FUNDAMENTALS OF NANOELECTRONICS

Basic Concepts

1. The New Perspective

Energy Band Model →

3. What and Where

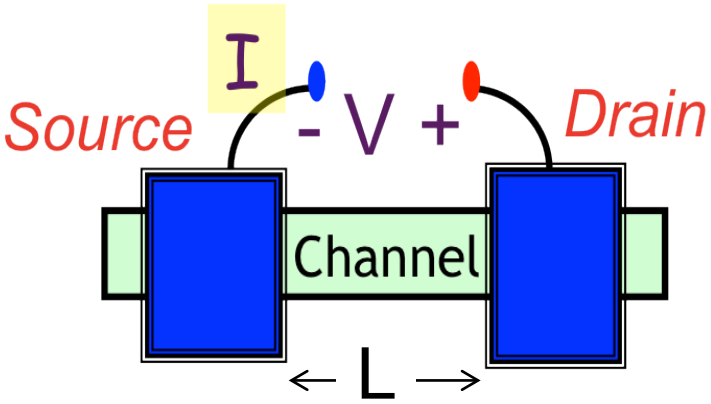
   is the Voltage?

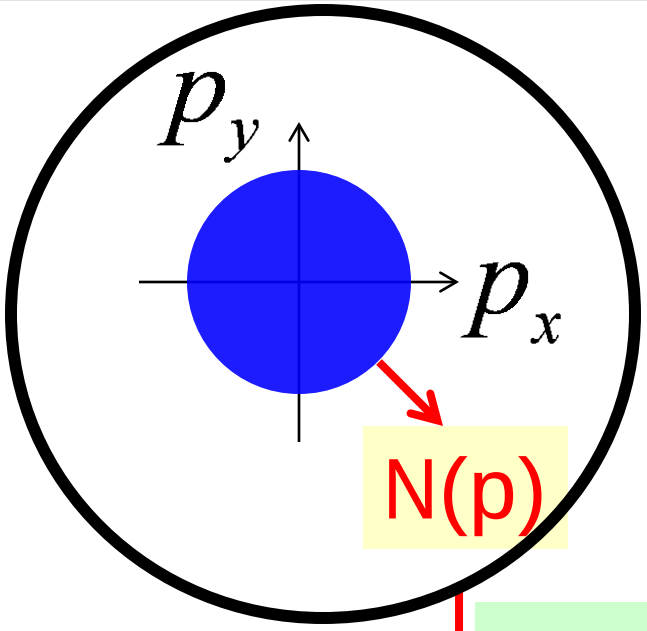
4. Heat & Electricity:

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 ..

2.3a Counting states



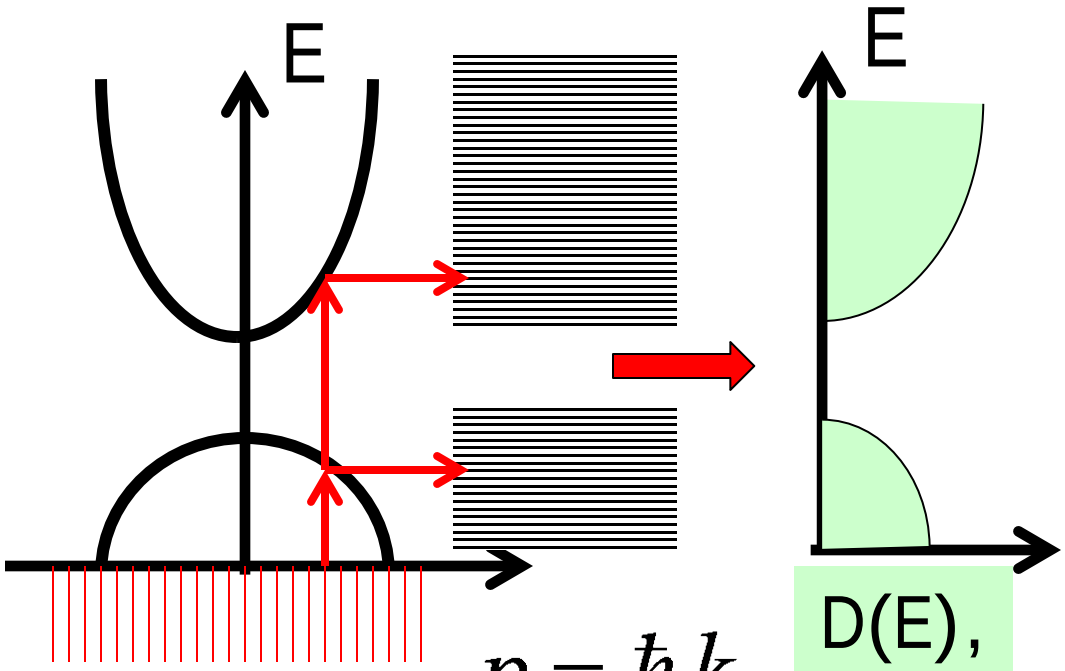


N(p)

E(p)

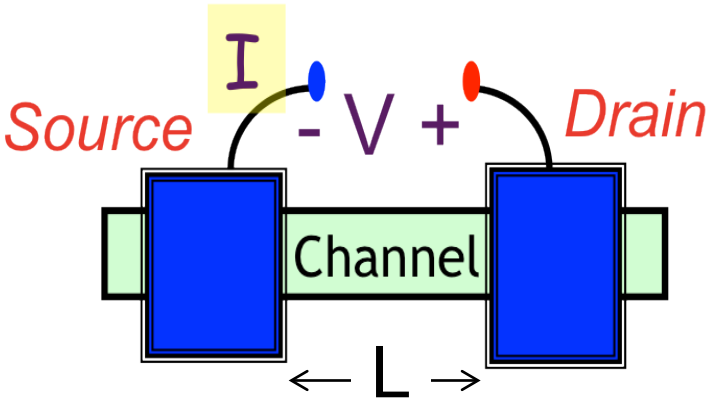
N(E)

$$D(E) = \frac{dN(E)}{dE}$$



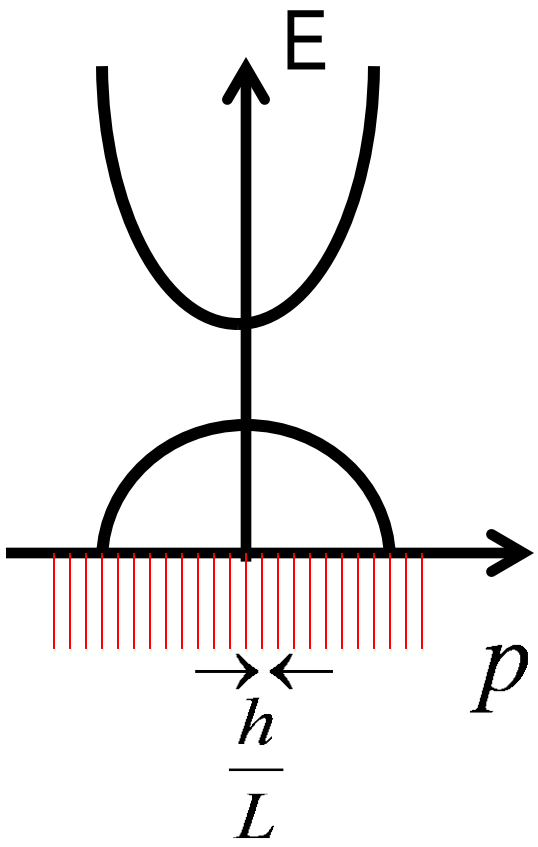
D(E),
M(E)

2.3b Counting states



$$\lambda_{De\ Broglie} = \frac{h}{p}$$

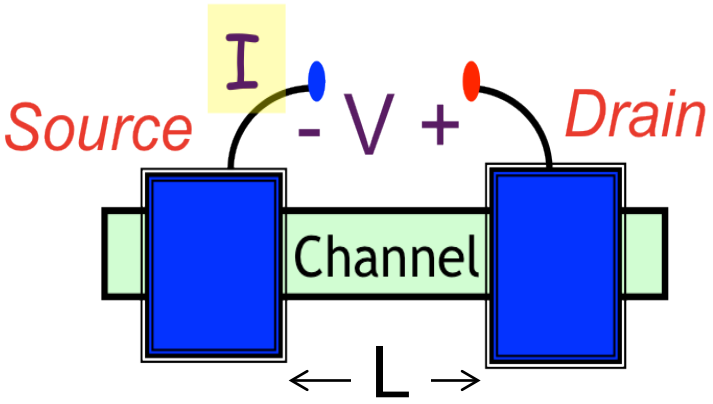
$$N(p) = \frac{2p}{h/L}$$



$$L = n\frac{h}{p_n} \rightarrow p_n = n\frac{h}{L}$$

$$\rightarrow k_n = \frac{n}{L}\frac{h}{\hbar} = n\frac{2\pi}{L}$$

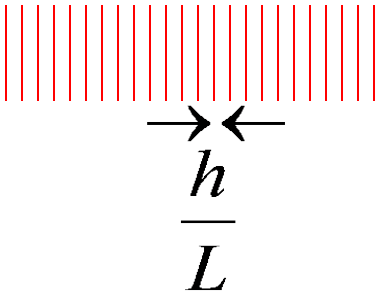
$$p = \hbar k \rightarrow \hbar\frac{2\pi}{\lambda_{De\ Broglie}} = \frac{h}{\lambda_{De\ Broglie}}$$

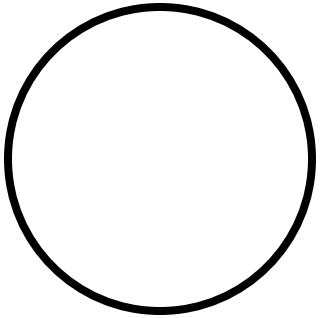


1D $N(p) = \dfrac{2p}{h/L}$

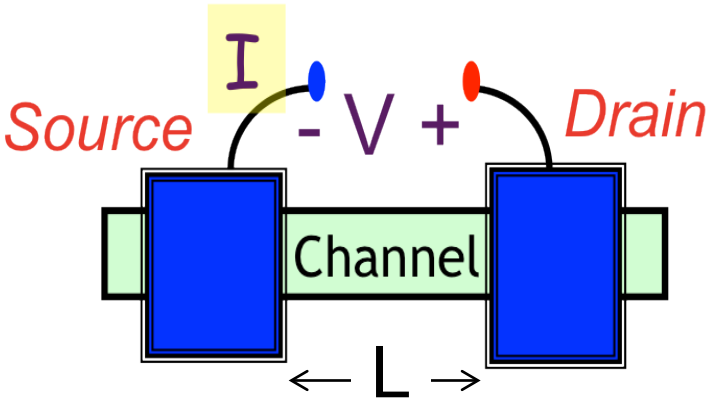
Periodic Boundary Condition PBC

$$L = n\frac{h}{p_n} \quad \rightarrow \quad p_n = n\frac{h}{L}$$

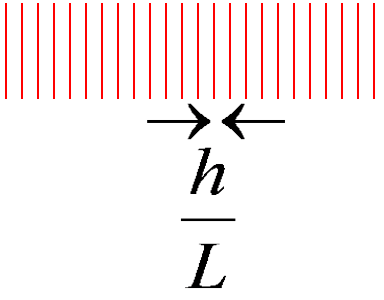




2.3d Counting states



1D $$N(p) = \frac{2p}{h/L}$$



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

2D $$N(p) = \frac{\pi p^2}{(h/L)(h/W)}$$

Periodic Boundary Condition PBC

3D $$N(p) = \frac{4\pi p^3/3}{(h/L)(h^2/A)}$$

Coming up next ..

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