8.325 Homework 4

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Due: MONDAY April 9.

Problem 1) Peskin & Schroeder 20.1 (Spontaneous Breaking of SU(5))

Problem 2) Peskin & Schroeder 20.2(b) (Z-Decays)

Problem 3) Peskin & Schroeder 20.5 (A Model with Two Higgs)

Problem 4) Peskin & Schroeder pg.775, (Final Project on Higgs Decay)

a) Do part a) on pg.776.

b) Do part b) on pg.776, but only do the decay $h^0 \to W^+W^-$ and not $h^0 \to Z^0Z^0$.

c) Do part c) on pg.776. Note that you can leave the answer in terms of Feynman parameters, but that you should verify the asymptotic properties that Peskin mentions.

d) Continuing from part c), in fact Peskin's $I(m_h^2/m_q^2) = F(x)$ where $x = 4m_q^2/m_h^2$ and

$$F(x) = \frac{3}{2}x[1 + (1-x)f(x)] \tag{1}$$

$$\text{with } f(x) = \begin{cases} [\sin^{-1}(1/\sqrt{x})]^2 & \text{for } x \geq 1 \\ -\frac{1}{4}\left[\ln\left(\frac{1+\sqrt{1-x}}{1-\sqrt{1-x}}\right) - i\pi\right]^2 & \text{for } x < 1 \end{cases}$$

Consider the $h^0 \to gg$ decay rate through the dominant top-quark loop, dropping the other terms. What is the decay rate in the limit $m_t^2 \gg m_h^2$? Using $F(x)$ and your answer in c), how good is this approximation for the range of Higgs masses we expect to probe at the LHC? (You should look up what this range is if you do not know it and cite your source.)