Lecture Notes in Physics

Jan A. Freund Thorsten Pöschel (Eds.)

Stochastic Processes in Physics, Chemistry, and Biology

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Stochastic Procebes In Physics Chemistry And Biology

L. Arnold,R. Lefever

Stochastic Procebes In Physics Chemistry And Biology:

Stochastic Processes in Physics, Chemistry, and Biology Jan A. Freund,Thorsten Poschel,2014-01-15 *Stochastic Processes in Physics, Chemistry, and Biology* Jan A. Freund,Thorsten Pöschel,2000-10-04 The theory of stochastic processes originally grew out of efforts to describe Brownian motion quantitatively Today it provides a huge arsenal of methods suitable for analyzing the influence of noise on a wide range of systems The credit for acquiring all the deep insights and powerful methods is due ma ly to a handful of physicists and mathematicians Einstein Smoluchowski Langevin Wiener Stratonovich etc Hence it is no surprise that until cently the bulk of basic and applied stochastic research was devoted to purely mathematical and physical questions However in the last decade we have witnessed an enormous growth of results achieved in other sciences especially chemistry and biology based on applying methods of stochastic processes One reason for this stochastics boom may be that the realization that noise plays a constructive rather than the expected deteriorating role has spread to communities beyond physics Besides their aesthetic appeal these noise induced noise supported or noise enhanced effects sometimes offer an explanation for so far open pr lems information transmission in the nervous system and information p cessing in the brain processes at the cell level enzymatic reactions etc They may also pave the way to novel technological applications noise hanced reaction rates noise induced transport and separation on the na scale etc Key words to be mentioned in this context are stochastic r onance Brownian motors or ratchets and noise supported phenomena in excitable systems **Stochastic Nonlinear Systems in Physics, Chemistry, and Biology** L. Arnold,R. Lefever,2012-12-06 This book contains the invited papers of the interdisciplinary workshop on Stochastic Nonlinear Systems in Physics Chemistry and Biology held at the Center for Interdisciplinary Research ZIF University of Bielefeld West Germany October 5 11 1980 The workshop brought some 25 physicists chemists and biologists who deal with stochastic phenomena and about an equal number of mathematicians who are experts in the theory of stochastic processes together The Scientific Commitee consisted of L Arnold Bremen A Dress Bielefeld W Horsthemke Brussels T Kurtz Madison R Lefever Brussels G Nicolis Brussels and V Wihstutz Bremen The main topics of the workshop were the transition from deterministic to stoch astic behavior external noise and noise induced transitions internal fluctuations phase transitions and irreversible thermodynamics and on the mathematical side approximation of stochastic processes qualitative theory of stochastic systems and space time processes The workshop was sponsored by ZIF Bielefeld and by the Universities of Bremen and Brussels We would like to thank the staff of ZIF and H Crauel and M Ehrhardt Bremen for the perfect organization and their assistance In addition our thanks go to Professor H Haken for having these Proceedings included in the Se ries in Synergetics Bremen and Brussels L Arnold and R Lefever December 1980 v Contents Part I Introduction From Deterministic to Stochastic Behavior On the Foundations of Kinetic Theory By B Misr and I Prigogine With 1 Figure **Stochastic Processes in Physics and Chemistry** N.G. Van Kampen,2011-08-30 The third edition of Van Kampen s standard work has been revised and updated The main difference

with the second edition is that the contrived application of the quantum master equation in section 6 of chapter XVII has been replaced with a satisfactory treatment of quantum fluctuations Apart from that throughout the text corrections have been made and a number of references to later developments have been included From the recent textbooks the following are the most relevant C W Gardiner Quantum Optics Springer Berlin 1991 D T Gillespie Markov Processes Academic Press San Diego 1992 W T Coffey Yu P Kalmykov and J T Waldron The Langevin Equation 2nd edition World Scientific 2004 Comprehensive coverage of fluctuations and stochastic methods for describing them A must for students and researchers in applied mathematics physics and physical chemistry *Stochasticity in Processes* Peter Schuster,2016-10-14 This book has developed over the past fifteen years from a modern course on stochastic chemical kinetics for graduate students in physics chemistry and biology The first part presents a systematic collection of the mathematical background material needed to understand probability statistics and stochastic processes as a prerequisite for the increasingly challenging practical applications in chemistry and the life sciences examined in the second part Recent advances in the development of new techniques and in the resolution of conventional experiments at nano scales have been tremendous today molecular spectroscopy can provide insights into processes down to scales at which current theories at the interface of physics chemistry and the life sciences cannot be successful without a firm grasp of randomness and its sources Routinely measured data is now sufficiently accurate to allow the direct recording of fluctuations As a result the sampling of data and the modeling of relevant processes are doomed to produce artifacts in interpretation unless the observer has a solid background in the mathematics of limited reproducibility The material covered is presented in a modular approach allowing more advanced sections to be skipped if the reader is primarily interested in applications At the same time most derivations of analytical solutions for the selected examples are provided in full length to guide more advanced readers in their attempts to derive solutions on their own The book employs uniform notation throughout and a glossary has been added to define the most important notions discussed Dynamical Modeling of Biological Systems Stilianos Louca,2023-06-07 This book introduces concepts and practical tools for dynamical mathematical modeling of biological systems Dynamical models describe the behavior of a system over time as a result of internal feedback loops and external forcing based on mathematically formulated dynamical laws similarly to how Newton s laws describe the movement of celestial bodies Dynamical models are increasingly popular in biology as they tend to be more powerful than static regression models This book is meant for undergraduate and graduate students in physics applied mathematics and data science with an interest in biology as well as students in biology with a strong interest in mathematical methods The book covers deterministic models for example differential equations stochastic models for example Markov chains and autoregressive models and model independent aspects of time series analysis Plenty of examples and exercises are included often taken or inspired from the scientific literature and covering a broad range of topics such as neuroscience cell biology genetics evolution ecology

microbiology physiology epidemiology and conservation The book delivers generic modeling techniques used across a wide range of situations in biology and hence readers from other scientific disciplines will find that much of the material is also applicable in their own field Proofs of most mathematical statements are included for the interested reader but are not essential for a practical understanding of the material The book introduces the popular scientific programming language MATLAB as a tool for simulating models fitting models to data and visualizing data and model predictions The material taught is current as of MATLAB version 2022b The material is taught in a sufficiently general way that also permits the use of alternative programming languages *Chaotic Flows* Oleg G. Bakunin,2011-08-29 The book introduces readers to and summarizes the current ideas and theories about the basic mechanisms for transport in chaotic flows Typically no single paradigmatic approach exists as this topic is relevant for fields as diverse as plasma physics geophysical flows and various branches of engineering Accordingly the dispersion of matter in chaotic or turbulent flows is analyzed from different perspectives Partly based on lecture courses given by the author this book addresses both graduate students and researchers in search of a high level but approachable and broad introduction to the topic **Stochastic Processes and Calculus Explained** Vikas Rathi,2025-02-20 Stochastic Processes and Calculus Explained is an essential textbook designed to help readers understand and apply stochastic processes across various fields Written in clear accessible language this book provides a solid foundation in probability theory and calculus while diving into stochastic processes including random variables probability distributions Brownian motion stochastic integration and stochastic differential equations We emphasize the practical relevance of these concepts in finance physics engineering and biology Our guide illustrates how stochastic processes model uncertainty and randomness aiding in informed decision making outcome prediction and complex system analysis With real world examples and exercises we ensure readers can grasp and apply these concepts effectively The book offers a strong mathematical foundation covering key tools and techniques such as probability theory calculus and linear algebra essential for understanding stochastic processes Catering to readers of all backgrounds and expertise levels Stochastic Processes and Calculus Explained is ideal for beginners and experienced practitioners alike Its clear explanations intuitive coverage and comprehensive approach make it an invaluable resource for students researchers and professionals worldwide **The Physics of Structure Formation** Werner Güttinger,Gerhard Dangelmayr,2012-12-06 The formation and evolution of complex dynamical structures is one of the most exciting areas of nonlinear physics Such pattern formation problems are common in practically all systems involving a large number of interacting components Here the basic problem is to understand how competing physical forces can shape stable geometries and to explain why nature prefers just these Motivation for the intensive study of pattern formation phenomena during the past few years derives from an increasing appreciation of the remarkable diversity of behaviour encountered in nonlinear systems and of universal features shared by entire classes of nonlinear processes As physics copes with ever more ambi tious problems in pattern formation summarizing

our present state of knowledge becomes a pressing issue This volume presents an overview of selected topics in this field of current interest It deals with theoretical models of pattern formation and with simulations that bridge the gap between theory and experiment The book is a product of the International Symposium on the Physics of Structure Formation held from October 27 through November 2 1986 at the Institute for Information Sciences of the University of Tiibingen The symposium brought together a group of distinguished scientists from various disciplines to exchange ideas about recent advances in pattern formation in the physical sciences and also to introduce young scientists to the fi **Self-Organization in Optical Systems and Applications in Information Technology** Mikhail A. Vorontsov,Walter B. Miller,2012-12-06 Contrary to monographs on non linear optics this book concentrates on problems of self organization in various important contexts The reader learns how patterns in non linear optical systems are created and what theoretical methods can be applied to describe them Next various aspects of pattern formation such as associative memory information processing spatio temporal instability photo refraction and so on are treated The book addresses graduate students and researchers in physics and optical engineering *Stochastic Processes* M. Girault,2012-12-06 Existing works on stochastic processes belong to a field of abstract mathematics which puts them beyond the scope of the non specialist The preoccupations of research mathematicians being more often than not distant from the practical problems of experimental methodology the needs of practical workers though real are not met by the majority of works that deal with processes By practical workers we mean research scientists in all the different disciplines Physics Chemistry Biology Medicine Population Economics Organisation Operational Research etc Indeed all scientific research today touches upon complex fields in which deterministic models can be useful for no more than an element ary and simple approximation The Calculus of Probability although offering some interesting models is still inadequate in many instances particularly in the study of evolving systems The practical worker must therefore have at his disposal a set of original and varied stochastic models These models must not be too general for in that case not only would their theoretical study prove difficult but above all the adaptation of such models to an observed system would lead to an estimation of a great number of parameters on the basis of a necessarily restricted sample This would constitute an insuperable difficulty for the practical scientist It is therefore essential for him to have at his disposal a varied range of very characteristic models **Instabilities and Nonequilibrium Structures VI** E. Tirapegui,Javier Martínez,Rolando Tiemann,2012-12-06 This book contains two introductory papers on important topics of nonlinear physics The first one by M San Miguel et al refers to the effect of noise in nonequilibrium systems The second by M E Brachet is a modern introduction to turbulence in fluids The material can be very useful for short courses and is presented accordingly The authors have made their texts self contained The volume also contains a selection of the invited seminars given at the Sixth International Workshop on Instabilities and Nonequilibrium Structures Audience This book should be of interest to graduate students and scientists interested in the fascinating problems of nonlinear physics **Path Integrals For**

Stochastic Processes: An Introduction Horacio Sergio Wio,2013-01-18 This book provides an introductory albeit solid presentation of path integration techniques as applied to the field of stochastic processes The subject began with the work of Wiener during the 1920 s corresponding to a sum over random trajectories anticipating by two decades Feynman s famous work on the path integral representation of quantum mechanics However the true trigger for the application of these techniques within nonequilibrium statistical mechanics and stochastic processes was the work of Onsager and Machlup in the early 1950 s The last quarter of the 20th century has witnessed a growing interest in this technique and its application in several branches of research even outside physics for instance in economy The aim of this book is to offer a brief but complete presentation of the path integral approach to stochastic processes It could be used as an advanced textbook for graduate students and even ambitious undergraduates in physics It describes how to apply these techniques for both Markov and non Markov processes The path expansion or semiclassical approximation is discussed and adapted to the stochastic context Also some examples of nonlinear transformations and some applications are discussed as well as examples of rather unusual applications An extensive bibliography is included The book is detailed enough to capture the interest of the curious reader and complete enough to provide a solid background to explore the research literature and start exploiting the learned material in real situations remove a **Foundations of Synergetics I** Alexander S. Mikhailov,2012-12-06 This book gives an introduction to the mathematical theory of cooperative behavior in active systems of various origins both natural and artificial It is based on a lecture course in synergetics which I held for almost ten years at the University of Moscow The first volume deals mainly with the problems of pattern fonnation and the properties of self organized regular patterns in distributed active systems It also contains a discussion of distributed analog information processing which is based on the cooperative dynamics of active systems The second volume is devoted to the stochastic aspects of self organization and the properties of self established chaos I have tried to avoid delving into particular applications The primary intention is to present general mathematical models that describe the principal kinds of coopera tive behavior in distributed active systems Simple examples ranging from chemical physics to economics serve only as illustrations of the typical context in which a particular model can apply The manner of exposition is more in the tradition of theoretical physics than of in mathematics Elaborate fonnal proofs and rigorous estimates are often replaced the text by arguments based on an intuitive understanding of the relevant models Because of the interdisciplinary nature of this book its readers might well come from very diverse fields of endeavor It was therefore desirable to minimize the re quired preliminary knowledge Generally a standard university course in differential calculus and linear algebra is sufficient **Guide to Programs** National Science Foundation (U.S.),1997 **Quantitative Physiology** Shangbin Chen,Alexey Zaikin,2021-02-09 Stephen Hawking says that the 21st century will be the century of complexity and indeed now systems biology or medicine means dealing with complexity Both the genome and physiome have emerged in studying complex physiological systems Computational and mathematical

modeling has been regarded as an efficient tool to boost the understanding about living systems in normal or pathophysiological states Covering applied methodology basic case studies and complex applications this volume provides researchers with an overview of modeling and computational studies of physiology i e quantitative physiology which is becoming an increasingly important branch of systems biology This book aims to build multi scale models to investigate functions in living systems and explain how biomolecules cells organs organ systems and organisms carry out the chemical or physical functions Some of the models addressed are related to gene expression calcium signalling neural activity blood dynamics and bone mechanics Combining theory and practice with extensive use of MATLAB this book is designed to establish a paradigm for quantitative physiology by integrating biology mathematics physics and informatics etc To benefit from this book the readers are expected to have a background in general physiology and mathematics **Nonlinear Nonequilibrium Thermodynamics II** Rouslan L. Stratonovich,2013-11-11 This two volume work gives the first detailed coherent treatment of a relatively young branch of statistical physics nonlinear nonequilibrium and fluctuational dissipative thermodynamics This area of research has taken shape rather recently its de elopment began in 1959 The earlier theory linear nonequilibrium ther modynamics is in principle a simple special case of the new theory Despite the fact that the title of the book includes the word nonlinear it also covers the results of linear nonequilibrium thermodynamics The presentation of the linear and nonlinear theories is done within a common theoretical framework that is not subject to the linearity condition The author hopes that the reader will perceive the intrinsic unjty of this dis cipline the uniformity and generality of its constituent parts This theory has a wide variety of applications in various domains of physics and physical chemistry enabling one to calculate thermal fluctuations in various nonlinearsystems The book is divided into two volumes Fluctuation dissipation theorems or relations of various types linear quadratic and cubic classical and quantum are considered in the first volume There one encounters the Markov and non Markov fluctuation dissipation theorems FDTs theorems of the first second and third kinds Nonlinear FDTs are less known than their linear counterparts The present second volume of the book deals with the advanced theory It consists of four chapters The connection and interdependence of the material in the various chapters of both volumes are illustrated in the accompanying diagram **Information and Self-Organization** Hermann Haken,2013-11-11 Complex systems are ubiquitous and practically all branches of science ranging from physics through chemistry and biology to economics and sociology have to deal with them In this book we wish to present concepts and methods for dealing with complex systems from a unifying point of view Therefore it may be of inter est to graduate students professors and research workers who are concerned with theoretical work in the above mentioned fields The basic idea for our unified ap proach sterns from that of synergetics In order to find unifying principles we shall focus our attention on those situations where a complex system changes its macroscopic behavior qualitatively or in other words where it changes its macroscopic spatial temporal or functional structure Until now the theory of synergetics has usually begun with a

microscopic or mesoscopic description of a complex system In this book we present an approach which starts out from macroscopic data In particular we shall treat systems that acquire their new structure without specific interference from the outside i e systems which are self organizing The vehicle we shall use is information Since this word has several quite different meanings all of which are important for our purpose we shall discuss its various aspects These range from Shannon information from which all semantics has been exorcised to the effects of information on receivers and the self creation of meaning Self-Organization and Management of Social Systems H. Ulrich,G.J.B. Probst,2012-12-06 Self organization of systems belonging to quite different discipl ines has been a central topic of synergetics since its beginning I am therefore particularly plea sed that Hans Ulrich and Gilbert Probst have not only undertaken to organize an interdisciplinary meeting on Self Organization and Management of Social Systems but have also edited these articles written by leading scientists after and based upon that symposium While the previous volumes of the Springer Series in Synergetics were mainly de voted to physical chemical and biological systems with only the book by W Weidlich and G Haag deal i ng with Quant i tat i ve Soc i 01 ogy Spri nger Ser Syn Vo 1 14 the present volume opens a new perspective As the reader will notice the multitude of facets of self organization is well reflected by various authors belonging to different discipl ines and representing different schools of thought When such a wide scope of fields ranging from phy sics to sociology is covered it is not surprising that the existence of a hiatus between sociology and the natural sciences was felt by some participants *Current Topics in Membranes and Transport* ,1991-01-18 Current Topics in Membranes and Transport

Thank you categorically much for downloading **Stochastic Procebes In Physics Chemistry And Biology**.Maybe you have knowledge that, people have look numerous period for their favorite books once this Stochastic Procebes In Physics Chemistry And Biology, but stop up in harmful downloads.

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