Contents

Preface ix

Contents of Part B xi

Chapter 1. **Lattice Dynamics**

1.1 Equations of Motion and Their Solution 1
1.2 The Reciprocal Lattice and the Brillouin Zone 10
1.3 Optical Properties: Classical Theory 16
1.4 Quantization of Lattice Vibrations 19
1.5 Thermodynamics and the Density of States 24
1.6 Scattering of Thermal Neutrons by a Vibrating Crystal Lattice 36
1.7 The Mössbauer Effect 51
1.8 Lattice Thermal Conductivity 55
1.9 Quantum Theory of the Interaction of Lattice Vibrations with Electromagnetic Radiation 70
Problems 76
References 78

Chapter **2.** **Phenomenological Theories of Magnetic Order**

2.1 General Description *80*
2.2 Interaction of Atomic Spins at Large Distances 81
2.3 Molecular Field Theory 87
2.4 Spin Waves 96
2.5 Scattering of Slow Neutrons by Magnetically Ordered Systems 122
2.6 The Ising Model 132
2.7 The Magnetic Phase Transition 149
Problems 165
References 167

Chapter **3.** **Symmetry and Its Consequences**

3.1 Space Groups and Point Groups 170
3.2 Irreducible Representations: Point Groups 179

3.3 Symmetry with Spin 190
3.4 Ions in Crystals 194
3.5 Irreducible Representations: Translation Groups and Bloch's Theorem 221
3.6 Irreducible Representations: Space Groups 224
3.7 Time Reversal Symmetry 231
Problems 238
References 239

Chapter 4. **Energy Bands**

4.1 General Properties of Energy Bands 243
4.2 Plane Wave Expansions 261
4.3 Orthogonalized Plane Waves 268
4.4 Pseudopotential Methods 278
4.5 The Tight Binding Method 291
4.6 The Cellular Method 299
4.7 The Green's Function Method 307
4.8 The Augmented Plane Wave Method 319
4.9 The Hartree–Fock Method 327
4.10 Determination of the Crystal Potential 335
Problems 347
References 348

Appendix A. **Summation Relations** 352

Appendix B. **Quantization of the Free Electromagnetic Field** 355

Appendix C. **Character Tables and Compatibility Tables** 358

Appendix D. **Second Quantization for a System of Fermions** 364

Author Index for Part ***A*** *1*
Subject Index for ***Parts A and B*** 7