Particle Physics Phenomenology II

FS 11, Series 3

Due date: 14.03.2011, 1 pm

Exercise 1 Compute the the following leading order Higgs decay widths:

i) The $H \to f\bar{f}$ decay width

$$\Gamma_{H\to f\bar{f}} = \frac{CG_F m_f^2 m_H}{4\sqrt{2}\pi}\left(1-\frac{4m_f^2}{m_H^2}\right)^{\frac{3}{2}}$$

where $C = 3$ for quarks and $C = 1$ for leptons.

ii) The $H \to W^+W^-$ decay width

$$\Gamma_{H\to W^+W^-} = \frac{G_F m_H^3}{8\sqrt{2}\pi}\left(1-\frac{4m_W^2}{m_H^2}\right)^{\frac{1}{2}}\left(1-\frac{4m_W^2}{m_H^2}+\frac{12m_W^4}{m_H^4}\right).$$

iii) The $H \to ZZ$ decay width

$$\Gamma_{H\to ZZ} = \frac{G_F m_H^3 m_W^2}{16\sqrt{2}\pi m_Z^2}\left(1-\frac{4m_Z^2}{m_H^2}\right)^{\frac{1}{2}}\left(1-\frac{4m_Z^2}{m_H^2}+\frac{12m_Z^4}{m_H^4}\right).$$

Hint: Mind the overall symmetry factor of 1/2, due to two identical bosons in the final state.

Exercise 2

i) What are the allowed higgs mass ranges for the different decay widths You computed in **Exercise 1** ?

ii) Plot the decay widths You computed in **Exercise 1** (i.e. $H \to \tau\bar{\tau}, b\bar{b}, t\bar{t}, W^+W^-, ZZ$) for a higgs in the mass range $100GeV < m_h < 1TeV$.

iii) Try to explain why it is easier to find the higgs boson for $m_h \gtrsim 160GeV$ at a hadron collider and hence why the Tevatron exclusion limits are much stronger there.