

Homework problems # 3

(deadline: 23.01.22)

19. (6 pts) In QED, calculate from first principles (without adopting Feynman rules, i.e. from the definition of the S-matrix):
- The S-matrix element in the momentum space for the scattering process $e^-(p) \mu^-(q) \rightarrow e^-(p') \mu^-(q')$ squared and summed over final and averaged over initial spins. Include only tree-level diagrams.
 - The total cross-section for this process.
20. (4 pts) In QED, adopting Feynman rules in the momentum space, calculate the matrix element for the process $\gamma(q_1) \gamma(q_2) \rightarrow e^+(p_1) e^-(p_2)$.
21. (5 pts) Calculate from first principles (without adopting Feynman rules, i.e. from the definition of the S-matrix) decay width for $\phi \rightarrow \bar{\psi}\psi$ within the theory defined by the following Lagrangian:

$$\mathcal{L} = \frac{1}{2} \partial_\mu \phi \partial^\mu \phi - \frac{1}{2} m_\phi^2 \phi^2 + \bar{\psi} (i \partial_\mu \gamma^\mu - m_\psi) \psi + g \phi \bar{\psi} \psi.$$