

Problem Set 4 for Many-body Physics II. Fall 2018

1. (20 points) Consider spin- $\frac{1}{2}$ fermions at finite temperature T , interacting by a spin-independent pair potential $V(r)$. Collect all the irreducible self-energy diagrams in the second order of the perturbation theory (4 points). Translate these into integrals in momentum/frequency space using the Feynman rules (4 points). Consider those three diagrams that do *not* contain a $V(\mathbf{q} = 0)$ interaction line. Perform the frequency summations (12 points).

Hints: Take care of the $e^{i\eta\omega_n}$ factors. Check if the integrals vanish on the circular contour when its radius goes to infinity. If not, a $e^{i\eta\omega_n}$ factor might be missing. Mind the direction you encircle the poles, and the signs that come from closed Fermi-loops. Be careful with the higher-order poles on the complex frequency plane.