Contents

List of Contributors vii

Preface ix

Contents of Volume I xiii

The Representations and Tensor Operators of the Unitary Groups $U(n)$

W. J. HOLMAN, III, AND L. C. BIEDENHARN

I. Introduction: The Connections between the Representation Theory of $S(n)$ and That of $U(n)$, and Other Preliminaries 1
II. The Group $SU(2)$ and Its Representations 21
III. The Matrix Elements for the Generators of $U(n)$ 27
IV. Tensor Operators and Wigner Coefficients on the Unitary Groups 45
References 71

Symmetry and Degeneracy

HAROLD V. MCINTOSH

I. Introduction 75
II. Symmetry of the Hydrogen Atom 80
III. Symmetry of the Harmonic Oscillator 84
IV. Symmetry of Tops and Rotators 87
V. Bertrand's Theorem 91
VI. Non-Bertrandian Systems 95
VII. Cyclotron Motion 98
VIII. The Magnetic Monopole 101
IX. Two Coulomb Centers 105
X. Relativistic Systems 109
XI. *Zitterbewegung* 115
XII. Dirac Equation for the Hydrogen Atom 120
XIII. Other Possible Systems and Symmetries 125
XIV. Universal Symmetry Groups 129
XV. Summary 134
References 137

Dynamical Groups in Atomic and Molecular Physics

CARL E. WULFMAN

I. Introduction 145
II. The Second Vector Constant of Motion in Kepler Systems 147

III. The Four-Dimensional Orthogonal Group and the Hydrogen Atom 150
IV. Generalization of Fock's Equation: $O(5)$ as a Dynamical Noninvariance Group 160
V. Symmetry Breaking in Helium 170
VI. Symmetry Breaking in First-Row Atoms 176
VII. The Conformal Group and One-Electron Systems 185
VIII. Conclusion 195
References 196

Symmetry Adaptation of Physical States by Means of Computers

STIG FLODMARK AND ESKO BLOKKER

I. Introduction 199
II. Constants of Motion and the Unitary Group of the Hamiltonian 199
III. Separation of Hilbert Space with Respect to the Constants of Motion 204
IV. Dixon's Method for Computing Irreducible Characters 206
V. Computation of Irreducible Matrix Representatives 211
VI. Group Theory and Computers 217
References 219

Galilei Group and Galilean Invariance

JEAN-MARC LÉVY-LEBLOND

I. Introduction 222
II. The Galilei Group and Its Lie Algebra 224
III. The Extended Galilei Group and Lie Algebra 235
IV. Representations of the Galilei Groups 243
V. Applications to Classical Physics 254
VI. Applications to Quantum Physics 271
References 296

Author Index 301

Subject Index 306