



Quantum Mechanics for PhD Study

Chapter One

The Basic Concepts of Quantum Mechanics

- 1-The properties of the eigen functions of operators with a discrete spectrum (with degenerate and non-degenerate states).
 - 2-The properties of the eigen functions of operators with a continuous spectrum.
 - 3-The properties of the eigen functions of operators when a continuous spectrum consists discrete one.
 - 4-Method to determine the states of quantum systems.
 - 5-The Hiesenberg relations for physical quantities.
 - 6-Description of states by means of the density matrix.
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Chapter Two

Change of Quantum States with Time

- 1-The Schrodinger equation
 - 2-Stationary states
 - 3-Change in time of average values of physical quantities
 - 4-Integrals of motion and symmetry conditions
 - a)Unitary of time
 - b)Unitary of space
 - c)Isotropy of space
 - 5-Continous and discrete transformation
Symmetries and conservation laws ,Space inversion-parity
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Chapter Three

Elementary Representation Theory(Quantum Dynamics)

- 1-Different representation of the state vector
 - 2-Different representation of operators
 - 3- The determination of the eigen functions and eigen values of operators given in the form of matrices
 - 4- The general theory of unitary transformation
 - 5- The unitary transformations corresponding to a change of state with time
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Chapter Four

Quantum Theory of Systems Consisting of Identical Particles

- 1-The Schrodinger equation for a system consisting of identical particles**
 - 2-Symmetric and anti-symmetric wave functions**
 - 3-The symmetric and anti-symmetric wave functions of hydrogen molecule**
 - 4-Heitler-London theory of hydrogen molecule**
 - 5-The helium atom**
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Chapter Five

Interaction of Radiation with Matter – Semi-classical Treatment

- 1-Preface**
 - 2-Radiative transitions in atoms**
 - 3-Electric dipole approximation –case of induced absorption**
 - 4-Rate of induced emission**
 - 5-Rate of spontaneous emission**
 - 6-Electric dipole selection rules –case of hydrogen atom**
 - 7-Forbidden transitions**
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Chapter six

Quantum Theory of Scattering

- 1-Scattering by spherically symmetric potential**
 - 2-Method of partial waves**
 - 3-Scattering by square well potential**
 - 4-Ramsauer-Townsend Effect**
 - 5-Resonance scattering**
 - 6-Scattering by a perfectly rigid sphere potential**
 - 7-The integral equation method**
 - 8-The Born approximation**
 - 9-The validity of Born approximation**
 - 10-Scattering by screened Coulomb potential**
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Chapter Seven

Relativistic Quantum Mechanics

- 1-Klein-Gordon Relativistic equation**
 - 2- The probability density and probability current density**
 - 3-Dirac relativistic equation**
 - 4- The Dirac equation in covariant**
 - 5-Dirac particle in an electromagnetic field**
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Chapter Eight

Second quantization

1-Lagrangian formulation of field

2-Hamiltonian Formulation of field

3-Poisson bracket formulation of field variables

4-Quantum equations for the field

5-Field with more than one component

6-Quantisation of the non-relativistic Schrodinger equation

7-The N-representation

8-System of fermions

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