

Modern Mathematical Physics

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Part I

Quantum mechanics

Chapter 1

Wave-particle duality

1.1 Particle properties of light

Black body radiation(1901) Photoelectric effect(1905) Compton scattering(1923)

1.2 Wave properties of electrons

Bohr atom model(1913) Rutherford scattering(1911) Franck-Hertz experiment(1914) De Broglie waves(1924)
Electron diffraction Davisson-Germer(1927) George Pagit Thompson(1928)

1.3 Interpretations of quantum mechanics

Heisenberg picture and Schrödinger picture Hilbert space, wave functions, Dirac notation Copenhagen interpretation observables and self-adjoint operators EPR paradox and entanglement?

1.4 Canonical commutation relation

canonical quantization fourier transform Stone-von Neumann theorem

Chapter 2

Schrödinger equation

2.1 Time-independent potentials

Infinite well Harmonic oscillator Free particle Hydrogen atom

2.2 Perturbative theory

WKB approximation Fine structure Scattering theory

Chapter 3

Spin

3.1 Spin of electrons

3.2 Dirac equation

Pair production(1941)

3.3 Wigner classification

Part II

Statistical mechanics

Chapter 4

Thermodynamics

4.1 Equilibrium

Equation of states Thermal processes

4.2 Kinetic theory of gas

ergodic theory BBGKY hierarchy

4.3 Ensembles

microcanonical, canonical, grand canonical

Chapter 5

Quantum statistics

5.1 Fermions and Bosons

Two statistics Fermi sea Bose-Einstein condensation

5.2 Solid state physics

phonon

Chapter 6

Renormalization group

6.1 Phase transition

Magnetic models Ginzburg Landau theory

Part III

Quantum field theory

Chapter 7

Perturbative field theory

7.1 Path integral formulation

7.2 Field equations

7.3 Feynman diagrams

Chapter 8

Non-perturbative field theory

8.1 Algebraic quantum field theory

Chapter 9

Nonabelian gauge theory

Part IV

Quantum gravity