ECE 495N
Fundamentals of Nanoelectronics
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Lecture: 30
Title: Diffusive and Coherence Transport
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Video Lectures posted at:
https://www.nanohub.org/resources/5346/

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Diffusive and Coherent Transport

Lecture 30

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\[ I = \frac{q}{h} \int dE \cdot \pi D \mu \left( f_1 - f_2 \right) \]

\[ N = \int dE \frac{D}{\epsilon} \left( \frac{1}{f_1} + \frac{1}{f_2} \right) \]

\[ I^+ = \frac{q}{h} M \cdot q V \quad \text{ballistic transport} \]

\[ \frac{dI^+}{dx} = - \frac{I}{\lambda} \quad \Rightarrow \quad \frac{dI^+}{dx} = - \frac{I}{\lambda} = \frac{dI^-}{dx} \]

\[ \frac{I}{V} = \frac{q^2}{h} \frac{M \lambda}{L + \lambda} \quad \text{(ballistic conductance)} \]
So the current is:

\[ I = \frac{q}{h} \int dE \cdot \pi D \frac{1}{L + \lambda} (f_1 - f_2) \]

\[ N = \int dE \frac{D}{\varepsilon} (f_1 + f_2) \]

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

\[ I^+ = q n^+ u \]

\[ I^- = q n^- u \]

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

\[ \Rightarrow I = -q \left( \frac{U_2}{2} \right) \frac{dn}{dx} \]

\[ D \text{ (diffusion coefficient)} \]

\[ \text{Standard Diffusion Equation} \]

\[ I = -q D \frac{dn}{dx} \]

\[ \frac{dI}{dx} \]

\[ \frac{d\mu}{dE} \]

\[ G \]

\[ \text{measurement (it doesn't go to zero)} \]
If we look at the overall conductance it looks like:

\[ G = \frac{q^2}{h} M \frac{\Delta}{L+\Delta} \]

\[ \Rightarrow R = \frac{1}{G} = \frac{h}{q^2} \frac{1}{M} \left(1 + \frac{L}{\Delta}\right) \]

\[ \text{Ballistic resistor} \]

this part follows Ohm's Law

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.