

Introduction to QFT

Assignment 8

Due on 20.01.16

1. (40 %) The Lagrangian

$$\mathcal{L} = \frac{1}{2} \partial_\mu \phi_A \partial^\mu \phi_A + \frac{1}{2} \partial_\mu \phi_B \partial^\mu \phi_B - \frac{1}{2} m_A^2 \phi_A^2 - \frac{1}{2} m_B^2 \phi_B^2 + \frac{\lambda}{4} \phi_A^2 \phi_B^2 ,$$

describes two real fields that interact with each other. Calculate the lowest-order non-trivial matrix element $\langle k_B, p_B | S | k_A, p_A \rangle$ for the scattering process $AA \rightarrow BB$. Then calculate the matrix elements for the processes $AB \rightarrow AB$ and $AA \rightarrow AB$.

2. (20%) Consider two real scalar fields A, B with an interaction Lagrangian given by $\mathcal{L}_{\text{int}} = gA^2B$. Calculate the lowest-order non-trivial matrix element $\langle p_a k_A | S | q_A, r_A \rangle$ for the scattering process $AA \rightarrow AA$ and write down the corresponding diagrams.
3. (20%) consider the same theory as in 2). Compute the invariant matrix element for the decay process $B \rightarrow AA$ at tree level. Draw at least two different Feynman diagrams contributing to this process at one loop order (order g^3) and at two loop order (order g^5).