

CONTENTS

Editor's Foreword	xi
Acknowledgments	xiii
Chapter 1 Introduction to Statistical Mechanics	
1.1 The Partition Function	1
Chapter 2 Density Matrices	
2.1 Introduction to Density Matrices	39
2.2 Additional Properties of the Density Matrix	44
2.3 Density Matrix in Statistical Mechanics	47
2.4 Density Matrix for a One-Dimensional Free Particle	48
2.5 Linear Harmonic Oscillator	49
2.6 Anharmonic Oscillator	53
2.7 Wigner's Function	58
2.8 Symmetrized Density Matrix for N Particles	60
2.9 Density Submatrix	64
2.10 Perturbation Expansion of the Density Matrix	66
2.11 Proof that $F \leq F_0 + \langle H - H_0 \rangle_0$	67
Chapter 3 Path Integrals	
3.1 Path Integral Formation of the Density Matrix	72
3.2 Calculation of Path Integrals	78
3.3 Path Integrals by Perturbation Expansion	84
3.4 Variational Principle for the Path Integral	86
3.5 An Application of the Variation Theorem	88
Chapter 4 Classical System of N Particles	
4.1 Introduction	97
4.2 The Second Virial Coefficient	100
4.3 Mayer Cluster Expansion	105
4.4 Radial Distribution Function	111

4.5	Thermodynamic Functions	113
4.6	The Born-Green Equation for n_2	115
4.7	One-Dimensional Gas	117
4.8	One-Dimensional Gas with Potential of the Form $e^{- x }$	120
4.9	Brief Discussion of Condensation	125
Chapter 5 Order-Disorder Theory		
5.1	Introduction	127
5.2	Order-Disorder in One-Dimension	130
5.3	Approximate Methods for Two Dimensions	131
5.4	The Onsager Problem	136
5.5	Miscellaneous Comments	149
Chapter 6 Creation and Annihilation Operators		
6.1	A Simple Mathematical Problem	151
6.2	The Linear Harmonic Oscillator	154
6.3	An Anharmonic Oscillator	156
6.4	Systems of Harmonic Oscillators	157
6.5	Phonons	159
6.6	Field Quantization	162
6.7	Systems of Indistinguishable Particles	167
6.8	The Hamiltonian and Other Operators	176
6.9	Ground State for a Fermion System	183
6.10	Hamiltonian for a Phonon-Electron System	185
6.11	Photon-Electron Interactions	190
6.12	Feynman Diagrams	192
Chapter 7 Spin Waves		
7.1	Spin-Spin Interactions	198
7.2	The Pauli Spin Algebra	200
7.3	Spin Wave in a Lattice	202
7.4	Semiclassical Interpretation of Spin Wave	206
7.5	Two Spin Waves	207
7.6	Two Spin Waves (Rigorous Treatment)	209
7.7	Scattering of Two Spin Waves	212
7.8	Non-Orthogonality	215
7.9	Operator Method	217
7.10	Scattering of Spin Waves-Oscillator Analog	218
Chapter 8 Polaron Problem		
8.1	Introduction	221
8.2	Perturbation Treatment of the Polaron Problem	225
8.3	Formulation for the Variational Treatment	231
8.4	The Variational Treatment	234
8.5	Effective Mass	241

Chapter 9 Electron Gas in a Metal

9.1	Introduction: The State Function φ	242
9.2	Sound Waves	244
9.3	Calculation of $P(R)$	246
9.4	Correlation Energy	248
9.5	Plasma Oscillation	249
9.6	Random Phase Approximation	252
9.7	Variational Approach	254
9.8	Correlation Energy and Feynman Diagrams	255
9.9	Higher-Order Perturbation	262

Chapter 10 Superconductivity

10.1	Experimental Results and Early Theory	265
10.2	Setting Up the Hamiltonian	269
10.3	A Helpful Theorem	273
10.4	Ground State of a Superconductor	274
10.5	Ground State of a Superconductor (<i>continued</i>)	277
10.6	Excitations	279
10.7	Finite Temperatures	281
10.8	Real Test of Existence of Pair States and Energy Gap	285
10.9	Superconductor with Current	290
10.10	Current Versus Field	293
10.11	Current at a Finite Temperature	298
10.12	Another Point of View	303

Chapter 11 Superfluidity

11.1	Introduction: Nature of Transition	312
11.2	Superfluidity—An Early Approach	319
11.3	Intuitive Derivation of Wave Functions: Ground State	321
11.4	Phonons and Rotons	326
11.5	Rotons	330
11.6	Critical Velocity	334
11.7	Irrotational Superfluid Flow	335
11.8	Rotational of the Superfluid	337
11.9	A Reasoning Leading to Vortex Lines	339
11.10	The λ Transition in Liquid Helium	343
Index		351