ECE 659 Quantum Transport: Atom to Transistor

Lecture 18: NEGF Equations

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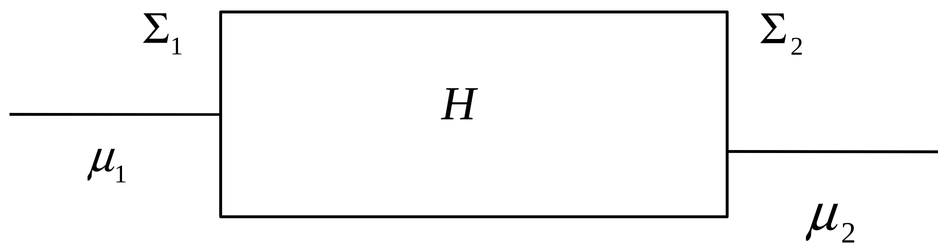
Notes prepared by Samiran Ganguly

$$G = \left[EI - H - \Sigma\right]^{-1}$$

$$G^n = G\Sigma^{in}G^+$$



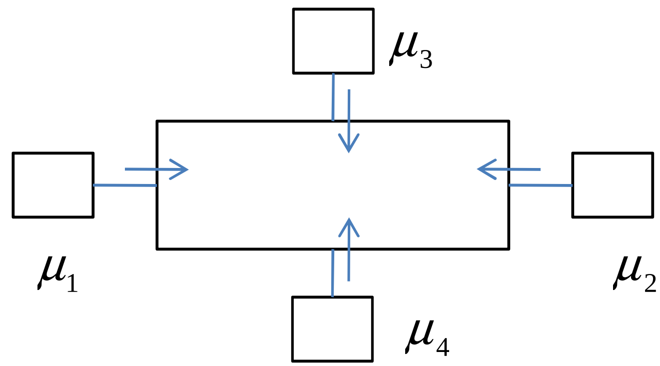
$$\begin{aligned} i\hbar I_{op} &= Trace\left[HG^n - G^nH\right] \\ &\quad + \left[\Sigma G^n - G^n\Sigma^+\right] \\ &\quad + \left[\Sigma^{in}G^+ - G\Sigma^{in}\right] \end{aligned}$$

$$E\psi = H\psi + \Sigma\psi + s$$

$$G^n = 2\pi\psi\psi^+$$

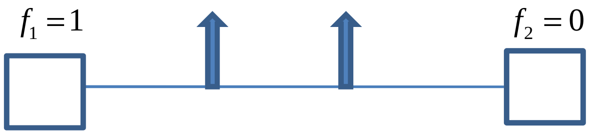
$$\begin{aligned} \Sigma_j^{in} &= 2\pi s_j s_j^+ \\ &= \Gamma_j f_j \end{aligned}$$

$$I_i = \frac{q}{h} Trace\left[\Sigma_i^{in}A - \Gamma_i G^n\right]$$

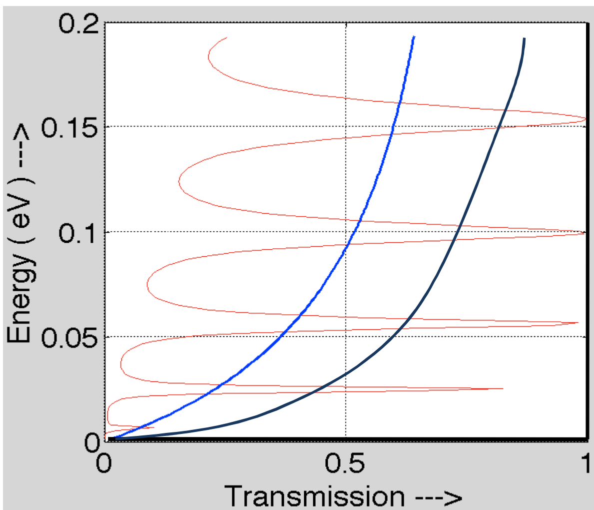


$$\begin{Bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \end{Bmatrix} = \begin{bmatrix} . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \end{bmatrix} \begin{Bmatrix} f_1 \\ f_2 \\ f_3 \\ f_4 \end{Bmatrix}$$

Phase breaking processes:



$$\frac{\lambda}{\lambda + L}$$



$$\Sigma_s^{in} \neq \Gamma_s f_s$$

This is because channel is in general not in equilibrium and the carriers are not distributed as per Fermi function

$$E\psi = H\psi + \Sigma\psi + s + U\psi$$

$$\Sigma_s^{in} = 2\pi UU^* \psi\psi^+ = DG^n$$

$$G^n = G\left[\Sigma^{in} + DG^n\right]G^+$$

$$G = \left[EI - H - \Sigma - \Sigma_s\right]^{-1}$$

$$\Sigma_s = DG$$

$$G = \left[EI - H - \Sigma - DG\right]^{-1}$$

These equations need to be solved self consistently

Current from the scattering terminal:

$$\Sigma_s G^n - G^n \Sigma_s^+ + \underbrace{\Sigma_s^{in}}_{DG^n} G^+ - G\Sigma_s^{in} = 0$$

$$\therefore \Sigma_s = DG$$

D can be thought of as the RMS value of the potential due to phase breaking processes