Venerdì 16 maggio

13-15 struttura della materia.

16-18 esonero FNSN in Aula La Ginestra

MER 21 maggio

12-13 struttura della materia

Decadimento β^- $\qquad n \to p e^- \bar{\nu}_e$

$\bar{\nu}_e + p \to n + e^+$ Decadimento β inverso.

NON È ~~(illegible)~~ UN DECADIMENTO.

$$\frac{1}{\tau} = \Gamma(n \to p e^- \bar{\nu}_e) \propto G_F^2 \, E_T^5 \qquad E_T = m_n - m_p$$

$$\frac{1}{\tau} = \Gamma(X \to Y + e^- + \bar{\nu}_e) \propto G_F^2 \, (m_X - m_Y)^5$$ legge di Sargent

$\tau_{neutrone} \simeq 880$ s.

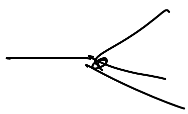
$$[\Gamma] = E = T^{-1}$$

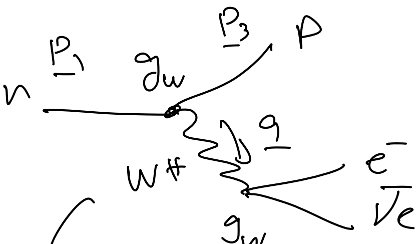
$$[G_F^2][E_T]^5 \implies [G_F] = E^{-2}$$

$$G_F = 1.1 \times 10^{-5} \text{ GeV}^{-2}$$

potenziale di Coulomb $\quad U \simeq \dfrac{z_1 z_2 e^2}{4\pi \varepsilon_0} \dfrac{1}{r} = \dfrac{z_1 z_2 \alpha}{r}$

α : adimensionale $= \dfrac{1}{137}$





$q = p_1 - p_3$

4-impulso ceduto da $n \to p$

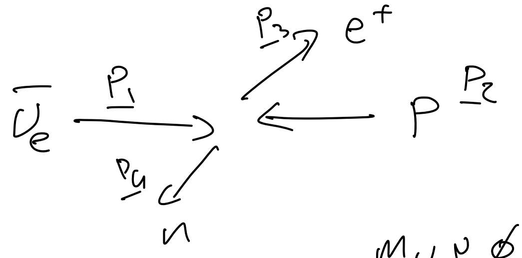
$$\frac{1}{q^2 - m_W^2}$$

$q^2 \simeq m_n^2 \simeq 1 \text{ GeV}^2$

$m_W \simeq 80\ GeV >> m_n$ $\qquad$ $\Delta E \cdot \Delta t \simeq \hbar = 1$

creare una W virtuale per un tempo $\Delta t = \frac{1}{m_W}$

$G_F^2 \simeq \frac{g_w^2}{m_W^2}$ $\qquad$ origine delle dimensione fisica di G_F



$\sigma(\bar{\nu} p \to n e^+) \sim G^2 \frac{pE}{\beta_\nu}$

$m_\nu \simeq \phi \Rightarrow \beta_\nu \simeq 1$ $\qquad$ nel. c.d.m $\vec{P_1} + \vec{P_2} = \phi$

$\vec{P_3} + \vec{P_4} = \phi$

$\sigma \sim G^2 pE = G^2 p^2 \frac{E}{p} = G^2 p^2 \left(\frac{1}{\beta_n}\right)$

$[\sigma] = cm^2 = L^2 = E^{-2}$

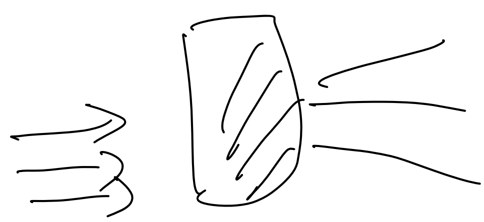
$G_F = 1.1 \times 10^{-5}\ GeV^2$ $\qquad$ $G_F^2 = 1 \times 10^{-10}\ GeV^4$

$1 = 200\ MeV \times fm \Rightarrow 200\ MeV = \frac{1}{1 fm}$

$GeV \to fm^{-1}$

$\sigma \sim 10^{-43}\ cm^2 \left(\frac{E}{MeV}\right)^2$ $\qquad$ E espresse in MeV.

$E \simeq 1\ MeV \Rightarrow \sigma \simeq 10^{-43}\ cm^2$



$\Phi_p = \Phi_0\, e^{-\frac{x}{\lambda}}$

$\frac{1}{\lambda} = \sigma \cdot n_b.$

λ: cammino libero medio.

$\frac{dN_r}{dt} = \sigma \cdot \frac{dN_p}{dt} \cdot n_b \cdot d$

$\lambda \simeq \frac{1}{\sigma \cdot n_b}$ $\qquad$ $\rho = 1\ g/cm^3$ $\qquad$ $n_b = \frac{\rho}{A} N_A \Rightarrow \lambda = 10^{16}\ km.$

$$1 \text{ anno luce} = 365 \times 86400 \times 3\times 10^{8}\ \text{m}$$

$$3\times10^{2} \times 9\times10^{4} \times 3 \times 10^{8}\ \text{m}$$

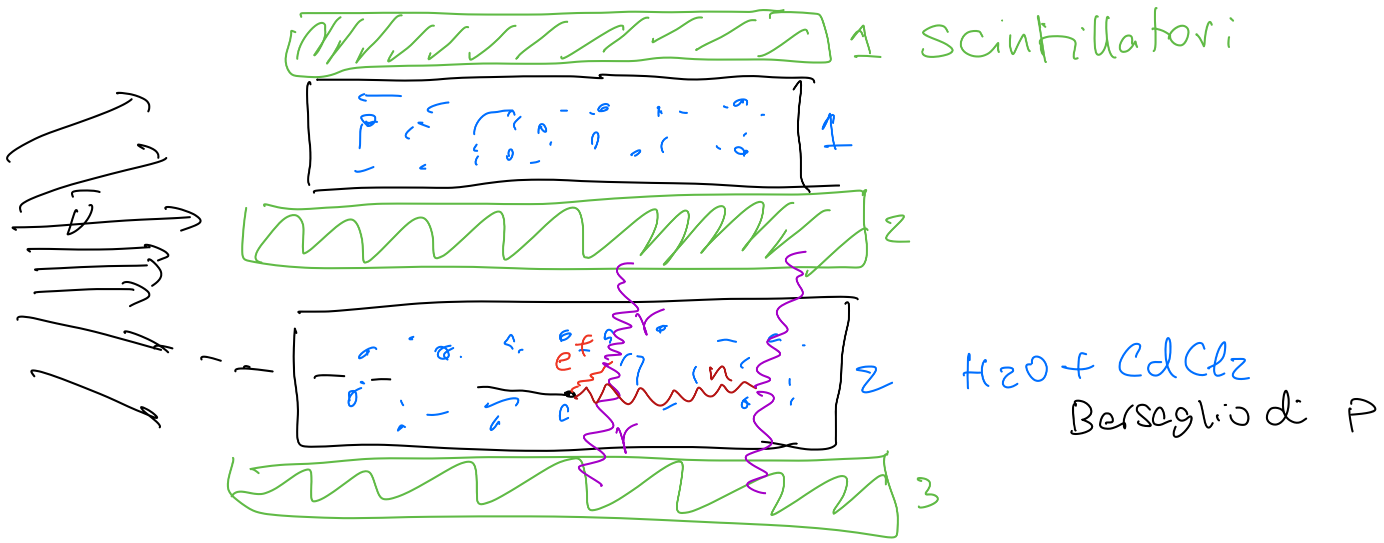
$$8 \times \cancel{10\times10^{2}} \times 10^{4} \times 10^{8}\ \cancel{\text{m}}\ \text{km}$$

$$8\times 10^{12}\ \text{km} \simeq 10^{13}\ \text{km}$$

in un anno

Reattore: $\dfrac{dN_\nu}{dt} \simeq 10^{20}\ \text{Hz}.$

$$\frac{dN_r}{dt} = \underbrace{\sigma}_{10^{-43}\ \text{cm}^2} \cdot \underbrace{\frac{dN_\nu}{dt}}_{10^{20}\ \text{Hz}}\ n_p \cdot d.$$



$$\bar{\nu}_e + p \longrightarrow n + e^+$$

↳ ionizzazione

$$e^+ + e^- \longrightarrow \text{positronio} \longrightarrow \gamma + \gamma$$
$$\tau \simeq 10^{-9}\ \text{s}$$

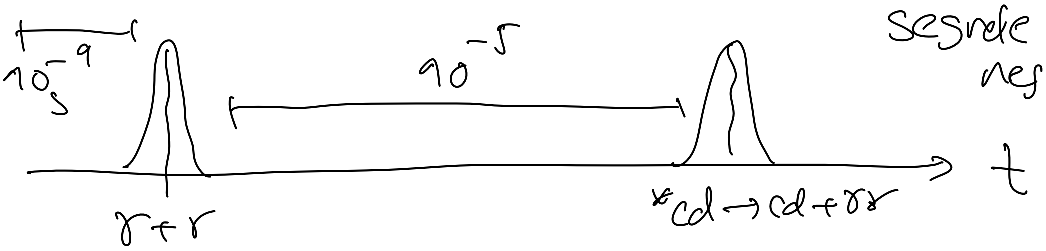
$$n + p \longrightarrow n + p$$
$$n + n \longrightarrow n + n$$

urti elastici con perdite di energia

termalizzazione dei neutroni

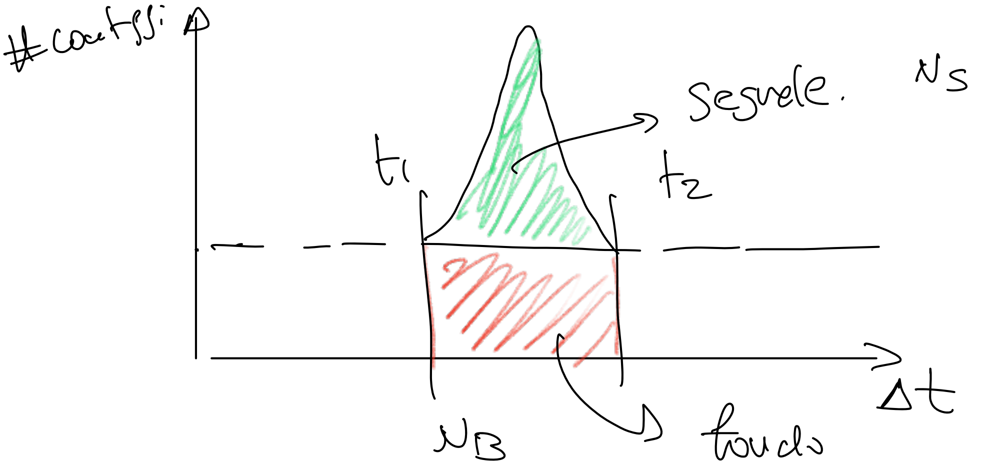
$n + Cd \rightarrow {}^{*}Cd \rightarrow Cd + \gamma + \gamma$ Decadim. γ del ${}^{*}Cd$

processo $\Delta T \simeq 10^{-5}$ sec



Segnale di coincid. negli scintillatori

Evento: conteggio di coincidenze a $\Delta t \simeq 10^{-5}$ sec.



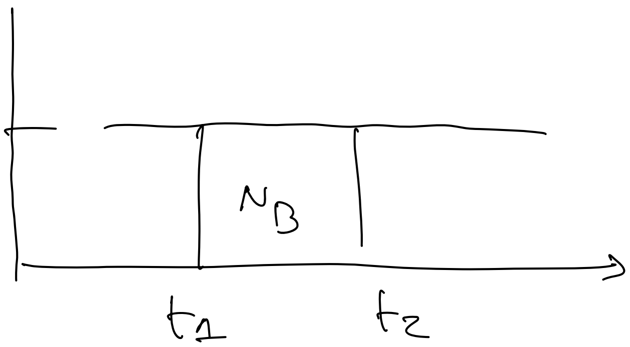
$N_{tot} = 567$

Misurate N_{tot}: # conteggi fra t_1 e t_2

$\hat{N}_S = N_{tot} - N_B$

Serve misura o stima di # eventi di fondo N_B.

N_B: misura con reattore spento.



$N_B = 209$

$\Rightarrow \quad N_S = N_{tot}\,(\text{reattore acceso}) - N_B\,(\text{reattore spento})$

$\hat{N}_S = N_{tot} - N_B = 358$

N_B può variare con $\sigma \simeq \sqrt{N_B}$

$$\frac{N_{tot} - N_B}{\sqrt{N_B}} = \frac{358}{15} \simeq 25 \text{ dev. std.}$$

$\Rightarrow$ osservazione diretta di $\bar{\nu}$