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Lecture 11 : Super Con

Below T_c, $R_{DC}(T) = 0$

Transition to SC state due to Cooper Pairs:
two e^- make a quasiparticles boson with $\vec{k}_{net} = 0$ in zeros field

in $H = 0$ second order
$H \neq 0$ first order

Define H_c - critical field :

$$\frac{H_c^2}{8\pi} = f_n(T) - f_s(T)$$

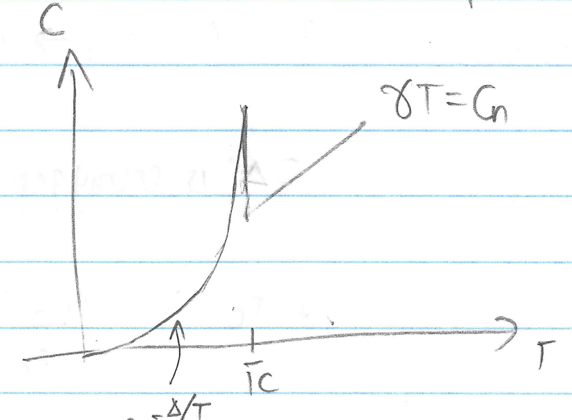
Emperically : $H_c(T) = H_c(0)\left[1 - \left(\frac{T}{T_c}\right)^2\right]$

$$\vec{B} = \vec{H} + 4\pi\vec{M}$$

$$\vec{B} = 0 \Rightarrow \vec{H} = -4\pi\vec{M}$$

$$\chi = \frac{\vec{M}}{\vec{H}} = -\frac{1}{4\pi}$$

Electronic Heat Capacity



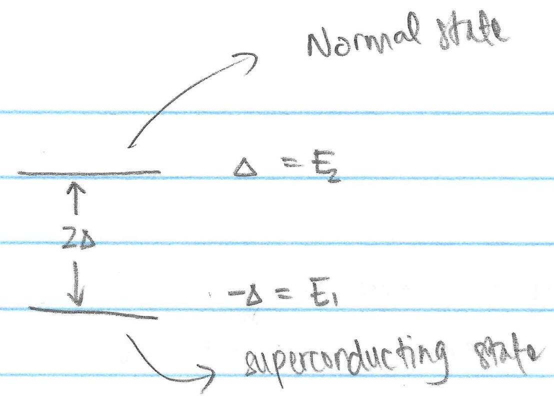
Penetration : $B(x) = B_0 \cdot e^{-x/\lambda}$

$$\lambda(T) = \frac{\lambda(0)}{\left[1 - \left(\frac{T}{T_c}\right)^4\right]^{1/2}}$$

$$\lambda(0) = \left(\frac{mc^2}{4\pi ne^2}\right)^{1/2}$$

$$\Delta S = \int_0^{T_c} \frac{C}{T}\, dT$$

$$\boxed{\int_0^{T_c} \frac{C_n}{T}\, dT = \int_0^{T_c} \frac{C_s}{T}\, dT}$$



$$Z = \sum_n e^{-\beta E_n} = -e^{-\beta\Delta} + e^{-\beta(-\Delta)}$$
$$= 2\cosh(\beta\Delta)$$

$$U = -\frac{\partial}{\partial\beta}\ln\beta = -\frac{1}{Z}\frac{\partial Z}{\partial\beta}$$
$$= -\Delta\tanh\beta\Delta$$

$$\beta = \frac{1}{kT} \qquad C = \frac{\partial U}{\partial T} = -k\beta^2\frac{\partial U}{\partial\beta}$$
$$C = \underline{+k\Delta^2\beta^2}\,\mathrm{sech}^2\beta\Delta$$

$$T \to 0 \to \beta \to \infty \to \quad C \propto e^{-\Delta/T}$$

2Δ is energygap (E_g) bt

at T_c : $\dfrac{C_s - C_n}{C_n} = 1.43$

Empirically + BCS : $\dfrac{\Delta(0)}{kT_c} = 1.76$

$$\Delta(T) = \Delta(0)\left[1 - \frac{T}{T_c}\right]^{1/2} \text{ near } T_c$$