

# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
1.1	Bibliographical Notes BN1 . . . . .	5
<b>2</b>	<b>States, Dynamical Functions, Evolution</b>	<b>7</b>
2.1	General Considerations . . . . .	7
2.2	Macroscopic Dynamical Systems . . . . .	8
2.3	Microscopic Dynamical Systems . . . . .	11
2.4	Systems of Interacting Particles . . . . .	15
2.5	Bibliographical Notes BN2 . . . . .	20
<b>3</b>	<b>General Formalism of Statistical Mechanics</b>	<b>21</b>
3.1	Macroscopic Physics and Microscopic Physics . . . . .	21
3.2	The Phase Space Distribution Function . . . . .	23
3.3	Equilibrium States . . . . .	29
3.4	Bibliographical Notes BN3 . . . . .	32
<b>4</b>	<b>Reduced Distribution Functions and Correlation Functions</b>	<b>35</b>
4.1	Classification of Dynamical Functions . . . . .	35
4.2	Reduced Distribution Functions . . . . .	37
4.3	Evolution of the Reduced Distribution Functions. . . . .	42
4.4	Correlation Functions . . . . .	47
4.5	Evolution of the Correlation Functions . . . . .	49
4.6	Bibliographical Notes BN4 . . . . .	52
<b>5</b>	<b>The Mean Field Approximation</b>	<b>55</b>
5.1	Weakly Coupled Systems . . . . .	55
5.2	Free Particle Dynamics. . . . .	59
5.3	The Vlasov Equation . . . . .	60
5.4	The Linearized Vlasov Equation . . . . .	65
5.5	Conclusions. . . . .	70
5.6	Bibliographical Notes BN5 . . . . .	71

<b>6 The Weak Coupling Kinetic Equation</b>	<b>73</b>
6.1 The Master Equation . . . . .	73
6.2 The Landau Equation . . . . .	75
6.3 Explicit form of the Landau collision term . . . . .	81
6.4 Conclusion . . . . .	84
6.5 Appendix. The Cauchy Integral . . . . .	84
6.6 Bibliographical Notes BN6 . . . . .	87
<b>7 Kinetic Equation for Dilute Gases</b>	<b>89</b>
7.1 The Dilute Gas Ordering. . . . .	89
7.2 The Boltzmann Equation . . . . .	90
7.3 Implementation of the Boltzmann Equation . . . . .	97
7.4 Bibliographical Notes BN7 . . . . .	101
<b>8 Kinetic Equation for Plasmas</b>	<b>105</b>
8.1 The Plasma Ordering . . . . .	105
8.2 The Integral Equation for the Correlation . . . . .	109
8.3 The Plasma Kinetic Equation . . . . .	112
8.4 Properties of the Balescu-Lenard Equation . . . . .	116
8.5 Bibliographical Notes BN8 . . . . .	118
<b>9 Properties of Kinetic Equations</b>	<b>121</b>
9.1 The Concept of a Kinetic Equation . . . . .	121
9.2 Stochastic Equations of Evolution . . . . .	123
9.3 Nature of the Collision Process . . . . .	129
9.4 Irreversibility and Entropy . . . . .	136
9.5 Spatially Inhomogeneous Systems . . . . .	142
9.6 The Collisional Invariants . . . . .	146
9.7 Bibliographical Notes BN9 . . . . .	148
<b>10 Hydrodynamics and Transport</b>	<b>151</b>
10.1 The Hydrodynamic Quantities . . . . .	151
10.2 The Hydrodynamical Balance Equations . . . . .	154
10.3 Diffusion and Heat Conduction . . . . .	156
10.4 The Hermitian Moment Expansion . . . . .	159
10.5 Derivation of the Transport Equations . . . . .	164
10.6 Properties of the Transport Coefficients . . . . .	167
10.7 Entropy and Transport . . . . .	170
10.8 Conclusions . . . . .	174
10.9 Bibliographical Notes BN10 . . . . .	174

<b>11 Transport and Autocorrelation Functions</b>	<b>177</b>
11.1 Introduction . . . . .	177
11.2 Mean Square Displacement and Diffusion . . . . .	177
11.3 The Langevin Equations . . . . .	180
11.4 The Hybrid Kinetic Equation . . . . .	188
11.5 The Green-Kubo Formulae . . . . .	193
11.6 Bibliographical Notes BN11 . . . . .	197
<b>12 Random Walks and Transport</b>	<b>199</b>
12.1 Classical Random Walks . . . . .	199
12.2 Continuous Time Random Walks (CTRW) . . . . .	206
12.3 The Standard Long-Tail CTRW (SLT-CTRW) . . . . .	211
12.4 SLT-CTRW: The Density Profile . . . . .	213
12.5 SLT-CTRW: The Non-Markovian Diffusion Equation . . . . .	215
12.6 Markovian vs. Non-Markovian Evolution . . . . .	221
12.7 Appendix. Stable Probability Distribution Functions . . . . .	226
12.8 Bibliographical Notes BN12 . . . . .	228
<b>13 Critical Phenomena</b>	<b>231</b>
13.1 Overview of the Equilibrium Critical Phenomena . . . . .	231
13.2 Percolation . . . . .	234
13.3 One-dimensional Systems . . . . .	238
13.4 Scaling Theory of Percolation . . . . .	240
13.5 Percolation Clusters and Fractals . . . . .	245
13.6 Bibliographical Notes BN13 . . . . .	248
<b>14 Transport on Percolation Structures</b>	<b>251</b>
14.1 Electrical Conductivity and Percolation . . . . .	251
14.2 Diffusion and Percolation . . . . .	254
14.3 Strange Diffusion on the Infinite Cluster . . . . .	258
14.4 Conclusions . . . . .	265
14.5 Bibliographical Notes BN14 . . . . .	266
<b>15 Chaos and Transport</b>	<b>269</b>
15.1 The Standard Map . . . . .	269
15.2 The Perron-Frobenius Operator . . . . .	278
15.3 The Diffusive Regime . . . . .	285
15.4 The Subdiffusive Regime . . . . .	293
15.5 Appendix. Transformation of the Resolvent . . . . .	308
15.6 Bibliographical Notes BN15 . . . . .	311

<b>16 Conclusions</b>	<b>313</b>
16.1 The Status of Statistical Dynamics . . . . .	313
16.2 Toward a Grand Theory of Irreversibility ? . . . . .	315
16.3 “Stochastic Statistical” Dynamics . . . . .	321
16.4 Bibliographical Notes BN16 . . . . .	322
<b>Index</b>	<b>325</b>