Lecture 8 : Weak interactions - 1

Charged leptonic weak interactions :

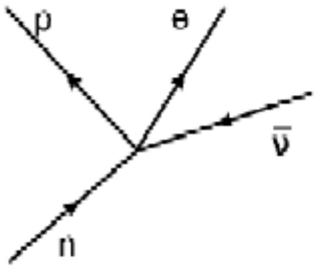
Mediators of the weak interactions are $W^{\pm}$ and Z^0 bosons.

They are first discoverd at CERN by C.Rubbia and van der Meer et.al. in 1982

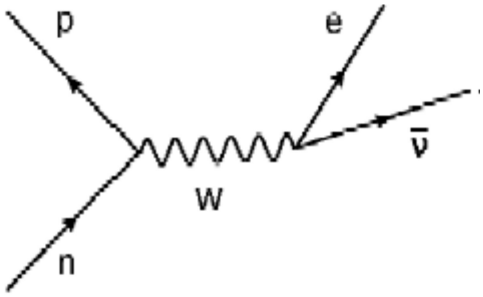
Their masses experimentally well determined now :

$M_W = 80.379$ GeV and $M_Z = 91.1876$ GeV

- Fermi theory of radioactive beta decay



Fermi theory



W boson exchange diagram

- Kurie plot
- Discovery of the neutrino
- Savannah River Experiment

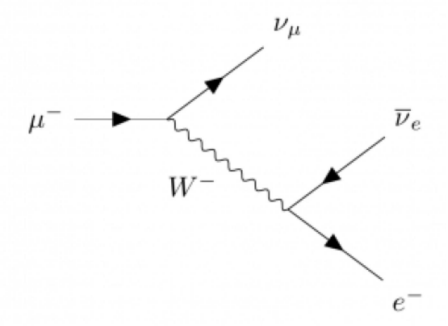
Example : Inverse muon decay $e^- + \nu_\mu \rightarrow \mu^- + \nu_e$

The total cross section in CM frame

$$\sigma = \frac{1}{8\pi}\left[\left(\frac{g_W}{M_W c^2}\right)^2 \hbar c E\right]^2 \left\{1 - \left(\frac{m_\mu c^2}{2E}\right)^2\right\}^2$$

See for the details D.Griffiths' textbook "Int.to Elementary Partciles, Wiley Pubication. Chapter 10 Section 2

Example : Decay of the muon : $\mu^- \rightarrow e^- + \nu_\mu + \bar{\nu}_e$



Total decay rate can be found to be

$$\Gamma = \left(\frac{m_\mu g_W}{M_W} \right)^4 \frac{m_\mu c^2}{12\hbar(8\pi)^3}$$

and the lifetime of the muon is given as $\tau = \frac{1}{\Gamma}$.

The above expressions can be recast in terns of the Fermi coupling constant.

For calculational details study the Chapter 10 Sections 1 and 2 of the D.Griffiths textbook “Int.Elementary Particles J.Wiley.

Homework and Study Problems :

Examine and try to solve some of the problems listed from the same textbook by D.Griffiths.

Solve Problem 10.1

Solve Problem 10.2

Solve Problem 10.3

Solve Problem 10.4

Solve Problem 10.5