## Contents

Pre	Preface		
	Part	one: Statics	1
1	Spin systems and fluids		3
	1.1	Spin models	3
	1.2	One-component fluids	10
	1.3	Binary fluid mixtures	23
	Appe	endix 1A Correlations with the stress tensor	30
	Refe	rences	32
2	Critical phenomena and scaling		34
	2.1	General aspects	34
	2.2	Critical phenomena in one-component fluids	45
	2.3	Critical phenomena in binary fluid mixtures	53
	2.4	<sup>4</sup> He near the superfluid transition	66
	Appendix 2A Calculation in non-azeotropic cases		74
	Refe	rences	75
3	Mean field theories		78
	3.1	Landau theory	78
	3.2	Tricritical behavior	84
	3.3	Bragg–Williams approximation	90
	3.4	van der Waals theory	99
	3.5	Mean field theories for polymers and gels	104
	Appendix 3A Finite-strain theory		119
	References		122
4	Advanced theories in statics		124
	4.1	Ginzburg-Landau-Wilson free energy	124
	4.2	Mapping onto fluids	133
	4.3	Static renormalization group theory	144
	4.4	Two-phase coexistence and surface tension	162
	4.5	Vortices in systems with a complex order parameter	173
	Appendix 4A Calculation of the critical exponent $\eta$		178
	Appendix 4B Random phase approximation for polymers		179

	Appendix 4C Renormalization group equations for <i>n</i> -component systems	180	
	Appendix 4D Calculation of a free-energy correction	181	
	Appendix 4E Calculation of the structure factors	182	
	Appendix 4F Specific heat in two-phase coexistence	183	
	References )	184	
	Part two: Dynamic models and dynamics in fluids and polymers	189	
5	Dynamic models	191	
	5.1 Langevin equation for a single particle	191	
	5.2 Nonlinear Langevin equations with many variables	198	
	5.3 Simple time-dependent Ginzburg–Landau models	203	
	5.4 Linear response	211	
	Appendix 5A Derivation of the Fokker–Planck equation	217	
	Appendix 5B Projection operator method	217	
	Appendix 5C Time reversal symmetry in equilibrium time-correlation		
	functions	222	
	Appendix 5D Renormalization group calculation in purely dissipative		
	dynamics	222	
	Appendix 5E Microscopic expressions for the stress tensor and energy current	223	
	References	224	
6	Dynamics in fluids	227	
	6.1 Hydrodynamic interaction in near-critical fluids	227	
	6.2 Critical dynamics in one-component fluids	237	
	6.3 Piston effect	252	
	6.4 Supercritical fluid hydrodynamics	265	
	6.5 Critical dynamics in binary fluid mixtures	271	
	6.6 Critical dynamics near the superfluid transition	281	
	6.7 <sup>4</sup> He near the superfluid transition in heat flow	298	
	Appendix 6A Derivation of the reversible stress tensor	307	
	Appendix 6B Calculation in the mode coupling theory	308	
	Appendix 6C Steady-state distribution in heat flow	309	
	Appendix 6D Calculation of the piston effect	310	
	References	311	
7	Dynamics in polymers and gels		
	7.1 Viscoelastic binary mixtures	317	
	7.2 Dynamics in gels	335	
	7.3 Heterogeneities in the network structure	351	
	Appendix 7A Single-chain dynamics in a polymer melt	359	
	Appendix 7B Two-fluid dynamics of polymer blends	360	
	Appendix 7C Calculation of the time-correlation function	362	
	Appendix 7D Stress tensor in polymer solutions	362	

.

Contents	vi	
Appendix 7E Elimination of the transverse degrees of freedom	363	
Appendix /F Calculation for weakly charged polymers	365	
Appendix 7G Surface modes of a uniaxial gel	366	
References	366	
Part three: Dynamics of phase changes	371	
Phase ordering and defect dynamics	373	
8.1 Phase ordering in nonconserved systems	373	
8.2 Interface dynamics in nonconserved systems	389	
8.3 Spinodal decomposition in conserved systems	400	
8.4 Interface dynamics in conserved systems	407	
8.5 Hydrodynamic interaction in fluids	421	
8.6 Spinodal decomposition and boiling in one-component fluids	432	
8.7 Adiabatic spinodal decomposition	437	
8.8 Periodic spinodal decomposition	440	
8.9 Viscoelastic spinodal decomposition in polymers and gels	444	
8.10 Vortex motion and mutual friction	453	
Appendix 8A Generalizations and variations of the Porod law	469	
Appendix 8B The pair correlation function in the nonconserved case	473	
Appendix 8C The Kawasaki–Yalabik–Gunton theory applied to periodic	175	
quench	474	
Appendix 8D The structure factor tail for $n = 2$		
Appendix 8E Differential geometry	476	
Appendix 8F Calculation in the Langer–Bar-on–Miller theory	477	
Appendix 8G The Stefan problem for a sphere and a circle	478	
Appendix 8H The velocity and pressure close to the interface	479	
Appendix 8I Calculation of vortex motion References	480	
	482	
Nucleation9.1Droplet evolution equation	488	
9.2 Birth of droplets	488	
9.3 Growth of droplets	499	
9.4 Nucleation in one-component fluids	506	
9.5 Nucleation at very low temperatures	518	
9.6 Viscoelastic nucleation in polymers	530	
9.7 Intrinsic critical velocity in superfluid helium	533	
Appendix 9A Relaxation to the steady droplet distribution	538	
Appendix 9B The nucleation rate near the aritical	543 544	
Appendix 9B The nucleation rate near the critical point Appendix 9C The asymptotic acaling function		
Appendix 9C The asymptotic scaling functions in droplet growth Appendix 9D Moving domains in the discinction of	545 546	
Appendix 9D Moving domains in the dissipative regime Appendix 9E Piston effect in the presence of growing droplets		
right and a reserve of growing droplets	547	

viii	Contents		
	Appendix 9F Calculation of the quantum decay rate References	547 548	
10	Phase transition dynamics in solids		
	10.1 Phase separation in isotropic elastic theory	<b>552</b> 556	
	10.2 Phase separation in cubic solids	577	
	10.3 Order-disorder and improper martensitic phase transitions	584	
	10.4 Proper martensitic transitions	593	
	10.5 Macroscopic instability	615	
	10.6 Surface instability	622	
	Appendix 10A Elimination of the elastic field	625	
	Appendix 10B Elastic deformation around an ellipsoidal domain	629	
	Appendix 10C Analysis of the Jahn–Teller coupling	630	
	Appendix 10D Nonlocal interaction in 2D elastic theory	631	
	Appendix 10E Macroscopic modes of a sphere	632	
	Appendix 10F Surface modes on a planar surface	635	
	References	635	
11	Phase transitions of fluids in shear flow		
	11.1 Near-critical fluids in shear	<b>641</b> 642	
	11.2 Shear-induced phase separation	668	
	11.3 Complex fluids at phase transitions in shear flow	684	
	11.4 Supercooled liquids in shear flow	686	
	Appendix 11.A Correlation functions in velocity gradient	700	
	References	700	
Inda			

Index

710

2