FUNDAMENTALS OF NANOELECTRONICS

Basic Concepts

1. The New Perspective

Energy Band Model

3. What and Where

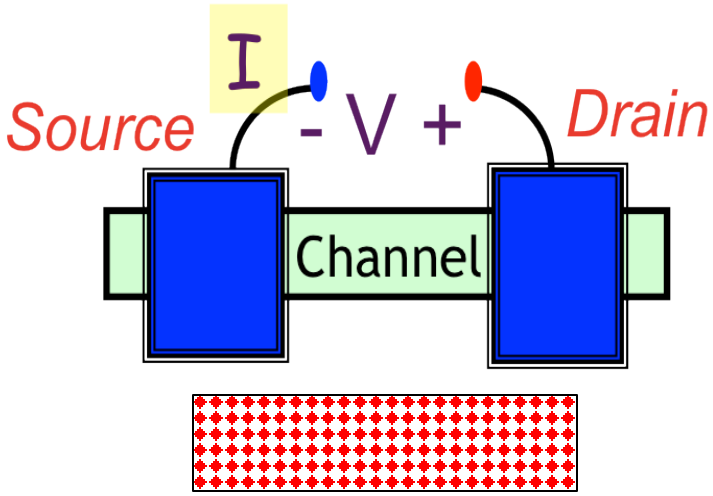
   is the Voltage?

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 ..

2.2a E(p) or E(k) relation



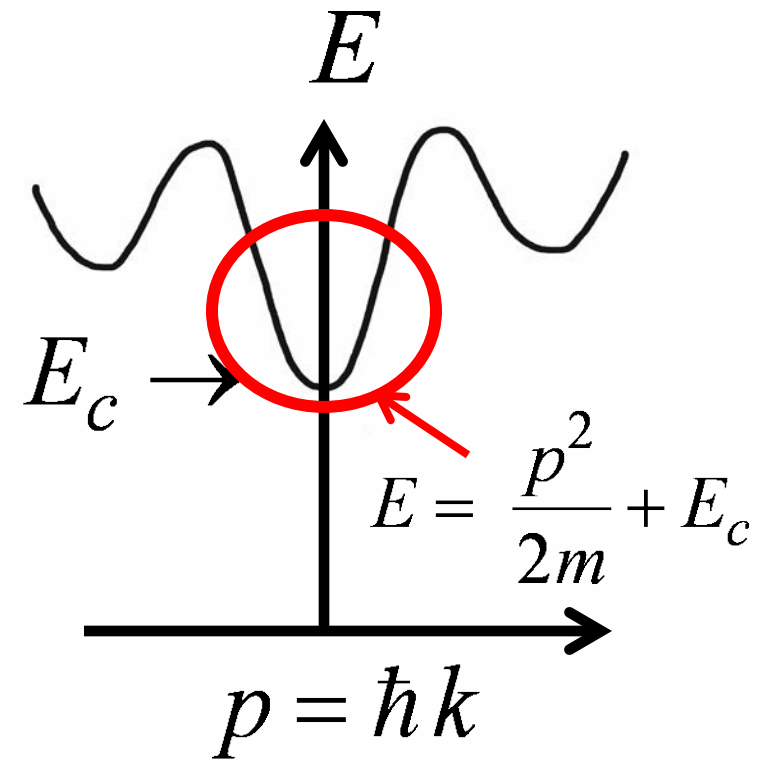
Electrons in vacuum

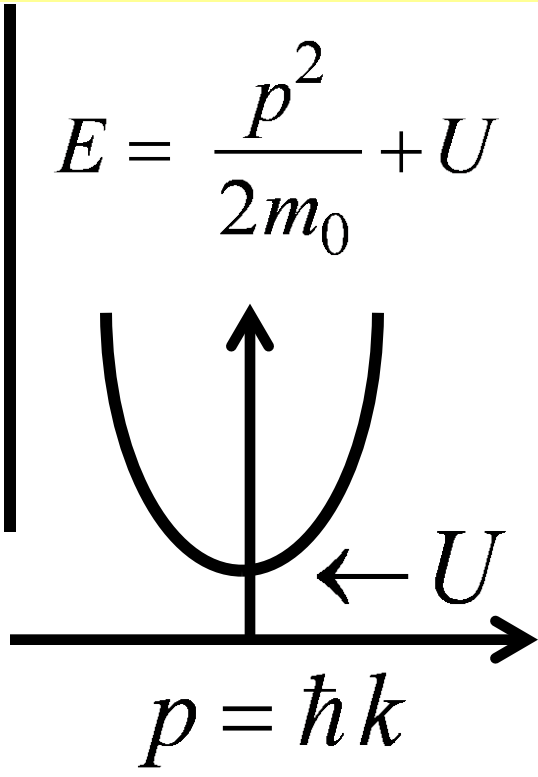
$$KE = \frac{1}{2} m_0 v^2$$

$$= \frac{1}{2} \frac{(m_0 v)^2}{m_0}$$

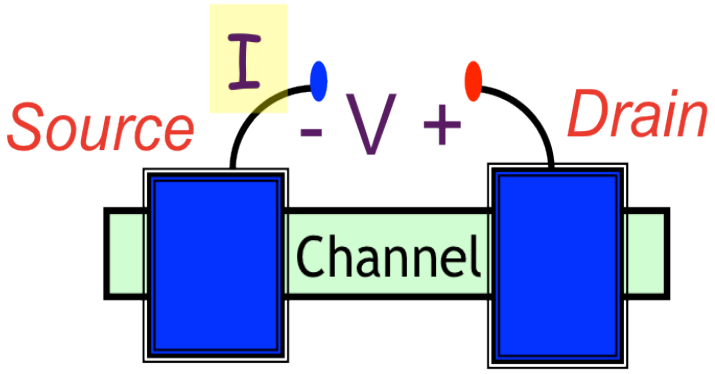
$$= \frac{1}{2} \frac{p^2}{m_0}$$

$$if \quad p = m_0 v$$





2.2b E(p) or E(k) relation



"Relativistic" band

$$E^2 = \left(m_0 c^2\right)^2 + c^2 p_z^2$$

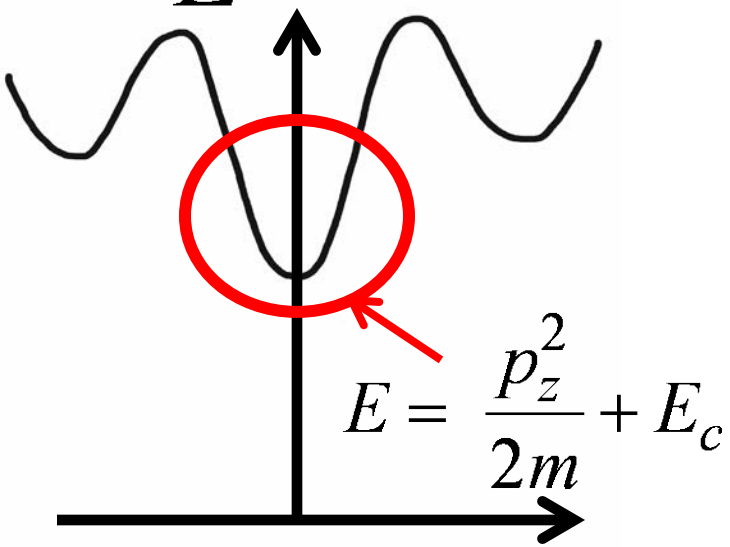
$$v_z = \frac{c^2 p_z}{E} \leftarrow 2E\frac{\partial E}{\partial p_z} = 2c^2 p_z$$

$$\downarrow$$

$$m = \frac{p_z}{v_z} = \frac{E}{c^2} \rightarrow \frac{m_0}{\sqrt{1-\frac{v_z^2}{c^2}}}$$

Drude formula

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

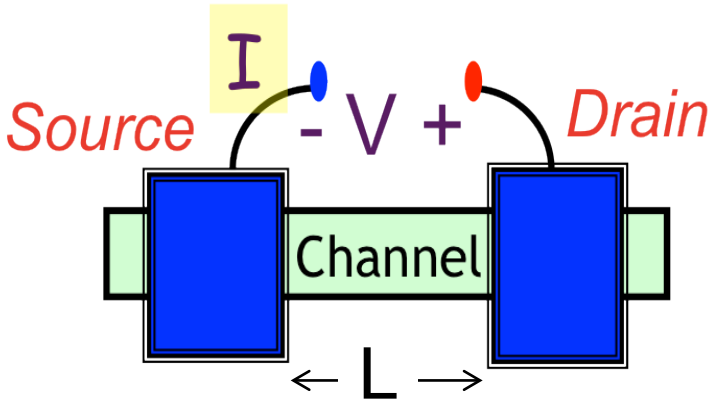


Parabolic band

$$v_z = \frac{\partial E}{\partial p_z} = \frac{p_z}{m}$$

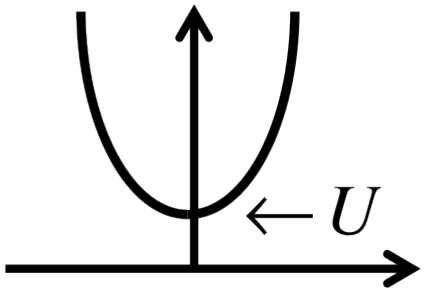
$$\frac{dz}{dt} = \frac{\partial E}{\partial p_z}, \quad \frac{dp_z}{dt} = -\frac{\partial E}{\partial z}$$

2.2c E(p) or E(k) relation

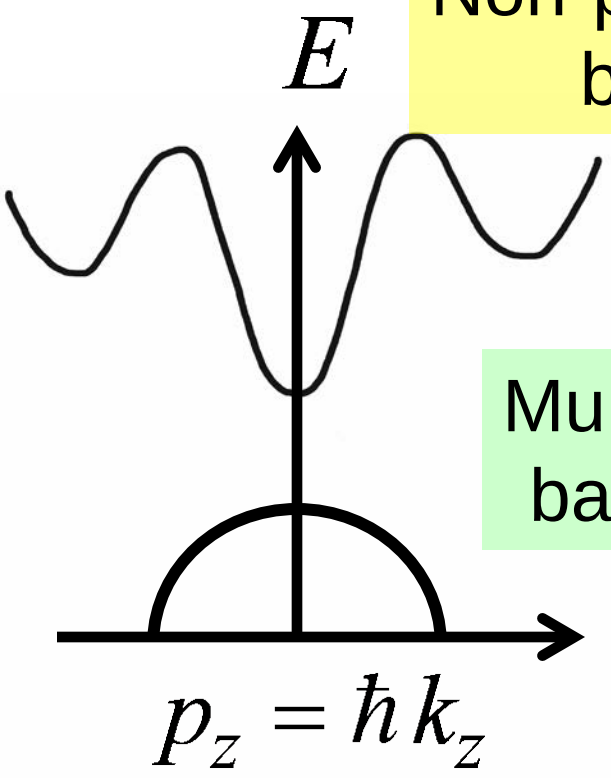


Electrons in vacuum

$$E = \frac{p^2}{2m_0} + U$$



Non-parabolic band



Multiple bands

$$\frac{dz}{dt} = \frac{\partial E}{\partial p_z} \quad , \quad \frac{dp_z}{dt} = -\frac{\partial E}{\partial z}$$

Coming up next ..