Quantum dynamics in condensed matter physics
Phys 578, Autumn 2021
Instructor: Mark Rudner

Course description:

This course we will cover a range of topics that fall outside the standard condensed matter physics curriculum, but which are highly relevant for current research in the field. An emphasis will be placed on using these topics to develop a powerful framework of intuition about the dynamics of few- and many-body quantum systems. Along the way, we will make connections wherever possible to current research in the field. A preliminary selection of topics is given below. Topics may be added or adjusted during the course based on time and interest.

Syllabus:

1. Classical physics, phase space, and least action principles
2. Quantization, approximation schemes for statics and dynamics
3. Two level systems (qubits): Coherent states, weak and strong driving, Floquet theory; dephasing and dynamical decoupling
4. Landau-Zener dynamics: adiabatic perturbation theory, exact solutions, extensions
5. Semiclassical equations of motion: Bloch bands, Berry curvature, anomalous velocity, and quantization of Hall conductance
6. Dirac materials, Anomalous Hall, spin-Hall, valley Hall effects, and experiments
7. Non-Abelian Berry phases, braiding