Theoretical Physics 6a (QFT): SS 2025
Exercise sheet 7

26.05.2025

(0 points) How much time did it take you to solve this exercise sheet?

Exercise 1. (70 points): Dyson Expansion

Considering the interaction Lagrangian for scalar fields

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

and the Dyson Expansion of the S-Matrix:

$$S = \sum_{n=0}^{\infty} \frac{i^n}{n!} \int d^4x_1 \cdots \int d^4x_n T\{\mathcal{L}_1(x_1) \cdots \mathcal{L}_1(x_n)\}.$$

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) and draw the diagrams which arise from it (at least 2 re-orderings of the external fields).

Exercise 2. (30 points): Symmetry coefficients

Calculate the symmetry coefficients for the following diagram and explain your answers. The line without arrows represent neutral spin-0 field. The line with the arrow corresponds to a fermion and the wavy line is a photon.

(a)

(b)

(c)

(d)

(e)

(f)

(g)

(h)

(i)

(j)

(k)

(l)

2