

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. Ballistic Conductance vs n

2.7. Conductivity vs n

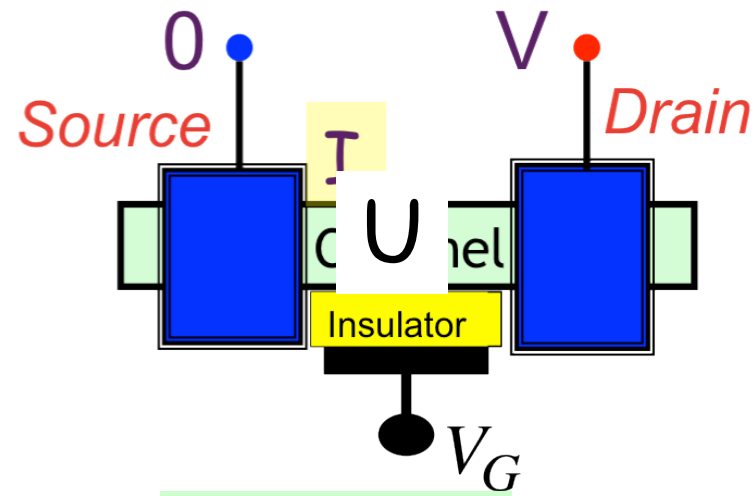
2.8. Quantum Capacitance

2.9. The Nanotransistor

2.10. Summing up ..



2.9a The nanotransistor



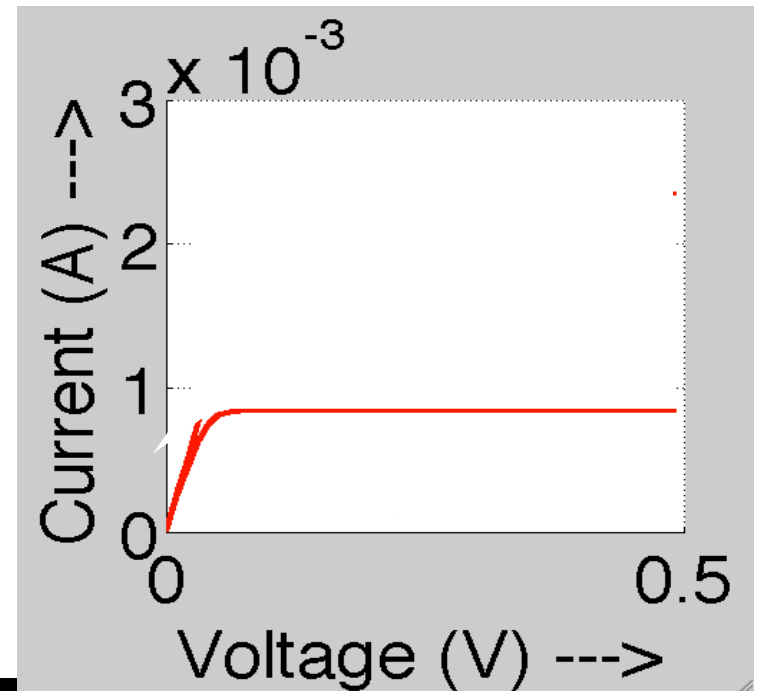
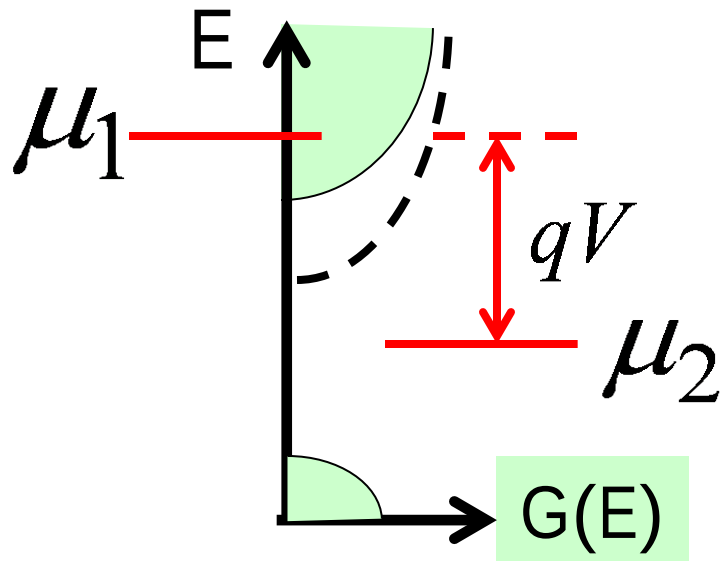
$$U = U_0(N - N_0) + \beta(-qV_G)$$

$$I =$$

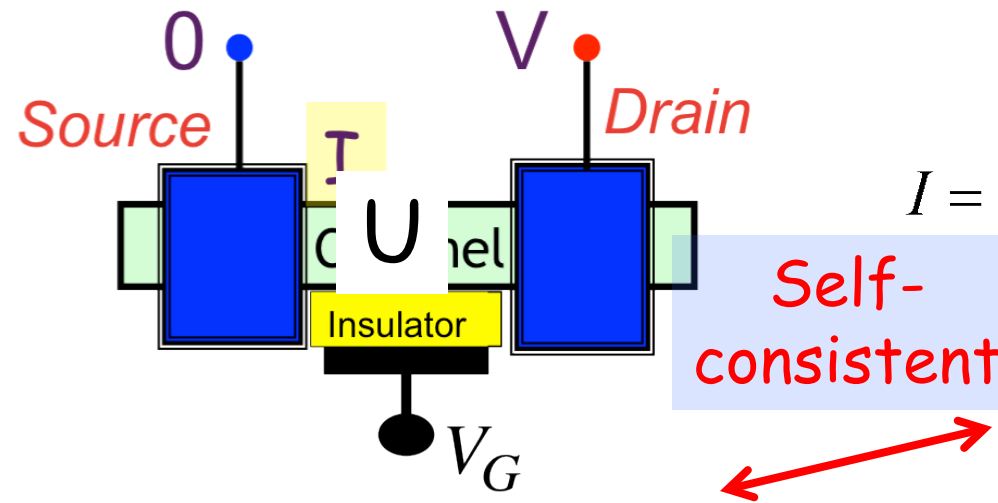
$$I = \frac{1}{q} \int_{-\infty}^{+\infty} dE G(E) (f_1(E) - f_2(E))$$

$$I = \frac{1}{q} \int_{-\infty}^{+\infty} dE G(E - U) (f_1(E) - f_2(E))$$

$$N = \int_{-\infty}^{+\infty} dE D(E - U) \frac{f_1(E) + f_2(E)}{2}$$



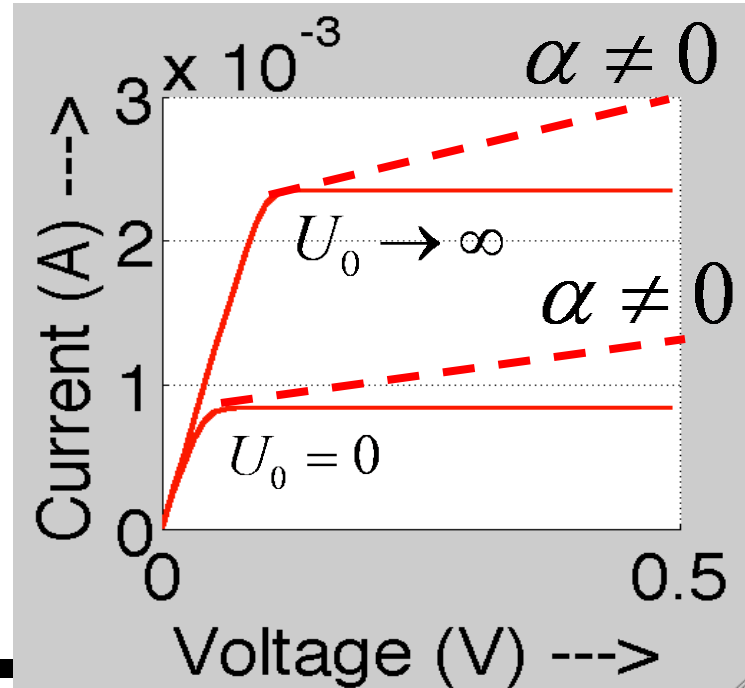
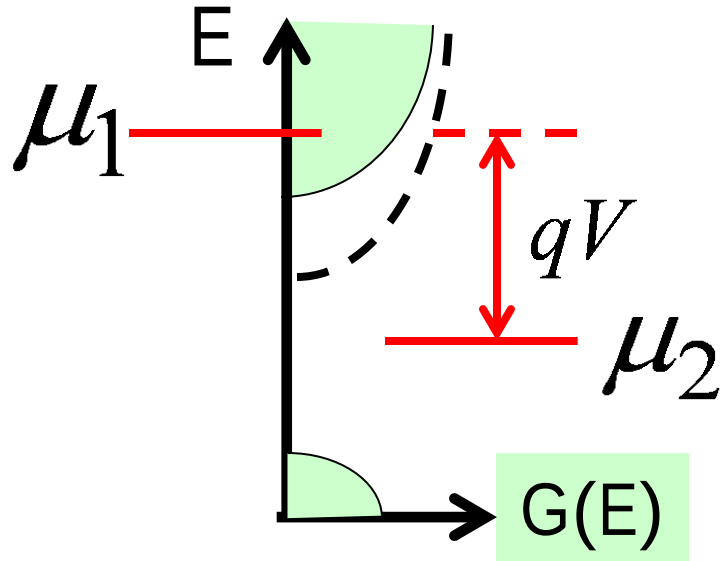
2.9b The nanotransistor



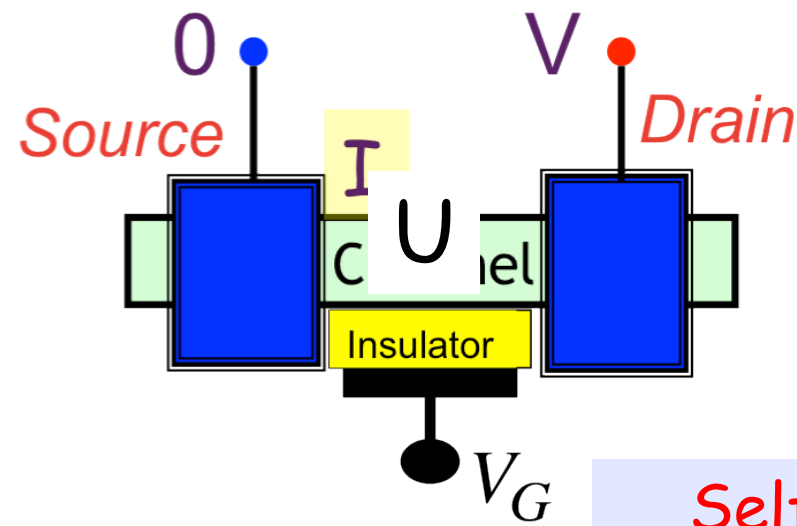
$$U = U_0(N - N_0) + \beta(-qV_G) + \alpha(-qV)$$

$$I = \frac{1}{q} \int_{-\infty}^{+\infty} dE G(E - U) (f_1(E) - f_2(E))$$

$$N = \int_{-\infty}^{+\infty} dE D(E - U) \frac{f_1(E) + f_2(E)}{2}$$



2.9c The nanotransistor



$$I = \frac{1}{q} \int_{-\infty}^{+\infty} dE G(E - U) (f_1(E) - f_2(E))$$

$$N = \int_{-\infty}^{+\infty} dE D(E - U) \frac{f_1(E) + f_2(E)}{2}$$

Self-consistent

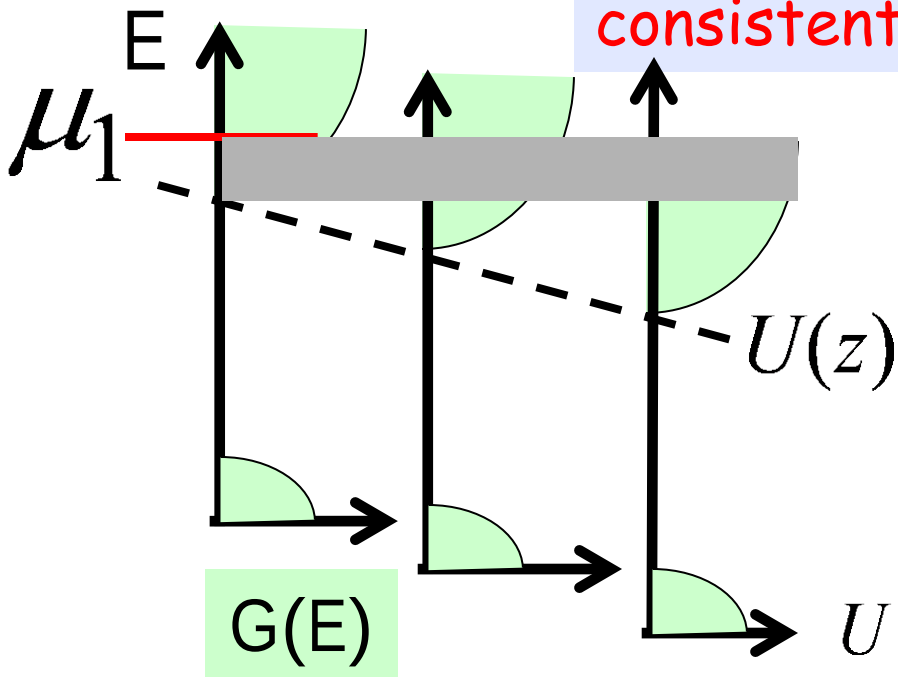
Drift
Diffusion
Equation

$$I = - \frac{\sigma(z)}{q} \frac{d\mu}{dz}$$

$$\frac{dI}{dz} = 0$$

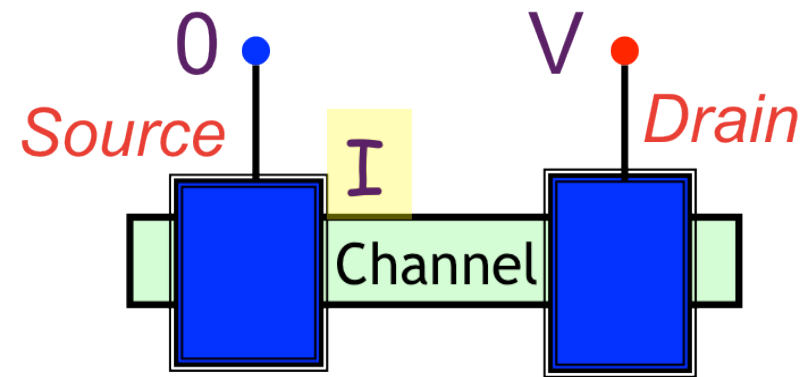
Poisson
Equation

$$\frac{d}{dz} \left(\epsilon \frac{dU}{dz} \right) = q^2 (n - n_0)$$



$$U = U_0(N - N_0) + \beta(-qV_G) + \alpha(-qV)$$

2.9d Summing up ..



$$I = \frac{1}{q} \int_{-\infty}^{+\infty} dE G(E - U) (f_1(E) - f_2(E))$$

$$\frac{R_B}{2} \quad R_B \frac{L}{\lambda} \quad \frac{R_B}{2}$$

Drift
Diffusion
Equation

$$I = - \frac{\sigma(z)}{q} \frac{d\mu}{dz}$$

$$\frac{dI}{dz} = 0$$

$$R = R_B \left(\frac{L + \lambda}{\lambda} \right) = R_B \frac{L}{\lambda} + R_B$$

Poisson
Equation

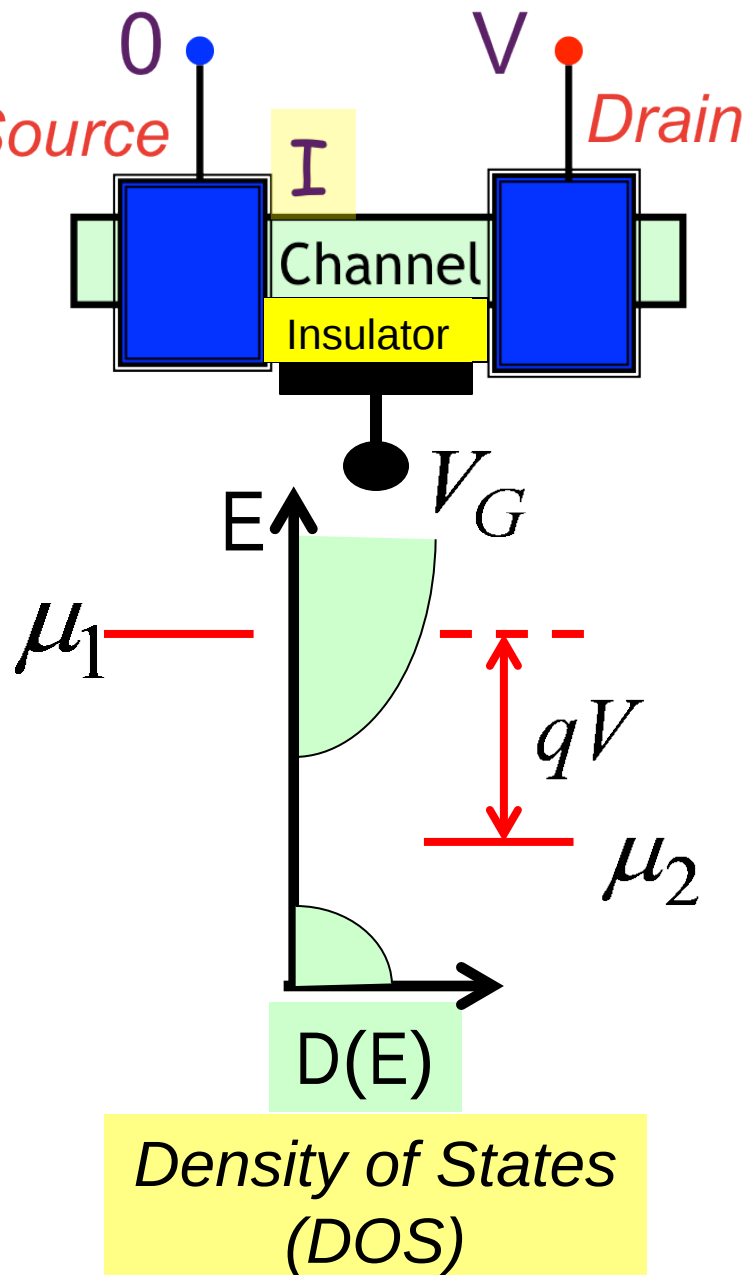
$$\frac{d}{dz} \left(\epsilon \frac{dU}{dz} \right) = q^2 (n - n_0)$$

↑

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

$$U = U_0(N - N_0) + \beta(-qV_G) + \alpha(-qV)$$

Coming up next ..



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- 2.5. Number of modes
- 2.6. Electron density (n)
- 2.7. Conductivity vs n
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