{dN_\alpha}{dt} \cdot n_b \cdot d$$

SPESSORE DEL BERSAGLIO

$$= \underbrace{\sigma}_{\text{DINAMICA}} \ \underbrace{\frac{dN_\alpha}{dt}\, n_b\, d}_{\text{COME FACCIO L'ESPERIMENTO}}$$

Sezione d'urto $= \dfrac{dN_r/dt}{\dfrac{dN_\alpha}{dt}\, n_b\, d}$

ipotesi

1ª $|i\rangle$ e $|f\rangle$: α LIBERA

$$\psi(\vec{r},t) \propto e^{i(\vec{p}\cdot\vec{r} - Et)}$$

2ª interazione EM

$$\tilde{V}(\vec{r}) = \frac{(Ze)(ze)}{4\pi\varepsilon_0} \cdot \frac{1}{r}$$

ENERGIA POTENZIALE

$$H = H_0 + \tilde{V}$$

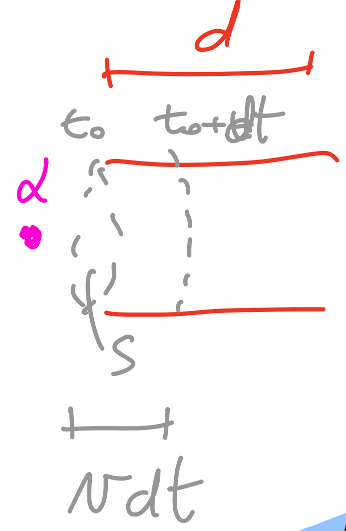
MQ posso scegliere la normalizzazione

di $\psi = A\, e^{\frac{i(\vec{p}\vec{r} - Et)}{\hbar}}$ $\hbar = c = 1$

$A \in \mathbb{C}$

P(particella α in un volume V) $= 1$

la quale risulta $u_A = \frac{1}{V}$



velocità

$$V = S \cdot d$$

$$n_b = \frac{1}{V}$$

$$\text{"}d\sigma\text{"} = \frac{dN_r/dt}{\frac{dN_\alpha}{dt} \cdot n_b \cdot d}$$

- $n_b = 1/V$
- $\frac{dN_\alpha}{dt} = \frac{dN_\alpha}{S v dt} \cdot S v$ — velocità delle α

  $= n_\alpha \cdot S \cdot v$
- $\frac{dN_\alpha}{dt} \cdot d = n_\alpha S v d$

  $= n_\alpha v V$

$$d\sigma = \frac{dN_r/dt}{n_b \cdot n_\alpha \cdot v \cdot V}$$

$$= \frac{dN_r/dt}{1/V \cdot 1/V \cdot v \cdot V} =$$

$$d\sigma = \frac{dN_r/dt}{\nu} V$$

• $|i\rangle$ e $|f\rangle$ particelle libere

$$\psi_{i,f} = A\, e^{i(\vec{p}_{i,f}\vec{r} - E_{i,f} t)} = \frac{1}{\sqrt{V}} e^{i(\vec{p}_{i,f}\vec{r} - E_{i,f} t)}$$

$$P(\alpha \text{ in } V) = 1 = \int_V d^3r\, \psi^* \psi$$

$$= V \cdot |A|^2 = 1 \implies A = \frac{1}{\sqrt{V}}$$

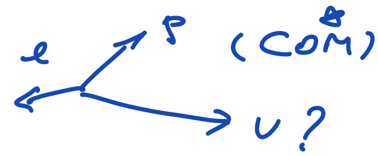
$$\boxed{\frac{dN_r}{dt}} = d\Gamma_{i\to f} = \frac{2\pi}{\hbar} \underbrace{|\langle f|\tilde{V}|i\rangle|^2}_{\text{DINAMICA}} \underbrace{\rho(E_i)}_{\text{CINEMATICA}}$$

(4) $\mu \to p + e + \nu$

$\mu \to e + \nu + \nu$

$$\rho(E_i) = \left.\frac{dn}{dE}\right|_{E_i=E_f}$$

$$= \left.\frac{dn}{dp}\frac{dp}{dE}\right|_{E_i=E_f}$$

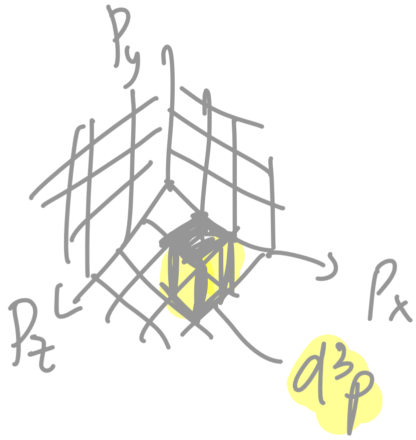
(A) 

$p_x^e = 15$ MeV

$p_x^p = 750$ MeV

$p_x^\nu = ? \to -765$ MeV

$$E\ (\equiv T) = \frac{p^2}{2m} \to \frac{dE}{dp} = \frac{p}{m} \implies \frac{dp}{dE} = \frac{m}{p}$$



$$\psi(x) \propto e^{ipx}$$

nello spazio 3D x, y, z:

$$V \equiv a^3$$

$$\psi(x+a) = \psi(x)$$

$$\psi(x+a) = e^{ip_x(x+a)}$$
$$= e^{ip_x x}$$

$$e^{ip_x a} = 1 \rightarrow p_x a = 2k\pi$$

$$k \in \mathbb{Z}$$

$$p_x = 2k\frac{\pi}{a}$$