

Contents

Contributors	v
General Preface	vii
Preface to Volumes 5a and 5b	ix

1. Monte Carlo Investigations of Phase Transitions and Critical Phenomena

K. BINDER

I. Introduction	2
II. Descriptions of the Monte Carlo Technique for Spin Systems	6
A. Master equation approach	6
B. Accuracy and convergence considerations	16
C. Monte Carlo calculations with conservation laws	21
D. Different boundary conditions and their correspondence to physical situations	29
III. Applications to Static Critical Phenomena	37
A. Two- and three-dimensional Ising models	37
B. Two- and three-dimensional classical Heisenberg models	44
C. Analysis of finite size and rounding effects	53
D. Spatial inhomogeneities in infinite systems (surfaces, interfaces, impurities)	61
E. Tricritical points	68
F. A test of M. E. Fisher's droplet model	70
IV. Applications to Dynamic Critical Phenomena	73
A. The single spin-flip kinetic Ising model	74
B. Comparison of the critical slowing down with other treatments	76
C. Metastable states and nonequilibrium relaxation	82
D. Further models	90
V. Discussion	94
References	96
Addendum	100

2. Systems with Weak Long-Range Potentials

P. C. HEMMER and J. L. LEBOWITZ

I. Introduction	108
A. The van der Waals-Maxwell theory	108
B. Rigorous results	110
C. Metastable states	112
D. Approximate results	112

II. Rigorous Derivation of van der Waals–Maxwell Theory	113
A. Preliminaries	113
B. Statement of main results	116
C. General bounds	118
D. Proof of theorem 1	120
E. Some consequences and extensions of theorem 1	128
F. Metastability	132
G. Oscillatory Kac potentials; Gates and Penrose theorem	136
III. Integral Equation Approach	138
A. Integral equation for the one-dimensional continuum gas	139
B. Integral equations for the lattice gas	143
C. The van der Waals limit	145
D. Expansion for small γ	149
E. The critical region	153
F. Correlation functions	157
G. Mixtures	161
H. External fields	163
I. Generalized interactions in one and higher dimensions	166
IV. Systematic Expansions	170
A. Graph expansion. Introduction	170
B. Graph expansion. Results	172
C. The Coulomb interaction	180
D. Functional integral approach	182
E. The critical region	186
V. Applications	189
A. The liquid–gas system	189
B. The solid–liquid transition	191
C. Several phase transitions	193
D. Quantum corrections to the location of the critical point	196
References	198

3. Correlation Functions and Their Generating Functionals: General Relations with Applications to the Theory of Fluids

G. STELL

I. Introduction	205
II. General Development	208
III. The Decomposition of W_n and Some Expressions Associated with it	216
IV. Results When the Pair Term is Further Decomposed	222
V. The Dyson-equation Form of the Ornstein–Zernike Equation	231
VI. Use of γ -ordering, Γ -ordering; the Core Condition on $g_2(1/2)$ and the Mean-spherical Model; Nodal Ordering	234
VII. Generalization of the Mean-spherical Approximation and The Self-consistent Γ -ordered Scheme to n -particle Functions	239
References	242
Appendix: Critical Behaviour of Approximations and Models for Which the Ornstein–Zernike Assumption is Satisfied	246
References to Appendix	258

4. Heisenberg Ferromagnet in the Green's Function Approximation

R. A. TAHIR-KHELI

I. Introductory Remarks	259
II. The Random Phase Approximation	260
A. The spin- $\frac{1}{2}$ case	260
B. The general spin case	265
III. The Callen Decoupling	277
IV. Boson Formalism: Extrapolation from Low Temperatures	283
V. The Intermediate Region	288
A. The low-temperature region	294
B. The high-temperature region	294
C. Temperature close to T_c	297
VI. Self-consistent Moment Conserving Decoupling Scheme	302
A. Series expansion schemes	308
B. Results in three dimensions	309
C. Near T_c	310
D. Results in one dimension	313
E. Results in two dimensions	316
VII. Random, Dilute Ferromagnet: an RPA Coherent Exchange Approximation (RPA-CEA) Treatment	317
References	340

5. Thermal Measurements and Critical Phenomena in Liquids

A. V. VORONEL

I. Isomorphy of Critical Phenomena	344
II. Experimental Working Conditions with a Liquid	347
A. Difficulties of the experiment	349
B. Difficulties of interpretation	363
III. Results of the Measurement of Thermodynamic Properties	365
A. Pure liquids	365
B. Dilute solution of heptane in ethane	370
C. The system ethane/carbon dioxide (liquid-vapour critical line)	375
D. The liquid-liquid critical line	378
IV. Discussion of Results	380
V. Conclusion	389
References	390
Appendix: Data on Critical Exponents	392
Author Index	395
Subject Index	403