

CONTENTS

PREFACE	vii
PROLOGUE	ix
INTRODUCTION	1
1 THE PLANCK-EINSTEIN REVOLUTION	7
1.1 Blackbody Radiation	9
1.2 The Arrival of h	11
1.3 The Photon	13
2 THE BIRTH OF QUANTUM MECHANICS	17
2.1 Bohr's Model of the Atom	19
2.2 The Dance of the Quantum Numbers	23
2.3 Einstein on Radiation Transitions	27
2.4 Quantum Mechanics	29
3 THE PRINCIPLE OF SUPERPOSITION	47
3.1 The Polarization of Light	49
3.2 Interference Phenomena	51
3.3 Mathematical Formulation of the Principle	56
3.4 Superpositions of Macroscopically Distinct States	65
4 DYNAMICAL VARIABLES AND OBSERVABLES	69
4.1 Observables and Operators	71
4.2 Representations	76
4.3 The Axioms of Quantum Mechanics	79
4.4 The Density Operator	83
4.5 Revisiting Heisenberg's Paper of July 1925	89

5	SYMMETRIES	99
5.1	Symmetries and Symmetry Transformations	101
5.2	Symmetries and Group Representations	106
5.3	Examples of Exact and Broken Symmetries	110
5.4	Symmetries in nuclear and particle physics	119
6	UNCERTAINTY	123
6.1	Superposition and Uncertainty	126
6.2	The Heisenberg Microscope	127
6.3	Simple Examples	128
6.4	Young's Experiment And The Uncertainty Principle	129
6.5	Uncertainty In The Stars	130
6.6	Probabilistic Derivation of the Uncertainty Principle	132
6.7	Trajectories in Cloud Chambers	134
7	ENTANGLEMENT	137
7.1	Introduction	139
7.2	David Bohm's Description of the EPR experiment	144
7.3	John Bell and the EPR experiment	147
7.4	A Different Analysis of the EPR Thought Experiment	150
7.5	Reduction of the State Vector	151
7.6	Quantum Teleportation	153
7.7	Decoherence	157
8	INTERPRETATIONS OF QUANTUM MECHANICS	163
8.1	The Copenhagen Interpretation	165
8.2	Other Interpretations	170
	Appendix: Foundational Attitudes Toward Quantum Mechanics	173
	EPILOGUE	175
	APPENDIX	177
	BIBLIOGRAPHY	179
	INDEX	183