Physics 722 — Quantum Field Theory ii

homework 1 — due 09 February 2017

1. Peskin and Schroeder, Problem 9.1 (page 312), parts (a) and (c).

2. At some point in the development of the photon propagator one had the expression

$$\int d^4x \; A_\mu \left(g^{\mu\nu}\partial^2 - \partial^\mu\partial^\nu \right) A_\nu \, .$$

Verify that the expression in this form remains invariant under the gauge transformation,

$$A_\lambda(x) \to A_\lambda(x) + \partial_\lambda \alpha(x) \, .$$

3. Give the diagrammatic expansion, to first order in the interaction, of the propagator in the functional integral (or path integral) formalism for ϕ^4 theory.

(For reference,

$$\langle 0 \left| T\phi(x_1)\phi(x_2) \right| 0 \rangle = \frac{\int \mathcal{D}\phi \; \phi(x_1)\phi(x_2)\, e^{i\int d^4x\, \mathcal{L}}}{\int \mathcal{D}\phi \; e^{i\int d^4x\, \mathcal{L}}} \, ,$$

and the interaction lagrangian is $\mathcal{L}_I = -(1/24)\lambda\phi^4$.)

Explain how terms in the expansion of the denominator cancel some terms in the expansion of the numerator.