

INSTRUCTOR: J. Sirker (Allen 515)

TEXTBOOKS:

There is no required textbook for this course. Course notes will be published online. However, you might want to consult some of the textbooks listed below:

1) J.J. Sakurai, *Modern Quantum Mechanics* (Addison-Wesley, 1994).

2) R. Shankar, *Principles of Quantum Mechanics* (Springer, 1994).

A book which does offer a lot of information about the mathematical framework of QM.

3) Albert Messiah, *Quantum Mechanics I+II* (North Holland Publishing).

A classic textbook, lots of examples, worth consulting. Recent single volume reprint available.

1. INTRODUCTION

- Applications of Quantum Mechanics: Natural Phenomena and Quantum Technologies
- Particle-wave duality, Energy scales
- Correspondence principle, Schrodinger Equation
- Continuity equation, expectation values, Ehrenfest theorem, commutators
- Stationary states, eigenvalue problem
- Hilbert space, momentum representation
- Qubits, quantum gates, quantum circuits, Deutsch algorithm

2. MATHEMATICAL FORMULATION OF QUANTUM MECHANICS

- Dirac formalism: vectors, operators, basis, representations
- Matrix quantum mechanics
- The eigenvalue problem
- The measuring process, Heisenberg uncertainty relation
- Quantum statistics, density operators
- Time evolution: Schroedinger and Heisenberg picture

3. PERTURBATION THEORY AND VARIATIONAL APPROACHES

- Non-degenerate/degenerate perturbation theory
- Variational principle
- Helium atom

4. TIME-DEPENDENT PERTURBATION THEORY AND SCATTERING THEORY

- Time-dependent perturbation theory
- Transition probabilities, Fermi's golden rule
- Scattering amplitude, Born approximation
- Phase shifts and partial waves
- Propagators
- Lippmann-Schwinger Equation

5. IDENTICAL PARTICLES

- Bose and Fermi statistics
- Spin-Statistic theorem: Symmetric and antisymmetric wave functions
- Pauli exclusion principle
- Slater determinant
- Ideal Fermi and Bose gas
- Entanglement measures
- Bell's inequalities