

832 Homework Set 2 (due Feb. 22)

The anomalous magnetic moment of charged leptons ($g - 2$):

Peskin-Schroeder prob.6.3, p.210.

Hints:

(a) Given the Higgs-fermion interaction

$$H_{int} = \int d^3x \frac{\lambda_\ell}{\sqrt{2}} h \bar{\psi} \psi,$$

the Feynman rule for this vertex is $-i\lambda_\ell/\sqrt{2}$, where the Yukawa coupling is proportional to the lepton mass $\lambda_\ell = m_\ell/(175 \text{ GeV})$.

Since you are asked to calculate $g - 2$, you can ignore the corrections to the γ^μ term, and concentrate only on $F_2(q^2)$. The result is supposed to be, in the limit $m_h \gg m_e$,

$$F_2^h(q^2) \approx \frac{\lambda_\ell^2 m_\ell^2}{16\pi^2 m_h^2} \left(\ln \frac{m_h^2}{m_\ell^2} - \frac{7}{6} \right).$$

(c) Here the axion coupling λ is not proportional to the lepton mass in general. Because of the observational constraints, an axion cannot be taken to be much heavier than the electron. So the full answer may require numerical integration.

In the limit $m_a \ll m_e$ instead. the result is supposed to be

$$F_2^a(q^2) \approx \frac{\lambda^2}{32\pi^2},$$

independent of the masses.