FUNDAMENTALS OF NANOELECTRONICS

B. Quantum Transport

1. Schrodinger Equation

Contact-ing Schrodinger

3. Advanced Examples

4. Spin Transport

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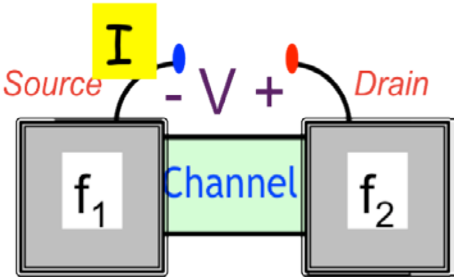
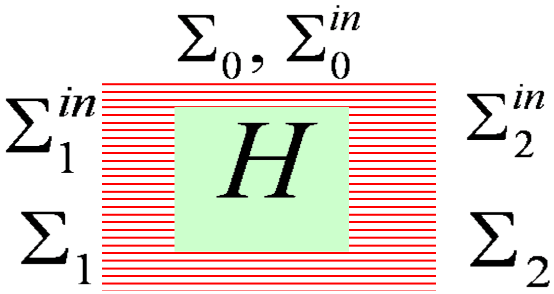
http://nanohub.org/groups/lnebook

2.9a Dephasing



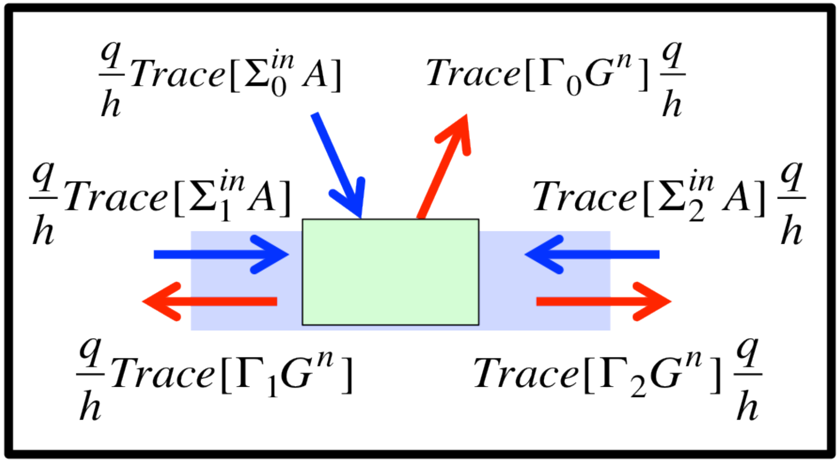
$$G^R = [EI - H - \Sigma_1 - \Sigma_2 - \Sigma_0]^{-1}$$



$$G^n = G^R (\Sigma_1^{in} + \Sigma_2^{in} + \Sigma_0^{in})\, G^A$$

$$\Sigma_1^{in} = \Gamma_1 f_1(E)$$

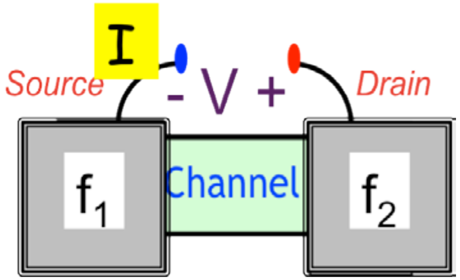
$$\Sigma_2^{in} = \Gamma_2 f_2(E)$$

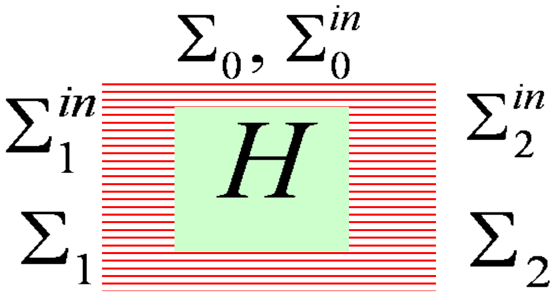


For the dephasing contact

$$Trace[\Sigma_0^{in} A] = Trace[\Gamma_0 G^n]$$

2.9b Dephasing





$$G^R = [EI - H - \Sigma_1 - \Sigma_2 - \Sigma_0]^{-1}$$

$$\Sigma_0 = d_0\, G^R \qquad [\Gamma_0] = i\,[\Sigma_0 - \Sigma_0^+]$$

$$= d_0\, i[G^R - G^A] \quad = d_0\,[A]$$

$$\boxed{Trace\,[\Gamma_0 G^n] = d_0\; Trace\,[A G^n]}$$

$$\Sigma_1^{in} = \Gamma_1\, f_1(E)$$

$$\Sigma_2^{in} = \Gamma_2\, f_2(E)$$

$$G^n = G^R\,(\Sigma_1^{in} + \Sigma_2^{in} + \Sigma_0^{in})\,G^A$$

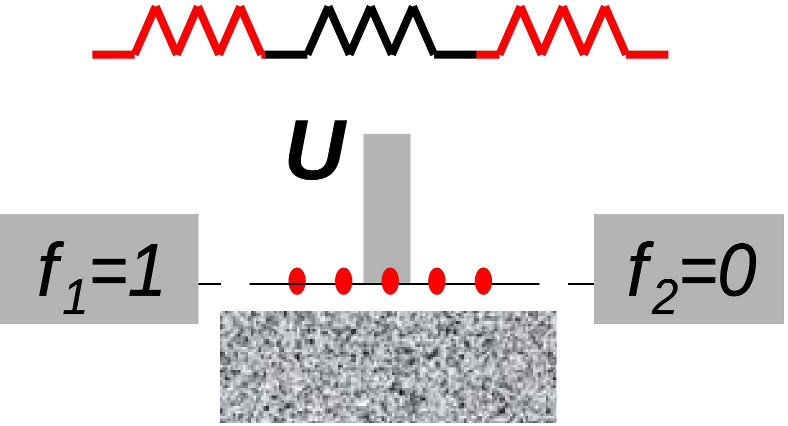
$$\Sigma_0^{in} = d_0\, G^n$$

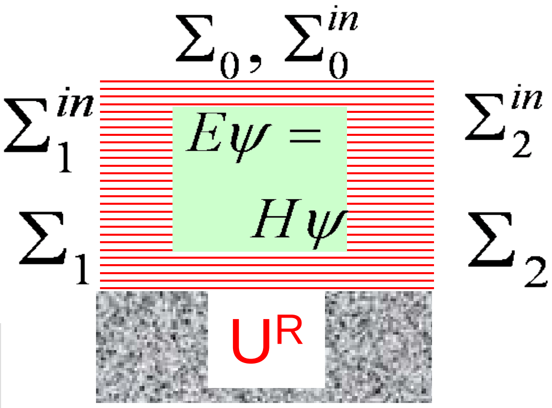
For the dephasing contact

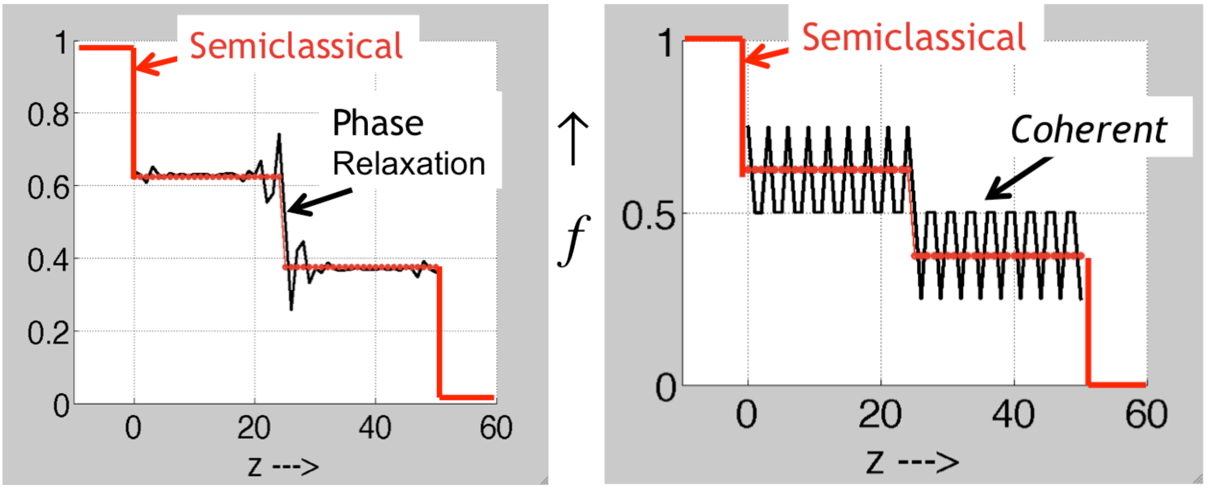
$$\boxed{Trace[\Sigma_0^{in} A] = d_0\; Trace\,[G^n A]}$$

$$Trace\,[\Sigma_0^{in} A] = Trace\,[\Gamma_0 G^n]$$

2.9c Dephasing







$$s = U^R \psi$$

$$ss^+ = U^R \, \psi\psi^+ \, U^R$$

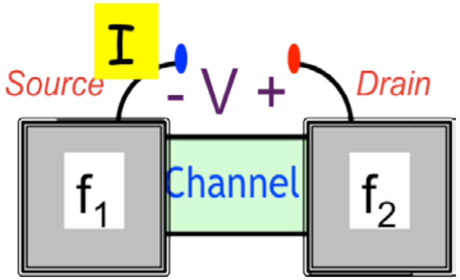
$$\frac{\Sigma_0^{in}}{2\pi} \qquad \frac{G^n}{2\pi}$$

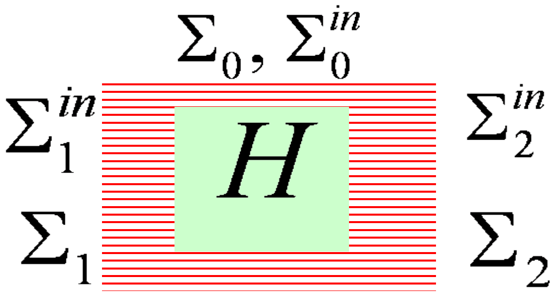
$$\Sigma_0 = d_0 \, G^R$$

$$\Sigma_0^{in} = d_0 \, G^n$$

$$d_0 = \langle U^R \, U^R \rangle$$

2.9d Dephasing





$$[\Sigma_0]_{ij} = D_{ij}\,[G^R]_{ij} \quad \rightarrow \quad [\Gamma_0]_{ij} = D_{ij}\,[A]_{ij}$$

$$Trace\,[\Gamma_0 G^n] = \sum_{i,j} [\Gamma_0]_{ij}\,[G^n]_{ji}$$

$$\boxed{= \sum_{i,j} D_{ij}\,[A]_{ij}\,[G^n]_{ji}}$$

$$\Sigma_1^{in} = \Gamma_1\, f_1(E)$$

$$\Sigma_2^{in} = \Gamma_2\, f_2(E)$$

$$[\Sigma_0^{in}]_{ji} = D_{ji}\,[G^n]_{ji}$$

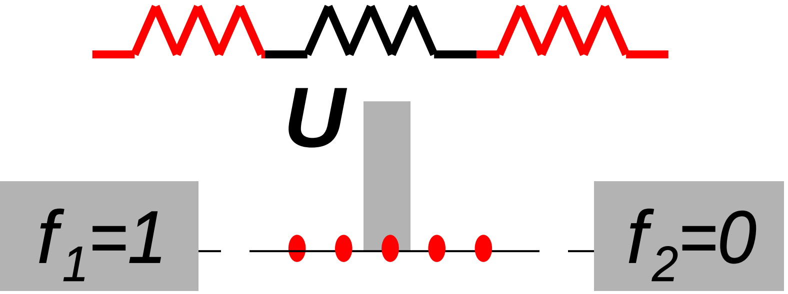
$$Trace\,[\Sigma_0^{in} A] = \sum_{i,j} [\Sigma_0^{in}]_{ji}\,[A]_{ij}$$

$$\boxed{= \sum_{i,j} D_{ji}\,[A]_{ij}\,[G^n]_{ji}}$$

For the dephasing contact

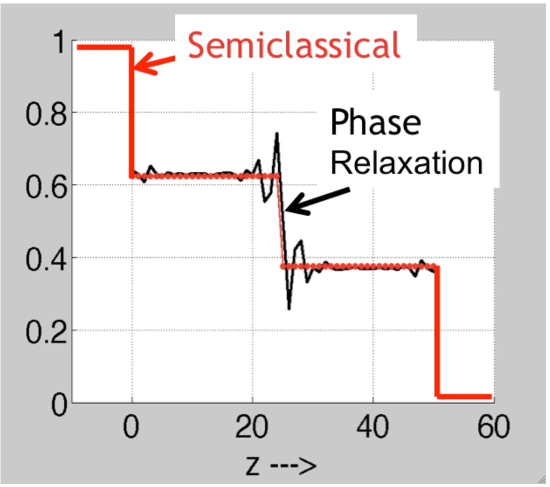
$$Trace\,[\Sigma_0^{in} A] = Trace\,[\Gamma_0 G^n]$$

2.9e Dephasing



$$[\Sigma_0]_{ij} = D_{ij}\,[G^R]_{ij}$$

$$[\Sigma_0^{in}]_{ij} = D_{ij}\,[G^n]_{ij}$$



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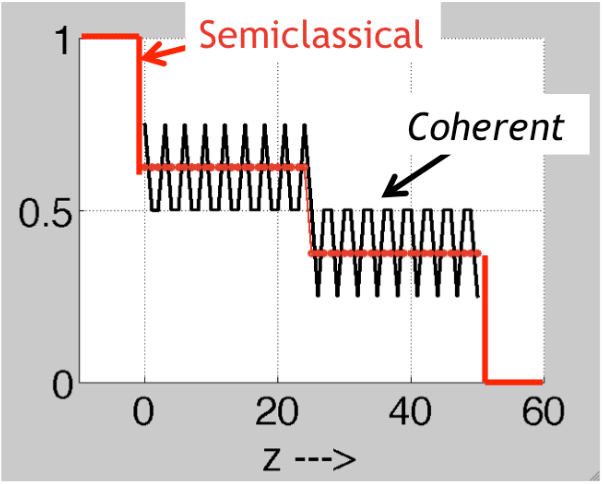
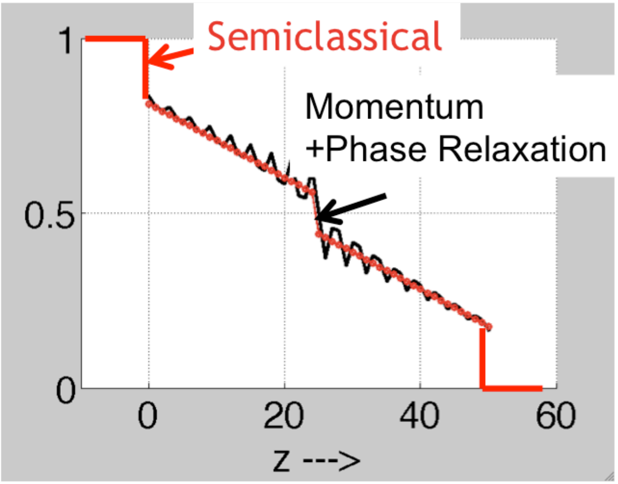


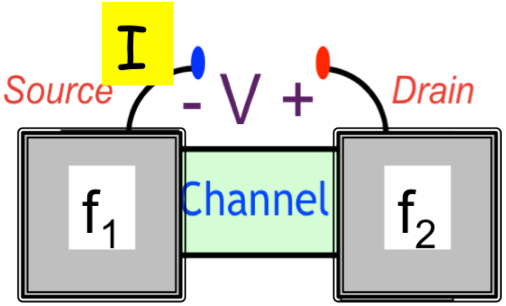


$$D = d_0 \begin{bmatrix} 1 & 1 & 1 & \cdots \\ 1 & 1 & 1 & \cdots \\ 1 & 1 & 1 & \cdots \\ & \cdots & \cdots & \end{bmatrix}$$

$$D_{ij} = \left\langle U_i^R U_j^R \right\rangle$$

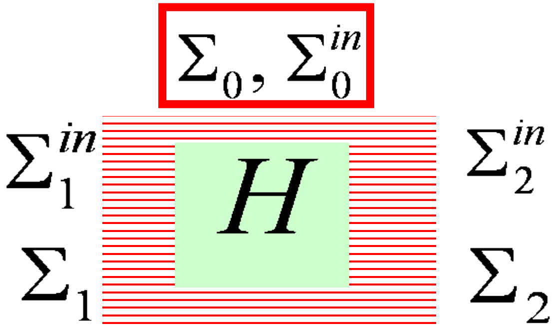
$$s = U^R \psi$$

$$D = d_0 \begin{bmatrix} 1 & 0 & 0 & \cdots \\ 0 & 1 & 0 & \cdots \\ 0 & 0 & 1 & \cdots \\ & \cdots & \cdots & \end{bmatrix}$$



$$[\Sigma_0]_{ij} = D_{ij}\,[G^R]_{ij}$$

$$[\Sigma_0^{in}]_{ij} = D_{ij}\,[G^n]_{ij}$$



$$[\Sigma_0]_{ij} = \sum_{k,l} D_{ijkl}\, G^R_{kl}$$

$$[\Sigma_0^{in}]_{ij} = \sum_{k,l} D_{ijkl}\, G^n_{kl}$$

For the dephasing contact

$$Trace\,[\Sigma_0^{in} A] = Trace[\Gamma_0 G^n]$$

Coming up next ..