CONTENTS

Preface to the third Russian edition	xili
From the prefaces to previous Russian editions	xv
Notation	xvii
I. THE FUNDAMENTAL PRINCIPLES OF STATISTICAL PH	YSICS
and a second by a second second states of an and a second s	ing the second
§ 1. Statistical distributions	
§ 2. Statistical independence	6
§ 3. Liouville's theorem	9
§ 4. The significance of energy	11
§ 5. The statistical matrix	14
§ 6. Statistical distributions in quantum statistics	21
§ 7. Entropy	23
§ 8. The law of increase of entropy	29
II. THERMODYNAMIC QUANTITIES	
§ 9. Temperature	34
§ 10. Macroscopic motion	36
§ 11. Adiabatic processes	38
§ 12. Pressure	41
§ 13. Work and quantity of heat	44
§ 14. The heat function	47
§ 15. The free energy and the thermodynamic potential	48
§ 16. Relations between the derivatives of thermodynamic quantities	51
§ 17. The thermodynamic scale of temperature	55
§ 18. The Joule-Thomson process	56
§ 19. Maximum work	57
§ 20. Maximum work done by a body in an external medium	59
21. Thermodynamic inequalities	63
§ 22. Le Chatelier's principle	65
§ 23. Nernst's theorem	68
§ 24. The dependence of the thermodynamic quantities on the number of p	articles 70
§ 25. Equilibrium of a body in an external field	73
§ 26. Rotating bodies	74
27. Thermodynamic relations in the relativistic region	76
III. THE GIBBS DISTRIBUTION	

ş	28. The Gibbs distribution	79
ş	29. The Maxwellian distribution	82
8	30. The probability distribution for an oscillator	87
8	31. The free energy in the Gibbs distribution	91
8	32. Thermodynamic perturbation theory	95
8	33. Expansion in powers of h	98

_		4
('0H	0.00	20
Con	1071	60

ŝ	34. The Gibbs distribution for rotating bodies35. The Gibbs distribution for a variable number of particles36. The derivation of the thermodynamic relations from the Gibbs distribution	104 106 109
	IV. IDEAL GASES	
5	37. The Boltzmann distribution	111
ŝ	38. The Boltzmann distribution in classical statistics	113
8	39. Molecular collisions	115
8	40. Ideal gases not in equilibrium	118
8	41. The free energy of an ideal Boltzmann gas	120
8	42. The equation of state of an ideal gas	121
ş	43. Ideal gases with constant specific heat	125
8	44. The law of equipartition	129
ş	45. Monatomic ideal gases	132
ş	46. Monatomic gases. The effect of the electronic angular momentum	135
ş	47. Diatomic gases with molecules of unlike atoms. Rotation of molecules	137
ş	48. Diatomic gases with molecules of like atoms. Rotation of molecules	141
ŝ	49. Diatomic gases. Vibrations of atoms	143
8	50. Diatomic gases. The effect of the electronic angular momentum	146
8	51. Polyatomic gases	148
ş	52. Magnetism of gases	152
	V. THE FERMI AND BOSE DISTRIBUTIONS	
ş	53. The Fermi distribution	158
§	54. The Bose distribution	159
ş	55. Fermi and Bose gases not in equilibrium	160
ş	56. Fermi and Bose gases of elementary particles	162
ş	57. A degenerate electron gas	166
ş	58. The specific heat of a degenerate electron gas	168
8	59. Magnetism of an electron gas. Weak fields	171
8		175
8		178
9		180 183
8	63. Black-body radiation	105
	VI. SOLIDS	
ş	64. Solids at low temperatures	191
ş		195
§		198
ş		201
ŝ		203
8	69. Crystal lattice vibrations	207

§ 69. Crystal lattice vibrations

ş	70. Number density of vibrations	
-	71 DL	

§ 71. Phonons

ş	72.	Phonon	creation	and	annihilation	operator	S
---	-----	--------	----------	-----	--------------	----------	---

§ 73. Negative temperatures

VII. NON-IDEAL GASES

211 215

218 221

8	74. Deviations of gases from the ideal state	225
	75. Expansion in powers of the density	230
8	76. Van der Waals' formula	232
	77. Relationship of the virial coefficient and the scattering amplitude	236
	78 Thermodynamic quantities for a classical plasma	239

vi

	Contents	vii
ş	79. The method of correlation functions	243
-	80. Thermodynamic quantities for a degenerate plasma	245
	VIII. PHASE EQUILIBRIUM	
8	81. Conditions of phase equilibrium	251
2		255
- 2		257
	of the critical point	260
	IX. SOLUTIONS	
	95 Custome constrining different posticles	263
8	85. Systems containing different particles	263
000		
00		265
000		267
ĝ		268
ŝ		271
ş		274
ğ	92. Solutions of strong electrolytes	277
8	93. Mixtures of ideal gases	279
ŝ	94. Mixtures of isotopes	281
8	95. Vapour pressure over concentrated solutions	283
ŝ		286
-		289
ŝ		295
ŝ		300
	100. Gases and liquids	301
	X. CHEMICAL REACTIONS	
8	101. The condition for chemical equilibrium	305
	102. The law of mass action	306
	103. Heat of reaction	310
	104. Ionisation equilibrium	313
9	105. Equilibrium with respect to pair production	315
	XI. PROPERTIES OF MATTER AT VERY HIGH DENSITY	
	106. The equation of state of matter at high density	317
§	107. Equilibrium of bodies of large mass	320
ş	108. The energy of a gravitating body	327
5	109. Equilibrium of a neutron sphere	329
	XII. FLUCTUATIONS	
8	110. The Gaussian distribution	333
~	111. The Gaussian distribution for more than one variable	335
	112. Fluctuations of the fundamental thermodynamic quantities	338
۳.	113. Fluctuations in an ideal gas	345
	114. Poisson's formula	347
	115. Fluctuations in solutions	349
-	116. Spatial correlation of density fluctuations	350
~	117. Correlation of density fluctuations in a degenerate gas	354
-	118. Correlations of fluctuations in time	359
	119. Time correlations of the fluctuations of more than one variable	
3	The correlations of the increations of more than one variable	363

§ 120. The symmetry of the kinetic coefficients	365
§ 121. The dissipative function	368
§ 122. Spectral resolution of fluctuations	371
§ 123. The generalised susceptibility	377
§ 124. The fluctuation-dissipation theorem	384
§ 125. The fluctuation-dissipation theorem for more than one variable	389
§ 126. The operator form of the generalised susceptibility	393
§ 127. Fluctuations in the curvature of long molecules	396

XIII. THE SYMMETRY OF CRYSTALS

§ 128. Symmetry elements of a crystal lattice	401
§ 129. The Bravais lattice	
	403
§ 130. Crystal systems	405
§ 131. Crystal classes	409
§ 132. Space groups	411
§ 133. The reciprocal lattice	413
§ 134. Irreducible representations of space groups	416
§ 135. Symmetry under time reversal	422
§ 136. Symmetry properties of normal vibrations of a crystal lattice	427
§ 137. Structures periodic in one and two dimensions	432
§ 138. The correlation function in two-dimensional systems	436
§ 139. Symmetry with respect to orientation of molecules	438
§ 140. Nematic and cholesteric liquid crystals	440
§ 141. Fluctuations in liquid crystals	442

XIV. PHASE TRANSITIONS OF THE SECOND KIND AND CRITICAL PHENOMENA

§ 142. Phase transitions of the second kind	446
§ 143. The discontinuity of specific heat	451
§ 144. Effect of an external field on a phase transition	456
§ 145. Change in symmetry in a phase transition of the second kind	459
§ 146. Fluctuations of the order parameter	471
§ 147. The effective Hamiltonian	478
§ 148. Critical indices	483
§ 149. Scale invariance	489
§ 150. Isolated and critical points of continuous transition	493
§ 151. Phase transitions of the second kind in a two-dimensional lattice	498
§ 152. Van der Waals theory of the critical point	506
§ 153. Fluctuation theory of the critical point	511

XV. SURFACES

§ 154. Surface tension	517
§ 155. Surface tension of crystals	520
§ 156. Surface pressure	522
§ 157. Surface tension of solutions	524
§ 158. Surface tension of solutions of strong electrolytes	526
§ 159. Adsorption	527
§ 160. Wetting	529
§ 161. The angle of contact	531
§ 162. Nucleation in phase transitions	533
§ 163. The impossibility of the existence of phases in one-dimensional systems	537

CONTENTS OF PART 2

Preface

Notation

I. THE NORMAL FERMI LIOUID Why its is more structure and

- 8 1. Elementary excitations in a quantum Fermi liquid
- 8 2. Interaction of quasi-particles
- 3. Magnetic susceptibility of a Fermi liquid ş
- 4. Zero sound ş
- ş 5. Spin waves in a Fermi liquid
- 6. A degenerate almost ideal Fermi gas with repulsion between the particles 8

II. GREEN'S FUNCTIONS IN A FERMI SYSTEM AT T = 0

- ş 7. Green's functions in a macroscopic system
- § 8. Determination of the energy spectrum from the Green's function
- ŝ 9. Green's function of an ideal Fermi gas
- ş 10. Particle momentum distribution in a Fermi liquid
- § 11. Calculation of thermodynamic quantities from the Green's function
- § 12. Ψ operators in the interaction representation
- 12. P operators in the interaction systems ş
- §. 14. The self-energy function
- 15. The two-particle Green's function ş
- § 16. The relation of the vertex function to the quasi-particle scattering amplitude
- ş 17. The vertex function for small momentum transfers
- § 18. The relation of the vertex function to the quasi-particle interaction function
- ş 19. Identities for derivatives of the Green's function
- ş 20. Derivation of the relation between the limiting momentum and the density
- 8 21. Green's function of an almost ideal Fermi gas

III. SUPERFLUIDITY

- § 22. Elementary excitations in a quantum Bose liquid
- 23. Superfluidity §
- 24. Phonons in a liquid δ
- 25. A degenerate almost ideal Bose gas Ş
- \$ 26. The wave function of the condensate
- 27. Temperature dependence of the condensate density 8
- ş 28. Behaviour of the superfluid density near the λ -point
- 8 29. Quantized vortex filaments
- § 30. A vortex filament in an almost ideal Bose gas
- § 31. Green's functions in a Bose liquid
- 32. The diagram technique for a Bose liquid ş
- 33. Self-energy functions §
- § 34. Disintegration of quasi-particles
- 35. Properties of the spectrum near its termination point ş

Contents of part 2

IV. GREEN'S FUNCTIONS AT NON-ZERO TEMPERATURES

- 36. Green's functions at non-zero temperatures
- § 37. Temperature Green's functions
- § 38. The diagram technique for temperature Green's functions

V SUPERCONDUCTIVITY

- 39. A superfluid Fermi gas. The energy spectrum \$
- 40. A superfluid Fermi gas. Thermodynamic properties ş
- § 41. Green's functions in a superfluid Fermi gas
- 8 42. Temperature Green's functions in a superfluid Fermi gas
- 43. Superconductivity in metals ş
- 44. The superconductivity current 8
- 45. The Ginzburg-Landau equations ş
- 46. Surface tension at the boundary of superconducting and normal phases 8
- 47. The two types of superconductor \$
- 48. The structure of the mixed state 8
- 49. Diamagnetic susceptibility above the transition point 8
- § 50. The Josephson effect
- § 51. Relation between current and magnetic field in a superconductor
- § 52. Depth of penetration of a magnetic field into a superconductor
- § 53. Superconducting alloys
- § 54. The Cooper effect for non-zero orbital angular momenta of the pair

VI. ELECTRONS IN THE CRYSTAL LATTICE

- 55. An electron in a periodic field 6
- § 56. Effect of an external field on electron motion in a lattice 11 The different technique for Petro synthesis
- 8 57. Quasi-classical trajectories
- 58. Quasi-classical energy levels 8
- 59. The electron effective mass tensor in the lattice 8
- 60. Symmetry of electron states in a lattice in a magnetic field Ş
- 61. Electron spectra of normal metals 8
- 62. Green's function of electrons in a metal 8
- § 63. The de Haas-van Alphen effect
- § 64. Electron-phonon interaction
- § 65. Effect of electron-phonon interaction on the electron spectrum in a metal
- § 66. The electron spectrum of solid insulators
- 8 67. Electrons and holes in semiconductors.
- § 68. The electron spectrum near the degeneracy point

VII. MAGNETISM

- § 69. Equation of motion of the magnetic moment in a ferromagnet
- 70. Magnons in a ferromagnet. The spectrum 8
- 71. Magnons in a ferromagnet. Thermodynamic quantities 8 in the subscription of the sense field decades the
- 8 72. The spin Hamiltonian
- § 73. Interaction of magnons
- § 74. Magnons in an antiferromagnet

VIII. ELECTROMAGNETIC FLUCTUATIONS

- 75. Green's function of a photon in a medium
- 8 76. Electromagnetic field fluctuations
- 77. Electromagnetic fluctuations in an infinite medium 8

x

Contents of part 2

- § 78. Current fluctuations in linear circuits
- § 79. Temperature Green's function of a photon in a medium
- § 80. The van der Waals stress tensor
- § 81. Forces of molecular interaction between solid bodies. The general formula
- § 82. Forces of molecular interaction between solid bodies. Limiting cases
- § 83. Asymptotic behaviour of the correlation function in a liquid
- § 84. Operator expression for the permittivity
- § 85. A degenerate plasma

IX. HYDRODYNAMIC FLUCTUATIONS

- § 86. Dynamic form factor of a liquid
- § 87. Summation rules for the form factor
- § 88. Hydrodynamic fluctuations
- § 89. Hydrodynamic fluctuations in an infinite medium
- § 90. Operator expressions for the transport coefficients
- § 91. Dynamic form factor of a Fermi liquid

Index