Theoretical Physics 6a (QFT): SS 2020
Exercise sheet 7

03.06.2020

Exercise 1. (50 points) : Scalar 2 $\rightarrow$ 4 scattering

Considering the interaction Lagrangian for scalar fields

$$\mathcal{L}_1 = -\frac{\lambda}{4!}\phi^4, \tag{1}$$

and the Dyson Expansion of the S-Matrix:

$$S = \sum_{n=0}^{\infty} \frac{(-i)^n}{n!} \int d^4x_1 \cdots \int d^4x_n T\left\{\mathcal{H}_1(x_1)\cdots\mathcal{H}_1(x_n)\right\}. \tag{2}$$

Calculate the second order ($n = 2$) S-matrix element for a process of 2 initial bosons (of momenta p_1 and p_2) going to 4 final ones (of momenta p_3, p_4, p_5 and p_6) by using Wicks theorem and draw the diagrams which arise from it (at least 2 re-orderings of the external fields).

Exercise 2. (50 points) : Photon Feynman Propagator

Consider the Lagrangian

$$\mathcal{L} = \mathcal{L}_{em} + \mathcal{L}_{G.F.} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} - \frac{1}{2\xi}\left(\partial_\mu A^\mu\right)^2, \tag{3}$$

where ξ is a real constant. Derive the equations of motion and invert the result to obtain the general Photon Feynman Propagator. *Hint*: Terms in the Feynman propagator can be proportional to $g_{\mu\lambda}$ and $k_\nu k_\lambda$.