UPDATES

Corrections to notes/handouts

A.H. Harker
Physics and Astronomy
UCL

Lecture 9

- Phonon spectra of real solids. In general: N atoms in the unit cell $\rightarrow 3$ acoustic branches and $3(N-1)$ optical branches (not $3N$ acoustic branches as in original version).

Lecture 11

- Density of states in 3-D and the Debye frequency. An unfortunate placement of two equations had run them together: instead of

$$N = \int_0^{\omega_\mathrm{D}} \frac{V}{2\pi^2} \frac{\omega^2}{v^3} \mathrm{d}\omega = \frac{V}{6\pi^2} \frac{{\omega_\mathrm{D}}^3}{v^3} {\omega_\mathrm{D}}^3 = \frac{6N\pi^2}{V} v^3$$

you should have

$$N = \int_0^{\omega_\mathrm{D}} \frac{V}{2\pi^2} \frac{\omega^2}{v^3} \mathrm{d}\omega = \frac{V}{6\pi^2} \frac{{\omega_\mathrm{D}}^3}{v^3} \qquad {\omega_\mathrm{D}}^3 = \frac{6N\pi^2}{V} v^3$$

- Debye theory of the specific heat:

$$C_V = Sk_B \frac{3N\hbar^3}{{k_B}^3{\Theta_D}^3}\frac{{k_B}^3T^3}{\hbar^3}\int_0^{x_D}\frac{x^4e^x}{(e^x-1)^2}\mathrm{d}x,$$
$$= 3NSk_B\frac{T^3}{{\Theta_D}^3}\int_0^{x_D}\frac{x^4e^x}{(e^x-1)^2}\mathrm{d}x:$$

the original version had an intrusive v^3 in the denominator in the first line.

Lecture 21

- Section 8.3.3 omitted a factor of $\hbar$ in two equations, which should read:

$$v_h = \frac{1}{\hbar}\nabla_{\mathbf{k}_h}E_h,$$

and

$$v_h = -\frac{1}{\hbar}\nabla_{\mathbf{k}_e}(-E_e) = v_e.$$

- The last equation conflated expressions for current and conductivity. The current is the sum of electron and hole currents,

$$J = -en_e v_e + en_h v_h,$$

so the conductivity is

$$\sigma = n_e e \mu_e + n_h e \mu_h,$$

or

$$\sigma = n_e \frac{e^2 \tau}{m_e^*} + n_h \frac{e^2 \tau}{m_h^*}.$$

Note that we have assumed equal relaxation times, τ, for electrons and holes – this is not necessarily true.

Lecture 22

- An erroneous power of $\hbar$ crept in in several places. The correct equations are

$$N_{\rm c}(T) = \frac{1}{4} V \left(\frac{2 m_{\rm e}^* k_{\rm B} T}{\pi \hbar^2} \right)^{3/2},$$

$$n_{\rm v}(T) = \frac{1}{4} \left(\frac{2 m_{\rm h}^* k_{\rm B} T}{\pi \hbar^2} \right)^{3/2},$$

$$n_{\rm i}(T) = e^{-E_{\rm g}/(2k_{\rm B}T)} \frac{1}{4} \left(\frac{2 k_{\rm B} T}{\pi \hbar^2} \right)^{3/2} \left(m_{\rm e}^* m_{\rm h}^* \right)^{3/4}$$

and

$$e^{-E_{\rm g}/(2k_{\rm B}T)} \frac{1}{4} \left(\frac{2 k_{\rm B} T}{\pi \hbar^2} \right)^{3/2} \left(m_{\rm e}^* m_{\rm h}^* \right)^{3/4}$$

$$= \frac{1}{4} \left(\frac{2 m_{\rm e}^* k_{\rm B} T}{\pi \hbar^2} \right)^{3/2} e^{(\mu - E_{\rm c})/(k_{\rm B}T)}.$$

- Furthermore, the number $5{\times}10^{25}$ which appears twice, in $n_{\rm c}(T)$ and in $n_{\rm i}(T)$, should be 5×10^{21}.