CONTENTS

I. Introductory 1
1. Theory and Experiment 1
2. The Fundamental Concepts of Quantum Theory . 4
a) Wilson Photographs 4
b) Diffraction of Matter Waves (Davisson and Germer, Thomson, Rupp) 5
c) The Diffraction of X-Rays 6
d) The Compton-Simon Experiment 7
e) The Collision Experiments of Franck and Hertz 9

II. Critique of the Physical Concepts of the Corpuscular Theory 13
1. The Uncertainty Relations 13
2. Illustrations of the Uncertainty Relations . . . 20
a) Determination of the Position of a Free Particle 21
b) Measurement of the Velocity or Momentum of a Free Particle 25
c) Bound Electrons 30
d) Energy Measurements 39

III. Critique of the Physical Concepts of the Wave Theory 47
1. The Uncertainty Relations for Waves 48
2. Discussion of an Actual Measurement of the Electromagnetic Field 52

IV. The Statistical Interpretation of Quantum Theory 55
1. Mathematical Considerations 55
2. Interference of Probabilities 59
3. Bohr's Concept of Complementarity 62

V. Discussion of Important Experiments 66
1. The C. T. R. Wilson Experiments 66

2. Diffraction Experiments 76
3. The Experiment of Einstein and Rupp 79
4. Emission, Absorption, and Dispersion of Radiation 80
a) Application of the Conservation Laws . . . 80
b) Correspondence Principle and the Method of Virtual Charges 82
c) The Complete Treatment of Radiation and Matter 84
5. Interference and the Conservation Laws . . . 88
6. The Compton Effect and the Compton-Simon Experiment 92
7. Radiation Fluctuation Phenomena 95
8. Relativistic Formulation of the Quantum Theory . 101

APPENDIX: THE MATHEMATICAL APPARATUS OF THE QUANTUM THEORY 105
1. The Corpuscular Concept of Matter 105
2. The Transformation Theory 123
3. The Schrödinger Equation 132
4. The Perturbation Method 138
5. Resonance between Two Atoms: the Physical Interpretation of the Transformation Matrices . . . 142
6. The Corpuscular Concept for Radiation 153
7. Quantum Statistics 153
8. The Wave Concept for Matter and Radiation: Classical Theory 157
9. Quantum Theory of Wave Fields 165
10. Application to Waves of Negative Charge . . . 172
11. Proof of the Mathematical Equivalence of the Quantum Theory of Particles and of Waves 177
12. Application to the Theory of Radiation 182

INDEX 184