Homework 3

1. Consider a system of fermions interacting via a short range two body force with potential $V(r)$. Compute the effective mass to lowest order in $V(r)$.

2. Construct the state

$$|q> = \Omega a_q^+ |\phi_o> = A^+{}_q |\psi_o> \tag{1}$$

   to lowest order in the interaction ($|\phi_o$) and $|\psi_o>$ are the ground state of the non interacting and interacting system respectively.

3. Compute the expectation value of the charge density and the current density in the state $|q>$

4. Repeat this calculation in a wave packett state
   $|x_o> = \Sigma_q e^{-\alpha(q-q_0)^2} e^{-iq.x_o} |q>.$

   Is the charge density and the current density localized around x_o? Discuss your findings.

5. Show that the conductivity has the form $\sigma(\omega) = \frac{c}{i\omega}$

   Compute c to lowest order in $V(r)$.