Physics 663 Problem Set 1
Revised Due Date 17 September 2008

Read Peskin and Schroeder (PS) Chapters 4, 5, 6.2, 6.3, 7 (and Ryder 9.5, 9.6, 9.7).

Do Problems:

1.) Consider a self interacting scalar field theory with mass m. The Lagrangian is given by

$$\mathcal{L} = \frac{1}{2}\partial_\mu\varphi\partial^\mu\varphi - \frac{1}{2}m^2\varphi^2 - \frac{\lambda}{4!}\varphi^4. \tag{1}$$

What are the Feynman rules for S-matrix elements? To lowest non-trivial order in the coupling constant λ calculate $(\vec{q}|S|\vec{p})$. Use a momentum cut-off for the loop momentum integral and determine the mass shift from the self-energy for large cut-off. Determine the Schwinger-Dyson equation for the full propagator.

2.) Peskin and Schroeder Problem 4.2.

3.) Peskin and Schroeder Problem 6.3. (This is a difficult problem.) Evaluate the anomalous magnetic moment for electron using $m_e = 0.511$ MeV and $\lambda_h = 3 \times 10^{-6}$ for the coupling to the electron. Also use the Higgs mass as $m_h = 120$ GeV. For the axion, use masses $m_a = 10^{-6} \to 0$ GeV and find the allowed axion couplings λ_a for both the electron and muon cases. Finally, the mass of the muon is $m_\mu = 106$ MeV and its coupling to the Higgs particle is $\lambda_h = 6 \times 10^{-4}$. Approximate the Feynman parameter integrals and then check your arguments by calculating the anomalous magnetic moments numerically if needed.