

Contents

Preface	vii
PART ONE	
BASIC CONCEPTS	1
CHAPTER 1	
Thermodynamical Principles and the Landau Theory of Phase Transitions	3
1.1. Introduction	3
1.2. Phase Equilibria in Isotropic Systems	4
1.3. Chemical Potentials in First-Order Phase Transitions and Metastable States	6
1.4. The van der Waals Equation of State	10
1.5. The Ehrenfest Definition of the Second-Order Phase Transition and the Landau Theory for a Binary Transition	14
1.6. Order-Parameter Susceptibility, the Curie–Weiss Law, and Domains	20
1.7. Beyond Classical Thermodynamics, the Nature of Critical Fluctuations	23
1.8. Remarks on Critical Exponents	26
CHAPTER 2	
Order Variables and Their Correlations, and the Mean-Field Approximation	28
2.1. Order Variables and Their Mean-Field Average	28
2.2. Probabilities, Short-Range Correlations, and the Order Parameter	30
2.3. Mean-Field Theory of Order–Disorder Statistics	34
2.4. The Ising Model for Spin–Spin Correlations	36
	ix

x	Contents	Contents	xi
CHAPTER 3			
Pseudospins and Their Collective Modes in Displacive Crystals	41	7.2. Rayleigh and Brillouin Scattering from Polar Crystals	139
3.1. Pseudospins in Displacive Crystals	41	7.3. Dielectric Relaxation	142
3.2. The Landau Criterion for Classical Fluctuations	44	7.4. Dielectric Spectra in the Ferroelectric Phase Transition of TSCC	145
3.3. Quantum-Mechanical Pseudospins and Their Correlations in Crystals	46	CHAPTER 8	
3.4. Collective Pseudospin Modes in Displacive Systems	49	The Spin Hamiltonian and Magnetic Resonance Spectroscopy	151
3.5. Examples of Collective Pseudospin Modes	51	8.1. Introduction	151
3.5.1. Strontium Titanate and Related Perovskites	52	8.2. Magnetic Resonance and Relaxation	153
3.5.2. Tris-Sarcosine Calcium Chloride and Related Crystals	55	8.3. Magnetic Resonance Spectrometers	157
3.6. The Curie-Weiss Singularity in Collective Pseudospin Modes	59	8.4. The Spin Hamiltonian	160
CHAPTER 4		8.5. The Fine Structure	164
Soft Lattice Modes and Pseudospin Condensates	62	8.6. Hyperfine Interactions and Forbidden Transitions	167
4.1. Introduction	62	8.7. Tensor Analysis for Spin-Hamiltonian Parameters	170
4.2. The Lyddane-Sachs-Teller Relation	65	CHAPTER 9	
4.3. Long-Range Interactions and the Cochran Soft-Mode Theory	69	Magnetic Resonance Sampling and Nuclear Spin Relaxation	
4.4. Anharmonic Lattice Potentials and the Cowley Theory	72	Studies of Pseudospin Condensates	174
4.5. Observation of Soft-Mode Spectra	75	9.1. Paramagnetic Spins in a Modulated Crystal	174
4.6. The Central Peak	79	9.2. The Spin Hamiltonian in Modulated Crystals	176
4.7. Symmetry-Breaking Fluctuations of Pseudospins	81	9.2.1. The \mathbf{g} Tensor Anomaly	176
4.8. Macroscopic Properties of Pseudospin Condensates	87	9.2.2. The Hyperfine Anomaly	180
CHAPTER 5		9.2.3. The Fine Structure Anomaly	180
Pinning and Dynamics of Pseudospin Condensates		9.3. Structural Phase Transitions as Observed by Paramagnetic	
in Practical Crystals	91	Resonance Spectra	182
5.1. Introduction	91	9.3.1. The Ferroelectric Phase Transition in TSCC Crystals	182
5.2. The Pinning Potential	92	9.3.2. Structural Phase Transitions in BCCD	191
5.3. Collective Pseudospin Dynamics in a One-Dimensional Lattice	95	9.4. Nuclear Quadrupole Relaxation in Incommensurate Phases	201
5.4. The Lifshitz Condition for Incommensurability	101	CHAPTER 10	
5.5. Condensate Locking by a Pseudoperiodic Lattice Potential	103	Structural Phase Transitions in Miscellaneous Systems	206
PART TWO		10.1. Cell-Doubling Transitions in Oxide Perovskites	206
EXPERIMENTAL STUDIES	111	10.2. The Incommensurate Phase in Beta Thorium Tetrabromide	211
CHAPTER 6		10.3. Phase Transitions in Deuterated Biphenyl Crystals	216
Diffuse X-Ray Diffraction and Neutron Inelastic Scattering		10.4. Successive Phase Transitions in A_2BX_4 Family Crystals	220
from Modulated Crystals	113	10.5. Incommensurate Phases in $RbH_3(SeO_3)_2$ and Related Crystals	224
6.1. Modulated Crystals	113	10.6. Phase Transitions in $(NH_4)_2SO_4$ and NH_4AlF_4	227
6.2. The Bragg Law for X-Ray Diffraction	115	10.7. Remarks on Proton Ordering in Hydrogen-Bonded Crystals	232
6.3. Diffraction from Weakly Modulated Structures	118	References	237
6.4. Diffuse Laue Diffraction from Perovskite Crystals in the Critical Region	122	Index	241
6.5. Neutron Inelastic Scattering	125		
CHAPTER 7			
Light Scattering and Dielectric Studies on Modulated Crystals	133		
7.1. Raman Scattering Studies on Structural Phase Transitions	133		