1. Practice with Feynman diagrams

Using the Feynman rules for the meson-nucleon theory, write down the scattering amplitudes for $N+N \to N+N$ and $N+N \to \phi + \phi$ scattering at $\mathcal{O}(g^2)$.

Similarly, write down the scattering amplitude for $\phi + \phi \to \phi + \phi$ scattering at $\mathcal{O}(g^4)$.

Be careful to include all diagrams that contribute to each process at the given order in $g$, and label all the external momenta and spins where relevant.

2. Generalized meson-nucleon interactions

The Lagrangian density for a generalized meson-nucleon theory is,

$$\mathcal{L} = \frac{1}{2} (\partial_\mu \phi)^2 - \frac{\mu^2}{2} \phi^2 + \bar{\psi}(i\gamma_5 - m)\psi - g \bar{\psi}(a + ib\gamma^5)\psi\phi,$$

with real constants $a$ and $b$.

What are the Feynman rules for this theory, i.e. the vertices, propagators and external lines?