# 842 test (10 points) Due Tuesday Oct 30 at the lecture.

**Problem 1**. (3 points)

Write down the momenta integrals (and symmetry coefficients, if applicable) for reduced amputated Green functions for the following diagrams describing $\pi^+\pi^+ \to \gamma\gamma$ transition. Dashed lines denote photons. (Do not try to calculate

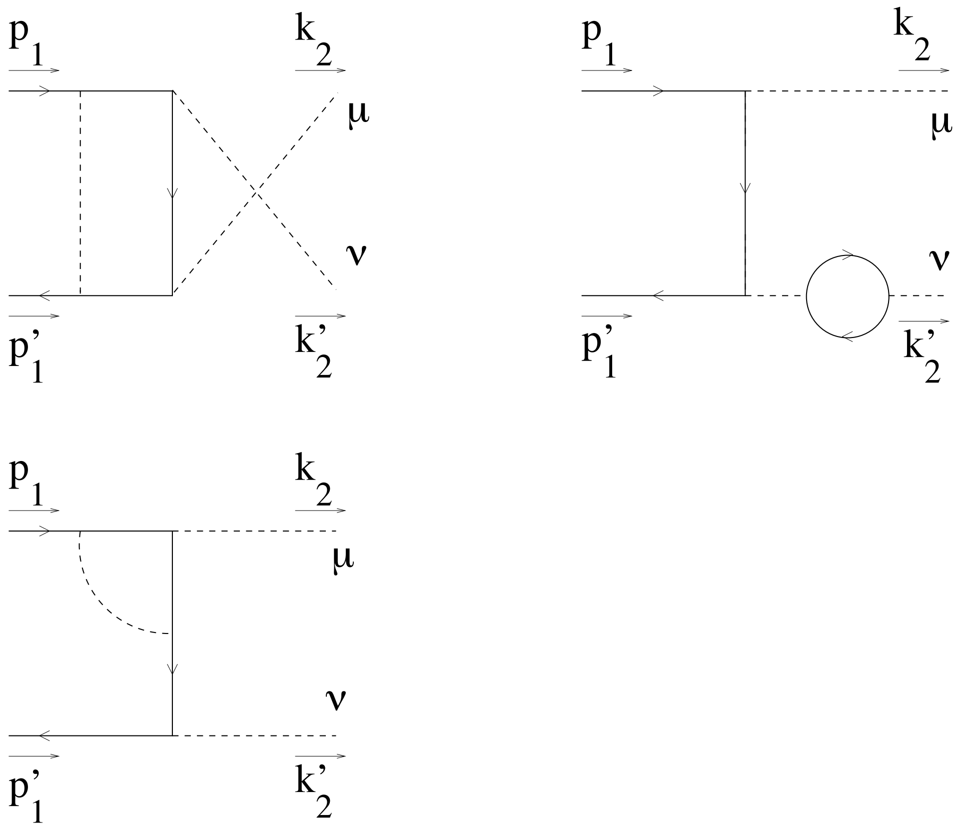


FIG. 1.
Diagrams

the integrals - they are divergent!)

**Problem 2**. (5 points)

As you know, the Higgs boson (spin-0 scalar meson with mass $m_H$) can decay in two photons. At moderate energies, this interaction can be modeled by a local vertex, see Fig. 2a where the wavy line denote Higgs boson. Suppose this is the only vertex of interaction of Higgs bosons with photons. This vertex for the set of reduced Green functions in the momentum space has the form

$$\lambda(g^{\mu\nu} k_1 \cdot k_2 - k_2^\mu k_1^\nu)$$

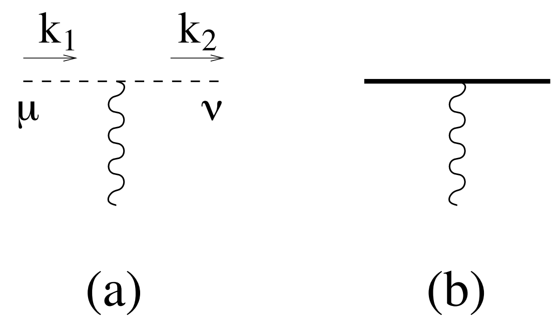


FIG. 2.
H$\gamma\gamma$ and $MMH$ vertices

where $\lambda$ is some constant.

Suppose, in addition to the $H\gamma\gamma$ vertex shown in Fig. 2a, we have also the "$MMH$" vertex describing the emission of Higgs boson by the M-boson (see Fig 2b) and let the vertex be $\lambda$ ($\Leftrightarrow \frac{i\lambda}{2}$ in the coordinate space), same as in our $\pi$M model. Find the total cross section of the scattering of positive-helicity photon from $M$-meson the lowest order in $\lambda$ in this model. (Reminder: the notion of *total* cross section includes summation over the polarizations of final photons).

**Problem 3**. (2 points)

Suppose you have a theory of Higgses interacting with photons as shown in Fig. 3 and suppose this is the only vertex in this model.

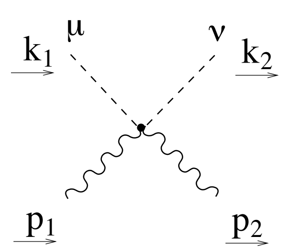


FIG. 3.
HH$\gamma\gamma$ vertex

Can this vertex for the set of reduced Green functions in the momentum space have the form

(*a*) $\lambda g^{\mu\nu}$ (*b*) $\lambda \epsilon_{\mu\nu\lambda\rho} k_1^\mu k_2^\nu p_1^\lambda p_2^\rho$ (*c*) $\lambda(g^{\mu\nu} k_1 \cdot k_2 - k_2^\mu k_1^\nu)$, (*d*) $\lambda(g^{\mu\nu} p_1 \cdot p_2 - p_1^\mu p_2^\nu)$,
(*e*) $\lambda[g^{\mu\nu}(k_1 \cdot p_2)(p_1 \cdot k_2) - p_2^\mu k_1^\nu (k_2 \cdot p_1) - p_1^\nu k_2^\mu (k_1 \cdot p_2) + (k_1 \cdot k_2) p_2^\mu p_1^\nu]$

Circle the correct answer(s).

Reminder: $\epsilon_{\mu\nu\lambda\rho}$ is a totally antisymmetric tensor discussed in the end of the Classical Electrodynamics course.

*GOOD LUCK*!