

731 Syllabus (Fall, 2005)

Quantum Mechanics I

1 Introduction to Quantum Mechanics

Brief Introduction to the Introduction

- 1.1 A historic count
- 1.2 Wave-particle duality
- 1.3 Discrete states

2 Mathematical Prelude

- 2.1 Linear vector spaces
- 2.2 Inner Product Spaces
- 2.3 The Dirac Notation
- 2.4 Linear Operators
- 2.5 Eigenvectors and Eigenvalues
- 2.6 Basics of Group Theory
- 2.7 Group Algebra
- 2.8 Recap: An Eigenvalue Problem
- 2.9 Generalization to Infinite Dimensions

3 Fundamentals of Quantum Mechanics

- 3.1 Postulates of Quantum Mechanics
- 3.2 Discussions of the Postulates
- 3.3 Observables: Compatible and Incompatible
- 3.4 Spatial Translation and the Momentum Operator
- 3.5 Time Evolution and the Hamiltonian Operator
- 3.6 "The Pictures": Schrödinger versus Heisenberg
- 3.7 Schrödinger's Wave Equation and the Classical Limit
- 3.8 Lagrangian, Action, and Path integrals
- 3.9 Potentials and Gauge Invariance

4 Simple Harmonic Oscillator

4.1 Creation and annihilation operators

4.2 Energy basis

4.3 Some applications

5 Theory of Angular Momentum

5.1 Rotational symmetry, generators, angular momentum operators

5.2 Spin 1/2 systems

5.3 Representations of SU(2)

5.4 Orbital Angular Momentum

5.5 Central force problem

5.6 Addition of angular momenta

5.7 Density Operators, Pure and Mixed Ensembles

5.8 Spin Correlation Measurements

5.9 Tensor operators and the Wigner-Eckart theorem

6 Symmetries in Quantum Mechanics

6.1 Symmetries, conservation laws, and degeneracy

6.2 Discrete symmetries: Parity

6.3 Lattice Translational Symmetry

6.4 Time Reversal symmetry

7 Identical Particles

7.1 Multi-Particle System

7.2 Permutation Symmetry

7.3 Symmetrization Postulate: Bosons and Fermions

7.4 Two-electron System

7.5 Young Tableaux