Homework assignment 3a.

(Dated: January 16, 2020)

Fermi liquid theory (Chapter 6 of Coleman' textbook)

Kinetic equation for quasiparticle distribution function $n = n(\boldsymbol{r}, \boldsymbol{p}, \sigma, t)$ where $\boldsymbol{r}$, $\boldsymbol{p}$, σ, t are coordinate, momentum, spin and time, reads:

$$\frac{\partial n}{\partial t} + \frac{\partial n}{\partial \boldsymbol{r}}\frac{\partial \varepsilon}{\partial \boldsymbol{p}} - \frac{\partial n}{\partial \boldsymbol{p}}\frac{\partial \varepsilon}{\partial \boldsymbol{r}} = 0 \tag{1}$$

Iterations between quasiparticles described in the framework of Fermi-liquid theory through the dependence of energy ε on the distribution function which is expressed by Landau interaction function $F_{\sigma,\sigma'}(\boldsymbol{p}, \boldsymbol{p}')$.

- Problem 1. Zero sound and plasma waves.

  (a) Calculate the spectrum of collective modes in Fermi liquid with short-range scalar interaction between quasiparticles when $F = F_0^s$.

  (b) Calculate the spectrum of collective modes in Fermi liquid the long-range (Coulomb) interaction when $F(\boldsymbol{p}, \boldsymbol{p}') = 4\pi e^2 \nu / |\boldsymbol{p} - \boldsymbol{p}'|^2$, where ν is density of states in the Fermi gas, e is electron charge.

- Problem 2. Spin waves. Calculate the spectrum of collective modes in Fermi liquid with spin-dependent interaction between quasiparticles

  $F_{\sigma,\sigma'} = \sigma\sigma' F_0^a$ where $\sigma, \sigma' = \pm 1$ for spin-up/down quasiparticles.