

Table of Contents

Chapter 1. Fundamental Notions of Quantum Mechanics	1
§ 1. Wave Functions	1
§ 2. Hilbert Spaces	4
§ 3. Linear Operators	9
§ 4. Hypermaximal Operators	12
§ 5. Separation of Variables	16
§ 6. One Electron in a Central Field	19
§ 7. Perturbation Theory	25
§ 8. Angular Momentum and Infinitesimal Rotations	27
Chapter 2. Groups and Their Representations	32
§ 9. Linear Transformations	32
§ 10. Groups	40
§ 11. Equivalence and Reducibility of Representations	46
§ 12. Representations of Abelian Groups. Examples	53
§ 13. Uniqueness Theorems	59
§ 14. Kronecker's Product Transformation	61
§ 15. The Operators Commuting with all Operators of a Given Representation	66
§ 16. Representations of Finite Groups	71
§ 17. Group Characters	78
Chapter 3. Translations, Rotations and Lorentz Transformations	82
§ 18. Lie Groups and their Infinitesimal Transformations	82
A. Lie Groups	82
B. One-dimensional Lie Groups and Semi-Groups	83
C. Causality and Translations in Time	86
D. The Lie Algebra of a Lie Group	87
E. Representations of Lie Groups	89
§ 19. The Unitary Groups $SU(2)$ and the Rotation Group \mathcal{O}_3	90

§ 20. Representations of the Rotation Group \mathcal{O}_3	96
§ 21. Examples and Applications	101
A. The Product Representation $\varrho_j \times \varrho_j$	101
B. The Clebsch-Gordan Series	102
C. Applications of (21.1)	107
D. The Reflection Character	109
§ 22. Selection and Intensity Rules	110
§ 23. The Representations of the Lorentz Group	114
A. The Group $SL(2)$ and the Restricted Lorentz Group	114
B. Infinitesimal Transformations	117
C. The Relation between World Vectors and Spinors	120
 Chapter IV. The Spinning Electron	 123
§ 24. The Spin	123
§ 25. The Wave Function of the Spinning Electron	125
A. Pauli's Pair of Functions (ψ_1, ψ_2)	125
B. Transformation of the Pair (ψ_1, ψ_2)	126
C. Infinitesimal Rotations	128
D. The Angular Momenta	129
E. The Doublet Splitting of the Alkali Terms	131
C. The Inversion s	132
§ 26. Dirac's Wave Equation	132
§ 27. Two-Component Spinors	137
A. Dirac's Equation Rewritten	137
B. Weyl's Equation	140
§ 28. The Several Electron Problem. Multiplet Structure. Zeeman Effect	 141
 Chapter V. The Group of Permutations and the Exclusion Principle	 148
§ 29. The Resonance of Equal Particles	148
§ 30. The Exclusion Principle and the Periodical System	157
§ 31. The Eigenfunctions of the Atom	161
§ 32. The Calculation of the Energy Values	171
§ 33. Pure Spin Functions and their Transformation under Rotations and Permutations	 174
§ 34. Representations of the Symmetric Group \mathcal{S}_n	182
 Chapter VI. Molecule Spectra	 188
§ 35. The Quantum Numbers of the Molecule	188
§ 36. The Rotation Levels	195
§ 37. The Case of Two Equal Nuclei	202