

FUNDAMENTALS OF NANO ELECTRONICS

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

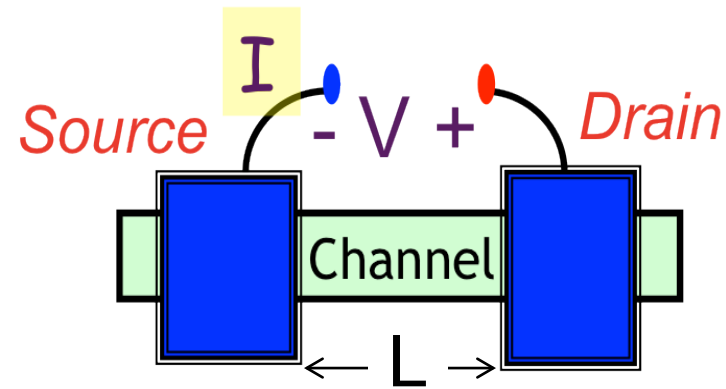
1.7. Connecting B to D

1.8. Angular Averaging

1.9. Drude Formula

1.10. Summing up ..

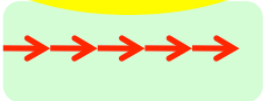
1.7a Connecting B to D



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

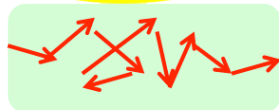
$$t = \frac{L}{\bar{v}} + \frac{L^2}{2\bar{D}}$$

Ballistic



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

Diffusive



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

$$= t_B \left(1 + \frac{L \bar{v}}{2\bar{D}} \right)$$

$$= t_B \left(1 + \frac{L}{\lambda} \right)$$

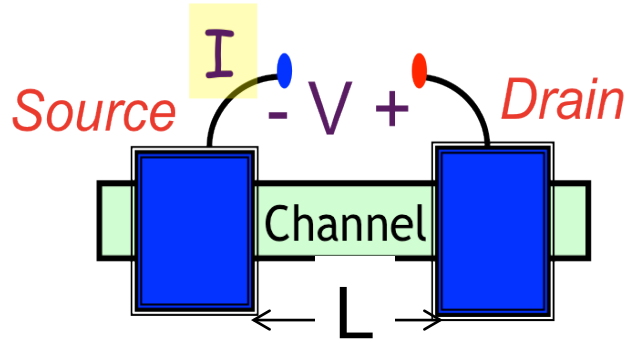
$$\text{where } \lambda \equiv \frac{2\bar{D}}{\bar{v}}$$

$$Q = I \times t$$

of
electrons
in channel

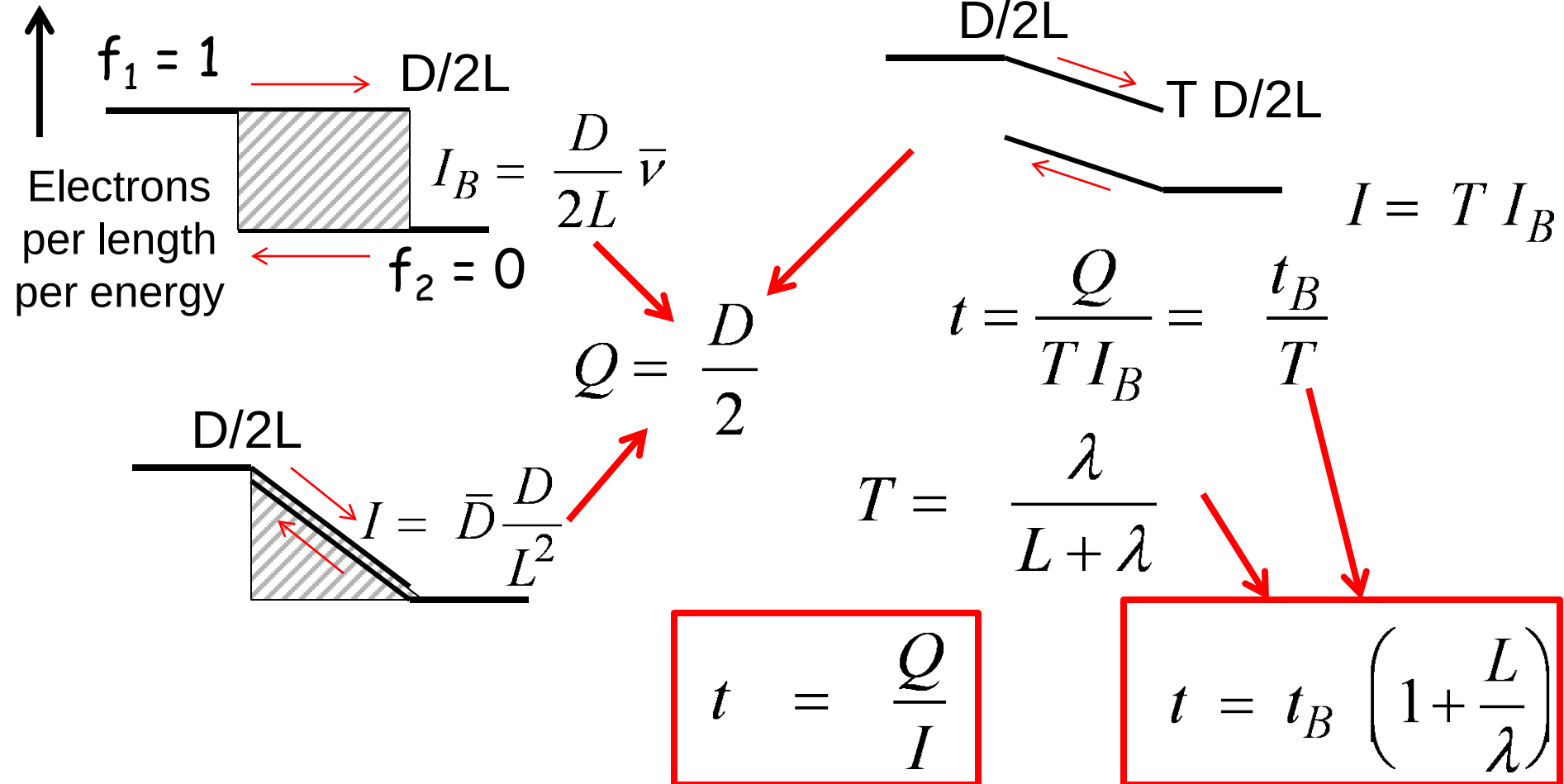
Electrons
/second

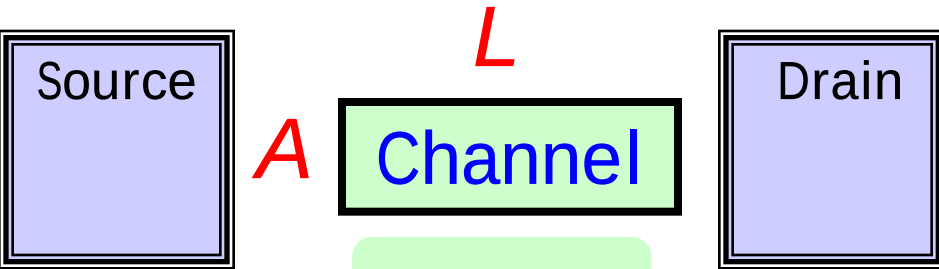
Time in
channel



1.7b Connecting B to D

T: Fraction of Electrons that make it from S to D





Ballistic

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

$$G = \frac{q^2 D}{2t} \rightarrow G_B = \frac{q^2 D \bar{v}}{2L}$$

General

$$G = \frac{G_B}{1 + \frac{L}{\lambda}} = \frac{G_B \lambda}{L + \lambda} \rightarrow \frac{\sigma A}{L + \lambda}$$

1.7c Connecting B to D

$$t = \frac{L}{\bar{v}} + \frac{L^2}{2\bar{D}}$$

$$= t_B \left(1 + \frac{L}{\lambda} \right)$$

where $\lambda \equiv \frac{2\bar{D}}{\bar{v}}$

$$\sigma A = G_B \lambda$$

Coming up next ..

$$G_B = q^2 \frac{D\bar{v}}{2L}, \quad \sigma = q^2 \frac{\bar{D}}{AL} D$$

Ballistic

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

Diffusive

$$G = \frac{\sigma A}{L + \lambda}, \quad \sigma = G_B \lambda, \quad \lambda \equiv \frac{2\bar{D}}{\bar{v}}$$

$$\bar{v} = \langle |\nu_z| \rangle$$

$$\bar{D} = \langle \nu_z^2 \tau \rangle$$

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