Superconductivity (Camerino)

Problem Set 3 Due Apr. 12, 2013 Marsiglio

1. Use the BCS gap equation to derive some of the properties discussed in class as well as a few others. Assume the weak coupling approximation (including $\hbar\omega_D >> k_B T_c$ or $\hbar\omega_D >> k_B T_c$ throughout).

(a) Derive the Tc equation and the gap equation, and find $\frac{2\Delta}{k_B T_c} = 3.53$.

(b) Derive that $\Delta(T)/\Delta(0) = 1.736\left(1 - T/T_c\right)^{1/2}$ near T_c.

(c) Then derive that the electronic specific heat jump (normalized to the normal state electronic specific heat) is $\frac{\Delta C}{C_N} = 1.43$ at $T = T_c$.

(d) Find that at low temperatures, $\frac{\Delta(t)}{\Delta_0} \approx 1 - 1.89(T/T_c)^{1/2} e^{-1.77T_c/T}$, where Δ_0 is the zero temperature value of the order parameter.

(e) Returning to part (a), drop the weak coupling condition that $\hbar\omega_D >> k_B T_c$ or $\hbar\omega_D >> k_B T_c$; instead adopt the opposite condition, that $\hbar\omega_D$ is much smaller than either of these energies, and derive the limiting (large) value of $\frac{2\Delta}{k_B T_c}$.