

FUNDAMENTALS OF NANO-ELECTRONICS

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

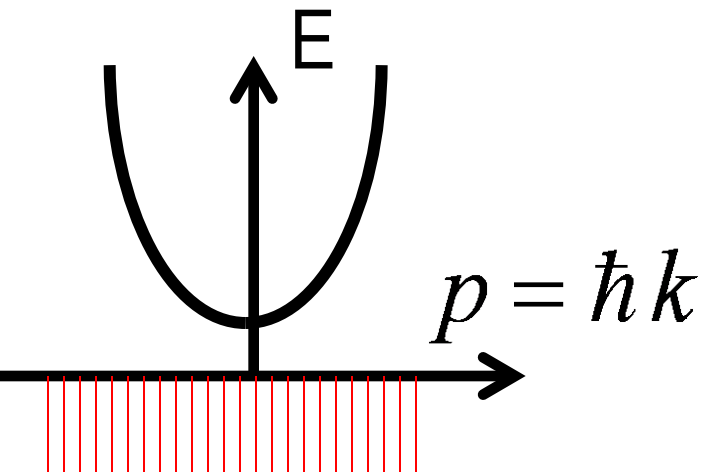
2.8. Quantum Capacitance

2.9. The Nanotransistor

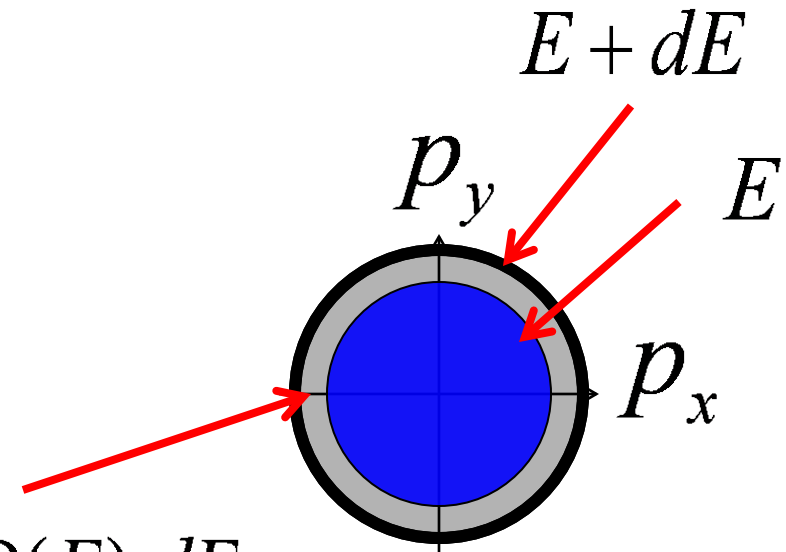
2.10. Summing up ..

2.4a Density of states

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



$$dN(E) = D(E) dE$$



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

The diagram shows a flow of information: a yellow box labeled $N(p)$ has a red arrow pointing down to a yellow box labeled $N(E)$. A red arrow points from the $N(E)$ box to the denominator dE in the equation $D(E) = \frac{dN(E)}{dE}$. A green box labeled $E(p)$ has a red arrow pointing down to the $N(E)$ box.

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

2.4b Density of states

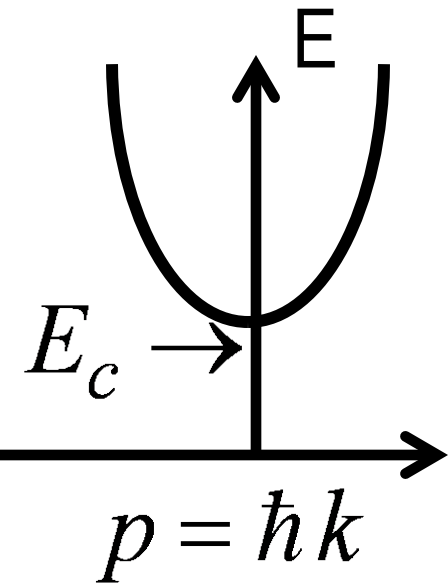
$$N(p) = A p^d$$

$$E(p) = E_c + B p^\alpha$$

$$N(E) = A \left(\frac{E - E_c}{B} \right)^{\frac{d}{\alpha}}$$

$$D(E) \sim (E - E_c)^{\frac{d}{\alpha} - 1}$$

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



$N(p)$

$E(p)$

$N(E)$

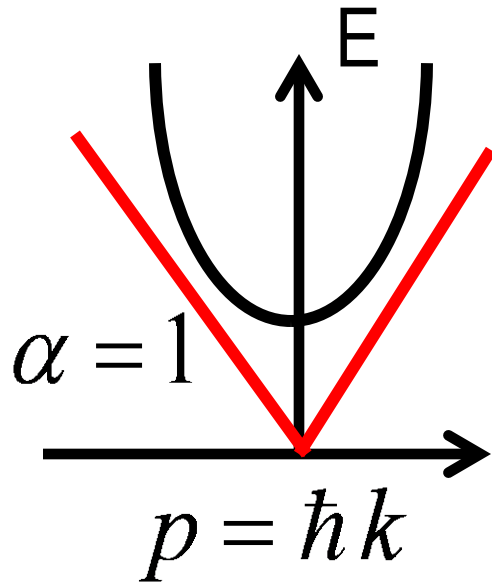
2.4c Density of states

$$N(p) = A p^d$$

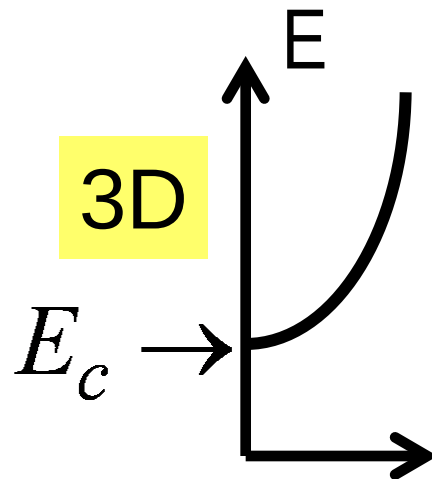
$$E(p) = E_c + B p^\alpha$$

$$D(E) \sim (E - E_c)^{\frac{d}{\alpha} - 1}$$

$$E(p) = \sqrt{E_g^2 + v_0^2 p^2}$$

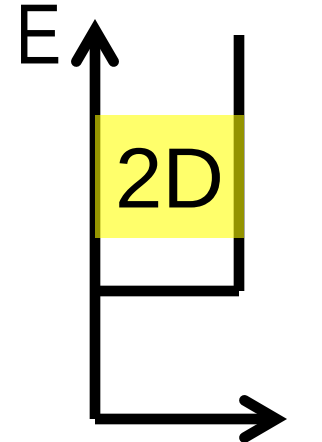


$$\alpha = 2$$

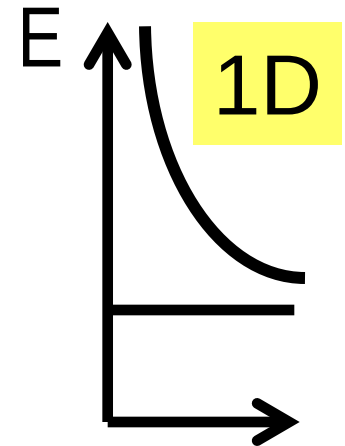


$$D(E)$$

$$\sim \sqrt{E - E_c}$$



$$D(E)$$



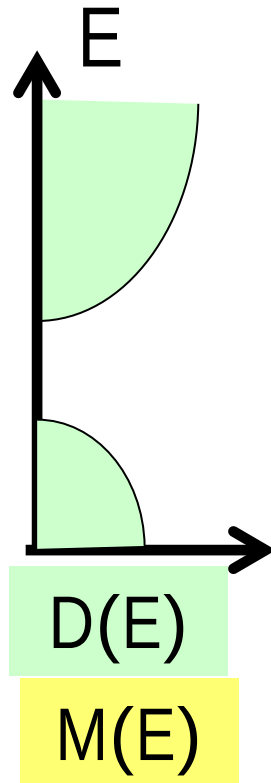
$$D(E)$$

$$\sim \frac{1}{\sqrt{E - E_c}}$$

Coming up next ..

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

$E(p)$



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