

Contents

1	Introduction	1
2	Thermodynamic Systems	6
2.1	The Macroscopic level	7
2.1.1	The 0. Law of Thermodynamics: The Existence of Temperature	7
2.1.2	The 1. Law of Thermodynamics: The Macroscopic Energy Principle	8
2.1.3	The 2. Law of Thermodynamics: The Law of Entropy	9
2.1.4	The 3. Law of Thermodynamics: The Limit Value Condition at the Zero Point of the Absolute Temperature	10
2.2	The Microscopic Level	11
2.2.1	The Molecular Energy	11
2.2.2	The Statistical Definition of Entropy	12
2.3	Statistics and Phase Transitions	19
2.3.1	Remarks on Landau's Theory	20
2.3.2	The Correlated Statistics	23
3	Aspects of System Theory	26
3.1	Information	27
3.1.1	The Basic Information Expression	27
3.1.2	The Meaning of Information	27
3.1.3	The Measurement Integral Formalism	29
3.1.4	Information and Measurement	30
3.2	The Maximum Information Entropy Principle	31
3.2.1	The Basic Principle	31
3.2.2	The General Solution of the Basic Principle	32
3.2.3	The General Principle	33
3.2.4	Some Additional Remarks	34
3.3	The Taylor Approximation	34
3.3.1	The Expansion	34
3.3.2	The Product Brackets	36
4	System Analysis	37
4.1	The Basic Equation System	39
4.2	Linear Determination Equations	40
4.3	The Non-Linear Inversion Problem	41
4.3.1	Some Numerical Results	42
4.3.2	The Problem of Partition Functions	48
4.3.3	Critical Hyper-Surface Equations	58

4.3.4	The Problem of One- and Two-Dimensional Hyper-Surface Equations of Fourth Order	64
4.3.5	Self-Similarity in Mathematical Terms	74
4.3.6	The Problem of High-Dimensional Hyper-Surface Equations of Fourth Order	75
4.3.7	Universal Hyper-Surface Equations	82
4.3.8	Functional Hyper-Surface Equations	89
5	Statistical Evolution Equations	93
5.1	A Universal Evolution Equation	94
5.1.1	The Structure of the Signal	94
5.1.2	The Basic Differential Equation	94
5.1.3	The Multi-System Equation	97
5.1.4	The Correlated Langevin Equation	97
5.1.5	The Power Series of the Time Difference	98
5.1.6	The Mean Values of the Fluctuation Forces and the Action Factor	99
5.1.7	A Basic Borderline Case	101
5.2	Differential Equations of the Kinetic Type	102
5.2.1	The Correlation Function Replacement	103
5.2.2	The Kinetic Differential Equations	105
5.2.3	Kinetic Differential Equations with Potentials. Kinetic Differential Equations of the Stationary Schrödinger Type	105
5.3	Ensemble Equations	107
5.3.1	The First Step: A Quasi-Time-Dependent Kinetic Equation	107
5.3.2	The Second Step: Ensemble Functions	108
5.3.3	The Third Step: Ensemble Equations	109
5.3.4	Master Equations	109
5.3.5	Ensemble Equations of the Fokker-Planck- and of the Schrödinger Type	111
5.4	Solutions	112
5.4.1	Solutions of Impulse Forms and the MIEP	112
5.4.2	Solutions of Kinetic Equations and Parabolic Cylinder Functions	113
5.4.3	The General Solution of the Master Equation	121
5.5	Meaning and Applicability	127
6	The Laser, a Self-Organizing System	130
6.1	The Ensemble Level of the Laser Activity	130
6.1.1	Laser Equations of the Molecular Ensemble	131
6.1.2	The Slaving Principle and Order Parameters	132
6.2	The Statistical Level of the Laser Activity	138
6.2.1	The Langevin Level	138
6.2.2	The Fokker-Planck Level	139

6.2.3	Stationary Solutions	140
6.2.4	Micro- and Macro-States. Hyper-Surface Equations	141
7	Aspects of Quantum System Theory	151
7.1	Motivation	151
7.2	A Basic Evolution Equation	153
7.3	Feynman's Path Integrals	155
7.3.1	The Method of Green's Function	155
7.3.2	The Feynman Kernel	156
7.3.3	The Statistical Basic Function	158
7.3.4	The Statistical Basic Principle	159
7.3.5	Feynman Kernels. A Basic Calculation Procedure	161
7.3.6	The Eigenfunction Structure	169
7.3.7	The Principle of Coupling of Elementary Systems	172
7.3.8	Hyper-Surface Equations in the Context of Quantum System Theory	173
7.3.9	Physical Meaning and Reference Frame	174
7.3.10	Path Integrals of the Fokker-Planck Type	175
7.4	State Functions and Measurement	179
7.4.1	Stationary Solutions and Measurement	179
7.4.2	Ensemble Functions and Measurement	180
7.5	Heisenberg's Formalism	182
7.5.1	The Basic Formalism	182
7.5.2	Creation and Annihilation Operators	184
7.5.3	The Second Quantization	187
7.5.4	Laser Equations of the Heisenberg Type	195
7.5.5	Additional Comments	197
8	Information	199
8.1	Information and Phase Transition	200
8.1.1	Information of a One-Mode Laser	200
8.1.2	The Multi-Mode Laser and Self-Similarity	202
8.2	Information and Distribution Width	204
8.2.1	Analytical and Numerical Facts	204
8.2.2	The Essence	204
8.3	Information and Multi-Particle Systems	206
8.3.1	Analytical and Numerical Facts	206
8.3.2	The Essence	208
8.4	Information and Human Life	209
9	Basics of Relativistic System Theory	210
9.1	Lorentz Transformations	211
9.2	Lorentz Covariant Evolution Equations of Particle Physics	213
9.2.1	Macroscopic Equations: The Maxwell Equations	213
9.2.2	Microscopic Equations: Klein-Gordon- and Dirac Equation	214

9.2.3	Wave Functions and Spinors	221
9.3	Metric	225
9.3.1	Fundamental Metric Tensor, Co- and Contravariance	225
9.3.2	Geodetic Lines	227
9.3.3	Einstein's Field Equation of Gravitation	230
9.4	Background Functions	234
9.4.1	The Definition	234
9.4.2	The Principle of Superposition of Elementary Functions	235
9.4.3	Self-Consistency Equations	236
9.5	The Riemann Universe	239
9.5.1	The Definition	239
9.5.2	Reference Frame Transformations and Riemann Universe	239
9.6	The Underlying Universe	240
10	Universality in Statistical Physics and Synergetics	241
10.1	The Highest Level of Consideration	241
10.1.1	The Riemann Universe	241
10.1.2	Self-Consistency Equations	241
10.1.3	The Euclidean Space	242
10.2	The Physical Systems Considered in this Book	242
10.2.1	Multi-Component Systems	242
10.2.2	Statistical Description	242
10.2.3	Synergetic Systems	243
10.2.4	Micro- and Macro-Levels	243
10.3	Universality	243
10.3.1	Extreme Principles	243
10.3.2	Covariance	244
10.3.3	Patterns, Self-Similarity	244
10.3.4	Self-Organization	244
10.3.5	The Slaving Principle	244
10.3.6	Phase Transitions	244
10.3.7	Hyper-Surface Equations	245
10.3.8	The Statistical Basic Function	245
10.3.9	Path Integrals, a General Calculation Procedure	245
10.3.10	The Principle of Coupling of Elementary Systems	245
10.3.11	Statistical Evolution Equations	246
10.3.12	Information	246
10.3.13	Reference Frame Transformations	246
10.3.14	Riemann Universe, Metric	246
10.4	The Comprehensive Structure of this Book	247
	Bibliography	248
	Index	253