08.128.809 Theoretische Elementarteilchenphysik
Quantum Field Theory II

Homework set 3

Due June 7, 2018
Please note how long it took you to solve each problem!

Reading 1 Read "Dimensional Analysis in Field Theory," P. M. Stevenson. Using the university wifi, you should have access to the published journal version at: https://doi.org/10.1016/0003-4916(81)90072-5 . Otherwise, you can also access a publicly available scanned copy from: https://lib-extopc.kek.jp/preprints/PDF/1980/8006/8006216.pdf .

Reading 2 Read "Radiative Corrections as the Origin of Spontaneous Symmetry Breaking," by S. Coleman and E. Weinberg. Using the university wifi, you should have access to the published journal version at: https://journals.aps.org/prd/abstract/10.1103/PhysRevD.7.1888 . If you are curious, you can work through this calculation following the steps of the final project of Part II of Peskin and Schroeder, p. 469-470, but this is not required for the homework.

Question 1 (Repeated from HW2) Using the functional method, derive the Feynman rules in momentum space for the following interaction vertices:

A. $\mathcal{L} = g\bar{\psi}\gamma_\mu A^\mu \psi$

B. $\mathcal{L} = y\phi\bar{\psi}\psi +$ h.c.

C. $\mathcal{L} = \lambda\phi^4$

D. $\mathcal{L} = g f_{abc}\partial_\mu A^a_\nu A^{\mu,\ b} A^{\nu,\ c}$. For convenience, define all momenta to flow into the vertex, and assume f_{abc} is totally antisymmetric under interchange of any two [group space] indices.

E. (Extra credit) $\mathcal{L} = \frac{1}{4}g^2(f^{eab}A^a_\mu A^b_\nu)(f^{ecd}A^{\mu,\ c}A^{\nu,\ d})$. Again, assume f_{abc} is totally antisymmetric under interchange of any two [group space] indices.

Question 2 Derive the β-function and the anomalous dimension γ of the fermion field and photon field in QED to leading order. The calculation is outlined on p. 416 of Peskin and Schroeder.