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Artificial Life

Sleep and wakefulness undergo important changes with age. Awakening, a crucial event in the sleep-wake rhythm, is a transition implying complex physiological mechanisms. Its involvement in sleep disturbances is also well known. This collective volume is the first attempt to systematically approach awakening across development.A methodological section considers criteria to define awakening in a developmental perspective. Theoretical considerations on development of wakefulness and on its relation to consciousness are included and provide a vigorous impulse to go beyond present criteria and classifications. Age changes are the core of studies on development: a section of the book examines old and new data from preterm to infants up to children, underscoring the main turning points along this developmental path. As for other aspects of development, awakening and the sleep-wake cycle are also influenced by external factors, both physical and human. Several contributions deal with this topic, in particular focusing on the parent-infant interaction and the influences of culture. Clinical contexts offer an opportunity to show both quantitative and qualitative changes of awakening and arousals in different pathological conditions. Either partial changes of one physiological variable or global and massive

changes can be observed. (Series B)

Canadian Patent Office Record

This volume contains a number of mini-review articles authored by speakers and attendees at the IMA workshop on Pattern Formation in Continuous and Coupled Systems. Pattern formation has been studied intensively for most of this century by both experimentalists and theoreticians. This workshop focused on new directions in the patterns literature. The goals were to continue communication between these groups, and to familiarize a larger audience with some of the newer directions in the field. Systems that generate new types of pattern such as discrete coupled systems, systems with global coupling, and combustion experiments were stressed, as were new types of pattern. The mini-reviews in this volume are intended to be pointers to the current literature for researchers at all levels and therefore include extensive bibliographies. They are also intended to discuss why certain subjects are currently exciting and worthy of additional research.

Nonlinear Dynamics and Spatial Complexity in Optical Systems

Systems exhibiting spontaneous regular rhythms abound in nature, and several that are characterized by more than two different time scales are known as relaxation oscillators. The density oscillator is an excellent model system for investigating the fundamental mechanisms of relaxation oscillators. It is a system consisting of an inner container, with a thin pipe in its bottom and filled with heavy fluid, inside an outer container filled with light fluid; the fluids alternately exhibit upflow and downflow through the pipe between the two containers. Although the density oscillator is a simple system, its oscillation mechanism is nontrivial and clarifying it is a challenging task. We have recently clarified the mechanism by constructing a simple model on the basis of detailed experiments. In this chapter, we review studies of this topic and introduce relevant work.

Emerging Technologies and Techniques in Porous Media

Chemical Oscillations, Waves, and Turbulence

Recent years have seen a growing interest in and activity at the interface between physics and biology, with the realization that both subjects have a great deal to learn from and to teach to one another. A particularly promising aspect of this interface concerns the area of cooperative phenomena and phase transitions. The present book addresses both the structure and motion of biological materials and the increasingly complex behaviour that arises out of interactions in large

systems, giving rise to self organization, adaptation, selection and evolution: concepts of interest not only to biology and living systems but also within condensed matter physics. The approach adopted by Physics of Biomaterials: Fluctuations, Self Assembly and Evolution is tutorial, but the book is fully up to date with the latest research. Written at a level appropriate to graduate researchers, preferably with a background either in condensed matter physics or theoretical or physically-oriented experimental biology.

Pattern Formation at Interfaces

The book deals with modern methods of nonlinear stability theory applied to problems of continuous media mechanics in the presence of interfaces, with applications to materials science, chemical engineering, heat transfer technologies, as well as in combustion and other reaction-diffusion systems. Interfaces play a dominant role at small scales, and their correct modeling is therefore also crucial in the rapidly expanding fields of microfluidics and nanotechnologies. To this aim, the book combines contributions of eminent specialists in the field, with a special emphasis on rigorous and predictive approaches. Other goals of this volume are to allow the reader to identify key problems of high scientific value, and to see the similarity between a variety of seemingly different physical problems.

Spontaneous Symmetry Breaking, Self-Trapping, and Josephson Oscillations

In this chapter, temporal and spatial patterns observed in the Belousov–Zhabotinsky (BZ) reaction are described, which is a typical nonlinear chemical reaction system that exhibits oscillation and wave propagation. Some related phenomena in biological systems are presented. The underlying mechanism and modeling of oscillation based on chemical equations are then introduced. Reaction diffusion equations are derived and numerical simulations are performed based on the model to explain how the dynamical pattern appears. Finally, synchronous phenomena observed in the BZ reaction are described with an analytical method based on the phase model.

Nonlinear Wave Methods for Charge Transport

This Research Note aims to provide an insight into recent developments in the theory of pattern formation. In the last decade there has been considerable progress in this field, both from a theoretical and a practical point of view. Recent mathematical developments concern the study of the nonlinear stability of systems at near-critical conditions by an appropriate system of modulation equations. The complexity of the original problem can be reduced drastically by this approximation. Moreover, it provides unifying point of view for a wide range of problems. New applications of the theory arise in a multitude of scientific areas such as hydrodynamics, reaction-diffusion problems, oceanography, meteorology,

combustion, geophysical and biological morphodynamics and semi-conductors. This book is intended to show the interactions between the mathematical theory of nonlinear dynamics and the study of pattern generating phenomena in the natural environment. There is an intimate relationship between new insights in the mathematical aspects of nonlinear pattern formation and the comprehension of such phenomena. Therefore there are two partly overlapping main themes: one in which the emphasis is on generally applicable mathematical theories and techniques and one in which the phenomenology of pattern evolution in various areas is discussed. The book comprises 19 contributions by experts in the field. Although the emphasis changes considerably from paper to paper, in each contribution the same two themes are present; all the authors have aimed to achieve a suitable balance between the mathematical theory and the physical phenomena. Contents:

Biological Physics of the Developing Embryo

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A collection of prestigious postgraduate lectures, Nonlinear Dynamics and Spatial Complexity in Optical Systems reviews developments in the theory and practice of nonlinear dynamics and structural complexity, and explores modern-day applications in nonlinear optics. The book addresses systems including both singlemode and multimode lasers, bistable and multistable devices, optical fibers, counter-propagating beam interactions, nonlinear mixing, and related optical phenomena.

Pattern Formations and Oscillatory Phenomena

Overview of current developments in nonlinear photorefractive optics. The book dicusses exciting discoveries, with special emphasis on transverse effects such as spatial soliton formation and interaction, spontaneous pattern formation and pattern competition in active feedback systems. Different aspects of potential applications, such as wave guiding in adaptive photorefractive solitons and techniques for pattern control for information processing, are also described.

Thermodynamics and Pattern Formation in Biology

Consists of the proceedings of: 1987, Interdisciplinary Workshop on the Synthesis and Simulation of Living Systems; 1990-1992, Artificial Life Workshop; 1994-1996, International Workshop on the Synthesis and Simulation of Living Systems; 1998- , International Conference on Artificial Life.

Mathematical Biology

Mathematical Biology is a richly illustrated textbook in an exciting and fast growing field. Providing an in-depth look at the practical use of math modeling, it features exercises throughout that are drawn from a variety of bioscientific disciplines - population biology, developmental biology, physiology, epidemiology, and evolution, among others. It maintains a consistent level throughout so that graduate students can use it to gain a foothold into this dynamic research area.

Stability and Oscillations in Delay Differential Equations of Population Dynamics

We present examples of familiar phenomena found in nonequilibrium systems, including oscillatory phenomena, order-formation processes, and pattern formation. In particular, we introduce commonly used mathematical methods to analyze their characteristics. First, we present oscillations described by the Lotka–Volterra and van der Pol equations, the Brusselator, the Oregonator, and relaxation oscillations as examples of oscillatory phenomena. Second, we investigate the order-formation process in colloidal crystals and present an experimental observation of 2D array formation. Third, we demonstrate pattern formation in crystals on the basis of the Mullins–Sekerka instability, and in chemical and biological systems on the basis of the Turing instability. In particular, we describe the optical properties and development of sophisticated structural patterns that directly interact with light. Finally, we briefly describe a theoretical phase-transition analogy that might clarify the concept of order formation in nonequilibrium systems.

An Introduction to the Physical Chemistry of Biological Organization

Tbis book is intended to provide a few asymptotic methods which can be applied to the dynamics of self-oscillating fields of the reaction-diffusion type and of some related systems. Such systems, forming cooperative fields of a large num of interacting similar subunits, are considered as typical synergetic systems. ber Because each local subunit itself represents an active dynamical system function ing only in far-from-equilibrium situations, the entire system is capable of showing a variety of curious pattern formations and turbulencelike behaviors quite unfamiliar in thermodynamic cooperative fields. I personally believe that the nonlinear dynamics, deterministic or statistical, of fields composed of similar active (Le., non-equilibrium) elements will form an extremely attractive branch of physics in the near future. For the study of non-equilibrium cooperative systems, some theoretical guid ing principle would be highly desirable. In this connection, this book pushes for ward a particular physical viewpoint based on the slaving principle. The dis covery of tbis principle in non-equilibrium phase transitions, especially in lasers, was due to Hermann Haken. The great utility of this concept will again be dem onstrated in tbis book for the fields of coupled nonlinear oscillators.

Applications of Bifurcation Theory

During development cells and tissues undergo changes in pattern and form that employ a wider range of physical mechanisms than at any other time in an organism's life. This book shows how physics can be used to analyze these biological phenomena. Written to be accessible to both biologists and physicists, major stages and components of the biological development process are introduced and then analyzed from the viewpoint of physics. The presentation of physical models requires no mathematics beyond basic calculus. Physical concepts introduced include diffusion, viscosity and elasticity, adhesion, dynamical systems, electrical potential, percolation, fractals, reaction-diffusion systems, and cellular automata. With full-color figures throughout, this comprehensive textbook teaches biophysics by application to developmental biology and is suitable for graduate and upper-undergraduate courses in physics and biology.

Collective Dynamics of Nonlinear and Disordered Systems

Nonlinear Dynamics of Production Systems

Some bird and insect species exhibit iridescent colors that originate from submicron microstructures. One example is a periodic stack of thin layers that selectively reflects light wavelengths with high efficiency through multilayer optical interference. However, the periodicity of the microstructure is not a unique factor in the coloration mechanism; other physical factors such as structural irregularities, large-scale structures, and pigmentation also contribute greatly to the coloration in natural examples. This chapter describes basic experimental and theoretical methods of studying structural color, mainly for those who are unfamiliar with this subject. The chapter discusses two insect species, the jewel beetle and Morpho butterfly, repeatedly rather than introducing many examples. It is emphasized in discussing these examples that additional factors are as important for the coloration as the periodicity in the microstructures.

Indian Journal of Chemistry

Spirals, vortices, crystalline lattices, and other attractive patterns are prevalent in Nature. How do such beautiful patterns appear from the initial chaos? What universal dynamical rules are responsible for their formation? What is the dynamical origin of spatial disorder in nonequilibrium media? Based on the many visual experiments in physics, hydrodynamics, chemistry, and biology, this invaluable book answers those and related intriguing questions. The mathematical models presented for the dynamical theory of pattern formation are nonlinear partial differential equations. The corresponding theory is not so accessible to a wide audience. Consequently, the authors have made every attempt to synthesize long and

complex mathematical calculations to exhibit the underlying physics. The book will be useful for final year undergraduates, but is primarily aimed at graduate students, postdoctoral fellows, and others interested in the puzzling phenomena of pattern formation. Contents:Patterns: Prelude to a Dynamical DescriptionLinear Stage of Pattern FormationModel EquationsThe Ginzburg–Landau Equation'Crystal' FormationQuasicrystalsBreaking of OrderLocalized PatternsSpiralsPatterns in Oscillating Soap FilmsPatterns in Colonies of MicroorganismsSpatial DisorderPatterns in Chaotic MediaEpilogue: Living Matter and Dynamic FormsA Short Guide to Nonlinear DynamicsKey Experiments in Pattern Formation Readership: Graduate students of mathematical physics and nonlinear science. Keywords:Quasicrystals;Disordered Patterns;Defects;Spirals;Turbulence;Synchronization;Convection;Capillary Waves;Chaotic Dynamics;Biological PatternsReviews: "This beautifully illustrated book brings together a remarkable array of pattern-forming phenomena ... The authors have assembled an impressive collection of striking photographs and computer-generated images, and the book would be worth buying for this alone ... the Appendix describing key experiments is a highlight. Here the authors outline the historical development of experiments in parametrically-excited patterns, thermal convection and diffusive chemical reactions." UK Nonlinear News "This book contains a very impressive account of key ideas and results in nonlinear dynamics and an equally excellent description of important experiments in pattern formation ... readers can gain quite comprehensive knowledge about all possible patterns and their mathematical theories by reading a single chapter, coupled with Appendix I." Mathematical Reviews

Marangoni and Interfacial Phenomena in Materials Procesessing

Pattern Formation

Hydrogen at Surface and Interfaces

Pattern Formation in Continuous and Coupled Systems

This monograph provides a definitive overview of recent advances in the stability and oscillation of autonomous delay differential equations. Topics include linear and nonlinear delay and integrodifferential equations, which have potential applications to both biological and physical dynamic processes. Chapter 1 deals with an analysis of the dynamical characteristics of the delay logistic equation, and a number of techniques and results relating to stability, oscillation and comparison of scalar delay and integrodifferential equations are presented. Chapter 2 provides a tutorial-style introduction

to the study of delay-induced Hopf bifurcation to periodicity and the related computations for the analysis of the stability of bifurcating periodic solutions. Chapter 3 is devoted to local analyses of nonlinear model systems and discusses many methods applicable to linear equations and their perturbations. Chapter 4 considers global convergence to equilibrium states of nonlinear systems, and includes oscillations of nonlinear systems about their equilibria. Qualitative analyses of both competitive and cooperative systems with time delays feature in both Chapters 3 and 4. Finally, Chapter 5 deals with recent developments in models of neutral differential equations and their applications to population dynamics. Each chapter concludes with a number of exercises and the overall exposition recommends this volume as a good supplementary text for graduate courses. For mathematicians whose work involves functional differential equations, and whose interest extends beyond the boundaries of linear stability analysis.

Transverse-Pattern Formation in Photorefractive Optics

Account of how complex patterns form in sustained nonequilibrium systems; for graduate students in biology, chemistry, engineering, mathematics, and physics.

Awakening and Sleep-wake Cycle Across Development

Fully illustrated mathematical guide to pattern formation. Includes instructive exercises and examples.

Self-Assembly, Pattern Formation and Growth Phenomena in Nano-Systems

The papers included in this issue of ECS Transactions were originally presented in the symposium ¿Oscillations and Pattern Formation in Electrochemistry¿, held during the 218th meeting of The Electrochemical Society, in Las Vegas, Nevada from October 10 to 15, 2010.

Pattern Formations and Oscillatory Phenomena

SIAM Journal on Numerical Analysis

Phase transitions in disordered systems and related dynamical phenomena are a topic of intrinsically high interest in theoretical and experimental physics. This book presents a unified view, adopting concepts from each of the disjoint fields of disordered systems and nonlinear dynamics. Special attention is paid to the glass transition, from both experimental and

theoretical viewpoints, to modern concepts of pattern formation, and to the application of the concepts of dynamical systems for understanding equilibrium and nonequilibrium properties of fluids and solids. The content is accessible to graduate students, but will also be of benefit to specialists, since the presentation extends as far as the topics of ongoing research work.

Nonlinear Dynamics and Pattern Formation in the Natural Environment

The study of heat and fluid flow in fluid-saturated porous media is applicable in a very wide range of fields, with practical applications in modern industry and environmental areas, such as nuclear waste management, the construction of thermal insulators, geothermal power, grain storage and many more. The vast amount of theoretical and experimental work reported has attracted the attention of industrialists, engineers, applied mathematicians, chemical, civil, environmental, mechanical and nuclear engineers, physicists, food scientists, medical researchers, etc. This book covers the full range of theoretical, computational and experimental approaches to the subject, grouped into reviews of: fundamentals, stability, anisotropy, permeability and non-equilibrium, applications, and experimental porous media.

Physics of Biomaterials: Fluctuations, Selfassembly and Evolution

This book is based on the 1997 Kongsberg seminar, organised by the Department of Geology at the University of Oslo. The seminar brought together scientists from various disciplines involved in the study of growth and dissolution of minerals and pattern formation in geosystems. The volume includes several chapters dealing with non-equilibrium growth processes and pattern formation, which have recently become recognised as much more common in geological systems than hitherto thought. The multidisciplinary context of this book will promote cross-fertilisation of ideas in a rapidly developing area that has a wide range of important applications in mineralogy and petrology as well as in other areas of science and technology. Audience: This volume will be of interest not only to a wide audience within the geoscience community, but also to scientists working in related disciplines interested in mineral growth and dissolution processes in general and the coupling of such processes with transport and deformation in sedimentary and metamorphic systems.

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This book introduces both physical and biological scientists to important thermodynamic and kinetic interpretations of living systems that involve major conceptual developments in the application of physio-chemical ideas. A concluding discussion relates these developments to other widely discussed ideas that have been recently applied to living systems, including thermodynamic aspects of evolution, information theory, and hierarchy and the question of reductionism. Students and

researchers in both physical and biological science will find this mathematically simplified account to be a clear and accessible introduction to the physical chemistry of biological organization.

Pattern Formation and Dynamics in Nonequilibrium Systems

This volume collects a a number of contributions on spontaneous symmetry breaking. Current studies in this general field are going ahead at a full speed. The book present review chapters which give an overview on the major break throughs of recent years. It covers a number of different physical settings which are introduced when a nonlinearity is added to the underlying symmetric problems and its strength exceeds a certain critical value. The corresponding loss of symmetry, called spontaneous symmetry breaking, alias self-trapping into asymmetric states is extensively discussed in this book. The book presents both active theoretical studies of spontaneous symmetry breaking effects as well as experimental findings, chiefly for Bose-Einstein-Condensates with the self-repulsive nonlinearity, and also for photorefractive media in optics.

Oscillations and Pattern Formation in Electrochemistry

Pattern Formations and Oscillatory Phenomena

The present book introduces and develops mathematical techniques for the treatment of nonlinear waves and singular perturbation methods at a level that is suitable for graduate students, researchers and faculty throughout the natural sciences and engineering. The practice of implementing these techniques and their value are largely realized by showing their application to problems of nonlinear wave phenomena in electronic transport in solid state materials, especially bulk semiconductors and semiconductor superlattices. The authors are recognized leaders in this field, with more than 30 combined years of contributions.

The Dynamics of Patterns

Pattern Formations and Oscillatory Phenomena

This reference work provides a comprehensive insight into the recent developments of applications of Nonlinear Dynamics in the field of production systems. Applications range from manufacturing and process engineering, to selected topics in mechanical engineering, automation technology and plant management. This compilation of contributions shows how

methods of Nonlinear Dynamics can be used to solve problems arising in traditional or non-conventional manufacturing techniques such as turning, high-speed milling, laser welding, jet cutting, or electrochemical processing. Recent progress in optimizing the dynamics of production lines and complete production systems is also covered. The book addresses both, experts in Nonlinear Dynamics who want to apply their methods to real-world problems, and practitioners who seek solutions for their engineering problems.

Patterns and Dynamics in Reactive Media

Reaction-diffusion Systems Modeling Pattern Formation in the Couette Flow Reactor

Realizing the need of interaction between universities and research groups in industry, the European Consortium for Mathematics in Industry (ECMI) was founded in 1986 by mathematicians from ten European universities. Since then it has been continuously extending and now it involves about all Euro pean countries. The aims of ECMI are • To promote the use of mathematical models in industry. • To educate industrial mathematicians to meet the growing demand for such experts. • To operate on a European Scale. Mathematics, as the language of the sciences, has always played an im portant role in technology, and now is applied also to a variety of problems in commerce and the environment. European industry is increasingly becoming dependent on high technology and the need for mathematical expertise in both research and development can only grow. These new demands on mathematics have stimulated academic interest in Industrial Mathematics and many mathematical groups world-wide are committed to interaction with industry as part of their research activities. ECMI was founded with the intention of offering its collective knowledge and expertise to European Industry. The experience of ECMI members is that similar technical problems are encountered by different companies in different countries. It is also true that the same mathematical expertise may often be used in differing industrial applications.

Progress in Industrial Mathematics at ECMI 2000

Ever since the seminal works on traveling waves and morphogenesis by Fisher, by Kolmogorov, Petrovski and Piscunov, and by Turing, scientists from many disciplines have been fascinated by questions concerning the formation of steady or dynamic patterns in reactive media. Contributions to this volume have been made by chemists, chemical engineers, mathematicians (both pure and applied), and physicists. The topics covered range from reports of experimental studies, through descriptions of numerical experiments, to rather abstract theoretical investigations, each exhibiting different aspects of a very diverse field.

Growth, Dissolution and Pattern Formation in Geosystems

Originating from contributions to a discussion of the Royal Society. Convection in fluids associated with gradients in surface tension, whether associated with pressure or concentration gradients, has been studied for over a century. There has been a growing awareness of the significance of the Marangoni effect in a wide range of materials processes, in particualr liquid metal processing (steelmaking, welding, joining, coating, secondary melting). The meeting brought together leading scientists who are elucidating the fundamental aspects of the effect.