Contents

P	art I	Classical Theory		
2.	Free	Charged Particles and a Field		
	2.1	The Equations of Particle Motion. Local Field		
	2.2	The Equations for Microscopic Field Strengths (Lorentz Equations)		
	2.3	A Coulomb Plasma		
	2.4	The Complete Set of Microscopic Equations for a Plasma		
	2.5	The Equation of Motion of Free Charged Particles and		
		Field Oscillators		
	2.6	Lagrange Function		
	2.7	Hamiltonian Function		
	2.8	The Equations of Motion for Phase Densities of Particles and		
		Field Oscillators		
	2.9	Distribution Functions of Particles and Field Oscillators		
	2.10	Chain of Equations for Distribution Functions of Particles and		
		Field Oscillators		
	2.11	Equations for Moments		
	2.12	The Relation Between Moments and Distribution Functions		
3.	Atoms and Field			
	3.1	The Equations of Motion of Pairs of Free Charged Particles		
		and Atoms		
	3.2	The Equations for Microscopic Phase Density of Atoms		
	3.3	Microscopic Field Equations		
	3.4	Lagrange Function		
	3.5	Hamiltonian Function		
	3.6	The Closed Equation for Phase Density of Atoms		
	3.7	The Interaction of Atoms		
	3.8	Atoms and Field Oscillators		
	3.9	The Method of Distribution Functions for a System of Atoms and		
		Field Oscillators		
4.	The !	Kinetic Equations for a System of Free Charged Particles		
		Field		
	A 1	The Principal Parameters (Free Charged Particles)		



	4.2	Princi	pal Parameters for a System of Atoms	58
		4.2.1	Interaction Parameters	58
		4.2.2	The Relaxation Processes Parameters for Atoms	59
		4.2.3	Comparison of the Density Parameters ε_d and ε_{em}	61
	4.3		Moments Approximation	62
	4.4	The Ki	inetic Equations for a Coulomb Plasma	65
	4.5	Electro	omagnetic Interaction in the Kinetic Equations of a Plasma	70
	4.6	The P	olarization Approximation for the System of Charged	
		Partic	les and Field Oscillators	73
	4.7	The E	quilibrium Fluctuations of an Electromagnetic Field	78
	4.8	The K	inetic Theory of Fluctuations	81
	4.9	Nonec	quilibrium Fluctuations of the Field	89
5.	Bro	wnian N	Aotion	93
-	5.1		angevin Equations	93
	5.2	The F	okker – Planck Equation	94
	5.3		sion of Brownian Particles	97
	5.4	The B	rownian Motion of a Harmonic Oscillator.	
			lyquist Formula	99
	5.5	Nond	issipative Nonlinearity. Brownian Motion at Phase	
		Trans	itions	100
		5.5.1	Fokker – Planck and Einstein – Smoluchowsky Equations	100
		5.5.2	The Equilibrium Distribution	101
		5.5.3	Energy Fluctuations	103
		5.5.4	Self-Consistent Approximation with Respect to Energy	104
		5.5.5		105
		5.5.6	Fluctuations of the Order Parameter	106
	5.6	Spect	ral Distribution of the Mean Energy	107
	5.7	The R	Response of the System to External Factors	108
		5.7.1	Dynamic Response. Spectral of Fluctuations	110
		5.7.2	The Critical Region	111
	5.8	Phase	Transition in a Distributed System	111
		5.8.1	A Langevin Source in the Ginzburg – Landau Equation	111
		5.8.2		113
		5.8.3	Fluctuations of the Order Parameter	113
		5.8.4	Spatial Correlations	114
		5.8.5	Extrapolation of Landau Theory into the Critical Region .	116
		5.8.6		117
		5.8.7		118
		5.8.8	The Critical Point	120
		5.8.9		120
			0 The Transition to the Results of Landau Theory	121
		5.8.1	1 Correlation Times and Spectrum Widths at a Phase	
			Transition	122
	5.9	Dissi	pative Nonlinearity	125
	5.1	0 The l	Langevin Equations for a Self-Oscillatory System.	105
		Thal	Fokker Planck Equation	127

		Contents	IX		
	5.11	The Stationary Distribution of the Energy of Oscillations	131		
	5.12	Fluctuations of Amplitude. Diffusion of a Phase	133		
		Spectral Distribution of the Energy of Autooscillations	135		
		The Response to Resonant Force	139		
	5.15	Kinetic Theory of Fluctuations in Brownian Motion	143		
6.	Kine	tic Equations for an Atom – Field System	147		
	6.1	Electromagnetic Fluctuations in a Gas	147		
	6.2	The Kinetic Equation. The Collision Integral	152		
	6.3	The Equation for the Polarization Vector	157		
	6.4	The Effective Lorentz Field	161		
	6.5	Dissipative Processes Due to Close Correlations	163		
	6.6 6.7	The Equation for the Polarization Vector	165		
		The Equation of Dispersion	167		
	6.8	Fluctuations of Polarization and Field at Above-Critical			
		Temperatures	170		
	6.9	Phase Transition in an Atom – Field System	173		
	•	6.9.1 Initial Equations	173		
		6.9.2 Fluctuations of the "Source" δP^{source}	175		
		6.9.3 Induced Fluctuations of the Polarization Vector	176		
P	art II	Quantum Theory			
-	Min	annia Escationa	180		
/.	7.1	Oscopic Equations	180		
	7.1	Partially Ionized Plasma	184		
	7.2	The Hamiltonian with Electromagnetic Interaction (Extreme Cases)	188		
	7.3 7.4	The Equations for Operators of Field and Particles	189		
	7.5	Operator Equations for an Atom – Field System in Dipole	109		
	7.5	Approximation	191		
8.	The	Kinetic Equations for Partially Ionized Plasma.			
•		Coulomb Approximation	194		
	8.1	The Polarization Approximation	194		
	8.2	The Correlation of the Source Fluctuations	196		
	8.3	Dielectric Permittivity	199		
	8.4	The Spectral Density of the Electric Field Fluctuations	205		
	8.5	The Collision Integral	207		
	8.6	The Structure of Collision Integrals	209		
	8.7	The Equations for Concentrations	213		
	8.8	The Kinetic Theory of Fluctuations in Partially Ionized Plasma	215		
9.		Kinetic Equations for Partially Ionized Plasma. The Processes			
		ditioned by a Transverse Electromagnetic Field	220		
		Dielectric Permittivity	220		

	9.2	The Spectral Density of Transverse Field Fluctuations	222
	9.3	The Collision Integral	223
	9.4	The Structure of the Collision Integrals for the Transparency	
		Region	225
	9.5	The Evolution of the Distribution Function of Atoms	226
	9.6	The Equations for Concentrations of Free Charged Particles	
		and Atoms. The Contribution from the Interaction of Particles	
		and Waves	230
	9.7	Cooling and Heating of Atoms by Resonant Field.	222
		Classical Theory	232
	9.8	Cooling and Heating of Atoms by a Resonant Field.	225
		Quantum Theory	235
10.	Spectr	ral Emission Line Broadening of Atoms	
		tially Ionized Plasma	238
	10.1	The Foundations of the Kinetic Theory of Spectral Line	
		Broadening	238
	10.2	The Dissipative Matrix. The Frequency Shift	243
	10.3	The Influence of the Source Fluctuations on Linewidth and	
		Frequency Shift	245
	10.4	The Probabilities of the Transition. The Broadening at	
		Spontaneous and Induced Processes	247
	10.5	Spectral Line Broadening by a Plasma's Electrons	250
	10.6	Resonant Broadening of Spectral Lines Due to Atoms'	
		Collisions	253
	10.7	Spectral Line Broadening upon Elastic Collisions of Atoms	255
	10.8	Radiation Capture (Inprisonment of Radiation)	259
	10.9	The Influence of the Static Electric Field upon the Atomic	262
	10.10	Emission Spectrum	263
	10.10	The Distribution of Microfields Created by Ions. The Holzmark	265
	10 11	Formula The Atomic Emission Spectrum with the Ion Field Distribution	203
	10.11	Taken into Account	267
	10 12	The Influence of an Electron Field on the Intensity Distribution	20,
	10.12	at the Wings of the Spectral Line	270
	10.13	Taking Strong Short-Range Interactions and Collective	
		Long-Range Interactions into Account Simultaneously	271
	10.14	Some Problems of the Kinetic Theory of Spectral Line	
		Broadening	272
4.4	T314	dans and Minetic December in Contains Comment	
11.		nations and Kinetic Processes in Systems Composed	275
	01 Str	ongly Interacting Particles	213
	11.1	Spontaneous Radiation	275
	11.2	The Effective Lorentz Field	277
	11.2	The Influence of the Correlations of Atoms' Positions	211
	11.5	on the Coefficient of Spontaneous Emission	278
	11 /	The Kubo and the Callen - Welton Equations	280

	11.5	Fluctuations of the Distribution Function of the Density Matrix. The Random Source in the Liouville Equation	286			
	11.6	Fluctuations in an Extended System. The Polarization	200			
	11.7	Approximation	288			
	11./	The Callen – Welton Equation for Nonequilibrium States	290			
	11.8	The Kinetic Equation Giving the Distribution Function for the	290			
	11.0	States of a System of Interacting Atoms	294			
	11.9	The Transition to the Kinetic Equation for One-Particle	234			
	11.9	Distribution Functions of Atoms	298			
	11 10	The Transparency Region. Probabilities of Transition	300			
		The Distribution Function of a System of Atoms and Mean	300			
	11.11	Field. The First-Moments Approximation	301			
	11 12	The Influence of the Correlations of Atoms' Positions on the	301			
	11.12	Absorption and Scattering of Electromagnetic Waves	302			
		Absorption and Scattering of Electromagnetic waves	302			
12	Flucto	nations in Quantum Self-Oscillatory Systems	305			
14.	12.1	A System Composed of Two-Level Atoms and a Field	305			
	12.2	Stationary Generation Regime, Without Taking Fluctuations	303			
	12.2	into Account	308			
	12.3	Sources of Fluctuations in a Quantum Generator	310			
	12.4	Field Equations with Fluctuations Taken into Account	313			
	12.5	Fluctuations of Radiation in a Quantum Optical Generator	315			
	12.6	Spatial and Temporal Correlations of a Field Below the	J.J			
	12.0	Generation Threshold	318			
	12.7	Spatial and Temporal Correlations of the Fluctuations of Laser	310			
	12.7	Radiation	320			
13.	Phase	Phase Transitions in a System Composed of Atoms and a Field 32				
	13.1	A Phase Transition in a System Composed of Two-Level Atoms				
		and a Field	324			
	13.2	Fluctuations in the Polarization and the Field at Above-Critical				
		Temperatures	327			
	13.3	Fluctuations in the Polarization and the Field in the Critical				
		Region	329			
		13.3.1 The Equation for the Polarization Vector	329			
		13.3.2 Induced Fluctuations of Polarization	331			
		13.3.3 Field Fluctuations	332			
	13.4	Laser-Radiation-Induced Phase Transitions in a System				
		of Two-Level Atoms	333			
	13.5	The Influence of a Phase Transition on Generation	338			
		13.5.1 In Ferroelectrics	338			
		13.5.2 In Liquid Crystals	342			
	14. C	onclusion	347			
	Refere	ences	349			
		ot Indov	361			