Quantum field theory
Exercises 12.
2006-04-10

• **Exercise 12.1.**

In the theory of a scalar field ϕ with mass m and cubic interaction $\mathscr{L}_{\text{int}} = -\frac{\lambda}{3!}\phi^3$ calculate the cross section σ of the $2\to 2$ scattering.

• **Exercise 12.2.**

Consider the theory with a scalar ϕ with mass M and Dirac fermion ψ with mass m and Yukawa interaction

$$\mathscr{L}_{\text{int}} = -f\phi\bar{\psi}\psi$$

(f – Yukawa coupling constant). Calculate decay width (and lifetime) of the scalar particle ($M > 2m$).

• **Exercise 12.3.**

In the lectures you considered a scalar theory with the interaction of the form $\lambda\phi^4$. One could also study a normal ordered interaction, $:\lambda\phi^4:$ (it is even quite natural – we considered that the free Hamiltonian is normal ordered, why not make the interaction normal ordered also?). Compare the perturbative expansions for the two cases. Specifically, show that the contribution to $\langle 0|T\{\phi(x)\phi(y)\}|0\rangle$ (or mass renormalisation) vanishes at the order $O(\lambda)$ for the normal ordered interaction.