ECE 659 Quantum Transport: Atom to Transistor

Lecture 20: Summary
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$G = \frac{\sigma A}{L}$

$\sigma = q n \frac{q \tau}{m}$

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

$\sigma = q^2 \int dE \left( -\frac{\partial f}{\partial E} \right) \frac{D(E) v^2 \tau}{AL} \frac{d}{d}$

$f = f_0 + \left( -\frac{\partial f}{\partial E} \right) \mu$

Drift diffusion

Boltzmann Equation

NEGF
\[ R_2 = 2R_1 \quad \text{Drift diffusion} \]

\[ R_2 > R_1 \quad \text{Boltzmann Equation} \]

\[ \frac{d\bar{x}}{dt} = \frac{1}{\hbar} \nabla_{\bar{k}} E \]

\[ \hbar \frac{d\bar{k}}{dt} = \nabla E \]

\[ i\hbar \frac{d\psi}{dt} = H\psi \]

\[ i\hbar \frac{d\{\psi\}}{dt} = [H]\{\psi\} \]

\[ \sin ka \approx ka \quad \cos ka \approx 1 - \frac{k^2a^2}{2} \]

\[ \mu_1 \quad \mu_2 \quad \Rightarrow \begin{bmatrix} \varepsilon & t \\ t & \varepsilon \end{bmatrix} \]

\[ i\hbar \frac{d\psi}{dt} = \frac{H}{H+U} \psi + \Sigma \psi + s \]
\[ \Sigma_s = DG \]
\[ G = [EI - H - \Sigma - DG]^{-1} \]

\[ E = \varepsilon - 2t \cos \frac{ka}{\sqrt{1 - \frac{a^2}{k^2}}} \]
\[ E = (\varepsilon - 2t) + ta^2 k^2 \]

In 2-D
\[ E = \varepsilon - 2t \cos k_x a - 2t \cos k_y a \]
\[ = (\varepsilon - 4t) - ta^2 (k_x^2 + k_y^2) \]

\[ \Sigma = \tau g \tau^+ \]
\[ \begin{bmatrix} EI - \alpha & -\beta \\ -\beta^+ & EI - \alpha & -\beta \\ \end{bmatrix} \]

\[ \alpha = \begin{bmatrix} 4t & -t \\ -t & 4t \\ \end{bmatrix} \]

\[ \beta = \begin{bmatrix} -t \\ -t \\ \end{bmatrix} \]

\[ [V, D] = \text{eig}(\alpha) \]
\[ D = V^+ \alpha V \]

\[ \begin{bmatrix} -te^{ik_x a} \\ -te^{ik_y a} \\ \end{bmatrix} \]