

Homework set 3

Problem 1: qualitative questions

(i) The total decay width of the Z^0 boson agrees within less than 20 MeV with theoretical calculation. Explain why this fact excludes the existence of a fourth generation of fermions, in which all particles except the neutrino are sufficiently massive to escape direct detection, and the neutrino is massless.

(ii) One can imagine that the most direct way to detect the Standard Model Higgs boson H is to look for its decay into muon-antimuon pair, since muons can be easily identified. However, this method is not practical. What is the ratio of decay rates

$$\frac{\Gamma(H \rightarrow \mu^+ \mu^-)}{\Gamma(H \rightarrow b\bar{b})} \quad (1)$$

Given are $m_H > 114$ GeV, $m_\mu = 106$ MeV, $m_b = 4.2$ GeV. Don't forget color.

Problem 2: Decay of top quark

This is Problem 4.2 in Burgess and Moore. In short:

Compute the decay width of the top quark to first order in perturbation theory. Given are: $m_t = 170$ GeV, $m_W = 80$ GeV, $m_Z = 91$ GeV, neglect masses of all fermions other than top, $\sin^2 \theta_W = 0.22$, $e^2/(4\pi) = 1/137$.

The formulation of the problem in the textbook contains, among other things, an outline of the steps necessary to reach the final answer.

Problem 3:

To be added...