## **Contents**

I.	Classical Hyperfine Structure	1
	<ol> <li>Introduction, 1</li> <li>Classical Hyperfine Interactions, 2</li> </ol>	
n.	Angular Momentum and Second Quantization	8
	<ol> <li>Coupling of Two Angular Momenta, 8</li> <li>Coupling of Three Angular Momenta, 10</li> <li>Coupling of Four Angular Momenta, 13</li> <li>Spherical Tensors, 14</li> <li>Second-Quantization Techniques, 16</li> <li>Graphs, 18</li> </ol>	
m.	Atomic Structure	21
	<ol> <li>Introduction, 21</li> <li>The Dirac Equation, 23</li> <li>Creation and Annihilation Operators for Relativistic Electrons, 27</li> <li>Groups and Group Generators, 30</li> <li>States, 34</li> <li>Perturbing Interactions, 40</li> <li>Operators and Representations, 45</li> <li>The Wigner-Eckart Theorem, 48</li> <li>Nonrelativistic Limit of the Perturbing Interactions, 49</li> <li>Discussion of Atomic Structure, 53</li> </ol>	
IV.	And design along the property of the contract of the property of the contract	57
	<ol> <li>Electromagnetic Fields of a Nonspherical Nucleus, 57</li> <li>The Hyperfine Hamiltonian, 62</li> </ol>	
		vii

viii	Contents

	3. The Hyperfine Hamiltonian for the Many-Electron	
	Atom, 64	
	<ol> <li>Effective Operators, 67</li> <li>Interaction Constants and Nuclear Moments, 68</li> </ol>	
	5. Interaction Constants and Nuclear Moments, 68 6. Nonrelativistic Limits of the Hyperfine Interactions, 73	
v.	The Central Field Approximation	79
	1. Introduction, 79	
	2. The Nonrelativistic Central Potential, 79	
	3. The Relativistic Central Field, 84	
	4. Breakdown of the Central Field Approximation, 86	
	5. Perturbations in the Nonrelativistic Theory, 95	
	6. Core Polarization—Perturbation Analysis, 96	
	7. Core Polarization—Hartree-Fock Treatment, 107	
	8. Quadrupole Shielding, 110	
	9. Correlation, 116	
VI.	Hyperfine Structure in an External Field	122
	1. External Magnetic Fields, 122	
	2. Diamagnetic Shielding, 129	
	3. External Uniform Electric Fields, 130	
	4. Interactions with the Gradient of an External Electric Field, 135	
VII.	Higher-Order Effects	137
	1. Introduction, 137	
	2. Hyperfine Anomalies, 137	
	3. Breakdown of J as a Good Quantum Number, 145	
	4. Atomic Electric Dipole Moments, 150	
	5. Differential Polarizability, 156	
VIII.	Hyperfine Structure of the One-Electron Atom	160
	1. Hyperfine Interaction Constants in One-Electron	
	Atoms, 160 2. Relativistic Radial Integrals—Casimir Factors, 161	
	2. Relativistic Radial Integrals—Casimir Factors, 161 3. Approximate Hyperfine Interaction Constants, 165	
IX.	Hyperfine Structure in the Many-Electron Atom	167
	•	107
	<ol> <li>Hyperfine Structure in the Configuration I<sup>n</sup>, 167</li> <li>The Half-Filled Shell, 174</li> </ol>	

4.	Hyperfine Structure in the Configuration l <sup>n</sup> l' <sup>m</sup> ,	176
5.	Hyperfine Structure of Samarium, 179	
Appendix.	Nonrelativistic Limits	189
References	3	193
Index		201

3. The Contact Interaction in l<sup>n</sup>, 175

Contents ix