

Contents

CHAPTER 1. QUANTUM BEHAVIOR

- 1-1 Atomic mechanics 1-1
- 1-2 An experiment with bullets 1-1
- 1-3 An experiment with waves 1-3
- 1-4 An experiment with electrons 1-4
- 1-5 The interference of electron waves 1-5
- 1-6 Watching the electrons 1-6
- 1-7 First principles of quantum mechanics 1-9
- 1-8 The uncertainty principle 1-11

CHAPTER 2. THE RELATION OF WAVE AND PARTICLE VIEWPOINTS

- 2-1 Probability wave amplitudes 2-1
- 2-2 Measurement of position and momentum 2-2
- 2-3 Crystal diffraction 2-4
- 2-4 The size of an atom 2-5
- 2-5 Energy levels 2-7
- 2-6 Philosophical implications 2-8

CHAPTER 3. PROBABILITY AMPLITUDES

- 3-1 The laws of combining amplitudes 3-1
- 3-2 The two-slit interference pattern 3-5
- 3-3 Scattering from a crystal 3-7
- 3-4 Identical particles 3-9

CHAPTER 4. IDENTICAL PARTICLES

- 4-1 Bose particles and Fermi particles 4-1
- 4-2 States with two Bose particles 4-3
- 4-3 States with n Bose particles 4-6
- 4-4 Emission and absorption of photons 4-7
- 4-5 The blackbody spectrum 4-8
- 4-6 Liquid helium 4-12
- 4-7 The exclusion principle 4-12

CHAPTER 5. SPIN ONE

- 5-1 Filtering atoms with a Stern-Gerlach apparatus 5-1
- 5-2 Experiments with filtered atoms 5-5
- 5-3 Stern-Gerlach filters in series 5-6
- 5-4 Base states 5-8
- 5-5 Interfering amplitudes 5-10
- 5-6 The machinery of quantum mechanics 5-12
- 5-7 Transforming to a different base 5-15
- 5-8 Other situations 5-16

CHAPTER 6. SPIN ONE-HALF

- 6-1 Transforming amplitudes 6-1
- 6-2 Transforming to a rotated coordinate system 6-3
- 6-3 Rotations about the z -axis 6-6
- 6-4 Rotations of 180° and 90° about y 6-9
- 6-5 Rotations about x 6-11
- 6-6 Arbitrary rotations 6-12

CHAPTER 7. THE DEPENDENCE OF AMPLITUDES ON TIME

- 7-1 Atoms at rest; stationary states 7-1
- 7-2 Uniform motion 7-3
- 7-3 Potential energy; energy conservation 7-6
- 7-4 Forces; the classical limit 7-9
- 7-5 The "precession" of a spin one-half particle 7-10

CHAPTER 8. THE HAMILTONIAN MATRIX

- 8-1 Amplitudes and vectors 8-1
- 8-2 Resolving state vectors 8-3
- 8-3 What are the base states of the world? 8-5
- 8-4 How states change with time 8-7
- 8-5 The Hamiltonian matrix 8-10
- 8-6 The ammonia molecule 8-11

CHAPTER 9. THE AMMONIA MASER

- 9-1 The states of an ammonia molecule 9-1
- 9-2 The molecule in a static electric field 9-5
- 9-3 Transitions in a time-dependent field 9-9
- 9-4 Transitions at resonance 9-11
- 9-5 Transitions off resonance 9-13
- 9-6 The absorption of light 9-14

CHAPTER 10. OTHER TWO-STATE SYSTEMS

- 10-1 The hydrogen molecular ion 10-1
- 10-2 Nuclear forces 10-6
- 10-3 The hydrogen molecule 10-8
- 10-4 The benzene molecule 10-10
- 10-5 Dyes 10-12
- 10-6 The Hamiltonian of a spin one-half particle in a magnetic field 10-12
- 10-7 The spinning electron in a magnetic field 10-15

CHAPTER 11. MORE TWO-STATE SYSTEMS

- 11-1 The Pauli spin matrices 11-1
- 11-2 The spin matrices as operators 11-5
- 11-3 The solution of the two-state equations 11-8
- 11-4 The polarization states of the photon 11-9
- 11-5 The neutral K-meson 11-12
- 11-6 Generalization to N -state systems 11-20

CHAPTER 12. THE HYPERFINE SPLITTING IN HYDROGEN

- 12-1 Base states for a system with two spin one-half particles 12-1
- 12-2 The Hamiltonian for the ground state of hydrogen 12-3
- 12-3 The energy levels 12-7
- 12-4 The Zeeman splitting 12-9
- 12-5 The states in a magnetic field 12-12
- 12-6 The projection matrix for spin one 12-14

CHAPTER 13. PROPAGATION IN A CRYSTAL LATTICE

- 13-1 States for an electron in a one-dimensional lattice 13-1
- 13-2 States of definite energy 13-3
- 13-3 Time-dependent states 13-6
- 13-4 An electron in a three-dimensional lattice 13-7
- 13-5 Other states in a lattice 13-8
- 13-6 Scattering by imperfections in the lattice 13-10
- 13-7 Trapping by a lattice imperfection 13-12
- 13-8 Scattering amplitudes and bound states 13-13

CHAPTER 14. SEMICONDUCTORS

- 14-1 Electrons and holes in semiconductors 14-1
- 14-2 Impure semiconductors 14-4
- 14-3 The Hall effect 14-7
- 14-4 Semiconductor junctions 14-8
- 14-5 Rectification at a semiconductor junction 14-10
- 14-6 The transistor 14-11

CHAPTER 15. THE INDEPENDENT PARTICLE APPROXIMATION

- 15-1 Spin waves 15-1
- 15-2 Two spin waves 15-4
- 15-3 Independent particles 15-6
- 15-4 The benzene molecule 15-7
- 15-5 More organic chemistry 15-10
- 15-6 Other uses of the approximation 15-12

CHAPTER 16. THE DEPENDENCE OF AMPLITUDES ON POSITION

- 16-1 Amplitudes on a line 16-1
- 16-2 The wave function 16-5
- 16-3 States of definite momentum 16-7
- 16-4 Normalization of the states in x 16-9
- 16-5 The Schrödinger equation 16-11
- 16-6 Quantized energy levels 16-14

CHAPTER 17. SYMMETRY AND CONSERVATION LAWS

- 17-1 Symmetry 17-1
- 17-2 Symmetry and conservation 17-3
- 17-3 The conservation laws 17-7
- 17-4 Polarized light 17-9
- 17-5 The distintegration of the Λ^0 17-11
- 17-6 Summary of the rotation matrices 17-15

CHAPTER 18. ANGULAR MOMENTUM

- 18-1 Electric dipole radiation 18-1
- 18-2 Light scattering 18-3
- 18-3 The annihilation of positronium 18-5
- 18-4 Rotation matrix for any spin 18-9
- 18-5 Measuring a nuclear spin 18-13
- 18-6 Composition of angular momentum 18-14
- Added Note 1: Derivation of the rotation matrix 18-19
- Added Note 2: Conservation of parity in photon emission 18-22

CHAPTER 19. THE HYDROGEN ATOM AND THE PERIODIC TABLE

- 19-1 Schrödinger's equation for the hydrogen atom 19-1
- 19-2 Spherically symmetric solutions 19-2
- 19-3 States with an angular dependence 19-6
- 19-4 The general solution for hydrogen 19-10
- 19-5 The hydrogen wave functions 19-12
- 19-6 The periodic table 19-13

CHAPTER 20. OPERATORS

- 20-1 Operations and operators 20-1
- 20-2 Average energies 20-3
- 20-3 The average energy of an atom 20-6
- 20-4 The position operator 20-8
- 20-5 The momentum operator 20-9
- 20-6 Angular momentum 20-14
- 20-7 The change of averages with time 20-15

CHAPTER 21. THE SCHRÖDINGER EQUATION IN A CLASSICAL CONTEXT: A SEMINAR ON SUPERCONDUCTIVITY

- 21-1 Schrödinger's equation in a magnetic field 21-1
- 21-2 The equation of continuity for probabilities 21-3
- 21-3 Two kinds of momentum 21-4
- 21-4 The meaning of the wave function 21-6
- 21-5 Superconductivity 21-7
- 21-6 The Meissner effect 21-8
- 21-7 Flux quantization 21-10
- 21-8 The dynamics of superconductivity 21-12
- 21-9 The Josephson junction 21-14

FEYNMAN'S EPILOGUE

APPENDIX

INDEX

