

A.S. Mikhailov

Foundations of Synergetics I

Distributed Active Systems



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Foundations Of Synergetics Distributed Active Systems

**Alexander S. Mikhailov, Alexander Yu.
Loskutov**



Foundations Of Synergetics Distributed Active Systems:

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 formation 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 cooperative 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 formal proofs and rigorous estimates are often replaced in 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 required preliminary knowledge Generally a standard university course in differential calculus and linear algebra is sufficient

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Foundations of Synergetics: Distributed active systems Alexander S. Mikhailov, 1990

Foundations of Synergetics Alexander S. Mikhailov, 1990 This textbook presents an introduction to the mathematical theory of cooperative behavior in active systems of various origin both natural and artificial This volume the first of two is

devoted to the properties of regular self organized patterns in distributed active systems An analysis of pattern formation and self supported wave propagation in active media is followed by a description of the properties of neural networks and their possible applications in the field of distributed analog information processing The volume ends with a discussion of reproductive networks and evolutionary systems Attention is focused on basic models which might appear in a wide range of applications As illustrations the author uses simplified examples borrowed from a variety of disciplines ranging from chemical and biological physics to market economics

Foundations of Synergetics II Alexander S. Mikhailov, Alexander Yu. Loskutov, 2012-12-06 This textbook is based on a lecture course in synergetics given at the University of Moscow In this second of two volumes we discuss the emergence and properties of complex chaotic patterns in distributed active systems Such patterns can be produced autonomously by a system or can result from selective amplification of fluctuations caused by external weak noise Although the material in this book is often described by refined mathematical theories we have tried to avoid a formal mathematical style Instead of rigorous proofs the reader will usually be offered only demonstrations the term used by Prof V I Arnold to encourage intuitive understanding of a problem and to explain why a particular statement seems plausible We also refrained from detailing concrete applications in physics or in other scientific fields so that the book can be used by students of different disciplines While preparing the lecture course and producing this book we had intensive discussions with and asked the advice of Prof V I Arnold Prof S Grossmann Prof H Haken Prof Yu L Klimontovich Prof R L Stratonovich and Prof Ya

Synergetics Hermann Haken, 2004-01-12 This book is an often requested reprint of two classic texts by H Haken Synergetics An Introduction and Advanced Synergetics Synergetics an interdisciplinary research program initiated by H Haken in 1969 deals with the systematic and methodological approach to the rapidly growing field of complexity Going well beyond qualitative analogies between complex systems in fields as diverse as physics chemistry biology sociology and economics Synergetics uses tools from theoretical physics and mathematics to construct an unifying framework within which quantitative descriptions of complex self organizing systems can be made This may well explain the timelessness of H Haken's original texts on this topic which are now recognized as landmarks in the field of complex systems They provide both the beginning graduate student and the seasoned researcher with solid knowledge of the basic concepts and mathematical tools Moreover they admirably convey the spirit of the pioneering work by the founder of Synergetics through the essential applications contained herein that have lost nothing of their paradigmatic character since they were conceived

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 *Synchronization and Waves in Active Media* Jan Frederik Totz, 2019-01-18 The interplay between synchronization and spatio temporal pattern formation is central for a broad variety of phenomena in nature such as the coordinated contraction of heart tissue associative memory and learning in neural networks and pathological synchronization during Parkinson disease or epilepsy In this thesis three open puzzles of fundametal research in Nonlinear Dynamics are tackled How does spatial confinement affect the dynamics of three dimensional vortex rings What role do permutation symmetries play in the spreading of excitation waves on networks Does the spiral wave chimera state really exist All investigations combine a theoretical approach and experimental verification which exploit an oscillatory chemical reaction A novel experimental setup is developed that allows for studying networks with N 1000 neuromorphic relaxation oscillators It facilitates the free choice of network topology coupling function as well as its strength range and time delay which can even be chosen as time dependent These experimental capabilities open the door to a broad range of future experimental inquiries into pattern formation and synchronization on large networks which were previously out of reach **Self-Organization, Computational Maps, and Motor Control** P.G. Morasso, V.

Sanguineti, 1997-03-19 In the study of the computational structure of biological robotic sensorimotor systems distributed models have gained center stage in recent years with a range of issues including self organization non linear dynamics field computing etc This multidisciplinary research area is addressed here by a multidisciplinary team of contributors who provide a balanced set of articulated presentations which include reviews computational models simulation studies psychophysical and neurophysiological experiments The book is divided into three parts each characterized by a slightly different focus in part I the major theme concerns computational maps which typically model cortical areas according to a view of the sensorimotor cortex as geometric engine and the site of internal models of external spaces Part II also addresses problems of self organization and field computing but in a simpler computational architecture which although lacking a specialized cortical machinery can still behave in a very adaptive and surprising way by exploiting the interaction with the real world Finally part III is focused on the motor control issues related to the physical properties of muscular actuators and the dynamic interactions with the world The reader will find different approaches on controversial issues such as the role and nature of force fields the need for internal representations the nature of invariant commands the vexing question about coordinate transformations the distinction between hierachiacal and bi directional modelling and the influence of muscle stiffness **From Cells to Societies** Alexander S. Mikhailov, Vera Calenbuhr, 2013-06-29 This book written by two well known scientists represents an excellent ad dition to the Springer Series in Synergetics in several ways It shows how by rather simple models we can gain remarkable insights into the behavior of complex systems At the same time it demonstrates the progress made in this interdisciplinary field While in the early days of Synergetics the self organized coherent action of atoms in the laser a physical device was in the foreground of interest of my book Synergetics An Introduction Springer Berlin

Heidelberg New York 1977 the coherent action of nerve cells got into the focus of research as is witnessed by the book by P Tass in this series P Tass Phase Resetting in Medicine and Biology Springer Berlin Heidelberg New York 1999 In these books the elements were disturbed by noise Now in the present book by Mikhailov and Calenbuhr the self organized coherent action of otherwise chaotic elements is studied and important as well as surprising results by Kaneko Mikhailov and others are presented Let me mention just another highly interesting problem treated in this book the coherent interaction of tens of thousands of reactions going on in biological cells But other phenomena such as the formation of swarms of fish or the collective behavior of ants are also modelled These are just a few examples of the many fascinating subjects dealt with in this book that relate to many disciplines under unifying aspects

Nonlinear Klein-gordon And Schrodinger Systems: Theory And Applications Luis Vazquez,Ludwig Streit,Victor Manuel Perez-garcia,1996-06-20 This is the first of two Euroconferences aimed at addressing the issues of Nonlinearity and Disorder The 1995 Euroconference was devoted to the mathematical numerical and experimental studies related to the Klein Gordon and Schr dinger systems The Euroconference was organized around main lectures in each area to introduce the main concepts and stimulate discussions The mathematical studies covered the functional analysis and stochastic techniques applied to the general Klein Gordon and Schr dinger wave equations Also a panoramic view of the numerical schemes was presented to simulate the above equations as well as an overview of the applications of such systems in the areas of condensed matter optical physics new materials and biophysics Special attention was devoted to the discrete Schr dinger and Klein Gordon systems and their applications

Dynamics of Self-Organized and Self-Assembled Structures Rashmi C. Desai,Raymond Kapral,2009-03-26 Describes pattern formation processes and how they can be modeled for graduate level courses

Working with Dynamical Systems Len Pismen,2020-12-15 This book provides working tools for the study and design of nonlinear dynamical systems applicable in physics and engineering It offers a broad based introduction to this challenging area of study taking an applications oriented approach that emphasizes qualitative analysis and approximations rather than formal mathematics or simulation The author an internationally recognized authority in the field makes extensive use of examples and includes executable Mathematica notebooks that may be used to generate new examples as hands on exercises The coverage includes discussion of mechanical models chemical and ecological interactions nonlinear oscillations and chaos forcing and synchronization spatial patterns and waves Key Features Written for a broad audience avoiding dependence on mathematical formulations in favor of qualitative constructive treatment Extensive use of physical and engineering applications Incorporates Mathematica notebooks for simulations and hands on self study Provides a gentle but rigorous introduction to real world nonlinear problems Features a final chapter dedicated to applications of dynamical systems to spatial patterns The book is aimed at student and researchers in applied mathematics and mathematical modelling of physical and engineering problems It teaches to see common features in systems of different origins and to apply common methods of study without losing sight of complications and uncertainties

related to their physical origin Epilepsy as a Dynamic Disease John Milton, Peter Jung, 2013-04-17 A brain defibrillator may be closer than we think An epileptic seizure involves a paroxysmal change in the activity of millions of neurons Feedback control of seizures would require an implantable device that could predict seizure occurrence and then deliver a stimulus to abort it To examine the feasibility of building such a device this text brings together experts in epilepsy bio engineering and dynamical systems theory Topics include the development of epileptic systems seizure prediction neural synchronization wave phenomena in excitable media and the control of complex neural dynamics using brief electrical stimuli Rhythms in Physiological Systems Hermann Haken, Hans P. Koepchen, 2012-12-06 Rhythms are a basic phenomenon in all physiological systems They cover an enormous range of frequencies with periods from the order of milliseconds up to some years They are described by many disciplines and are investigated usually in the context of the physiology of the respective function or organ The importance given to the research on rhythmicity is quite different in different systems In some cases where the functional significance is obvious rhythms are at the center of interest as in the case of respiration or locomotion In other fields they are considered more or less as interesting epiphenomena or at best as indicators without essential functional significance as in the case of cardiovascular or EEG rhythms Recently the study of physiological rhythms has attracted growing interest in several fields especially with respect to rhythm research in humans and its rapidly spreading applications in basic behavioral research and as a diagnostic tool in clinical medicine This development was favored by two methodological and conceptual advances on the one hand the availability of non invasive methods of continuous recording of physiological parameters and their computer assisted evaluation and on the other the rapid development of theoretical analyses for example the understanding of dynamic systems the generation of coordinated macroscopic processes in systems comprising many single elements and the mathematical tools for treating nonlinear oscillators and their mutual coupling

Autosolitons B.S. Kerner, V.V. Osipov, 2013-06-29 This monograph is devoted to an entirely new branch of nonlinear physics solitary intrinsic states or autosolitons which form in a broad class of physical chemical and biological dissipative systems Autosolitons are often observed as highly nonequilibrium regions in slightly nonequilibrium systems in many ways resembling ball lightning which occurs in the atmosphere We develop a new approach to problems of self organization and turbulence treating these phenomena as a result of spontaneous formation and subsequent evolution of autosolitons Scenarios of self organization involve sophisticated interactions between autosolitons whereas turbulence is regarded as a pattern of autosolitons which appear and disappear at random in different parts of the system This monograph is the first attempt to provide a comprehensive summary of the theory of autosolitons as developed by the authors over the years of research The monograph is comprised of three more or less autonomous parts Part I deals with the physical nature and experimental studies of autosolitons and self organization in various physical systems semiconductor and gas plasma heated gas mixture semiconductor structures composite superconductors optical and magnetic media systems with uniformly

generated combustion matter distributed gas discharge and electronic systems We discuss feasibility of autosolitons in the form of highly nonequilibrium regions in slightly nonequilibrium gases and semiconductors hot and cold regions in semiconductor and gas plasmas static pulsating and traveling combustion fronts

Asymptotic Approaches in Nonlinear Dynamics Jan Awrejcewicz,Igor V. Andrianov,Leonid I. Manevitch,2012-12-06 How well is Nature simulated by the varied asymptotic models that imaginative scientists have invented B Birkhoff 52J This book deals with asymptotic methods in nonlinear dynamics For the first time a detailed and systematic treatment of new asymptotic methods in combination with the Pade approximant method is presented Most of the basic results included in this manuscript have not been treated but just mentioned in the literature Providing a state of the art review of asymptotic applications this book will prove useful as an introduction to the field for novices as well a reference for specialists Asymptotic methods of solving mechanical and physical problems have been developed by many authors For example we can refer to the excellent courses by A Nayfeh 119 122 M Van Dyke 154 E J Hinch 94J and many others 59 66 95 109 126 155 163 50d 59dJ The main features of the monograph presented are 1 it is devoted to the basic principles of asymptotics and its applications and 2 it deals with both traditional approaches such as regular and singular perturbations averaging and homogenization perturbations of the domain and boundary shape and less widely used new approaches such as one and two point Pade approximants the distributional approach and the method of boundary perturbations

Interfacial Wave Theory of Pattern Formation Jian-Jun Xu,2012-12-06 For the last several years the study of interfacial instability and pattern formation phenomena has preoccupied many researchers in the broad area of nonlinear science These phenomena occur in a variety of dynamical systems far from equilibrium In many practically very important physical systems some fascinating patterns are always displayed at the interface between solid and liquid or between two liquids Two prototypes of these phenomena are dendrite growth in solidification and viscous fingering in a Hele Shaw cell These two phenomena occur in completely different scientific fields but both are described by similar nonlinear free boundary problems of partial differential equation systems the boundary conditions on the interface for both cases contain a curvature operator involving the surface tension which is nonlinear Moreover both cases raise the same challenging theoretical issues interfacial instability mechanisms and pattern selection and it is now found that these issues can be solved by the same analytical approach Thus these two phenomena are regarded as special examples of a class of nonlinear pattern formation phenomena in nature and they are the prominent topics of the new interdisciplinary field of nonlinear science This research monograph is based on a series of lectures I have given at McGill University Canada 1993 1994 Northwestern Poly technical Institute China 1994 Aachen University Germany 1994 and the CRM summer school at Banff Alberta Canada 1995

Encyclopedia of Chemical Physics and Physical Chemistry: Applications Nicholas D. Spencer,John H. Moore,2001 *Encyclopedia of Chemical Physics and Physical Chemistry* John H. Moore,Nicholas D. Spencer,2023-07-03 The Encyclopedia of Physical Chemistry and Chemical Physics

introduces possibly unfamiliar areas explains important experimental and computational techniques and describes modern endeavors The encyclopedia quickly provides the basics defines the scope of each subdiscipline and indicates where to go for a more complete and detailed explanation Particular attention has been paid to symbols and abbreviations to make this a user friendly encyclopedia Care has been taken to ensure that the reading level is suitable for the trained chemist or physicist The encyclopedia is divided in three major sections FUNDAMENTALS the mechanics of atoms and molecules and their interactions the macroscopic and statistical description of systems at equilibrium and the basic ways of treating reacting systems The contributions in this section assume a somewhat less sophisticated audience than the two subsequent sections At least a portion of each article inevitably covers material that might also be found in a modern undergraduate physical chemistry text METHODS the instrumentation and fundamental theory employed in the major spectroscopic techniques the experimental means for characterizing materials the instrumentation and basic theory employed in the study of chemical kinetics and the computational techniques used to predict the static and dynamic properties of materials APPLICATIONS specific topics of current interest and intensive research For the practicing physicist or chemist this encyclopedia is the place to start when confronted with a new problem or when the techniques of an unfamiliar area might be exploited For a graduate student in chemistry or physics the encyclopedia gives a synopsis of the basics and an overview of the range of activities in which physical principles are applied to chemical problems It will lead any of these groups to the salient points of a new field as rapidly as possible and gives pointers as to where to read about the topic in more detail

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