

Contents

<i>Preface</i>	<i>page ix</i>
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
Appendix 1A Correlations with the stress tensor	30
References	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 ⁴ He near the superfluid transition	66
Appendix 2A Calculation in non-azeotropic cases	74
References	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 η	178
Appendix 4B Random phase approximation for polymers	179

Appendix 4C Renormalization group equations for n -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 ^4He 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	317
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

	<i>Contents</i>	vii
	Appendix 7E Elimination of the transverse degrees of freedom	363
	Appendix 7F Calculation for weakly charged polymers	365
	Appendix 7G Surface modes of a uniaxial gel	366
	References	366
	Part three: Dynamics of phase changes	371
8	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 quench	474
	Appendix 8D The structure factor tail for $n = 2$	475
	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	480
	References	482
9	Nucleation	488
9.1	Droplet evolution equation	488
9.2	Birth of droplets	499
9.3	Growth of droplets	506
9.4	Nucleation in one-component fluids	518
9.5	Nucleation at very low temperatures	530
9.6	Viscoelastic nucleation in polymers	533
9.7	Intrinsic critical velocity in superfluid helium	538
	Appendix 9A Relaxation to the steady droplet distribution	543
	Appendix 9B The nucleation rate near the critical point	544
	Appendix 9C The asymptotic scaling functions in droplet growth	545
	Appendix 9D Moving domains in the dissipative regime	546
	Appendix 9E Piston effect in the presence of growing droplets	547

viii	<i>Contents</i>	
	Appendix 9F Calculation of the quantum decay rate	547
	References	548
10	Phase transition dynamics in solids	552
10.1	Phase separation in isotropic elastic theory	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	641
11.1	Near-critical fluids in shear	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	701
	<i>Index</i>	710