FUNDAMENTALS OF NANOELECTRONICS

Basic Concepts

1. The New Perspective

Energy Band Model

3. What and Where

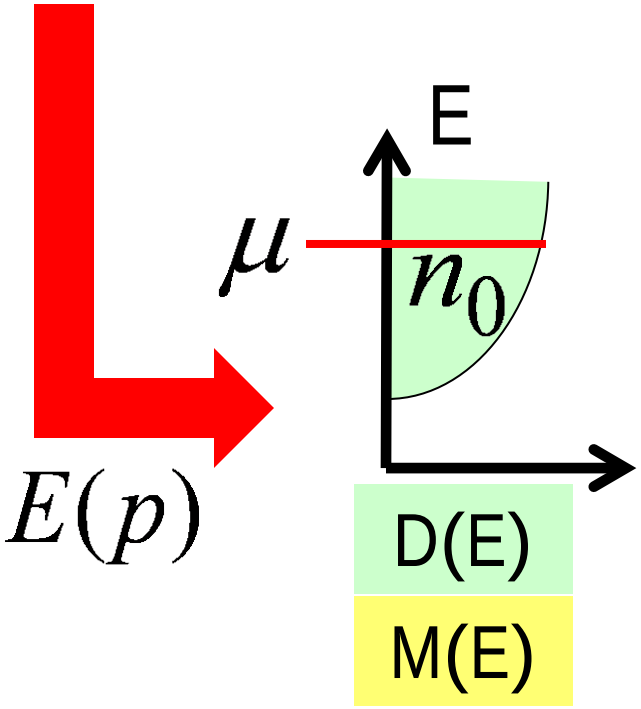
   is the Voltage?

4. Heat & Electricity:

Second Law & Information

- 2.1. Introduction
- 2.2. E(p) or E(k) relation
- 2.3. Counting States
- 2.4. Density of states
- 2.5. Number of modes
- **2.6. Electron density (n)**
- 2.7. Conductivity vs n
- 2.8. Quantum Capacitance
- 2.9. The Nanotransistor
- 2.10. Summing up ..

$$N(p) = \left(\frac{p}{h}\right)^d \begin{Bmatrix} 1D & 2D & 3D \\ 2L & \pi WL & \frac{4\pi}{3}AL \end{Bmatrix}$$



$$n(p) = \left(\frac{p}{h}\right)^d \begin{Bmatrix} 1D & 2D & 3D \\ 2 & \pi & \frac{4\pi}{3} \end{Bmatrix}$$

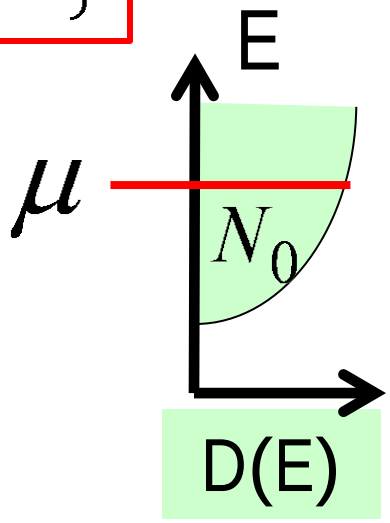
E(p) → n(E) —(E=μ, T=0K)→ n(μ)

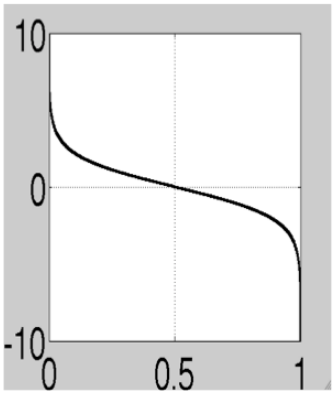
$$N(p) = \left(\frac{p}{h}\right)^d \begin{Bmatrix} 1D & 2D & 3D \\ 2L & \pi WL & \frac{4\pi}{3} AL \end{Bmatrix}$$

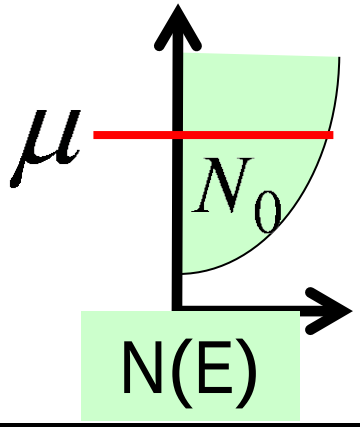
$$N_0 = \int_{-\infty}^{+\infty} dE\, D(E)\, f_0(E)$$

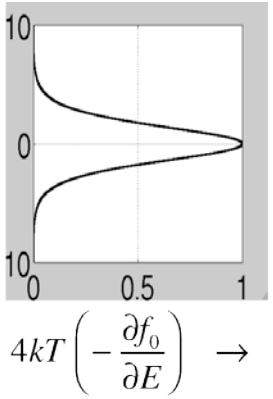
$$= \int_{-\infty}^{\mp\infty} dE\, \frac{dN}{dE}\, f_0(E)$$

$$= \left[N f_0\right]_{-\infty}^{+\infty} + \int_{-\infty}^{+\infty} dE\, N(E) \left(-\frac{\partial f_0}{\partial E}\right)$$





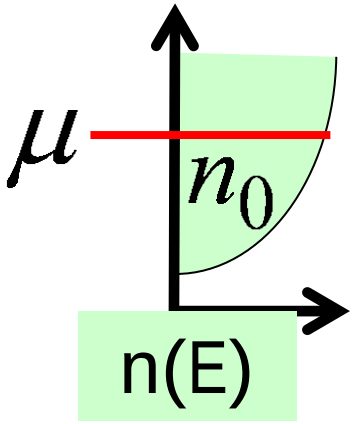


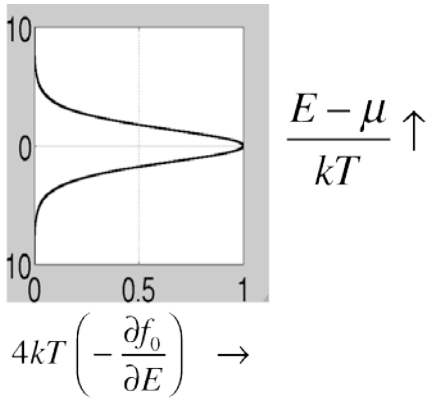


2.6c Electron density

$$N(p) = \left(\frac{p}{h}\right)^d \begin{Bmatrix} 1D & 2D & 3D \\ 2L & \pi WL & \frac{4\pi}{3}AL \end{Bmatrix}$$

$$n(p) = \left(\frac{p}{h}\right)^d \begin{Bmatrix} 2 & \pi & \frac{4\pi}{3} \end{Bmatrix}$$





$$n_0 = \int_{-\infty}^{+\infty} dE\, n(E)\left(-\frac{\partial f_0}{\partial E}\right)$$

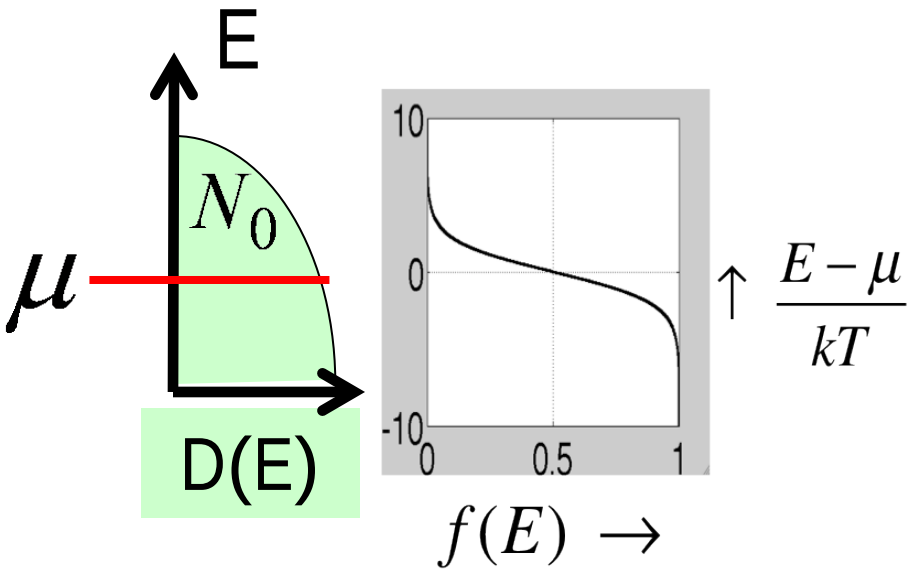
$$G_B = \frac{q^2 D \bar{\nu}}{2L} = \frac{q^2}{h} M$$

Recall $$G_0 = \int_{-\infty}^{+\infty} dE \left(-\frac{\partial f_0}{\partial E}\right) G(E) \rightarrow \frac{G_B \lambda}{L+\lambda}$$

$$N_0 = \int_{-\infty}^{+\infty} dE\, D(E)\,(1-f_0(E))$$

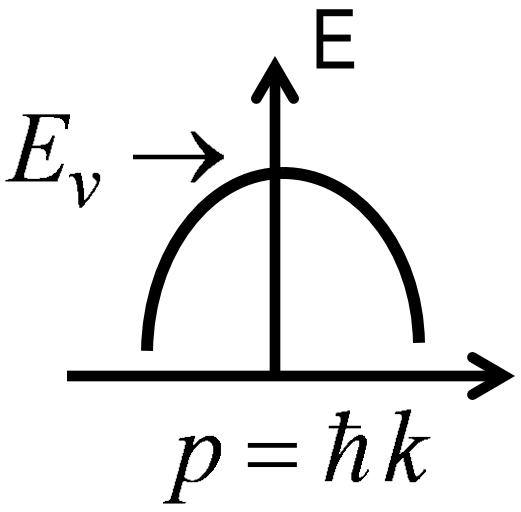
$$= \int_{-\infty}^{+\infty} dE \left(-\frac{dN}{dE}\right)(1-f_0(E))$$

$$= \left[-N(1-f_0)\right]_{-\infty}^{+\infty} + \int_{-\infty}^{+\infty} dE\, N(E)\left(-\frac{\partial f_0}{\partial E}\right)$$



$$N(1-f_0) = 0 \quad as \quad E \rightarrow -\infty$$

$$N f_0 \neq 0 \quad as \quad E \rightarrow -\infty$$



$$n(p) = \left(\frac{p}{h}\right)^d \left\{2 \quad \pi \quad \frac{4\pi}{3}\right\}$$

$$n_0 = \int_{-\infty}^{+\infty} dE\, n(E)\left(-\frac{\partial f_0}{\partial E}\right)$$

New perspective

$$\sigma = \frac{G_B}{A}\lambda$$

Drude formula

$$\sigma = q^2 \frac{n}{m}\tau$$

Coming up next ..