
Winter, 2009. Homework Set 3. Due Wed, Feb. 18.

Problem numbers refer to your textbook.

1. Calculate the vacuum polarization in QED, using dimensional regularization and the Feynman parameter trick (don't do the Feynman parameter integral at this stage). Verify that the result is transverse.
2. Consider the limit $q^2 \rightarrow 0$. Write an expression for the renormalized coupling in terms of the bare coupling.
3. Consider now the following slightly unrealistic problem. Imagine a world in which the muon is stable, and both the muon and proton are 1000 times more massive than their observed value. In this world, there is a stable $\mu - p$ atom. Discuss the modifications of the Coulomb force law you expect from the vacuum polarization due to the electron and muon. Note that in an atom, the typical momentum transfers are of order αm (where m is the lighter charged particle).