Lecture 6

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$$N = 2 \underbrace{\left(\frac{L}{2\pi}\right)^3}_{\text{\# of modes per unit k-space}} \frac{4}{3}\pi K_F^3$$

$$n = \frac{N}{V} = \frac{K_F^3}{3\pi^2}$$

$$K_F = (3\pi^2 n)^{1/3}$$
$$= \left(3\pi^2 \cdot \frac{3}{4\pi}\right)^{1/3} \frac{1}{r_s}$$
$$= \left(\frac{9\pi}{4}\right)^{1/3} \frac{1}{r_s}$$

(Review) ✓ Chapter 4 & 5
Go through : Chapter 3 , lattice & Brilluon Zone , empty lattice , Bragg's reflection

$$g(\varepsilon)\, d\varepsilon = \frac{1}{V} \times \text{\# of } 1e^- \text{ levels between } \varepsilon \;\&\; \varepsilon + d\varepsilon$$

$N(\varepsilon)$ & $D(\varepsilon)$ $\longrightarrow$ Density of states !

$$g(\varepsilon)\, d\varepsilon = \frac{1}{V} D(\varepsilon)\, d\varepsilon$$

$$T=0 \rightarrow n = \int_{-\infty}^{\infty} g(\varepsilon)\, d\varepsilon \Rightarrow dn = g(\varepsilon)\, d\varepsilon$$

$$\boxed{g(\varepsilon) = \frac{dn}{d\varepsilon}}$$

$$\bar{x} = \int_{-\infty}^{\infty} g(\varepsilon)\, x \, d\varepsilon \qquad u = \int_{-\infty}^{\infty} g(\varepsilon)\, \varepsilon \, d\varepsilon$$

$T \neq 0$

$$n = \int_{-\infty}^{\infty} g(\varepsilon)\, f_{FD}(\varepsilon)\, d\varepsilon$$

$$u = \int_{-\infty}^{\infty} g(\varepsilon)\, u\, f_{FD}(\varepsilon)\, d\varepsilon$$

$$g(\varepsilon) = \frac{dn}{d\varepsilon} = \frac{dn}{dk} \cdot \frac{dk}{d\varepsilon}$$

$$= \frac{k^2}{2\pi^2} \left(\frac{2m}{\hbar^2} \right)^{1/2} \varepsilon^{-1/2}$$

$$= \frac{3}{2} \frac{n}{\varepsilon_F} \left(\frac{\varepsilon}{\varepsilon_F} \right)^{1/2}$$

At low T :

$$u = u_0 + \frac{\pi}{6} (k_B T)^2 g(\varepsilon_F)$$

$$C_v = \frac{\partial U}{\partial T} = \frac{\pi k_B^2 T}{3} g(\varepsilon_F) = \gamma T$$

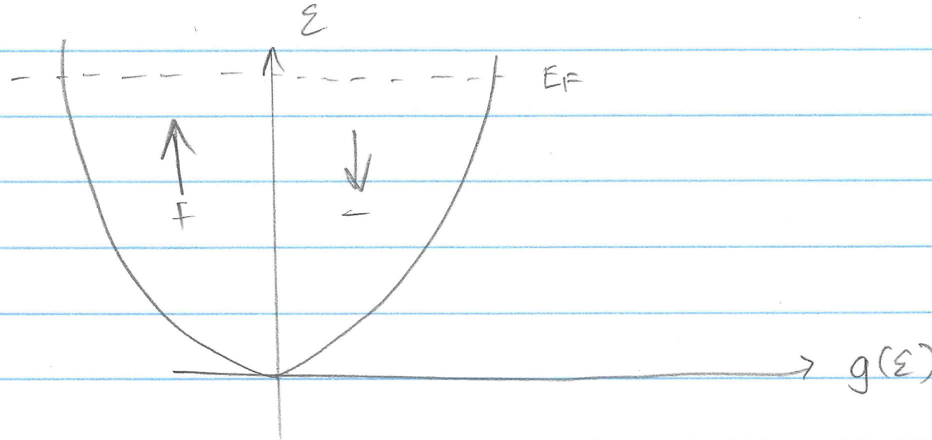
$\gamma = \frac{\pi k_B^2}{3} g(\varepsilon_F) \rightarrow$ Sommerfeld Coefficient

$$C_v = \gamma T + C_{mag} + C_{lattice} + \dots$$

$C_{latt} = \beta T^3 \rightarrow$ Debye model at low T $\quad T \ll \frac{\Theta_D}{50}$

For most material : $C_v = \gamma T + \beta T^3 \Rightarrow \Delta S = C \ln(T_f - T_i)$

Pauli Paramagnetism → Comparing temperature to the Fermi temperature



$$g_{\pm}(\varepsilon) = \frac{g(\varepsilon)}{2}$$

$$U_+ - U_- = 2\mu_B H$$

$$\chi_{CW} = \frac{1}{3} n \frac{p^2 \mu_B^2}{k_B T}$$

$$\chi \sim \frac{\left(n \frac{T}{T_F}\right) \cdot \mu_B^2}{k_B T} \sim \frac{n \mu_B^2}{k_B T_F}$$

$$g_{\pm}(\varepsilon) = \frac{1}{2} g(\varepsilon \mp \mu_B H)$$

$$\chi = \mu_B^2 \, g(\varepsilon_F) = \mu_B^2 \, \frac{3}{2} \frac{n}{k_B T_F}$$