

Homework Set No. 1, Physics 880.08

Deadline – Wednesday, January 19, 2011

1. Consider real scalar φ^4 -theory described by the Lagrangian density

$$\mathcal{L} = \frac{1}{2} \partial_\mu \varphi \partial^\mu \varphi - \frac{m^2}{2} \varphi^2 - \frac{\lambda}{4!} \varphi^4.$$

- a. (10 pts) Draw all connected Feynman diagrams contributing to the two-point function

$$\langle \psi_0 | T \varphi(x) \varphi(y) | \psi_0 \rangle$$

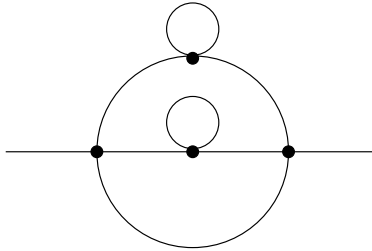
at the order λ^3 . Find the symmetry factors for all the graphs.

- b. (15 pts) Draw all connected (= no vacuum bubbles) Feynman diagrams contributing to the four-point function

$$\langle \psi_0 | T \varphi(x_1) \varphi(x_2) \varphi(x_3) \varphi(x_4) | \psi_0 \rangle$$

up to the order λ^3 . Calculate the symmetry factors.

- c. (5 pts) What is the symmetry factor of the following Feynman diagram?



2. Consider real scalar φ^3 -theory described by the Lagrangian density

$$\mathcal{L} = \frac{1}{2} \partial_\mu \varphi \partial^\mu \varphi - \frac{m^2}{2} \varphi^2 - \frac{\lambda}{3!} \varphi^3.$$

- a. (10 pts) Draw all connected Feynman diagrams contributing to the two-point function

$$\langle \psi_0 | T \varphi(x) \varphi(y) | \psi_0 \rangle$$

up to the order λ^4 . Find the symmetry factors.

- b. (10 pts) Draw all connected (= no vacuum bubbles) Feynman diagrams contributing to the three-point function

$$\langle \psi_0 | T \varphi(x_1) \varphi(x_2) \varphi(x_3) | \psi_0 \rangle$$

up to the order λ^3 . Calculate the symmetry factors.