

Contents

| | |
|--|------|
| <i>Preface</i> | xii |
| <i>List of Figures</i> | xiii |
| 1. Classical Mechanics | 1 |
| 1.1 Quantum Mechanics and Philosophical Intuition | 1 |
| 1.2 Newtonian Mechanics | 4 |
| 1.3 Problems with Classical Mechanics | 8 |
| 1.4 The Stability of Matter | 11 |
| 2. Quantum Phenomena | 15 |
| 2.1 Spin Properties | 15 |
| 2.2 Basic Properties of the Boxes | 17 |
| 2.3 Quantum-Mechanical Interference | 20 |
| 2.4 How Electrons Move | 23 |
| 2.5 Superpositions, Property Attribution, and the Total-of-Nothing Box | 27 |
| 2.6 Random, Nonlocal, and Indeterminate | 29 |
| 3. The Mathematics of Quantum Mechanics | 30 |
| 3.1 Hilbert Space | 30 |
| 3.2 Spin Space | 39 |
| 4. The Standard Formulation of Quantum Mechanics | 42 |
| 4.1 The von Neumann–Dirac Theory | 42 |
| 4.2 Spin Boxes and the Linear Dynamics | 53 |
| 4.3 Quantum Statistics | 58 |
| 4.4 Combining Boxes | 61 |
| 4.5 Physical Properties more Generally: K Mesons and Qubits | 63 |
| 5. Quantum Interference | 66 |
| 5.1 The Simple Two-Path Experiment | 66 |
| 5.2 Measurement | 68 |
| 5.3 Barriers | 72 |
| 5.4 Decoherence | 76 |
| 5.5 Quantum Records | 81 |
| 5.6 Total-of-Nothing | 84 |
| 5.7 The Wave Function | 86 |
| 6. Real and/or Local | 89 |
| 6.1 The EPR Argument | 89 |
| 6.2 Quantum Mechanics and Relativity | 93 |
| 6.3 Bell's Theorem | 96 |

| | | |
|------|---|-----|
| 6.4 | Bell-Type Theorems | 98 |
| 6.5 | Quantum Property Attribution Redux | 101 |
| 6.6 | EPR Morals | 102 |
| 7. | The Quantum Measurement Problem | 105 |
| 7.1 | Wigner's Friend | 105 |
| 7.2 | The Measurement Problem | 111 |
| 7.3 | Why A-Type Measurements are Difficult | 113 |
| 8. | The Collapse of the Quantum State | 118 |
| 8.1 | Wigner's Solution | 118 |
| 8.2 | GRW* | 121 |
| 8.3 | GRW | 130 |
| 8.4 | GRWr, GRWm, and GRWf | 134 |
| 8.5 | Empirical Ontology and Experience | 140 |
| 9. | Pure Wave Mechanics | 143 |
| 9.1 | Everett's Solution to the Measurement Problem | 143 |
| 9.2 | The Bare Theory | 145 |
| 9.3 | Pure Wave Mechanics with just the Standard Interpretation of States | 153 |
| 9.4 | The Relative-State Formulation of Pure Wave Mechanics | 154 |
| 9.5 | Everett's Empiricism | 158 |
| 10. | Many Worlds and Such | 162 |
| 10.1 | Extending Pure Wave Mechanics | 162 |
| 10.2 | Splitting-Worlds | 163 |
| 10.3 | Probability and Typical Worlds | 168 |
| 10.4 | Decohering Worlds | 174 |
| 10.5 | Single-Mind and Many-Minds Theories | 181 |
| 10.6 | Many Threads and Many Maps | 184 |
| 10.7 | Epistemological, Pragmatic, and Information-Theoretic Interpretations | 187 |
| 11. | Bohmian Mechanics | 190 |
| 11.1 | Bohm's Theory | 190 |
| 11.2 | Basic Spin Experiments | 193 |
| 11.3 | Interference and the Two-Path Experiment | 200 |
| 11.4 | Measurements and Records | 203 |
| 11.5 | Surreal Trajectories and Decoherence | 208 |
| 11.6 | How the Theory Explains Experience | 213 |
| 11.7 | EPR and Relativity | 214 |
| 11.8 | Virtues and Vices | 217 |
| 12. | Empirical Ontology and Explanation | 220 |
| 12.1 | The Explanatory Work of Metaphysics | 220 |
| 12.2 | Beables and Experience | 222 |
| 12.3 | Metaphysics and Empirical Adequacy | 226 |

| | |
|--|-----|
| 12.4 Empirical Ontology and Experience | 230 |
| 12.5 Philosophical Morals | 231 |
| Appendix A: A Formal Characterization of Hilbert Space | 233 |
| <i>Bibliography</i> | 235 |
| <i>Index</i> | 241 |