HOMEWORK 2

Physics 751
Advanced Solid State Physics
Fall, 2001

1. Show that the damping of long-lived single particle excitations is given by

$$\gamma(p) = Im\Sigma(\epsilon(p), p) * [1 - \frac{\partial Re\Sigma(\omega, p)}{\partial \omega}_{|_{\omega=\epsilon(p)}}]^{-1} \tag{1}$$

2. Polarization operator is defined as

$$\Pi(k\omega) = \int \frac{d^3q d\Omega}{(2\pi)^4} \, G(q, \Omega) G(k + q, \omega + \Omega) \tag{2}$$

Compute $\Pi(k, 0)$ for a free Fermi gas and analyze the behavior of $\Pi(k, 0)$ at $|k| \approx k_F$.

3. Show that in a degenerate electron gas

$$\Sigma(q, \omega) = -\frac{e^2}{2\pi} \left(\frac{p_F^2 - q^2}{q} \log |\frac{p_F + q}{p_F - q}| + 2p_F \right) \tag{3}$$

Sketch the resulting single-particle spectrum and compare the effective mass with the result that we obtained before.