ECE 495N

Fundamentals of Nanoelectronics

Fall 2008

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Lecture: 30
Title: Diffusive and Coherence Transport
Date: November 12, 2008

Video Lectures posted at:
https://www.nanohub.org/resources/5346/

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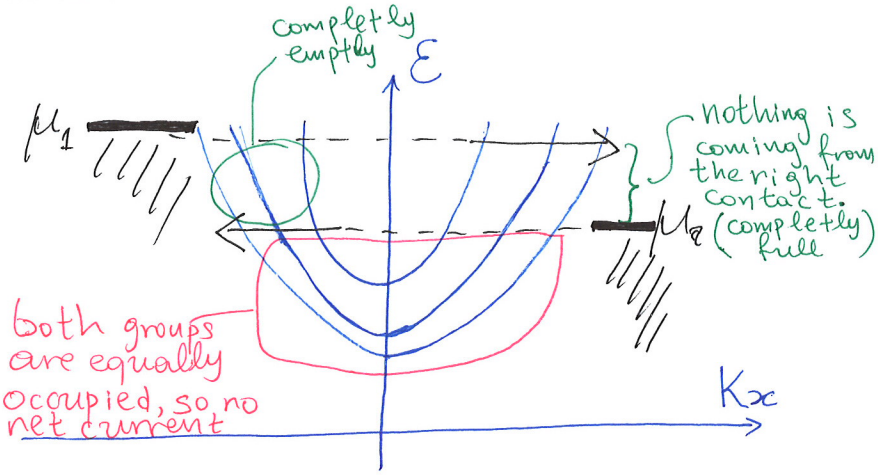
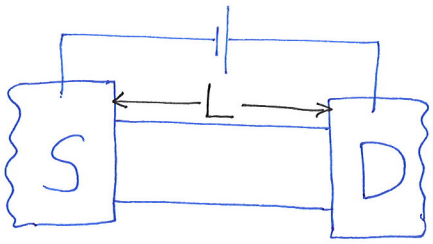
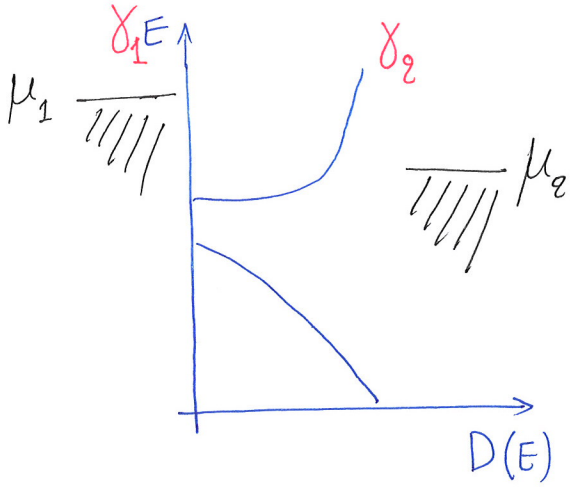
Diffusive and Coherent Transport

Lecture 30

Nov. 12, 2008



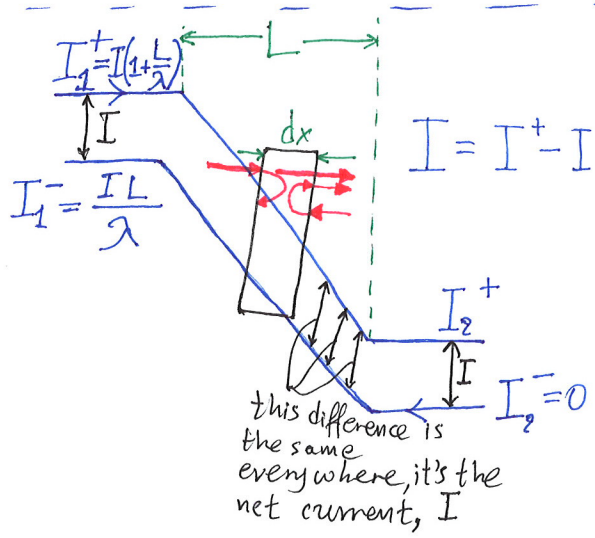




$$I = \frac{q}{h}\int dE \cdot \overbrace{\pi \underbrace{D\gamma}_{\frac{\hbar U_x}{L}}}^{M} (f_1 - f_2)$$

$$N = \int dE \, \frac{D}{2}(f_1 + f_2)$$

$$I^+ = \frac{q}{h} M \cdot qV$$ ← ballistic transport



$$I = I^+ - I^-$$

$$dI^+ = \left(-I^+ + I^-\right)\frac{dx}{\lambda}$$

$$\Rightarrow \boxed{\frac{dI^+}{dx} = -\frac{I}{\lambda} = \frac{dI^-}{dx}}$$

$$\underbrace{\frac{I}{V}}_{\text{conductance}} = \underbrace{\frac{q^2}{h} M}_{\text{ballistic conductance}} \frac{\lambda}{L+\lambda}$$

So the current is:

$$I = \frac{q}{h}\int dE \cdot \overbrace{\pi D \gamma}^{M} \frac{\lambda}{L+\lambda}\left(f_1 - f_2\right)$$

$$N = \int dE \frac{D}{2}\left(f_1 + f_2\right)$$

$$\frac{dI^+}{dx} = \frac{dI^-}{dx} = -\frac{I}{\lambda} \Rightarrow \frac{d}{dx}\left[I^+ + I^-\right] = -\frac{2I}{\lambda}$$

$$I^+ = q n^+ v$$

$$I^- = q n^- v$$

$$\Rightarrow \frac{d}{dx}\left[q(n^+ + n^-)v\right] = -\frac{2I}{\lambda} \Rightarrow q v \frac{dn}{dx} = -\frac{2I}{\lambda}$$

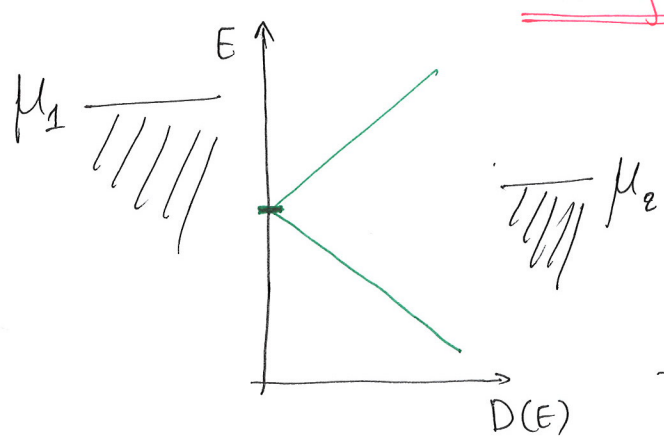
$$\Rightarrow \boxed{I = -q \frac{v\lambda}{2} \frac{dn}{dx}}$$

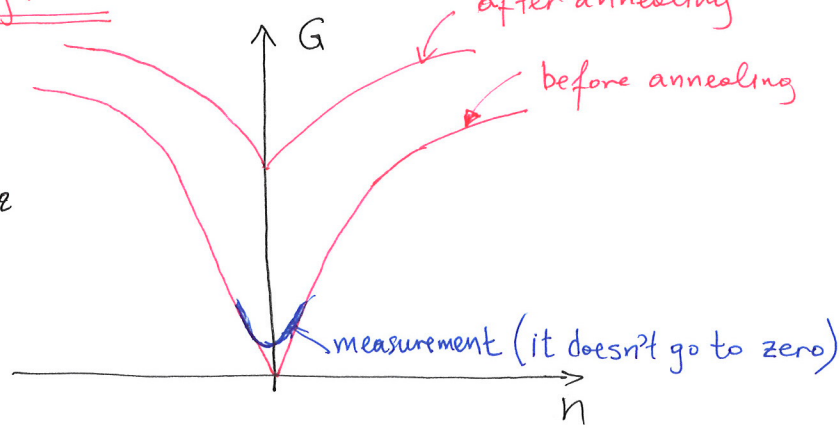
D (diffusion coefficient)

Standard Diffusion Equation

$$I = -qD\frac{dn}{dx}$$

Grafine



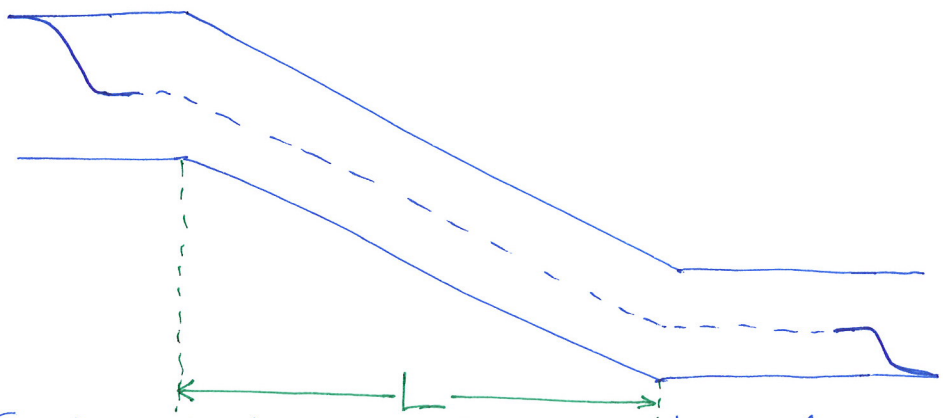


If we look at the overall conductance it look like:

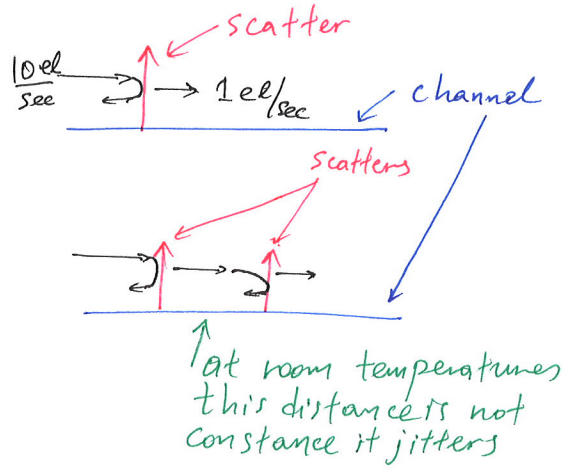
$$G = \frac{q^2}{h} M \frac{\lambda}{L+\lambda}$$

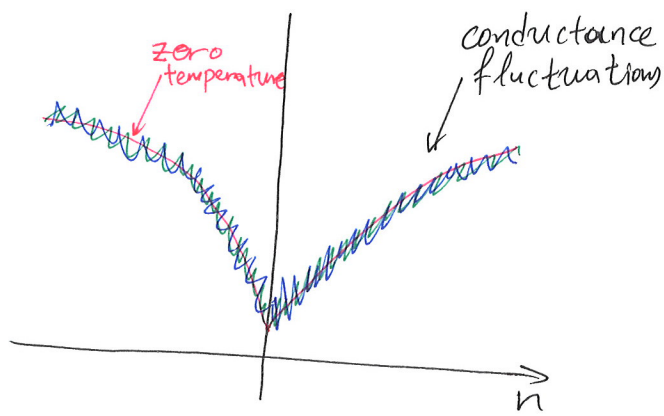
this part follows Ohm's Law

$$\Rightarrow R = \frac{1}{G} = \underbrace{\frac{h}{q^2}\frac{1}{M}}_{\text{Ballistic Resistor}}\left(1 + \frac{L}{\lambda}\right)$$



Good contact means: large number of modes.
Electrons are also waves which means that there is interference.





Normally we don't have to worry for the fluctuations because all of it interference washes out, either the jiggling around or the average.