## CONTENTS

Ι.	THE PRINCIPLE OF SUPERPOSIT	ION			•	1
	1. The Need for a Quantum Theory		•	•		1
	2. The Polarization of Photons		•		•	4
	3. Interference of Photons .			•	•	7
	4. Superposition and Indeterminacy		•			10
	5. Mathematical Formulation of the	Princip	ole			14
	6. Bra and Ket Vectors .		•			18
II.	DYNAMICAL VARIABLES AND OF	BSERV	ABLES	•	•	23
	7. Linear Operators .		•	•	•	23
	8. Conjugate Relations .	•			•	<b>26</b>
	9. Eigenvalues and Eigenvectors			•	•	29
	10. Observables			•		34
	11. Functions of Observables	•	•			41
	12. The General Physical Interpretat	ion	•	•		<b>45</b>
	13. Commutability and Compatibility	у	•			49
III.	REPRESENTATIONS .	•	•	•	•	53
	14. Basic Vectors .	•	•	•	•	53
	15. The $\delta$ Function .	•	•	•	•	<b>58</b>
	16. Properties of the Basic Vectors	•	•	•	•	<b>62</b>
	17. The Representation of Linear Op	perators		•		67
	18. Probability Amplitudes	• -	•	•	•	72
	19. Theorems about Functions of Ob	oservabl	es	•	•	76
	20. Developments in Notation	•	•	•	4	79
τv	THE QUANTUM CONDITIONS					84
<b>T</b>	21. Poisson Brackets	•	•	•	•	84
	22. Schrödinger's Representation	•	•	•	•	80
	23. The Momentum Representation	•	•	•	•	04
	24 Heisenberg's Principle of Uncert	aintv	•	•	•	07
	25 Displacement Operators	anity	•	•	•	00
	26 Unitary Transformations	•	•	•	·	103
	20. Onitary Hanstonnations	•	•	•	·	100
v.	THE EQUATIONS OF MOTION				•	108
	27. Schrodinger's Form for the Equ	ations o	f Motior	1		108
	28. Heisenberg's Form for the Equa	tions of	Motion			111
	29. Stationary States .					116
	30. The Free Particle				•	118
	31. The Motion of Wave Packets					121
	32. The Action Principle					125
	33. The Gibbs Ensemble .					130
					•	
VI.	ELEMENTARY APPLICATIONS		•	•	٠	136
	34. The Harmonic Oscillator		•	•		136
	35. Angular Momentum .	÷	•	٠		140

## CONTENTS

	36. Properties of Angular Momentum		144
	37. The Spin of the Electron	•	149
	38. Motion in a Central Field of Force		152
	39. Energy-levels of the Hydrogen Atom		156
	40. Selection Rules		159
	41. The Zeeman Effect for the Hydrogen Atom .	•	165
VII.	PERTURBATION THEORY		167
	42. General Remarks		167
	43. The Change in the Energy-levels caused by a Perturbat	ion	168
	44. The Perturbation considered as causing Transitions		172
	45. Application to Radiation		175
	46. Transitions caused by a Perturbation Independent of t	he	
	Time		178
	47. The Anomalous Zeeman Effect .	•	181
VIII.	COLLISION PROBLEMS		185
	48. General Remarks		185
	49. The Scattering Coefficient		188
	50. Solution with the Momentum Representation		193
	51. Dispersive Scattering		199
	52. Resonance Scattering		201
	53. Emission and Absorption		204
	<b>-</b>		
IX.	SYSTEMS CONTAINING SEVERAL SIMILAR PARTICLI	$\mathbf{ES}$	207
	54. Symmetrical and Antisymmetrical States .	•	207
	55. Permutations as Dynamical Variables .	•	211
	56. Permutations as Constants of the Motion .	•	213
	57. Determination of the Energy-levels	•	.216
	58. Application to Electrons	•	219
x.	THEORY OF RADIATION		225
	59. An Assembly of Bosons		225
	60. The Connexion between Bosons and Oscillators .		227
	61. Emission and Absorption of Bosons .		232
	62. Application to Photons		235
	63. The Interaction Energy between Photons and an Atom		239
	64. Emission, Absorption, and Scattering of Radiation		244
	65. An Assembly of Fermions	•	248
XI.	RELATIVISTIC THEORY OF THE ELECTRON .		253
	66. Relativistic Treatment of a Particle		253
	67. The Wave Equation for the Electron		254
	68. Invariance under a Lorentz Transformation	•	258
	69. The Motion of a Free Electron		261
	70. Existence of the Spin	-	263
	71. Transition to Polar Variables		267
	72. The Fine-structure of the Energy-levels of Hydrogen		269
-	73. Theory of the Positron	•	273
		•	· · · -

xi

## CONTENTS

XII.	QUANTUM ELECTRODYNAMICS	•	· .	276	
	74. The Electromagnetic Field in the Absence of	Matter		276	
	75. Relativistic Form of the Quantum Conditions .				
	76. The Schrödinger Dynamical Variables .	•		283	
	77. The Supplementary Conditions .	÷.		287	
	78. Electrons and Positrons by Themselves .	•		292	
	79. The Interaction	•		298	
	80. The Physical Variables	•		302	
	81. Difficulties of the Theory			306	
	INDEX			311	

xii