FUNDAMENTALS OF NANOELECTRONICS

Basic Concepts

The New Perspective →

2. Energy Band Model

3. What and Where

   is the Voltage?

4. Heat & Electricity:

   Second Law & Information

1.1. Introduction

1.2. Two Key Concepts

1.3. Why Electrons Flow

1.4. Conductance Formula

1.5. Ballistic(B) Conductance

1.6. Diffusive(D) Conductance

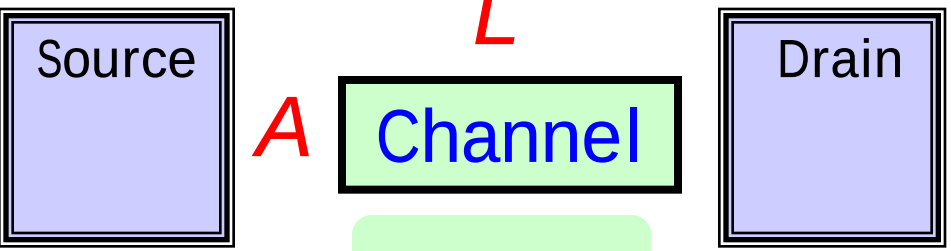
1.7. Connecting B to D

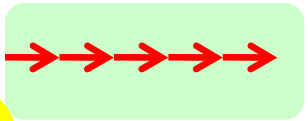
1.8. Angular Averaging

1.9. Drude Formula

1.10. Summing up ..

1.6a Diffusive Conductance





Ballistic

$$t_B = \frac{L}{\bar{v}}$$

D ~ AL

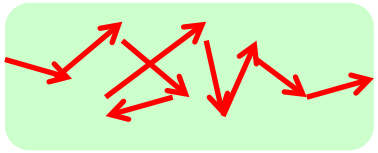
$$G_B = \frac{q^2 D \bar{v}}{2L} \sim A$$

$$G = \frac{q^2 D}{2t}$$

$$G = \frac{A}{L} \overbrace{q^2 \frac{D}{AL} \bar{D}}^{\sigma}$$

Diffusive

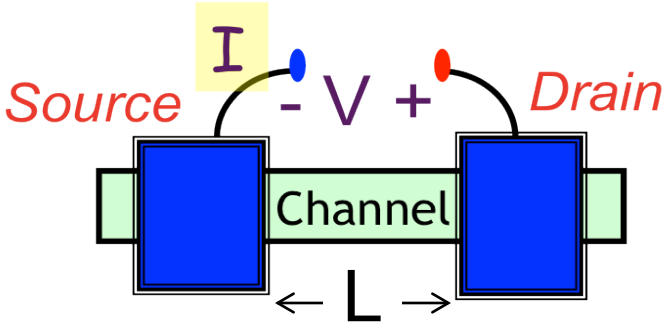
$$t_D = \frac{L^2}{2\bar{D}}$$



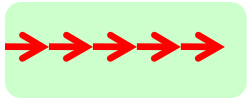
Drude formula

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

1.6b Diffusive Conductance

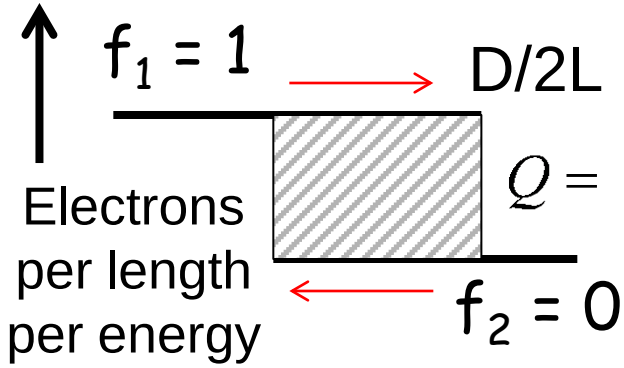


$$t = \frac{L}{\bar{v}}$$



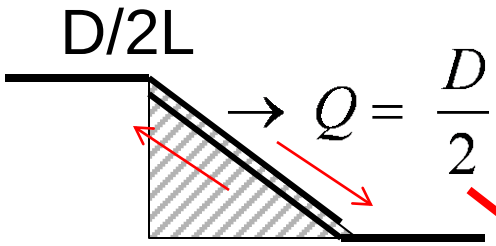
$$Q = I \times t$$

# of electrons in channel | *Electrons /second* | *Time in channel*

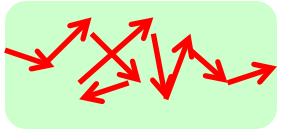


$$Q = \frac{D}{2}, \quad I = \frac{D}{2L}\bar{v}$$

# of PhD students | *PhD's /year* | *Time to PhD*



$$Q = \frac{D}{2}$$



$$t_D = \frac{L^2}{2\bar{D}} \qquad t_B = \frac{L}{\bar{v}}$$

$$\bar{D} = \left\langle v_z^2 \tau \right\rangle \qquad G = \frac{q^2 D}{2t}$$

$$I = -\bar{D}\frac{dn}{dz} = \bar{D}\frac{D}{L^2} \rightarrow t = \frac{Q}{I} = \frac{L^2}{2\bar{D}}$$

Berg: Random Walks in Biology, Princeton 1993

$$I/V = \int_{-\infty}^{+\infty} dE \left(-\frac{\partial f_0}{\partial E}\right) G(E)$$

$$G(E) = \frac{q^2 D}{2t} = \frac{G_B \lambda}{L+\lambda} \quad , \quad \lambda \equiv \frac{2\bar{D}}{\bar{\nu}}$$

$$\sigma A = G_B \lambda$$

$$\bar{\nu} = \langle |v_z| \rangle \quad , \quad \bar{D} = \langle v_z^2 \tau \rangle$$

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

Diffusive $\sigma = q^2 \bar{D} \frac{D}{AL}$

Coming up next ..