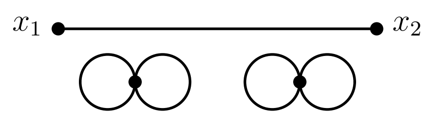
Homework #5

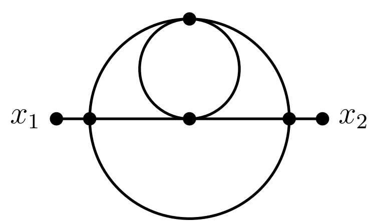
Please hand in by next Thursday (November 20), either during the lecture or email to <Philipp.Kleinert@physics.ox.ac.uk>. Tutorials location: Fisher Room (14. November), Conference Room (21. November).

1. Consider the following potential $O(\lambda^2)$ vacuum bubble contribution to the two-point function $\langle \phi_1 \phi_2 \rangle$:



   Identify the terms that give rise to this Wick contraction, find their symmetry factors, and show that they cancel their contribution to $\langle \phi_1 \phi_2 \rangle$.

2. Compute the symmetry factor for the diagram



3. Confirm the formula

$$W_G = \frac{1}{2!^{S+D} 3!^T 4!^F N_{\text{IVP}}} \tag{1}$$

   where

   - S is the number of self-connections,
   - D is the number of double connections,
   - T is the number of triple connections,
   - N_{IVP} is the number of identical vertex permutations.

   for the diagrams in the first two exercises.

4. Write the Feynman rules (in momentum space) for the theory of two real scalars of mass m and M and interaction

$$\begin{aligned} \mathcal{L}_0 &= -\frac{1}{2}\partial_\mu \phi \partial^\mu \phi - \frac{1}{2} m^2 \phi^2 - \frac{1}{2}\partial_\mu \chi \partial^\mu \chi - \frac{1}{2} M^2 \chi^2 \\ \mathcal{L}_{\text{int}} &= -\frac{1}{2}\lambda \phi^2 \chi \end{aligned} \tag{2}$$

   Use plain and dashed lines for the ϕ and χ-propagator.