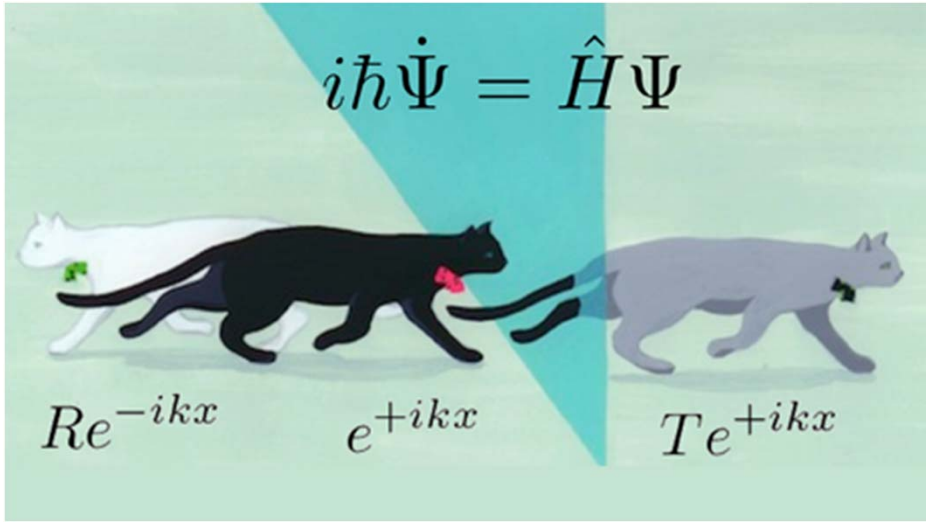
Exploring Quantum Physics

Coursera, Spring 2013 Instructors: Charles W. Clark and Victor Galitski

Using Feynman path integral

Part II: *Quantum corrections to diffusion: localization*



Conductivity of a metal: 1900 theory

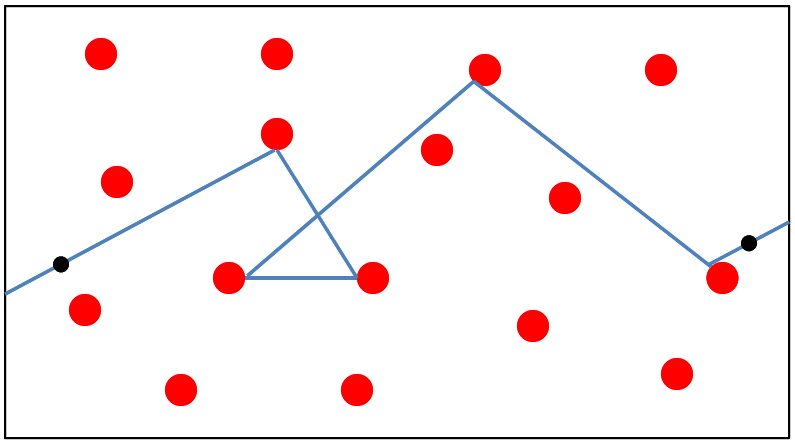
- Simplistic Drude model

$$m\vec{a} = q\vec{E} + \vec{F}_{\text{fr}}$$

- The "friction" force

$$\vec{F}_{\text{fr}} = -\gamma\vec{v} = -\frac{\vec{p}}{\tau}$$

- In equilibrium, $\vec{a} = 0$



$$\frac{d\vec{p}}{dt} = q\vec{E} - \frac{\vec{p}}{\tau} = 0$$

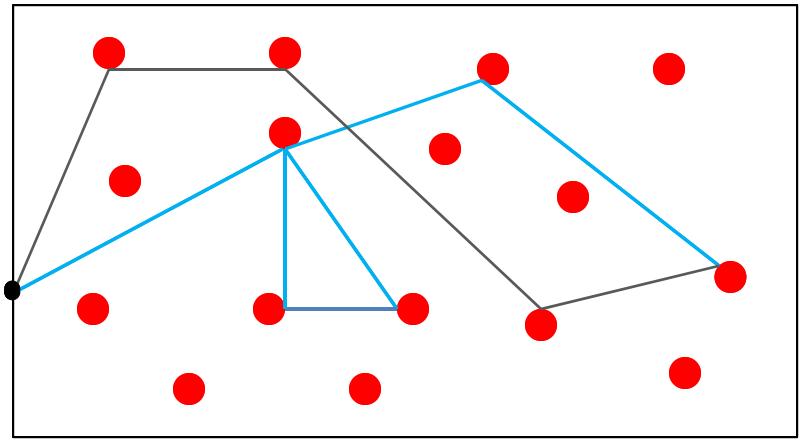
- Current

$$\vec{J} = qn\vec{v} = \underbrace{\frac{nq^2\tau}{m}}_{\sigma}\vec{E}$$

Path-integral view of electron motion

- Probability to propagate $\vec{r}_i \to \vec{r}_f$

$$w_{i\to f} = \left| \sum_l e^{\frac{i}{\hbar} S_l} \right|^2$$



- Typical action, $S_l \sim \int \frac{m\vec{v}^2}{2} dt \sim pL$

- Quantum (interference) terms

$$w_{i\to f}^{quantum} \propto \sum_{l_1 \neq l_2} e^{\frac{i}{\hbar} p_F (L_1 - L_2)} + c.c.$$