Toward Precision Fermi Liquid Theory in Flatland

William Marshall

What is a (ultra-cold, low-density, 2d) Fermi liquid?

The Problem:

Monte Carlo simulations of the ground state energy do not agree with perturbation theory to 2nd order in the (weak) coupling strength

The Solution:

Go to 3rd order, EFT helps

The EFT:

$$\mathcal{L} = \psi^\dagger \left[i\partial_t + \frac{\overrightarrow{\nabla}^2}{2M} \right] \psi - \frac{C_0}{2} (\psi^\dagger \psi)^2 + \frac{C_2}{16} \left[(\psi\psi)^\dagger (\psi \nabla^2 \psi) + \text{ h.c.} \right]$$
$$+ \frac{C_2'}{8} (\psi \nabla \psi)^\dagger \cdot (\psi \nabla \psi) - \frac{D_0}{6} (\psi^\dagger \psi)^3 + \ldots$$

Should look familiar from Eric Braaten's fermionic NREFT lecture

Match LECs to QM in vacuum

Interesting problem in renormalization

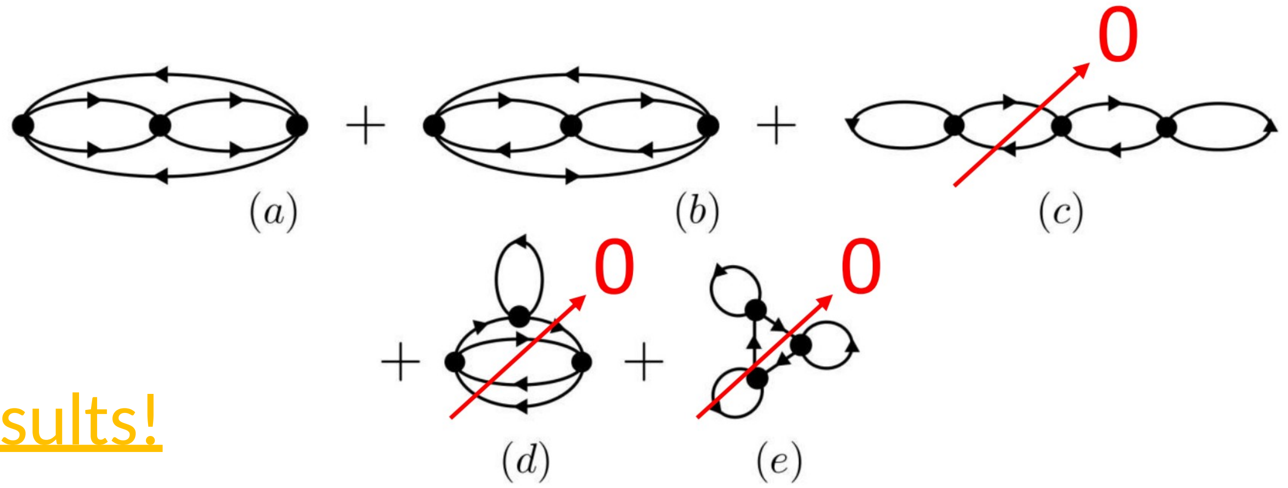
Fermi-liquid calculation:

Set renormalization scale to Fermi surface

New Feynman Rules:

$$iG_0(\widetilde{k})_{\alpha\gamma} = \delta_{\alpha\gamma}\left(\frac{i}{k_0 - \omega_{\mathbf{k}} + i\epsilon} - 2\pi\delta(k_0 - \omega_{\mathbf{k}})\theta(k_F - k)\right)$$

Use tricks to calculate:



See poster for details/results!