

Elementary Particle Physics: Assignment # 11

Due Thursday May 7 before class

Assume that the vertex for the coupling of a X spin 1 boson to a pair of massless fermions f_1 and \bar{f}_2 is $-ig_X\gamma^\mu\frac{1}{2}(g_V - g_A\gamma^5)$.

- a) Compute the Feynman amplitude for $X \rightarrow f_1\bar{f}_2$, its square average and show that the decay width

$$\Gamma[X \rightarrow f_1\bar{f}_2] = \frac{g_X^2 M_X}{48\pi} (g_V^2 + g_A^2) \quad (1)$$

- b) Use (a) to obtain the analytical expressions of:
 $\Gamma[Z \rightarrow e^+e^-]$, $\Gamma[Z \rightarrow \nu\bar{\nu}]$, $\Gamma[Z \rightarrow \text{hadrons}]$, $\Gamma_{\text{tot}}[Z]$,
 $\Gamma[W^+ \rightarrow e^+\nu_e]$, $\Gamma[W^+ \rightarrow \text{hadrons}]$, $\Gamma_{\text{tot}}[W]$.
(neglect the mass of all fermions except the top $m_{\text{top}} = 174 \text{ GeV}$) .
- c) Evaluate them numerically using $G_F = 1.16 \times 10^{-5} \text{ GeV}^{-2}$, $M_W = 80.4 \text{ GeV}$, $M_Z = 91.2 \text{ GeV}$, $\sin^2 \theta_W = 0.22$.
- d) Compare with the results in PDB and comment on the comparison.