

ECE 659 Quantum Transport: Atom to Transistor

Lecture 15: Coherent Transport II

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$$\Sigma = \Sigma_1 + \Sigma_2$$

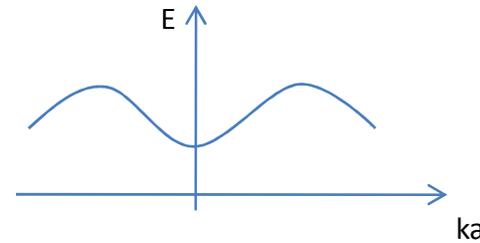
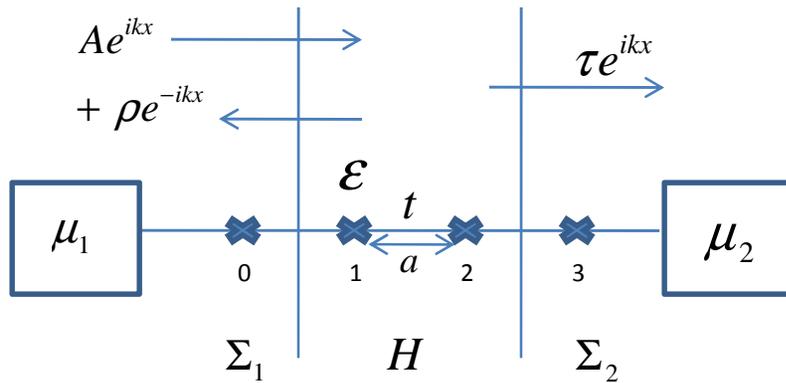
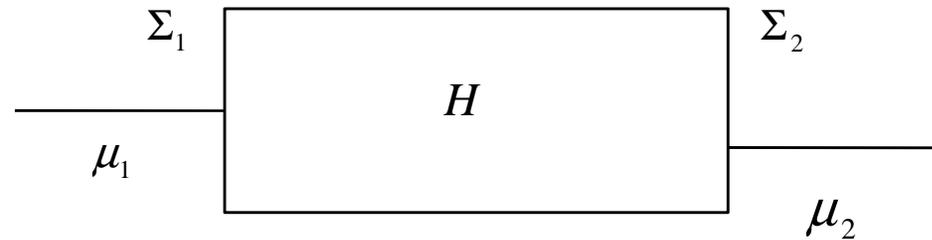
$$\Gamma = i[\Sigma - \Sigma^+]$$

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

$$A = i[G - G^+]$$

$$G^n = [G\Gamma_1 G^+] f_1 + [G\Gamma_2 G^+] f_2$$

$$I_i = \frac{q}{h} \text{Trace}([\Gamma_i A] f_i - [\Gamma_i G^n])$$



$$E = \epsilon - 2t \cos ka$$

$$E\psi_1 = \epsilon\psi_1 - t\psi_2 - t\psi_0$$

$$E\psi_2 = \epsilon\psi_2 - t\psi_1 - t\psi_3$$

$$\psi_2 = \tau e^{ik2a}$$

$$\psi_3 = \tau e^{ik3a}$$

$$\psi_3 = \psi_2 e^{ika}$$

$$\psi_0 = A + \rho$$

$$\psi_1 = Ae^{ika} + \rho e^{-ika}$$

$$\therefore \psi_0 = e^{ika} \psi_1 + A(1 - e^{2ika})$$

The second term can be thought of as a source term

$$[EI - H - \Sigma]\psi = s$$

$$E\psi_1 = \varepsilon\psi_1 - t\psi_2 - t(e^{ika}\psi_1 + A(1 - e^{2ika}))$$

$$E\psi_2 = -t\psi_1 + \varepsilon\psi_2 - t\psi_2 e^{ika}$$

$$E \begin{Bmatrix} \psi_1 \\ \psi_2 \end{Bmatrix} = \begin{bmatrix} \varepsilon & -t \\ -t & \varepsilon \end{bmatrix} \begin{Bmatrix} \psi_1 \\ \psi_2 \end{Bmatrix} + \begin{bmatrix} -te^{ika} & 0 \\ 0 & -te^{ika} \end{bmatrix} \begin{Bmatrix} \psi_1 \\ \psi_2 \end{Bmatrix} + \begin{Bmatrix} -tA(1 - e^{2ika}) \\ 0 \end{Bmatrix}$$

$$\Sigma_1 = \begin{bmatrix} -te^{ika} & 0 \\ 0 & 0 \end{bmatrix}$$

$$\Sigma_2 = \begin{bmatrix} 0 & 0 \\ 0 & -te^{ika} \end{bmatrix}$$

$$s_1 = -tA(1 - e^{2ika})$$

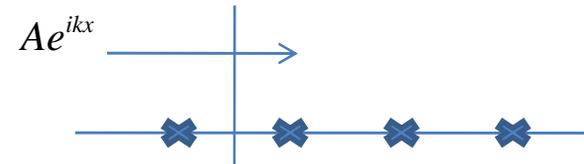
$$= tAe^{ika}(e^{+ika} - e^{-ika})$$

$$|s_1|^2 = |A|^2 (2t \sin ka)^2$$

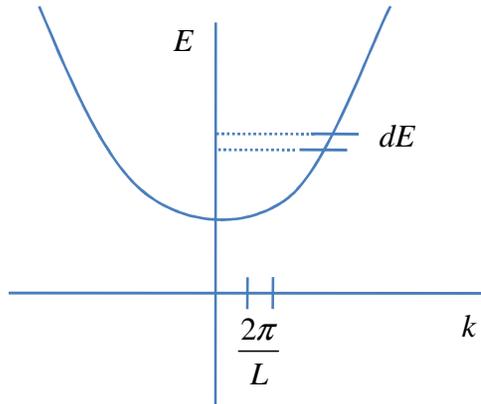
$$E(k) = \varepsilon - 2t \cos ka$$

$$\hbar v(k) = \frac{dE}{dk} = 2ta \sin ka$$

$$|s_1|^2 = |A|^2 \left(\frac{\hbar v}{a} \right)^2$$



$$|A|^2 = dE \frac{D(E)}{2} f_1(E)$$



$$\frac{dk}{2\pi} = dE \frac{L}{2\pi \underbrace{\frac{dE}{dk}}_{\hbar v}}$$

$$|A|^2 = dE f_1(E) \frac{a}{2\pi \hbar v}$$

$$|s_1|^2 = \frac{dE}{2\pi} f_1(E) \left(\frac{\hbar v}{a} \right)$$

$$\Sigma_1 = -te^{ika}$$

$$\Gamma_1 = i(-te^{ika} + te^{-ika})$$

$$= 2t \sin ka$$

$$= \frac{\hbar v}{a}$$