

Easter (Takeaway) Problem

[the deadline is the 11th of May 2015]

Calculate beta-function in scalar QCD theory (i.e. replacing quarks with scalars) at one-loop for general SU(N) case using dimensional regularisation. Compare with known result for QCD for running coupling as a function of energy scale [100]:

- a) derive Feynman Rules for this model [8]
- b) write counter-terms, draw respective diagrams and write general equations for β -function [6]
- c) check contribution from tad-poles [2] and write general integrals for dimensional regularization together with Lie Algebra properties [4]
- d) draw scalar self-energy diagrams [2], respective integrals[4] and perform their evaluation [8]
- e) draw boson self-energy diagrams [2], respective integrals[12] and perform their evaluation [16]
- f) draw vertex correction diagrams [2], respective integrals[12] and perform their evaluation [16]
- g) perform combination of the above results, write the final expression for β -function, comparing it with β -function for QCD [6], which at 1-loop takes form $\beta(g)_{1\text{loop}} = \frac{g^3}{16\pi^2} \left(-\frac{11}{3} N_c + \frac{2}{3} N_f \right)$