Homework 7

1. Show explicitly that in thermal equilibrium the sum of the collision terms in the electron-phonon Boltzmann equation vanish. See page from class notes.

2. Read sections 7.8.2 and 7.8.3 in Sander, starting on page 158.

$$\left(\frac{\delta f_k}{\delta t}\right)_{coll} = \left(\frac{\delta f_k}{\delta t}\right)^{out}_{coll} + \left(\frac{\delta f_k}{\delta t}\right)^{in}_{coll}$$

$$= -\frac{2\pi}{\hbar}\sum_q |g_q|^2 f_k (1-f_{k+q})$$

$$\times \left\{ N_q\, \delta(\epsilon_{k+q} - \epsilon_k - \hbar\omega_q) + (N_{-q}+1)\delta(\epsilon_{k+q} + \hbar\omega_{-q} - \epsilon_k)\right\}$$

$k' = k-q$

$$+ \frac{2\pi}{\hbar}\sum_q |g_q|^2 f_{k+q}(1-f_k)$$

$$\left\{ N_{-q}\, \delta(\epsilon_k - \epsilon_{k+q} - \hbar\omega_{-q}) + (N_q+1)\,\delta(\epsilon_k + \hbar\omega_q - \epsilon_{k+q})\right\}$$

In thermal equilibrium

$$N_q = \frac{1}{e^{\hbar\beta\omega_q}-1} \quad ; \quad f_k = \frac{1}{e^{\beta(\epsilon_k-\mu)}+1} = n_k$$