

Contents

<i>Preface</i>	<i>page</i> vii
1 Basic concepts of dynamical systems theory	1
1.1 Deterministic systems	1
1.2 Unpredictability: systems with many degrees of freedom	7
1.3 Unpredictability: deterministic chaos	12
1.4 Probabilistic aspects of dynamical systems	16
References	23
2 Dynamical indicators for chaotic systems: Lyapunov exponents, entropies and beyond	24
2.1 Dynamical systems approach	25
2.2 Information theory approach	28
2.3 Beyond the Lyapunov exponents and the Kolmogorov–Sinai entropy	44
References	54
3 Coarse graining, entropies and Lyapunov exponents at work	58
3.1 Characterization of the complexity and system modeling	58
3.2 How random is a random number generator?	71
3.3 Lyapunov exponents and complexity in dynamical systems with noise	79
3.4 Conclusions	88
References	89
4 Foundation of statistical mechanics and dynamical systems	92
4.1 The ergodic problem: a brief random walk among an intricate history	93
4.2 Beyond abstract ergodic theory	97
4.3 The connection between analytical mechanics and the ergodic problem	103
4.4 An unexpected result revitalizes interest in the ergodic problem	106

Cambridge University Press

978-0-521-89593-4 - Chaos and Coarse Graining in Statistical Mechanics

Patrizia Castiglione, Massimo Falcioni, Annick Lesne and Angelo Vulpiani

Table of Contents

[More information](#)

vi	<i>Contents</i>	
	4.5 Some modern developments	109
	4.6 On the role of chaos in statistical mechanics	114
	4.7 Some general remarks	116
	References	117
5	On the origin of irreversibility	120
	5.1 The problem	120
	5.2 Toward the solution	122
	5.3 Some results	130
	5.4 About ensembles, the number of degrees of freedom and chaos	140
	References	148
6	The role of chaos in non-equilibrium statistical mechanics	150
	6.1 On the connection between the Kolmogorov–Sinai entropy and production rate of the coarse-grained Gibbs entropy	152
	6.2 Gibbs and Boltzmann entropies: the role of chaos, interaction and coarse graining	159
	6.3 Fluctuation-response relation and chaos	167
	6.4 Chaos and pseudochaos for diffusion and conduction	174
	6.5 Remarks and perspectives	180
	References	182
7	Coarse-graining equations in complex systems	185
	7.1 A short parenthesis: secular terms and multiscale analysis	187
	7.2 From molecular level to Brownian motion	189
	7.3 Diffusion at large scale and eddy diffusivity	198
	7.4 The adiabatic piston: a system between the microscopic and macroscopic realms	203
	7.5 Remarks and perspectives	210
	References	215
8	Renormalization-group approaches	217
	8.1 Renormalization group(s): a brief overview	218
	8.2 Renormalization groups to cure singular perturbation expansions	220
	8.3 A multiscale and constructive approach to capture critical behavior	225
	8.4 Renormalization groups: a multiscale approach for asymptotic analysis	236
	8.5 Probabilistic viewpoint on renormalization groups	243
	8.6 Conclusions and perspectives	262
	References	264
	<i>Index</i>	266