

Problem Set 1

1) Evaluate the following Greens functions for a free Fermi gas. Take the average $\langle \rangle$ with respect to a state characterized by a distribution function $\langle a_p^\dagger a_p \rangle = n_p$

Evaluate the Fourier Transform in space and time of the following Greens functions.

a) $G^t(1, 2) = -i \langle T(\psi(x_1 t_1) \psi^\dagger(x_1 t_2)) \rangle$

b) $G^{\tilde{t}}(1, 2) = -i \langle \tilde{T}(\psi(x_1 t_1) \psi^\dagger(x_1 t_2)) \rangle$

c) $G^>(1, 2) = -i \langle \psi(x_1 t_1) \psi^\dagger(x_1 t_2) \rangle$

d) $G^<(1, 2) = i \langle \psi^\dagger(x_1 t_2) \psi(x_1 t_1) \rangle$

e) $G^K(1, 2) = -i \langle [\psi(x_1 t_1), \psi^\dagger(x_1 t_2)] \rangle$

f) $G^R(1, 2) = -i\theta(t_1 - t_2) \langle \{\psi(x_1 t_1) \psi^\dagger(x_1 t_2)\} \rangle$

g) $G^A(1, 2) = i\theta(t_2 - t_1) \langle \{\psi(x_1 t_1), \psi^\dagger(x_1 t_2)\} \rangle$

Compare them with the Fourier transform of the Matsubara Greens function. $g(\tau, x) = - \langle T(\psi(\tau, x) \psi^\dagger(0, 0)) \rangle$.