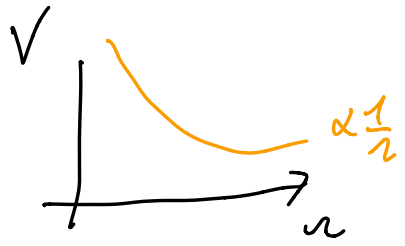
OPIS: G8BTJTCH

(prove di prenotarsi su infostud!)

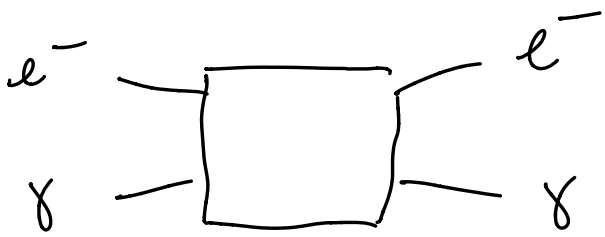
COSA SAPPIAMO OGGI

- FORZE
  - EM $$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}\hat{r}$$



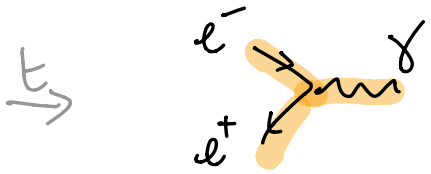
Mediatore: γ ($m_\gamma = 0$, $J^P = 1^-$)

(es)

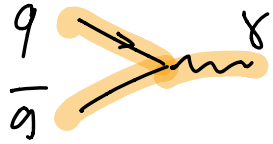


$|i\rangle$ $|f\rangle$

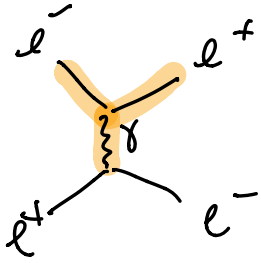
calcolo σ $\left(\frac{d\sigma}{d\Omega}\right)$



NON SI PUO'

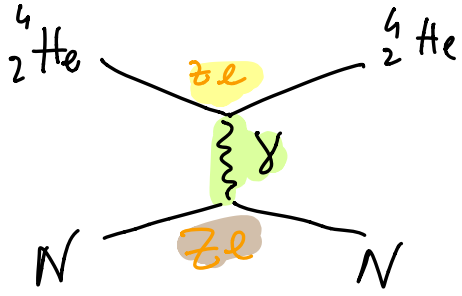


PROPAGATORE: $\frac{1}{q^2}$



$\vec{q} = \vec{p}_f - \vec{p}_i$

(ES) SCATT. RUTHERFORD



$$d\sigma = \frac{\Gamma_{fi}}{N_B \phi} = \frac{2\pi |M_{fi}|^2 \rho(E_f)}{N_B \cdot \phi}$$

$(\hbar = c = 1)$

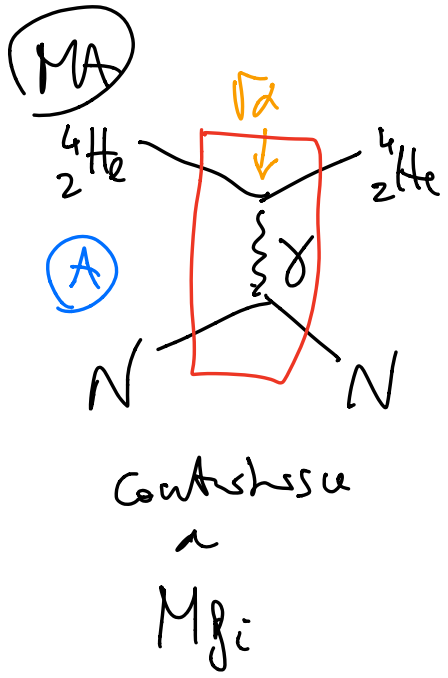
$$M_{fi} = \frac{4\pi \alpha \, z Z}{q^2} \qquad \left(\alpha = \frac{e^2}{4\pi\varepsilon_0 \hbar c}\right)$$

$$= 4\pi \frac{(z\sqrt{\alpha})(Z\sqrt{\alpha})}{q^2}$$

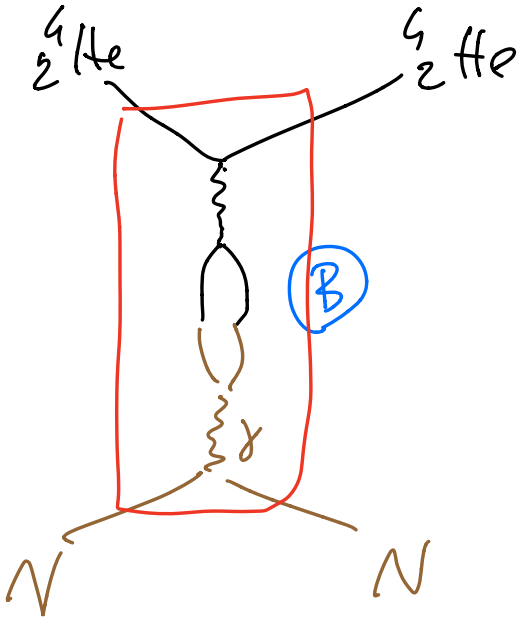
$$q^2 = (\vec{p}_f - \vec{p}_i)^2 = p_f^2 + p_i^2 - 2 p_f p_i \cos\theta$$

(MA) $E_f = \frac{p_f^2}{2m} = \frac{p_i^2}{2m}$ perché

$$q^2 = 2P_f^2(1-\cos\theta)$$
$$= 4mE(1-\cos\theta)$$
$$= 8mE(\sin^2\theta/2)$$



Contribution
$\propto$
M_{fi}



A $\quad M_{fi} \mathrel{+}= K \cdot \sqrt{\alpha}\cdot\sqrt{\alpha}$

$\sigma \mathrel{+}= K\cdot(\sqrt{\alpha}\cdot\sqrt{\alpha})^2 \propto \left(\frac{1}{137}\right)^2$

B $\quad M_{fi} \mathrel{+}= K' \cdot \sqrt{\alpha}\sqrt{\alpha}\ldots\sqrt{\alpha}$

$\sigma \mathrel{+}= \alpha\left(\frac{1}{137}\right)^4$

$$\alpha_{EM} = \frac{1}{137}$$

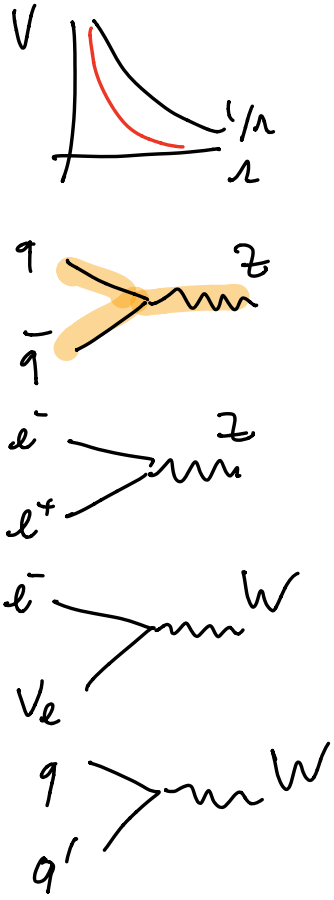
Conserva: Q, B, L_e, L_μ, L_τ

P, C, T, S, I_3

$$Q = I_3 + \frac{1}{2}(B+S)$$

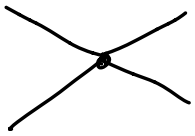
- DEBOLE

Mediatori: $W^\pm$, Z

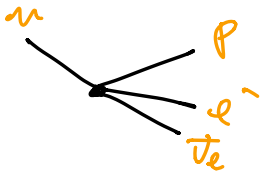


a bassa energia:

- $G_F \cong 10^{-5}\ GeV^{-2}$
  è la costante di accoppiamento

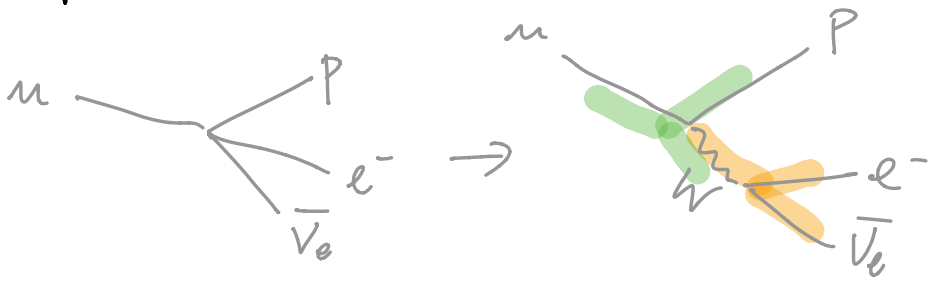


oppure (β decay)



questo perché?

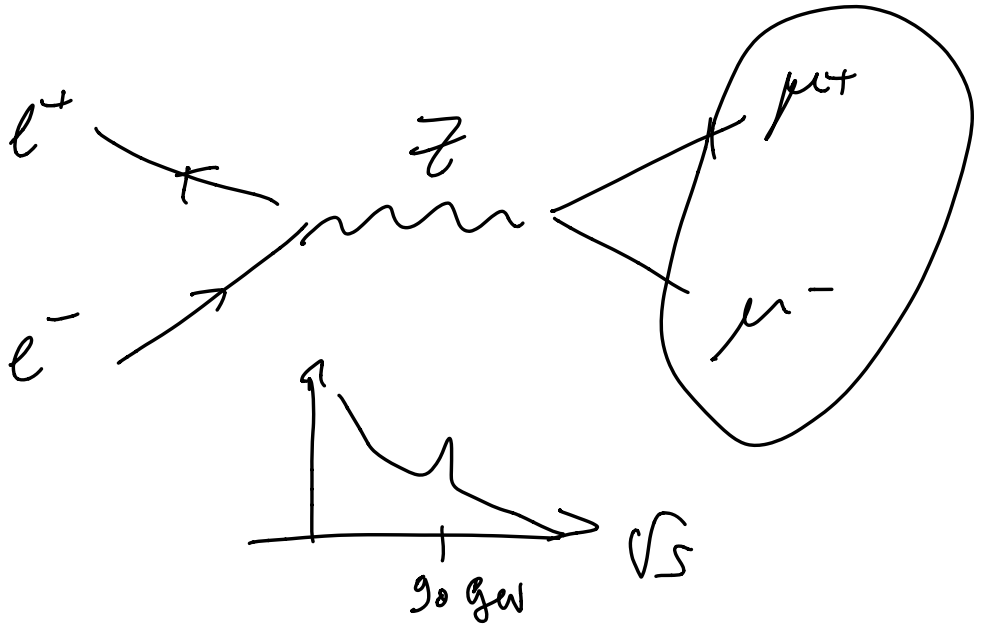
$$\propto \frac{1}{q^2 + M^2} \xrightarrow{|q| \to 0} \frac{1}{M^2} = \text{cost}$$

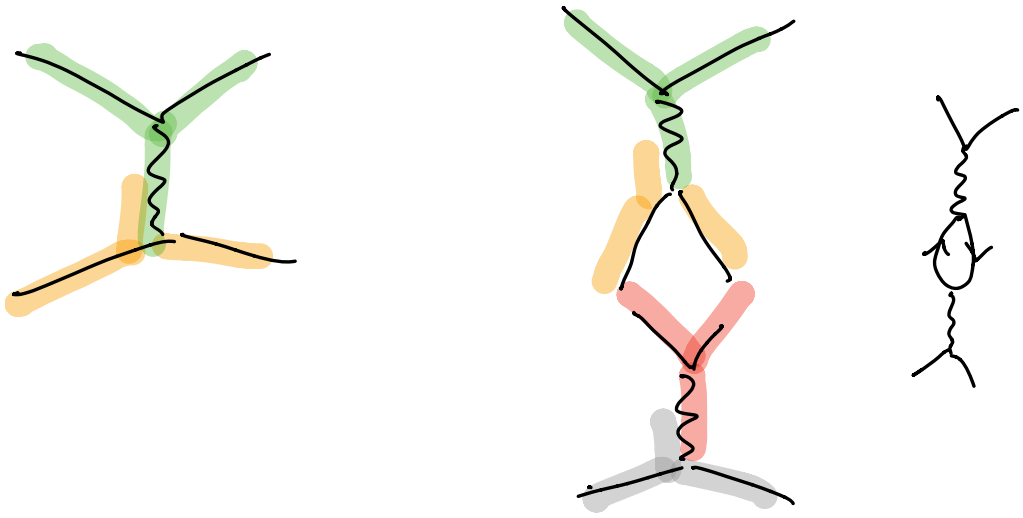


Conserva Q, B, L_e, L_μ, L_τ

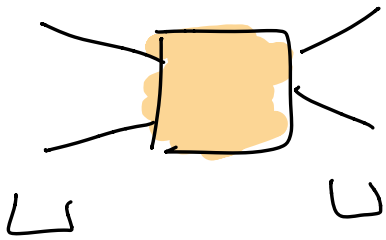
Viola: C, P, T, CP
S, I

si osserva $|\Delta S| \cong 0,1$





PUNTO CHIAVE (particelle reali vs virtuali):

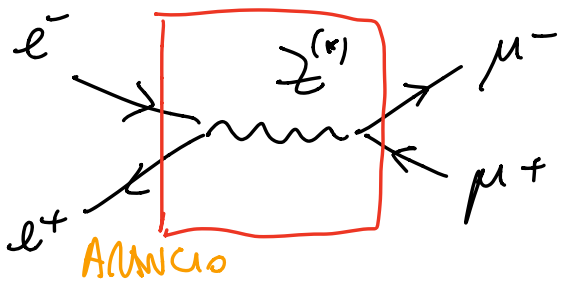


QUESTI LI OSSERVO & le particelle obbediscono a

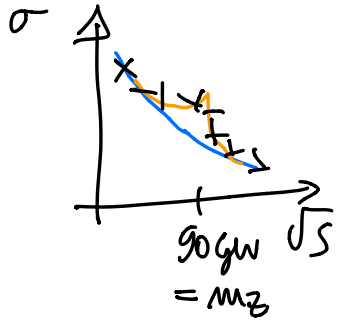
$$E_i^2 = p_i^2 + m_i^2 \qquad (c=1)$$

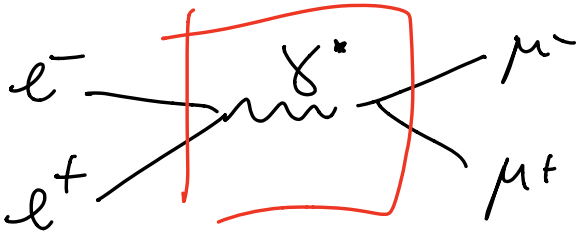
QUI LE PARTICELLE POSSONO NON AVERE $E_i^2 = p_i^2 + m_i^2$

$\Rightarrow$ VIRTUALI

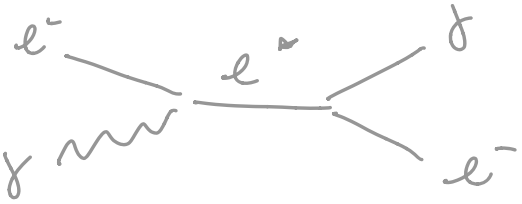


ANNICHILAZIONE





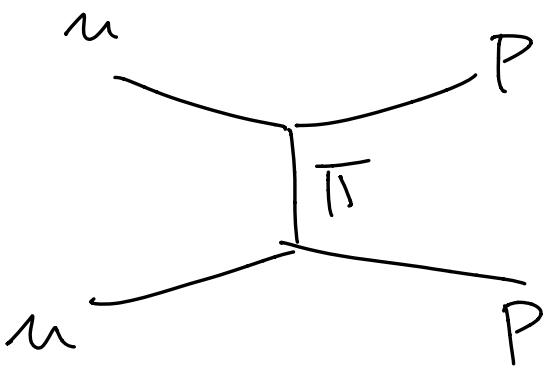
BHABHA



- FORTE

per basso q^2 : Yukawa

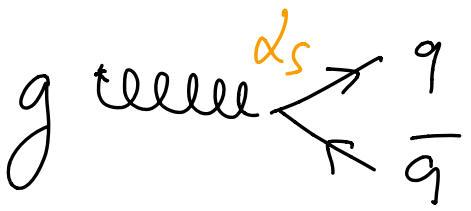
$$\frac{1}{q^2+M^2} \qquad \pi \sim 140 \ \frac{MeV}{c^2}$$



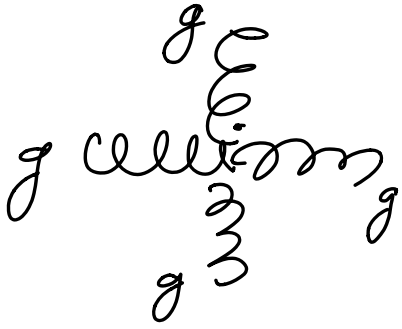
$$V \propto \frac{e^{-Mr}}{r} \equiv \frac{e^{-r/r_0}}{r}$$

in vita: gluoni

(QCD) (8, cariche)



$\alpha_S > \alpha_{EM}$

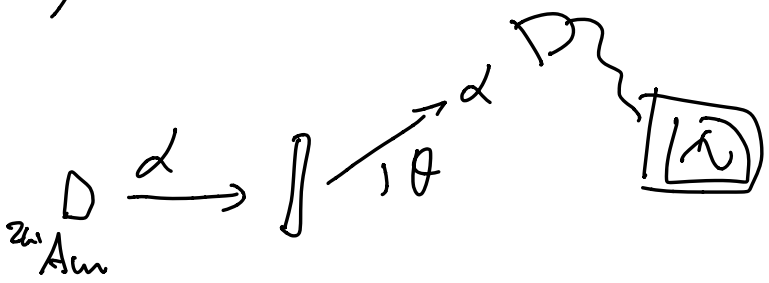


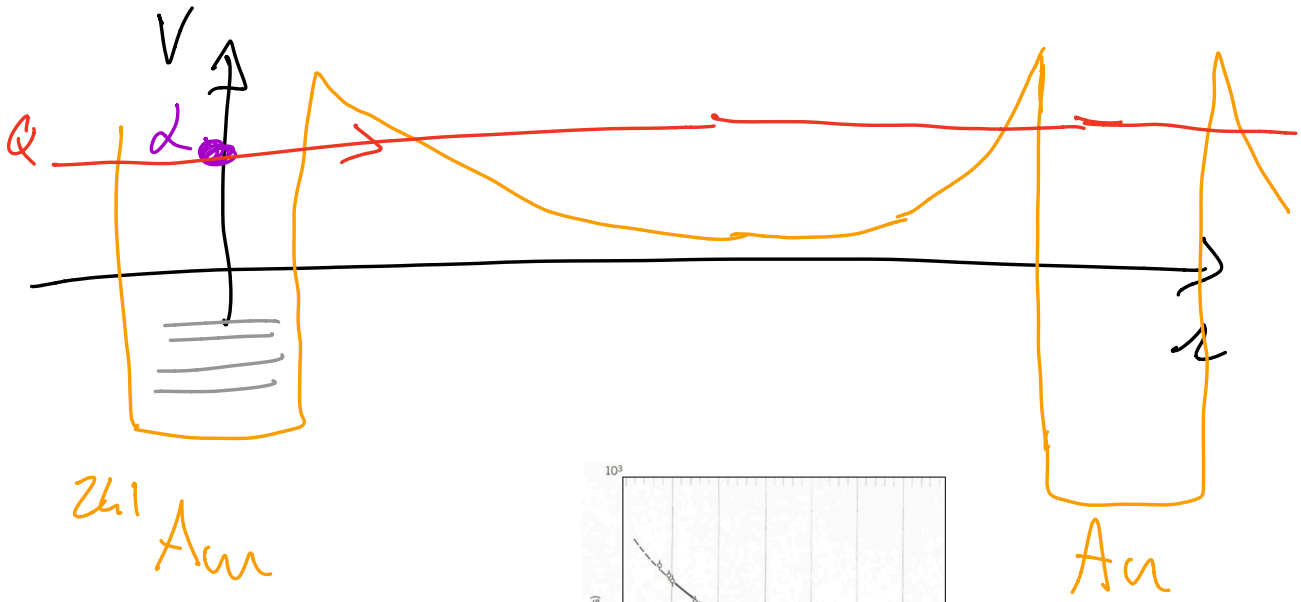
- Conservano Q, B, L_e, L_μ, L_τ
  I, I_3, S, ...
  P, C, T, CP...

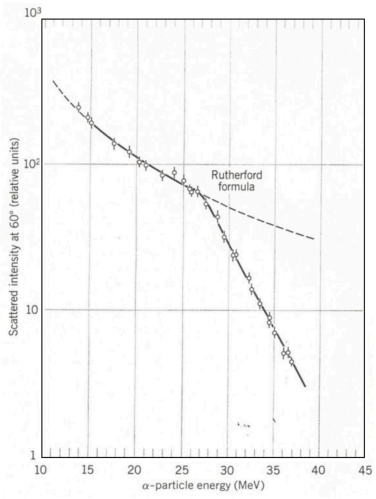
DOVE CONTANO?

(EM) atomo, Rutherford, decadimento α.

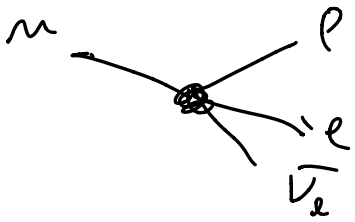
1) ^{241}Am produce α
2) α impatta su Au
3) viene α ad angolo θ

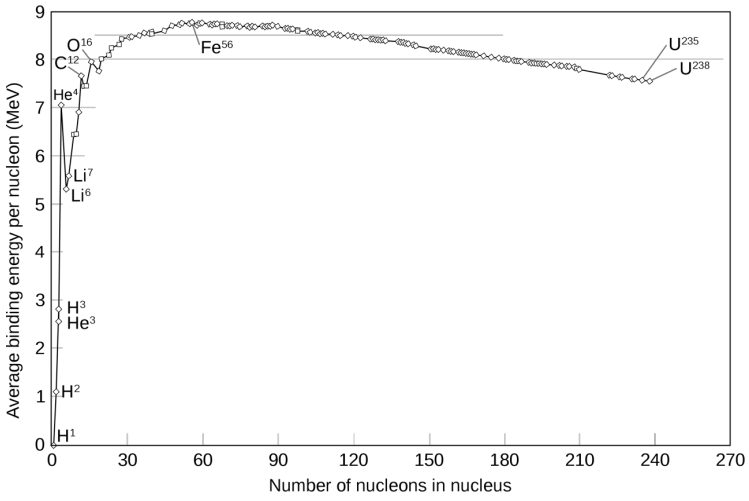



V
α
Au
Au


Rutherford formula
Scattered intensity at 60° (relative units)
α-particle energy (MeV)
10³
10²
10
1
10
15
20
25
30
35
40
45

- DECAIMENTO


n
p
e
$\bar{\nu}_e$



Sole: 90% p

α 5% He

⋮

$T \sim 10^7\,K \sim 1\,keV$

$$p + p \rightarrow d + \nu_e + e^+$$

$Q \sim 1.4\,MeV$

$$V_{pp} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{2(1\,fm)} \sim 700\,MeV$$

$\sigma \sim 10^{-33}$ b

$d + p \rightarrow {}^3He + \gamma$

$Q \sim 5$ MeV

${}^3He + p \not\rightarrow {}^4Li \rightarrow {}^3He + p$

SUBITO

${}^3He + {}^3He \rightarrow {}^4_2He + 2p + \gamma$

$Q = 13$ MeV

$4p \rightarrow {}^4He + 2e^+ + 2\nu_e$

$+ 2\gamma$

$Q = 25$ MeV

Verifica il Modello:

misuro

$\nu_e + {}^{37}Cl \rightarrow {}^{37}Ar^+ + e^-$

MISTERO 1

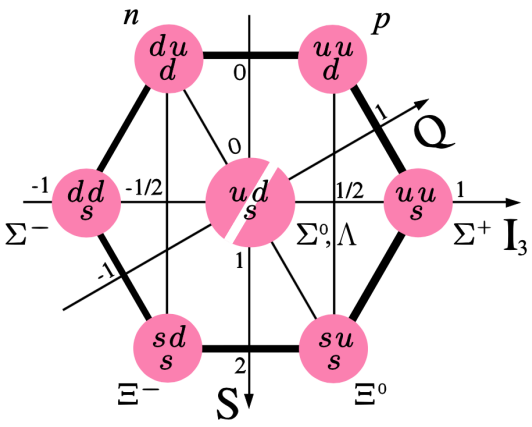
trovo 1/3 dei ν_e che mi aspetto

→ è dovuto a

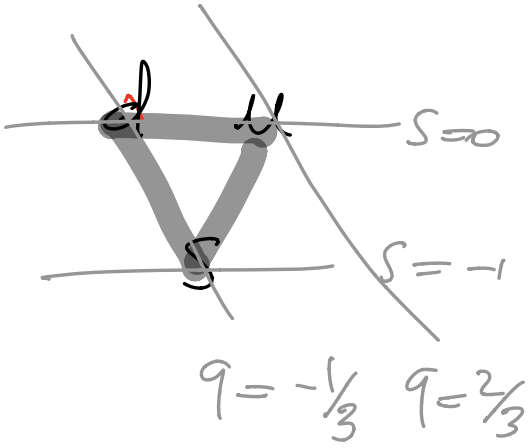
$$\nu_e \longrightarrow \nu_\mu, \nu_\tau$$

$$\begin{pmatrix} \nu_e \\ \nu_\mu \\ \nu_\tau \end{pmatrix} = U \begin{pmatrix} \nu_1 \\ \nu_2 \\ \nu_2 \end{pmatrix}$$

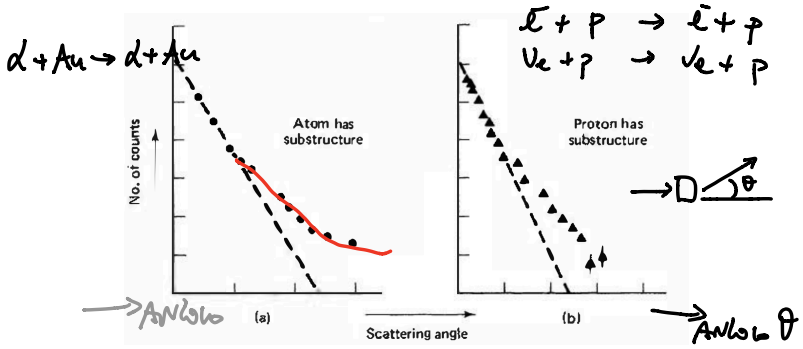
Modello a Quark

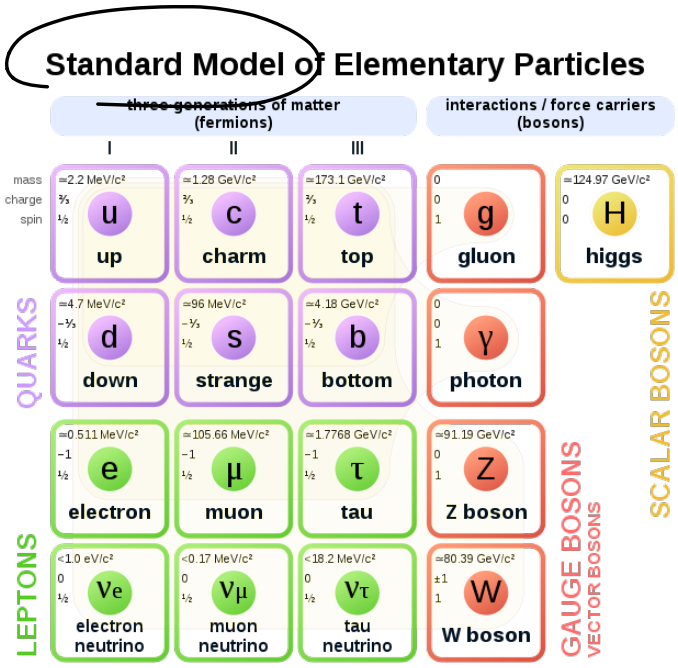


$$\begin{pmatrix} u \\ d \end{pmatrix} \begin{pmatrix} c \\ s \end{pmatrix} \begin{pmatrix} t \\ b \end{pmatrix}$$



$q = -1/3 \quad q = 2/3$





MISTERO 2 = è lunto del M.S

MATERIA OSCURA