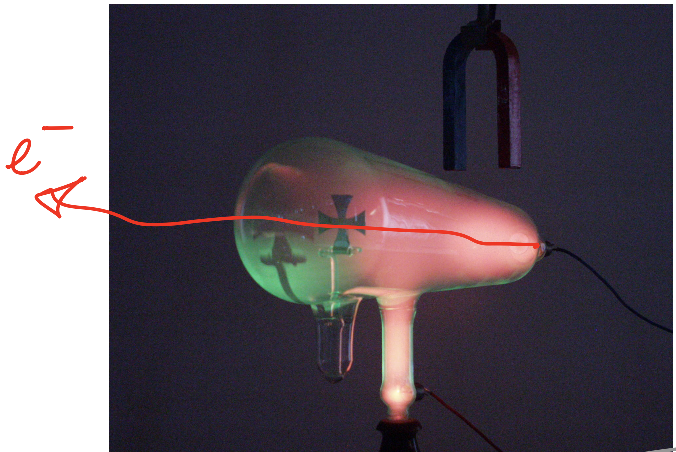
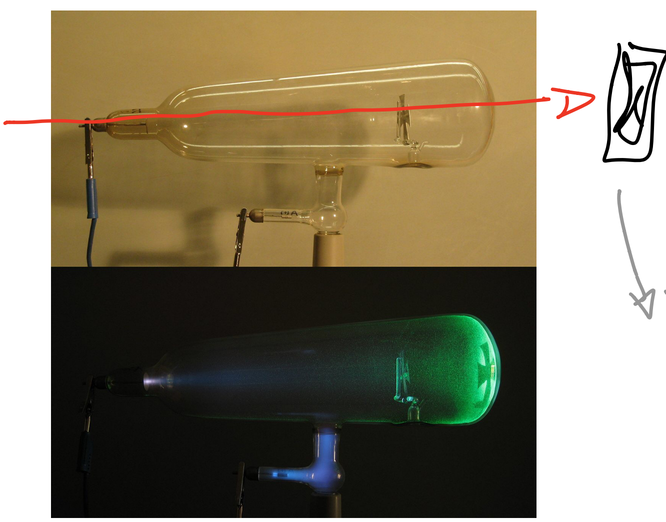
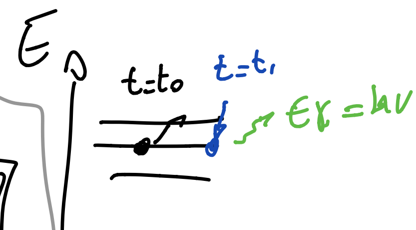
DAL TUBO DI CROOKES ALLA RADIOATTIVITA'



PERCHE' VEDO LUCE VERDE SUL BULBO?





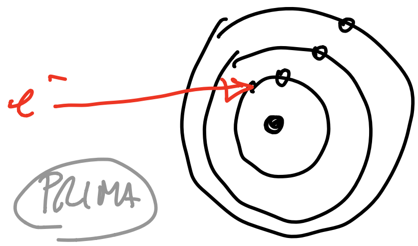
livelli atomici

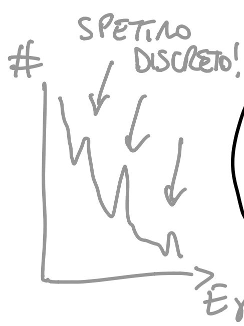
DEL BULBO

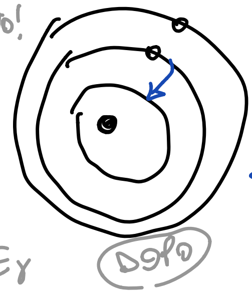
SE SCHERMO (ES. CON DEI LIBRI)

raggi X

(FOTONI)







e^- INTERNO (shell-K)

$E_\gamma = h\nu$

NOME	COS'È	E	RANGE
α	${}^4He^{2+}$	MeV	cm
β^+	e^+	~keV <1MeV	mm
β^-	e^-		
γ	$]\gamma$	keV÷MeV	~km
X		100 1000 eV	~km

IN ARIA

→ osservo diversi tipi di radiazione emessa (a volte SPONTANEAMENTE → RADIOATTIVITÀ NATURALE)

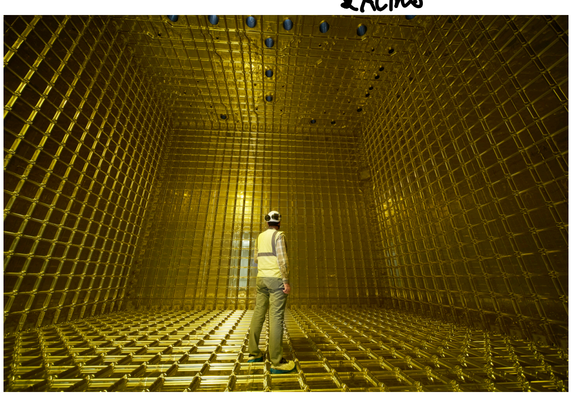
Strumento chiave per capire cosa accade:

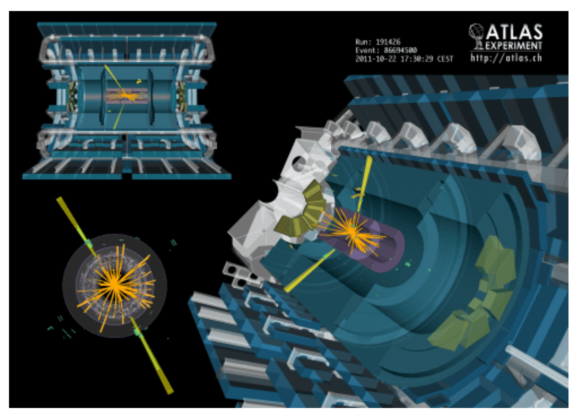
SCATTERING (diffusione)

FISICA MEDICA ↗

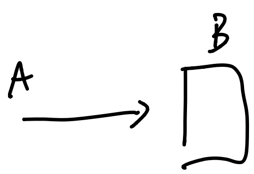
LHC ↘

MATERIA OSCURA & ALTRO ↓



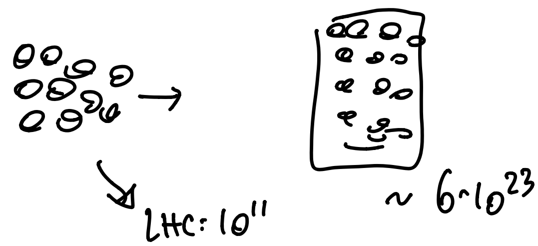


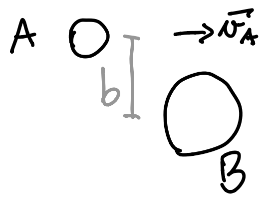
IDEA



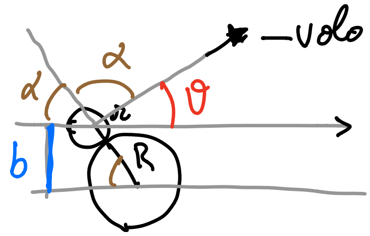
TARGHETTA FISSA (TARGET) BERSAGLIO

- caratterizzo B
- studio come A & B interagiscono





b PARAMETRO D'IMPATTO



—volo finale della A

$$A + B \to A + B$$

$$(A + B \to C + D + E + F \ldots)$$

CASO SEMPLICE: SFERE RIGIDE (URTO = INTERAZIONE DI CONTATTO)

$$\pi = 2\alpha + \theta$$

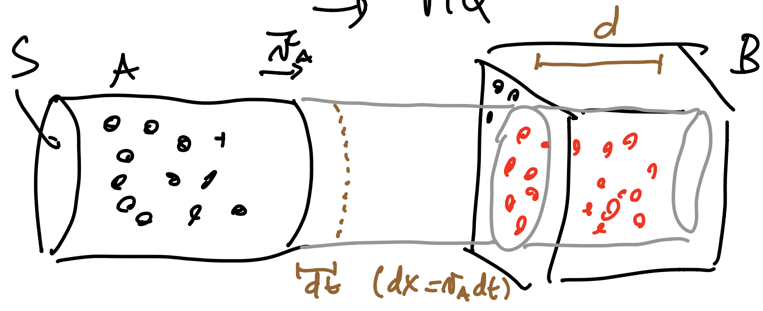
$$\begin{aligned} b &= (r+R) \cdot \sin\alpha \\ &= (r+R) \sin\left(\frac{\pi}{2} - \frac{\theta}{2}\right) \\ &= (r+R) \cos(\theta/2) \end{aligned}$$

$$\boxed{\theta = \theta(b) \quad !}$$

→ caratterizzo cioè quello che misuro (θ) in funzione di b

non conosco b davvero → perchè è difficile

→ MQ



FLUSSO $\dfrac{dN_A}{dt\cdot S} = \dfrac{dN_A}{dt\cdot S}\,\dfrac{v_A}{v_A}$

$= n_A\, v_A$

$$N_B = n_B\cdot (S\, d)$$

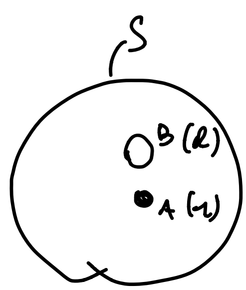
$\Phi,\ N_B$ condizioni sperimentali

OBIETTIVO

RATE: $\dfrac{dN_I}{dt}$ → è quello che misuro!

SEZIONE D'URTO

misura P dell'interazione

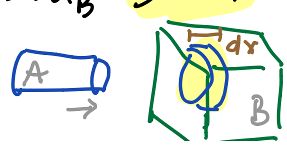


$$\delta P_{contatto} = \frac{\pi (r+R)^2}{S}$$

$$\equiv \frac{\sigma}{S}$$

$dP = \delta P \cdot \tilde{N}_B$ PARTICELLE NEL CILINDRO GIALLO

$= \dfrac{\sigma}{S}\cdot n_B \cdot S\cdot dx$



$$\frac{dN_I}{dt} = \frac{dP}{dt} N_A$$

$$= \frac{\sigma\, n_B\, dx}{dt} \cdot n_A \cdot S \cdot d$$

$$= \sigma \cdot (n_A \cdot v_A) \cdot (S \cdot d\, n_B)$$

$$= \sigma \cdot \phi_A \cdot N_B$$

$$= \sigma \cdot \mathcal{L} \qquad \text{LUMINOSITA'}$$

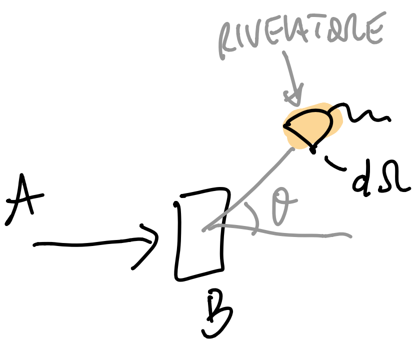
$$[\sigma] = [L]^2$$

$$10^{-28}\, m^2 \equiv \text{BARN} \quad b$$

$(10^{-14}\, cm)^2$ ↳ ATOMO

INT. DEBOLE

$\sigma \sim 10^{-40}\, m^2$ ⟹ σ MISURA LA PROB. DI INTERAZIONE NON LA DIMENSIONE GEOMETRICA DI A E B



RATE

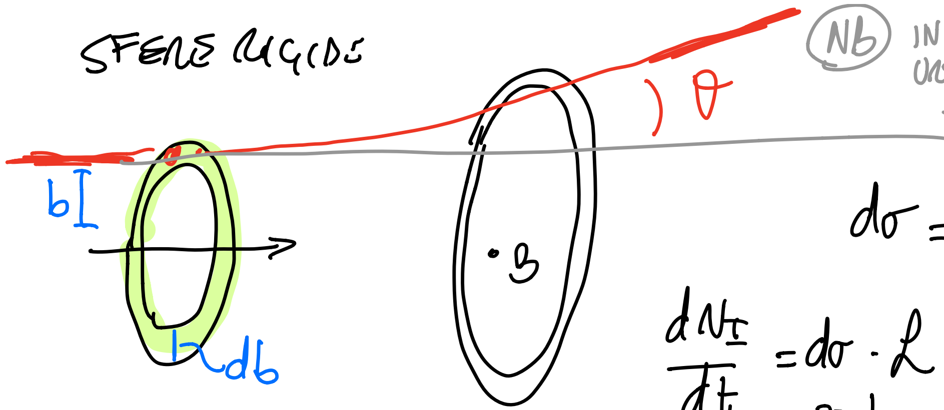
$$\frac{dN_I}{dt} = \sigma \cdot \phi_A \cdot N_B = \sigma \cdot \mathcal{L}$$

$$\frac{dN_I(\theta,\phi)}{dt} = \frac{d\sigma}{d\theta\, d\phi} \cdot \mathcal{L} \cdot (d\theta\, d\phi)$$

SEZIONE D'URTO DIFFERENZIALE

QUANTO E' GRANDE IL DETECTOR

SFERE RIGIDE



NB IN REALTA' E' UN URTO DI CONTATTO → TRAIETTORIA "SPEZZATA"

$$d\sigma = 2\pi b \cdot db$$

$$\frac{dN_I}{dt} = d\sigma \cdot \mathcal{L} = 2\pi b \cdot db \cdot \mathcal{L}$$

$$b = (R+r)\cos\theta/2$$

$$db = \left| -(R+r)\,\tfrac{1}{2}\sin\theta/2 \right| d\theta \quad = \left|\frac{db}{d\theta}\right| d\theta$$

$$\frac{dN_I}{dt} = 2\pi\,(R+r)\cos\theta/2 \cdot (R+r)\cdot \tfrac{1}{2}\sin\theta/2 \; d\theta\,\mathcal{L}$$

$$= 2\pi\,(R+r)^2 \cdot \frac{\sin\theta}{4}\,\mathcal{L}\,d\theta$$

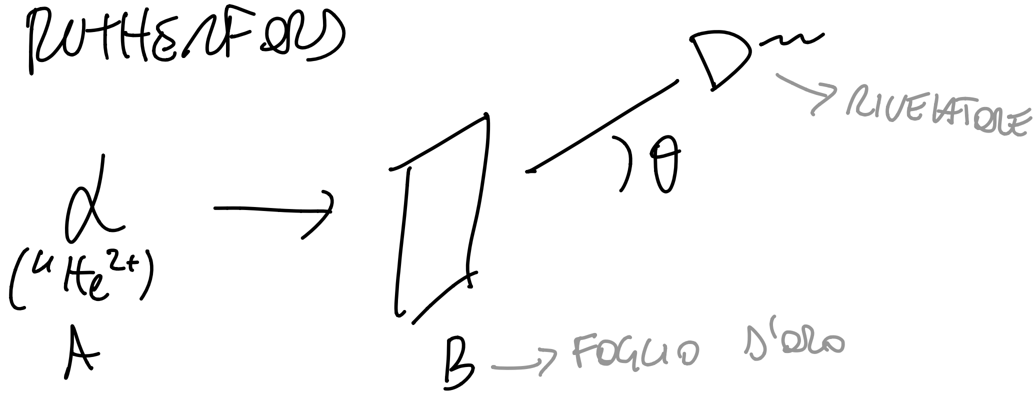
$$\frac{dN_I}{dt\,d\Omega} = \frac{2\pi (R+r)^2 \cdot \frac{\sin\theta}{4}\,\mathcal{L}\,d\theta}{\underbrace{2\pi}_{d\phi}\,\sin\theta\,d\theta} = \frac{(R+r)^2}{4}\cdot\mathcal{L}$$

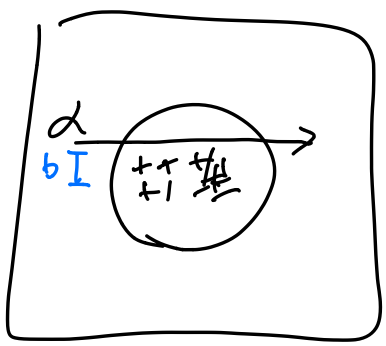
SEZ. D'URTO DIFF.

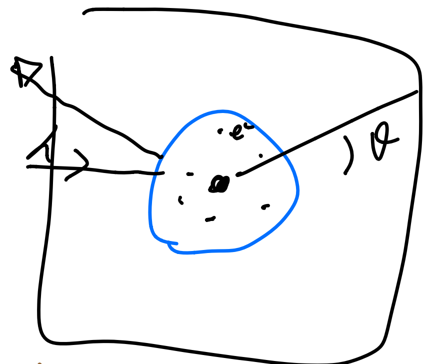
$$\frac{d\sigma}{d\Omega}(\theta,\phi) = \text{cost} = \frac{(R+r)^2}{4}$$

$$\sigma = \int \left(\frac{d\sigma}{d\Omega}\right) d\Omega = 4\pi \cdot \frac{(R+r)^2}{4} = \pi (R+r)^2$$

RUTHERFORD







THOMSON] NON TORNA CON L'ESPERIMENTO

α IMPERTURBATA CAUSA TEOREMA DI GAUSS

RUTHERFORD] SPIEGA I DATI

POSSO AVERE ADDIRITTURA "BACKSCATTERING" ($\theta \sim \pi$)

- urto elastico
- $\cancel{E_\alpha} = T_\alpha$
  $= 5.5\ \mathrm{MeV}$

$\alpha + \text{"}N\text{"} \rightarrow \alpha + \text{"}N\text{"}$

(Zp)

CIOE': ATTENZIONE A OSSERVARE CHE 5 MeV E' ENERGIA CINETICA, NON TOTALE

$E = T + mc^2$ DEFINIZIONE DI ENERGIA CINETICA T

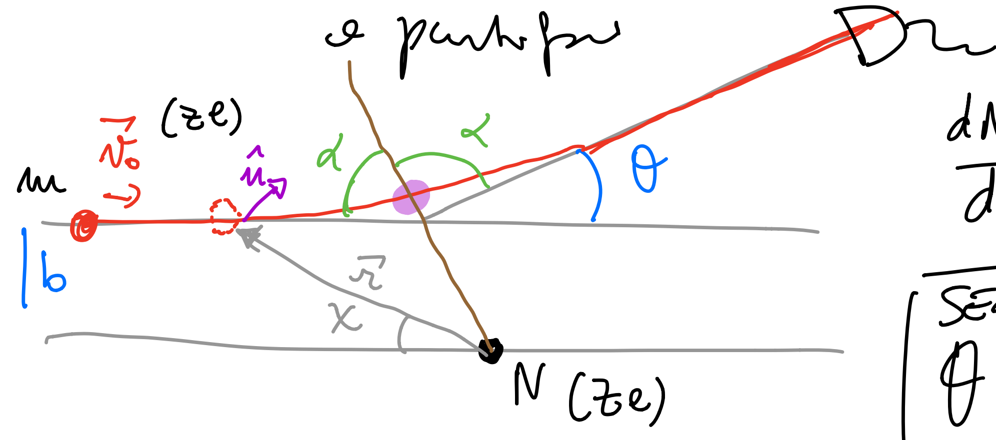
$= \sqrt{p^2c^2 + m^2c^4}$

$\gamma = \frac{E}{mc^2} \sim 1$

$E \rightarrow 5\ \mathrm{MeV}$

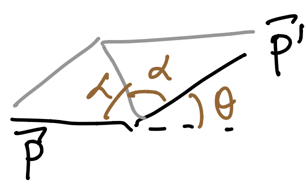
$mc^2 \rightarrow 4 m_p \sim 4\ \mathrm{GeV}$

— nucleo "positivo" e cessione e particella



$$\frac{dN_I(\theta)}{dt}$$

$$\boxed{\text{SERVE } \theta(b)}$$



$$|\vec{p}| = |\vec{p}'|$$

$$V(\vec{r}) = V(r) = \frac{1}{4\pi\varepsilon_0}\frac{zZe^2}{r}$$

$$\vec{L} = \vec{r}\times\vec{p} = m\,\vec{r}\times\vec{v} = m\,b\,\vec{v}_0$$

$$= \text{costante}$$

$$L = m b v_0$$

$$E = \frac{1}{2}mv_0^2 \Rightarrow v_0 = \sqrt{\frac{2E}{m}}$$

$$b^2 = \frac{L^2}{2mE}$$

$$\vec{L} = m\left(\vec{r}\times\frac{d\vec{r}}{dt}\right) = m\,\vec{r}\times\left(\frac{dr}{dt}\hat{r} + r\frac{d\hat{r}}{dt}\right)$$

$$= 0 + m \hat{u}\, r^2 \left(\frac{d\chi}{dt}\right) \Longrightarrow \frac{d\chi}{dt} = \frac{L}{mr^2}$$

$$E = \frac{1}{2} m V_0^2 = \frac{1}{2} m v^2(t) + V(r) \quad \square$$

SOSTITUISCO

$$v(t) \rightarrow \frac{dr}{dt}\hat{r} + r\frac{d\hat{r}}{dt}$$

VA QUA DENTRO

CERCO POI $\frac{dr}{dt}$ che viene $dr \, \square + \frac{d\chi}{dt}$

$$\frac{d\chi}{dt} = \frac{L}{mr^2}$$

Cerco $\chi = \alpha$

$r = r_{MIN}$

SO CHE $\theta = \pi - 2\alpha$ DOVE α E' IL VALORE DI χ QUANDO LA PARTICELLA E' NEL PUNTO DI MINIMA DISTANZA DAL NUCLEO

$$\frac{1}{(dr/dt)}$$

$$d\chi = \frac{L}{mr^2} dt = \frac{L}{mr^2}\left(\frac{dt}{dr}\right) dr$$

$$\alpha = \int_{r=\infty}^{r=r_{MIN}} d\chi$$

NB LO SCOPO E' SEMPRE TROVARE L'ESPRESSIONE DI $\theta = \theta(b)$ PER POI CALCOLARE $\frac{dN_I(\theta)}{dt}$

$$\theta = \pi - 2\alpha$$

$$= \pi - 2b \int_{r_0}^{\infty} dr \frac{1}{r\sqrt{r^2\left(1 - \frac{V(r)}{E}\right) - b^2}}$$

FIN QUI, VERO PER OGNI POTENZIALE CENTRALE

dopo semplici passaggi (vedi dispense)

$$\longrightarrow \quad b = \frac{A}{2} \frac{1}{\tan \theta/2}$$

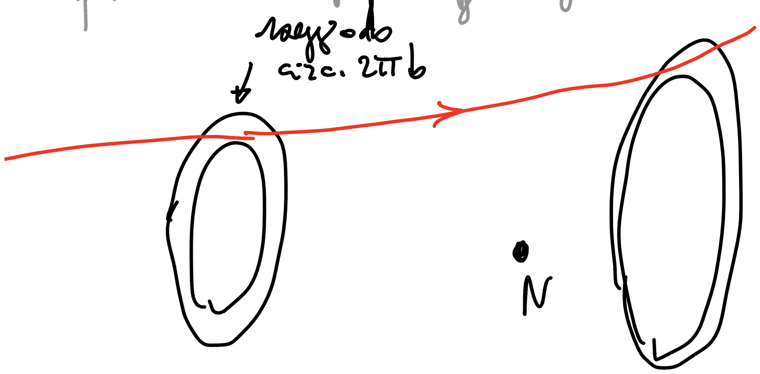
dove A è una costante

A?

$$V(r) = \frac{1}{4\pi\varepsilon_0} \frac{zZe^2}{r}$$

$$A = \frac{1}{4\pi\varepsilon_0} \frac{zZe^2}{E}$$

per $dN_I/dt = f(\theta)$ procedo come per le sfere rigide:



$$d\sigma = 2\pi b \, db$$

$$b = \frac{A}{2} \frac{1}{\tan \theta/2}$$

$$db = \frac{A}{2} \cdot \frac{1}{\sin^2 \theta/2} \cdot \frac{1}{2}\, d\theta$$

$$d\sigma = 2\pi \cdot \frac{A}{2} \cdot \frac{1}{\tan \theta/2} \cdot \frac{A}{2} \cdot \frac{1}{2} \cdot \frac{1}{\sin^2 \theta/2}\, d\theta$$

$$= 2\pi \cdot \frac{A^2}{8} \cdot \frac{\cos \theta/2}{\sin^3 \theta/2}\, d\theta$$

$$\frac{d\sigma}{d\Omega} = \frac{d\sigma}{2\pi \sin\theta \, d\theta} = \frac{A^2}{8} \cdot \frac{\cos \theta/2}{\sin^3 \theta/2} \cdot \frac{1}{\sin\theta}$$

$$= \frac{A^2}{16} \frac{1}{\sin^4 \theta/2}$$

$$= \left(\frac{zZe^2}{4\pi\varepsilon_0 E} \right)^2 \cdot \frac{1}{16} \cdot \frac{1}{\sin^4 \theta/2}$$

$$= \left(\frac{zZe^2}{16\pi\varepsilon_0 \underbrace{E}_{\text{CINETICA}}} \right)^2 \cdot \frac{1}{\sin^4 \theta/2} = \frac{d\sigma}{d\Omega}$$

(CIOE' T)

$$\frac{dN_t}{dt} = \frac{d\sigma}{d\Omega} \cdot \Delta\Omega \cdot \mathcal{L}$$

DIPENDE SOLO DA θ

DIMENSIONE FISICA DEL RIVELATORE