

Physics 615

Fall, 2013

Homework #6.

Due Oct. 18 at 3:00

- 1) Consider adding a cubic interaction to the lagrangian density of Eq. 4.1, so

$$\mathcal{L} = \frac{1}{2}(\partial_\mu\phi)^2 - \frac{1}{2}m^2\phi^2 - \frac{g}{3!}\phi^3 - \frac{\lambda}{4!}\phi^4.$$

Thus the interaction hamiltonian becomes

$$H_{\text{int}} = \int d^3x \left( \frac{g}{3!}\phi^3(x) + \frac{\lambda}{4!}\phi^4(x) \right)$$

which means there will now be two kinds of vertices,

$$\begin{array}{c} \diagup \\ \bullet \\ \diagdown \end{array} - i\lambda \int d^4z \quad \text{and} \quad \begin{array}{c} | \\ \bullet \\ \diagup \quad \diagdown \end{array} - ig \int d^4z.$$

All the diagrams we had without the  $\phi^3$  term will still enter any  $n$ -point correlation function (for even  $n$ ) but there will be additional diagrams.

Draw all the diagrams that enter the 3-point function

$$\langle \Omega | T\phi(x)\phi(y)\phi(z) | \Omega \rangle$$

that enter with at most one power of  $g$  and at most one power of  $\lambda$ , and give the symmetry factor for each, with an explanation of how you found the symmetry factor.

It may be useful to also draw, and count, the diagrams which do not enter the 3-point function, but if you do, be sure to label that they *do not* enter.

- 2) Now do the same for the contributions of order  $g^3\lambda^0$ , without any  $\phi^4$  interaction.