Physics 220- Fall 2017

Theory of Many Body Physics

Homework 8

1 December, 2017

1. The tunneling formalism is described nicely in the Tinkham book, and I have included the notes on the website. Verify Eq(2-76) and understand it thoroughly.

   Using this expression for the current work through the section 2-8.2 on Normal-Normal tunneling. In the expression 2-77 is the relevant equation for STM with small changes. For interacting electrons we can write

   $$I = A|T|^2 \int N_1(E)\langle\rho_G(E+eV)\rangle(f(E) - f(E+eV)dE,$$

   where $\langle\rho_G(E+eV)\rangle$ is the momentum averaged version of the spectral function. I am assuming the STM metal tip to be , so that $N(E_1)$ is roughly a constant.

2. Starting from the above expression for I show that the differential conductance dI/dV measures the spectral function $\langle\rho_G(-eV)\rangle$ at various energies related to the voltage of the probe.

3. Write down the contributions to self energy $\Sigma(k, i\omega_k)$ explicitly for the Hubbard model to second order in U and label all internal lines with momenta and frequencies. You can use the bare G_0 expansion for simplicity.

4. Carry out the frequency summation in the second order diagram explicitly and express the final answer in terms of the external frequency $i\omega_k$ and Fermi functions of other energies.

   You may find it useful to use the standard frequency sum for G_0 given in the notes in class, and also a partial fraction expression for simplifying more complicated denominators, as exemplified in

   $$\frac{1}{(i\omega_n + A)(i\omega_n + B)} = \frac{1}{B-A} \times \left[\frac{1}{(i\omega_n + A)} - \frac{1}{(i\omega_n + B)}\right],$$

   where A and B are arbitrary.