FUNDAMENTALS OF NANOELECTRONICS

B. Quantum Transport

1. Schrodinger Equation
2. Contact-ing Schrodinger

More Examples →

4. Spin Transport

3.1. Introduction

3.2. Quantum Point Contact

3.3. Self-Energy

3.4. Surface Green's Function

3.5. Graphene

3.6. Magnetic Field

3.7. Golden Rule

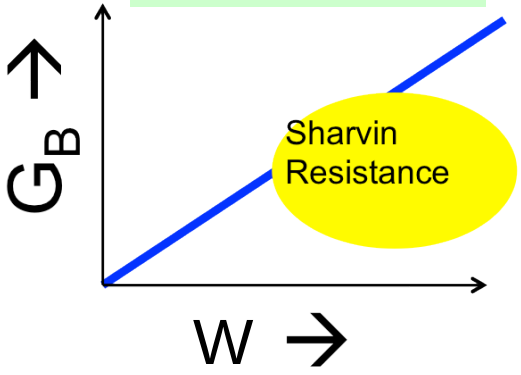
3.8. Inelastic Scattering

3.9. Can NEGF Include Everything?

3.10. Summing up ..

Part A, 1.5

3.2a Quantum Point Contact



VOLUME 60, NUMBER 9 PHYSICAL REVIEW LETTERS 29 FEBRUARY 1988

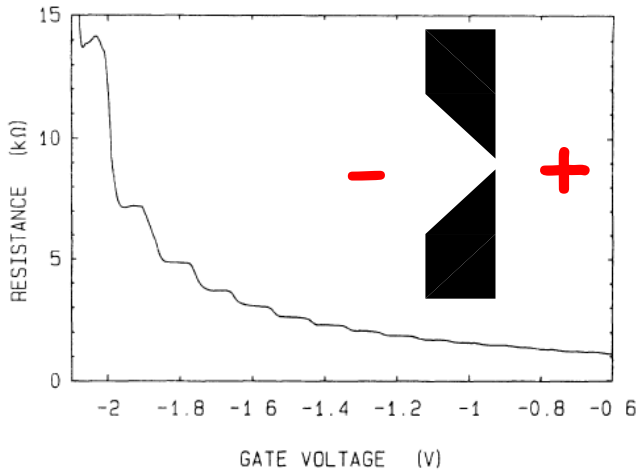


FIG. 1. Point-contact resistance as a function of gate voltage at 0.6 K. Inset: Point-contact layout.

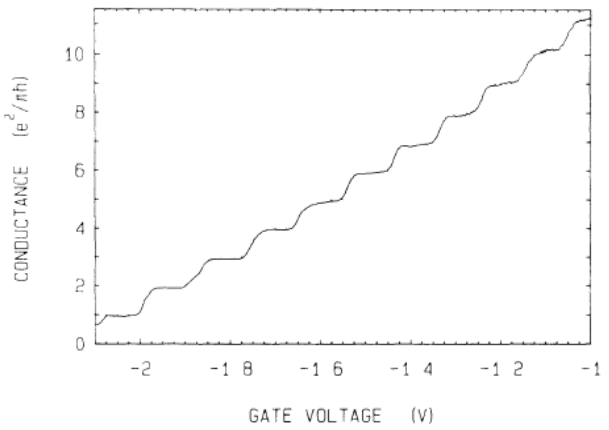


FIG. 2. Point-contact conductance as a function of gate voltage, obtained from the data of Fig. 1 after subtraction of the lead resistance. The conductance shows plateaus at multiples of $e^2/\pi h$.

$$G \sim \underbrace{2}_{\text{for spin}} \underbrace{(q^2/h)}_{1/25.8\,K\Omega} M$$

Also,

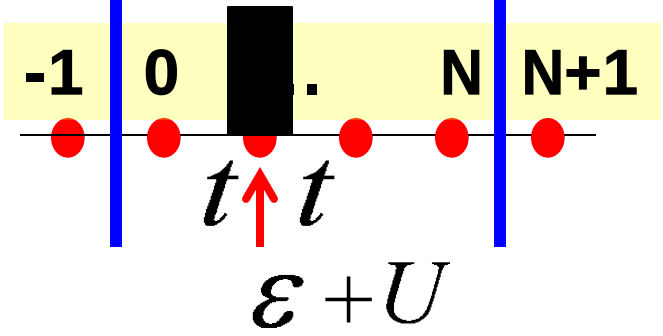
J. Phys. C: Solid State Phys. **21** (1988) L209–L214. Printed in the UK

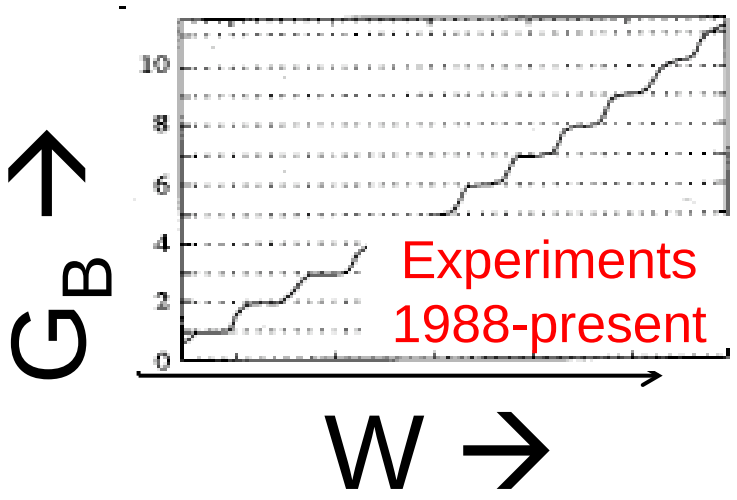
LETTER TO THE EDITOR

$$+\begin{bmatrix} 0 & 0 & 0 \\ 0 & U & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

Σ_1 H Σ_2

$$\begin{bmatrix} te^{ika} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \quad \begin{bmatrix} \varepsilon & t & 0 \\ t & \varepsilon & t \\ 0 & t & \varepsilon \end{bmatrix} \quad \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & te^{ika} \end{bmatrix}$$

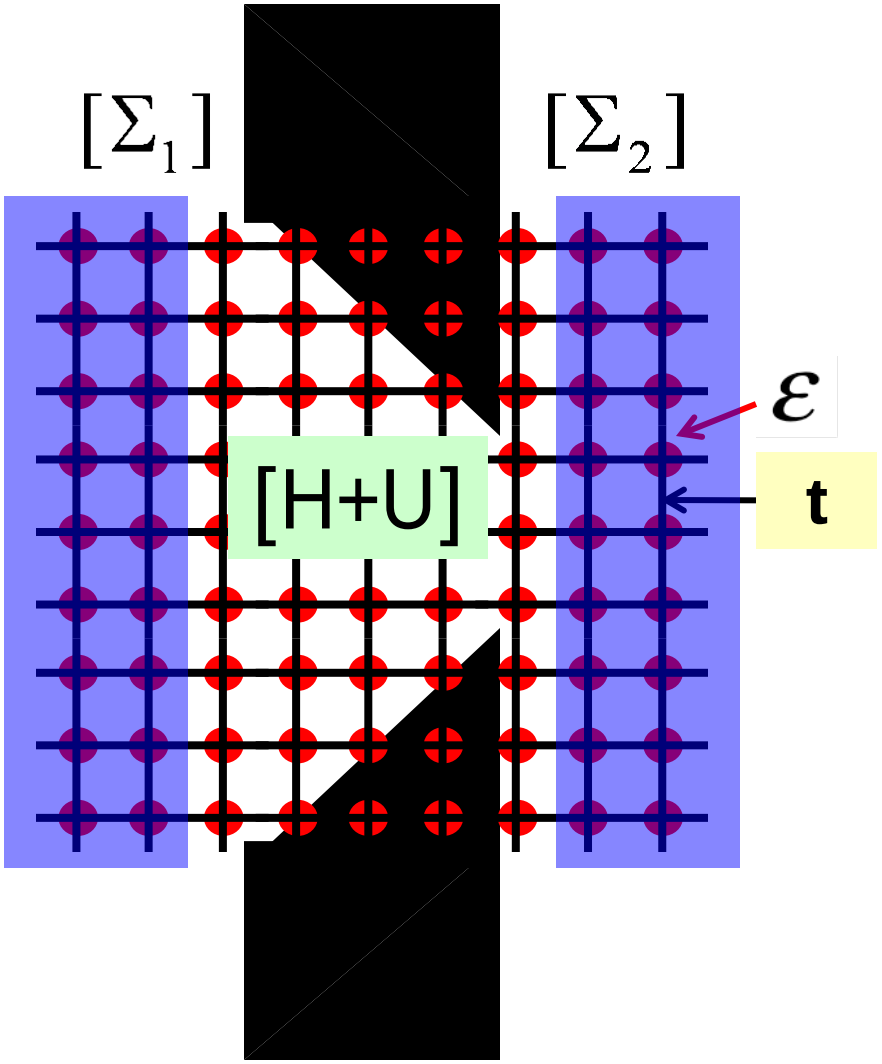


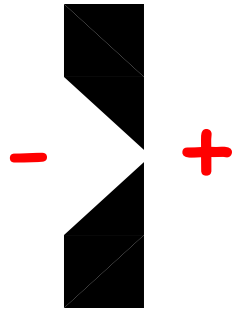


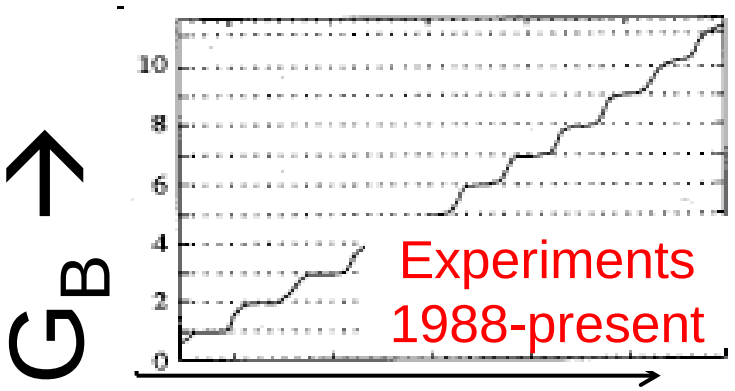
$$ka = \cos^{-1}\left(\frac{E-\varepsilon}{2t}\right) \quad \leftarrow \quad E = \varepsilon + 2t\cos ka$$

$$G \sim \underbrace{2}_{\text{for spin}} \underbrace{(q^2/h)}_{1/25.8\ K\Omega} M$$

3.2c Quantum Point Contact

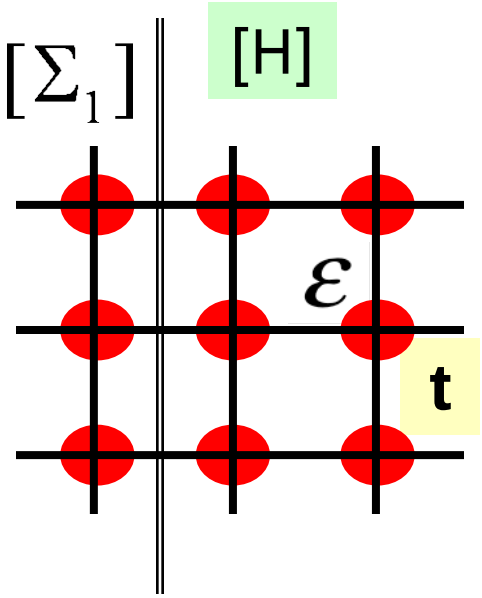






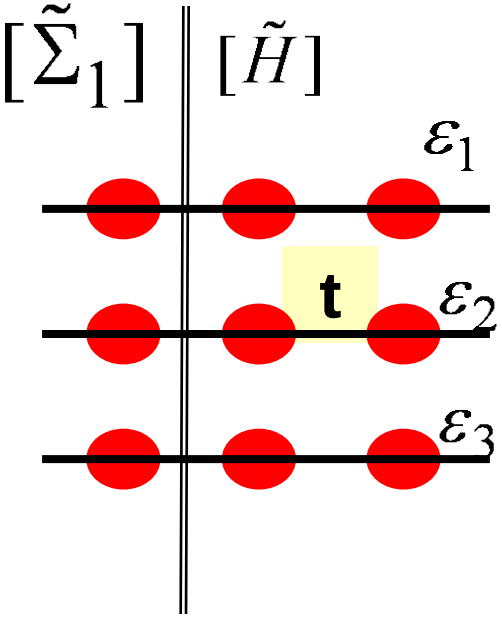
$$G \sim \underbrace{2}_{\text{for spin}} \underbrace{(q^2/h)}_{1/25.8\ K\Omega} M$$

Lattice basis

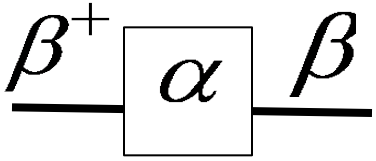


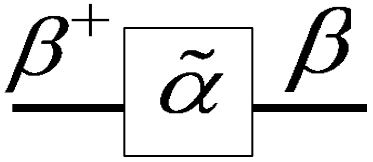
$$[\tilde{\alpha}] = [V]^{+}[\alpha][V]$$

Eigenmode basis



$$\alpha = \begin{bmatrix} \varepsilon & t & 0 \\ t & \varepsilon & t \\ 0 & t & \varepsilon \end{bmatrix} \qquad \tilde{\alpha} = \begin{bmatrix} \varepsilon_1 & 0 & 0 \\ 0 & \varepsilon_2 & 0 \\ 0 & 0 & \varepsilon_3 \end{bmatrix}$$

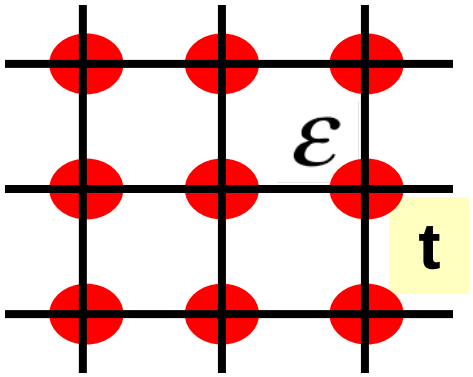




$$\beta = \begin{bmatrix} t & 0 & 0 \\ 0 & t & 0 \\ 0 & 0 & t \end{bmatrix} = \tilde{\beta}$$

Lattice basis

$[\Sigma_1]$ [H]



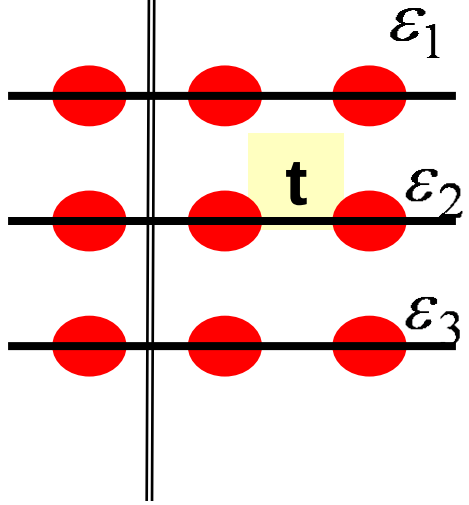
$$[\tilde{\alpha}] = [V]^{+}[\alpha][V]$$

$$[\alpha] = [V][\tilde{\alpha}][V]^{+}$$

$$[\Sigma_1] = [V][\tilde{\Sigma}_1][V]^{+}$$

Eigenmode basis

$[\tilde{\Sigma}_1]$ $[\tilde{H}]$

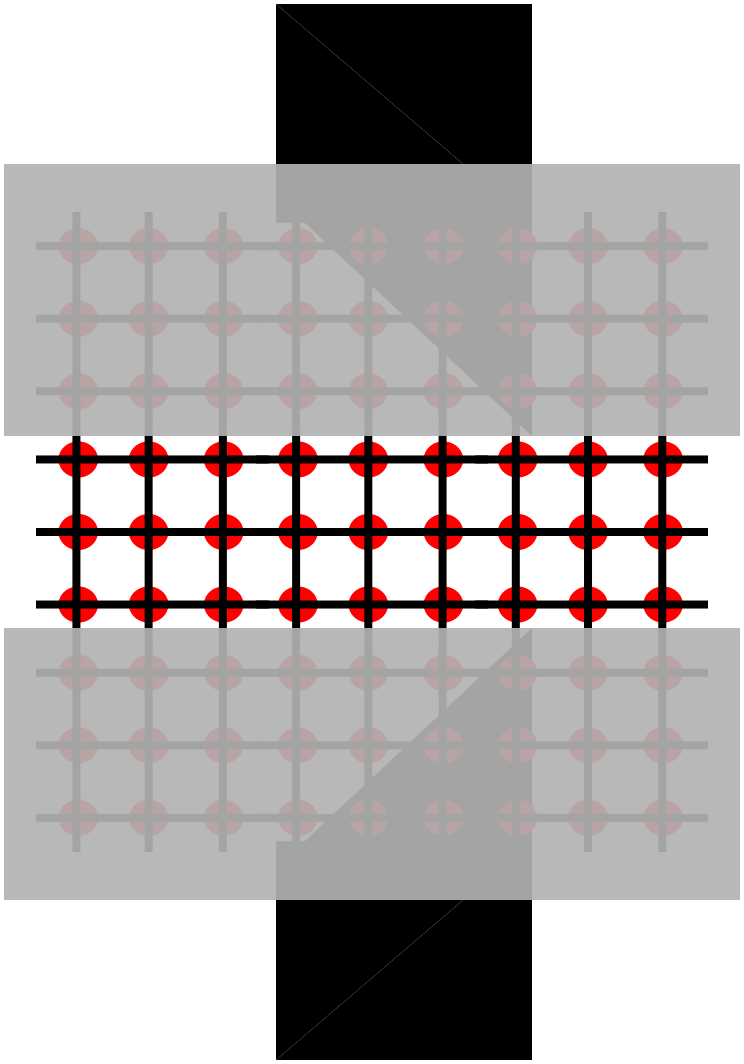


$$k_n a = \cos^{-1}\left(\frac{E-\varepsilon_n}{2t}\right)$$

$$\uparrow$$

$$E = \varepsilon_n + 2t\cos k_n a$$

$$\tilde{\Sigma}_1 = \begin{bmatrix} te^{ik_1 a} & 0 & 0 \\ 0 & te^{ik_2 a} & 0 \\ 0 & 0 & te^{ik_3 a} \end{bmatrix}$$



Eigenmode basis

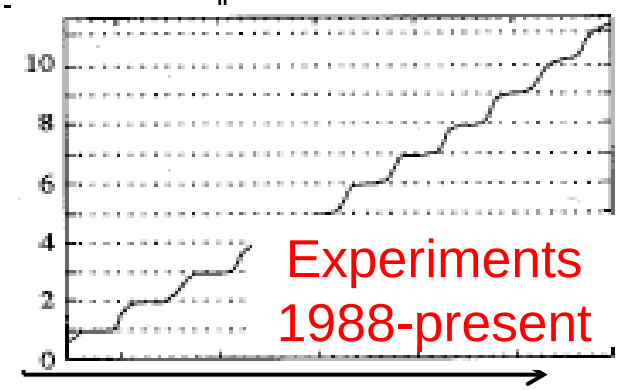
$[\tilde{\Sigma}_1]$ | $[\tilde{H}]$

ε_1

t

ε_2

ε_3

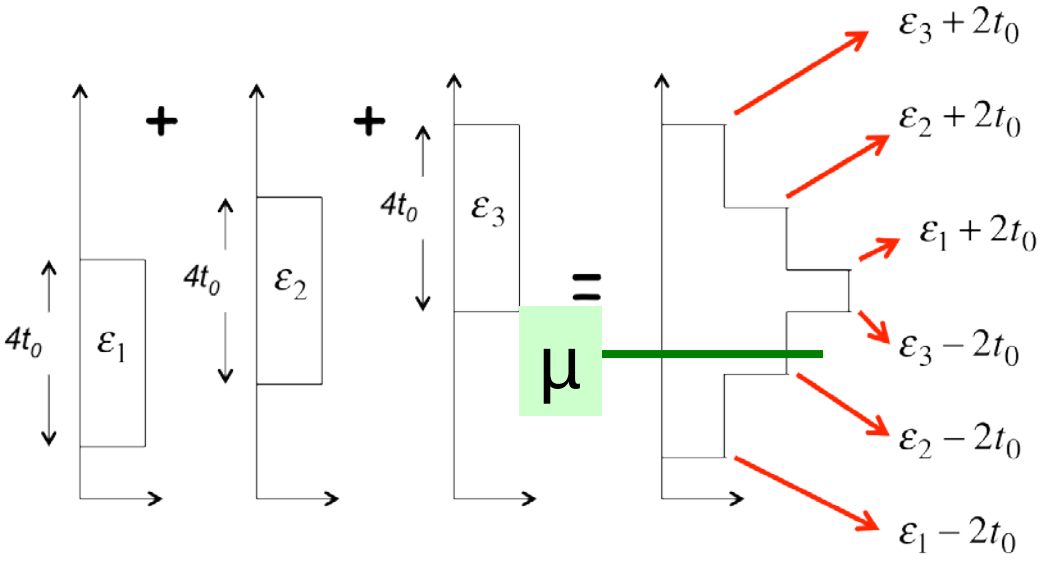


G_B ↑

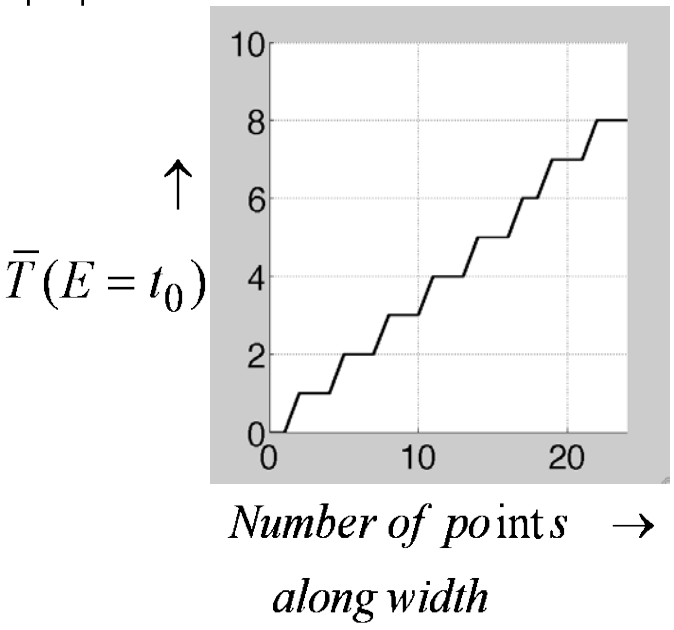
Experiments
1988-present

W → ∞

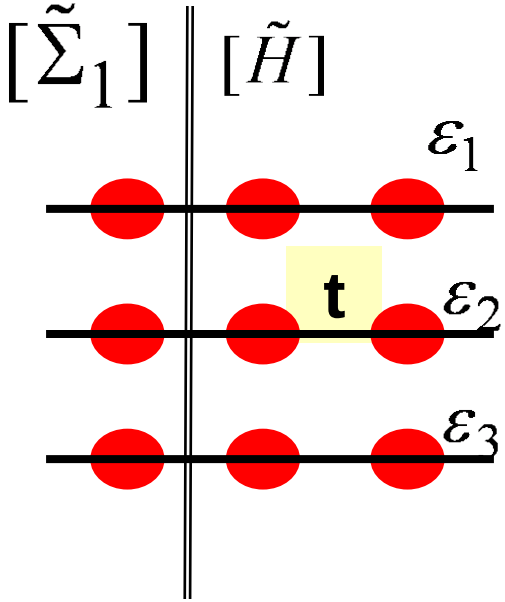
3.2g Quantum Point Contact

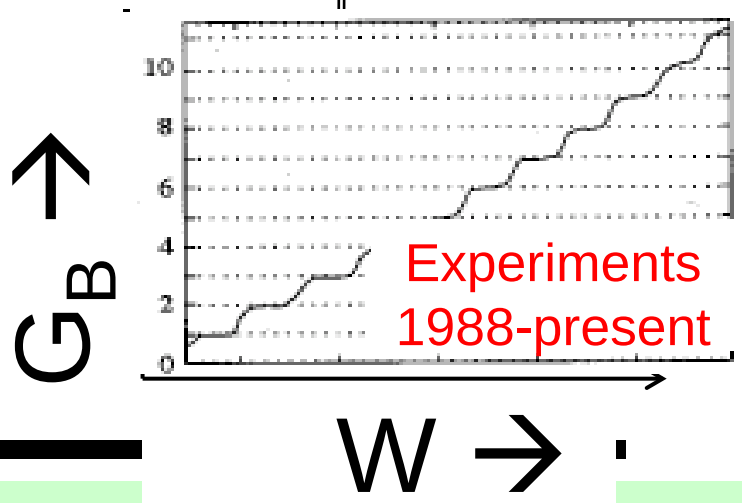


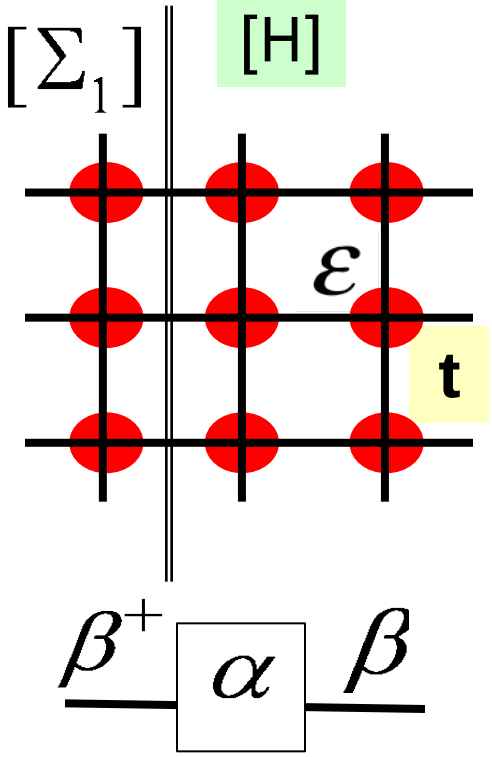
$$t_0 = |t|$$



Eigenmode basis







$$\alpha = \begin{bmatrix} \varepsilon & t & 0 \\ t & \varepsilon & t \\ 0 & t & \varepsilon \end{bmatrix} \qquad \beta = \begin{bmatrix} t & 0 & 0 \\ 0 & t & 0 \\ 0 & 0 & t \end{bmatrix}$$

Coming up next ..