Theoretical Physics 6a (QFT): SS 2020
Exercise sheet 9

15.06.2020

For all the exercises consider the Dyson Expansion of S-Matrix:

$$S = \sum_{n=0}^{\infty} \frac{(-i)^n}{n!} \int d^4x_1 \cdots \int d^4x_n T\left\{\mathcal{H}_1(x_1) \cdots \mathcal{H}_1(x_n)\right\}. \tag{1}$$

at second order ($n = 2$). And also, the QED interaction Lagrangian

$$\mathcal{H}_1 = q\bar{\psi}\gamma_\mu\psi A^\mu, \tag{2}$$

with q the lepton charge ($q = -e < 0$ for the electron).

Exercise 1. (50 points) : Electron-Positron scattering

Calculate the S-matrix element (S_{fi}) for the electron-positron scattering and draw the respective diagrams.
Hint: Notice that there are two contributions, what is the relative sign between them?

Exercise 2. (50 points) : $\gamma\gamma \to e^+e^-$ production

Calculate the S-matrix element for the photon-photon fusion into e^+e^- and draw its respective diagrams.
Hint: There are two independent contributions.