Self Organized Criticality Emergent Complex Behavior In Physical And Biological Systems Cambridge Lecture Notes In Physics

This volume is comprised of the proceedings of "20 Years of Nonlinear Dynamics in Geosciences", held June 11-16, 2006 in Rhodes, Greece as part of the Aegean Conferences. The volume brings together research from the atmospheric sciences, hydrology, geology, and other areas of Geosciences, and discusses the advances made and the future directions of nonlinear dynamics. The topics covered include predictability, ensemble prediction, nonlinear prediction, nonlinear time series analysis, low-dimensional chaos, nonlinear modeling, fractals and multifractals, bifurcation, and other aspects of nonlinear science

Although its roots can be traced to the 19th century, progress in the study of nonlinear dynamical systems has taken off in the last 30 years. While pertinent source material exists, it is strewn about the literature in mathematics, physics, biology, economics, and psychology at varying levels of accessibility. A compendium research methods reflect

This book capitalizes on the developments in dynamical systems and education by presenting some of the most recent advances in this area in seventeen non-overlapping chapters. The first half of the book discusses the conceptual framework of complex dynamical systems and its applicability to educational processes. The second half presents a set of empirical studies that that illustrate the use of various research methodologies to investigate complex dynamical processes in education, and help the reader appreciate what we learn about dynamical processes in education from using these approaches.

Within our knowledge, the series of the International Conference on Cognitive Neurodynamics (ICCN) is the only conference series dedicating to cognitive neurodynamis. This volume is the proceedings of the 3rd International Conference on Cognitive Neurodynamics held in 2011, which reviews the progress in this field since the 1st ICCN - 2007. The topics include: Neural coding and realistic neural network dynamics, Neural population dynamics, Firing Oscillations and Patterns in Neuronal Networks, Brain imaging, EEG, MEG, Sensory and Motor Dynamics, Global cognitive function, Multi-scalar Neurodynamics - from Physiology to Systems Theory, Neural computing, Emerging Technologies for Brain Computer Interfaces, Neural dynamics of brain disorders.

This book constitutes the thoroughly refereed post-proceedings of the First International Conference on Formal Aspects of Security, FASec 2002, held in London, UK, in December 2002. The 11 revised full papers presented together with 7 invited contributions were carefully reviewed, selected, and improved for inclusion in the book. The papers are organized in topical sections on protocol verification, analysis of protocols, security modelling and reasoning, and intrusion detection systems and liveness.

This book deals with the theory and the applications of a new time domain, termed natural time domain, that has been forwarded by the authors almost a decade ago (P.A. Varotsos, N.V. Sarlis and E.S. Skordas, Practica of Athens Academy 76, 294-321, 2001; Physical Review E 66, 011902, 2002). In particular, it has been found that novel dynamical features hidden behind time series in complex systems can emerge upon analyzing them in this new time domain, which conforms to the desire to reduce uncertainty and extract signal information as much as possible. The analysis in natural time enables the study of the dynamical evolution of a complex system and identifies when the system enters a critical stage. Hence, natural time plays a key role in predicting impending catastrophic events in general. Relevant examples of data analysis in this new time domain have been published during the last decade in a large variety of fields, e.g., Earth Sciences, Biology and

Physics. The book explains in detail a series of such examples including the identification of the sudden cardiac death risk in Cardiology, the recognition of electric signals that precede earthquakes, the determination of the time of an impending major mainshock in Seismology, and the analysis of the avalanches of the penetration of magnetic flux into thin films of type II superconductors in Condensed Matter Physics. In general, this book is concerned with the time-series analysis of signals emitted from complex systems by means of the new time domain and provides advanced students and research workers in diverse fields with a sound grounding in the fundamentals of current research work on detecting (long-range) correlations in complex time series. Furthermore, the modern techniques of Statistical Physics in time series analysis, for example Hurst analysis, the detrended fluctuation analysis, the wavelet transform etc., are presented along with their advantages when natural time domain is employed.

The many kinds of porous geomaterials (rocks, soils, concrete, etc.) exhibit a range of responses when undergoing inelastic deformation. In doing so they commonly develop well-ordered fabric elements, forming fractures, shear bands and compaction bands, so creating the planar fabrics that are regarded as localization. Because these induced localization fabrics alter the bulk material properties (such as permeability, acoustic characteristics and strength), it is important to understand how and why localization occurs, and how it relates to its setting. The concept of damage (in several uses) describes both the precursor to localization and the context within which it occurs. A key theme is that geomaterials display a strong material evolution during deformation, revealing a close linkage between the damage and localization processes. This volume assembles perspectives from a number of disciplines, including soil mechanics, rock mechanics, structural geology, seismic anisotropy and reservoir engineering. The papers range from theoretical to observational, and include contributions showing how the deformed geomaterial's emergent bulk characteristics, like permeability and seismic anisotropy, can be predicted.

This book is a printed edition of the Special Issue "Thermodynamics and Statistical Mechanics of Small Systems" that was published in Entropy

Today’s IT systems with its ever-growing communication infrastructures and computing applications are becoming more and more large in scale, which results in exponential complexity in their engineering, operation and maintenance. Recently, it has widely been recognized that self-organization and self-management / regulation offer the most promising approach to addressing such challenges. Self-organization and adaptation are concepts stemming from the nature and have been adopted in systems theory. They are considered to be the essential ingredients of any living organism and, as such, are studied intensively in biology, sociology and organizational theory. They have also penetrated into control theory, cybernetics and the study of adaptive complex systems. Computing and communication systems are basically artificial systems. This prevents conventional self-organization and adaptation principles and approaches from being directly applicable to computing and communication systems. The methodology of multi-agent systems and the technology of Grid computing have shed lights for the exploration into the self-organization and adaptation of large-scale complex IT systems. This book provides in-depth thoughts about the above discussed challenges as well as a range of state-of-the-art methodologies and technologies for the entirely new area. We refer to this newly emerging area as Self-Organization and Autonomic Informatics, which has represented the future generation of IT systems, comprised of communication infrastructures and computing applications, which are inherently large-scale, complex and open.

What are the principles that keep our society together? This question is even more difficult to answer than the long-standing question, what are the forces that keep our world together. However, the social challenges of humanity in the 21st century ranging from the financial crises to the impacts of globalization, require us to make fast progress in our understanding of how society works, and how our future can be managed in a resilient and sustainable way. This book can present only a few very first steps towards this ambitious goal. However, based on simple models of social interactions, one can already gain some surprising insights into the social, ``macro-level'' outcomes and dynamics that is implied by individual, ``micro-level'' interactions. Depending on the nature of these interactions, they may imply the spontaneous formation of social conventions or the birth of social cooperation, but also their sudden breakdown. This can end in deadly crowd disasters or tragedies of the commons (such as financial crises or environmental destruction). Furthermore, we demonstrate that classical modeling approaches (such as representative agent models) do not provide a sufficient understanding of the self-organization in social systems resulting from individual interactions. The consideration of randomness, spatial or network interdependencies, and nonlinear feedback effects turns out to be crucial to get fundamental insights into how social patterns and dynamics emerge. Given the explanation of sometimes counter-intuitive phenomena resulting from these features and their combination, our evolutionary modeling approach appears to be powerful and insightful. The chapters of this book range from a discussion of the modeling strategy for socio-economic systems over experimental issues up the right way of doing agent-based modeling. We furthermore discuss applications ranging from pedestrian and crowd dynamics over opinion formation, coordination, and cooperation up to conflict, and also address the response to information, issues of systemic risks in society and economics, and new approaches to manage complexity in socio-economic systems. Selected parts of this book had been previously published in peer reviewed journals.
The present book describes novel theories of mutation pathogen systems showing critical fluctuations, as a paradigmatic example of an application of the mathematics of critical phenomena to the life sciences. It will enable the reader to understand the implications and future impact of these findings, yet at same time allow him to actively follow the mathematical tools and scientific origins of critical phenomena. This book also seeks to pave the way to further fruitful applications of the mathematics of critical phenomena in other fields of the life sciences.
The book you hold in your hands is the outcome of the “2014 Interdisciplinary Symposium on Complex Systems” held in the historical city of Florence. The book consists of 37 chapters from 4 areas of Physical Modeling of Complex Systems, Evolutionary Computations, Complex Biological Systems and Complex Networks. All 4 parts contain contributions that give interesting point of view on complexity in different areas in science and technology. The book starts with a comprehensive overview and classification of complexity problems entitled Physics in the world of ideas: Complexity as Energy” , followed by chapters about complexity measures and physical principles, its observation, modeling and its applications, to solving various problems including real-life applications. Further chapters contain recent research about evolution, randomness and complexity, as well as complexity in biological systems and complex networks. All selected papers represent innovative ideas, philosophical overviews and state-of-the-

art discussions on aspects of complexity. The book will be useful as an instructional material for senior undergraduate and entry-level graduate students in computer science, physics, applied mathematics and engineering-type work in the area of complexity. The book will also be valuable as a resource of knowledge for practitioners who want to apply complexity to solve real-life problems in their own challenging applications.

While knowledge on substance abuse and addictions is expanding rapidly, clinical practice still lags behind. This book brings together leading experts to describe what treatment and prevention would look like if it were based on the best science available. The volume incorporates developmental, neurobiological, genetic, behavioral, and social–environmental perspectives. Tightly edited chapters summarize current thinking on the nature and causes of alcohol and other drug problems; discuss what works at the individual, family, and societal levels; and offer robust principles for developing more effective treatments and services.

Published by the American Geophysical Union as part of the Geophysical Monograph Series, Volume 118. The magnetosphere is an open system that interacts with the solar wind. In this system, solar wind energy continuously permeates different regions of the magnetosphere through electromagnetic processes, which we can well describe in terms of current systems. In fact, our ability to use various methods to study magnetospheric current systems has recently prompted significant progress in our understanding of the phenomenon. Unprecedented coverage of satellite and ground?]based observations has advanced global approaches to magnetospheric current systems, whereas advanced measurements of electromagnetic fields and particles have brought new insights about micro?]processes. Increased computer capabilities have enabled us to simulate the dynamics not only of the terrestrial magnetosphere but also the magnetospheres of other planets. Based on such developments, the present volume revisits outstanding issues about magnetospheric current systems.

Applied probability is a broad research area that is of interest to scientists in diverse disciplines in science and technology, including: anthropology, biology, communication theory, economics, epidemiology, finance, geography, linguistics, medicine, meteorology, operations research, psychology, quality control, sociology, and statistics. Recent Advances in Applied Probability is a collection of survey articles that bring together the work of leading researchers in applied probability to present current research advances in this important area. This volume will be of interest to graduate students and researchers whose research is closely connected to probability modelling and their applications. It is suitable for one semester graduate level research seminar in applied probability.

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Metaphors, generalizations and unifications are natural and desirable ingredients of the evolution of scientific theories and concepts. Physics, in particular, obviously walks along these paths since its very beginning. This book focuses on nonextensive statistical mechanics, a current generalization of Boltzmann-Gibbs (BG) statistical mechanics, one of the greatest monuments of contemporary physics. Conceived more than 130 years ago by Maxwell, Boltzmann and Gibbs, the BG theory exhibits uncountable – some of them impressive – successes in physics, chemistry, mathematics, and computational sciences, to name a few. Presently, more than two thousand publications, by over 1800 scientists around the world, have been dedicated to the nonextensive generalization. Remarkable applications have emerged, and its mathematical grounding is by now relatively well established. A pedagogical introduction to its concepts – nonlinear dynamics, extensivity of the nonadditive entropy, global correlations, generalization of the standard CLT's, among others – is presented in this book as well as a selection of paradigmatic applications in various sciences together with diversified experimental verifications of some of its predictions. This is the first pedagogical book on the subject, written by the proponent of the theory Presents many applications to interdisciplinary complex phenomena in virtually all sciences, ranging from physics to medicine, from economics to biology, through signal and image processing and others Offers a detailed derivation of results, illustrations and for the first time detailed presentation of Nonextensive Statistical Mechanics

This book compiles recent advances of evolutionary algorithms in dynamic and uncertain environments within a unified framework. The book is motivated by the fact that some degree of uncertainty is inevitable in characterizing any realistic engineering systems. Discussion includes representative methods for addressing major sources of uncertainties in evolutionary computation, including handle of noisy fitness functions, use of approximate fitness functions, search for robust solutions, and tracking moving optimums.

The proceedings of the 2005 les Houches summer school on Mathematical Statistical Physics give and broad and clear overview on this fast developing area of interest to both physicists and mathematicians. Introduction to a field of math with many interdisciplinary connections in physics, biology, and computer science Roadmap to the next decade of mathematical statistical mechanics Volume for reference years to come

Self-organized criticality (SOC) has become a magic word in various scientific disciplines; it provides a framework for understanding complexity and scale invariance in systems showing irregular fluctuations. In the first 10 years after Per Bak and his co-workers presented their seminal idea, more than 2000 papers on this topic appeared. Seismology has been a field in earth sciences where the SOC concept has already deepened the understanding, but there seem to be much more examples in earth sciences where applying the SOC concept may be fruitful. After introducing the reader into the basics of fractals, chaos and SOC, the book presents established and new applications of SOC in earth sciences, namely earthquakes, forest fires, landslides and drainage networks.

Self-organized criticality, the spontaneous development of systems to a critical state, is the first general theory of complex systems with a firm mathematical basis. This theory describes how many seemingly desperate aspects of the world, from stock market crashes to mass extinctions, avalanches to solar flares, all share a set of simple, easily described properties. "...a'must read'...Bak writes with such ease and lucidity, and his ideas are so intriguing...essential reading for those interested in complex systems...it will reward a sufficiently skeptical reader." -NATURE "...presents the theory (self-organized criticality) in a form easily absorbed by the non-mathematically inclined reader." -BOSTON BOOK REVIEW "I picture Bak as a kind of scientific musketeer; flamboyant, touchy, full of swagger and ready to join every fray... His book is written with panache. The style is brisk, the content stimulating. I recommend it as a bracing experience." -NEW SCIENTIST

Emergence and complexity refer to the appearance of higher-level properties and behaviours of a system that obviously comes from the collective dynamics of that system's components. These properties are not directly deducible from the lower-level motion of that system. Emergent properties are properties of the "whole" that are not possessed by any of the individual parts making up that whole. Such phenomena exist in various domains and can be described, using complexity concepts and thematic knowledges. This book highlights complexity modelling through dynamical or behavioral systems. The pluridisciplinary purposes, developed along the chapters, are able to design links between a wide-range of fundamental and applicative Sciences. Developing such links - instead of focusing on specific and narrow researches - is characteristic of the Science of Complexity that we try to promote by this contribution.

Self-Organized CriticalityEmergent Complex Behavior in Physical and Biological SystemsCambridge University Press
Many approaches exist for scientific investigations and space research is no exception. The early approach during which each space plasma region within the Sun-Earth system was investigated separately with physics-based tools has now progressed to encompass investigations on coupling between these regions. Ample evidence now exists indicating the dynamic processes in these regions exhibit disturbances over a wide range of scales both in time and space. This new reckoning naturally leads to an emerging perspective of probing these natural phenomena with concepts and tools developed in modern statistical mechanics for physical processes governing the evolution of out-of-equilibrium and complex systems. These new developments have prompted a topical conference on Sun-Earth connection, held on February 9-13, 2004 at Kailua-Kona, Hawaii, USA, with the goal of promoting interactions among scientists practicing the traditional physics-based approach and those utilizing modern statistical techniques. This monograph is a product of this conference, a compilation of thirty-nine articles assembled into seven chapters: (1) multiscale features in complexity dynamics, (2) space storms, (3) magnetospheric substorms, (4) turbulence and magnetic reconnection, (5) modeling and coupling of space phenomena, (6) techniques for multiscale space plasma problems, and (7) present and future multiscale space missions. These articles show a diversity of space phenomena exhibiting scale free characteristics, intermittency, and non-Gaussian distributions of probability density function of fluctuations in the physical parameters of the Sun-Earth system. The scope covers the latest observations, theories, simulations, and techniques on the multiscale nature of Sun-Earth phenomena and underscores the usefulness in cross-disciplinary exchange needed to unravel the underlying physical processes, which may eventually lead to a possible unified description and prediction for space disturbances. * Extensive collection of state-of-the-art papers on multiscale coupling of Sun-Earth Processes * Present and future multiscale space missions * New techniques and models for performing multiscale analysis
Designed for biology, physics, and medical students, Introductory Biophysics: Perspectives on the Living State, provides a comprehensive overview of the complex subject of biological physics. The companion CD-ROM (eBook version does not include the CD-ROM), with MATLAB examples and the student version of QuickFieldTM, allows the student to perform biophysical simulations and modify the textbook example files. Included in the text are computer simulations of thermodynamics, astrobiology, the response of living cells to external fields, chaos in population dynamics, numerical models of evolution, electrical circuit models of cell suspension, gap junctions, and neuronal action potentials. With this text students will be able to perform biophysical simulations within hours. MATLAB examples include; the Hodgkin Huxley equations; the FitzHugh-Nagumo model of action potentials; fractal structures in biology; chaos in population dynamics; the cellular automaton model (the game of life); pattern formation in reaction-diffusion systems. QuickFieldTM tutorials and examples include; calculation of currents in biological tissue; cells under electrical stimulation; induced membrane potentials; heat transfer and analysis of stress in biomaterials.
'Confidence Games' argues that money and markets do not exist in a vacuum, but grow in a profoundly cultual medium, reflecting and in turn shaping their world. To understand the ongoing changes in the economy, one must consider the influence of art, philosophy and religion.
Self-organized criticality (SOC) is based upon the idea that complex behavior can develop spontaneously in certain multi-body systems

whose dynamics vary abruptly. This book is a clear and concise introduction to the field of self-organized criticality, and contains an overview of the main research results. The author begins with an examination of what is meant by SOC, and the systems in which it can occur. He then presents and analyzes computer models to describe a number of systems, and he explains the different mathematical formalisms developed to understand SOC. The final chapter assesses the impact of this field of study, and highlights some key areas of new research. The author assumes no previous knowledge of the field, and the book contains several exercises. It will be ideal as a textbook for graduate students taking physics, engineering, or mathematical biology courses in nonlinear science or complexity.

Written in a style that breaks the barriers between the disciplines, this monograph enables researchers from life science, physics, engineering, or chemistry to access the most recent results in a common language. The resulting review character of this project sets it apart from specialized journals, and allows each volume to respond quickly to new developments. This third volume contains new topics ranging from chaotic computing, via random dice tossing and stochastic limit-cycle oscillators, to a number theoretic example of self-organized criticality, wave localization in complex networks and anomalous diffusion. A first-class board of international scientists advises the editor, such that the carefully selected and invited contributions represent the latest and most relevant findings.

Interpersonal coordination is an important feature of all social systems. From everyday activities to playing sport and participating in the performing arts, human behaviour is constrained by the need to continually interact with others. This book examines how interpersonal coordination tendencies in social systems emerge, across a range of contexts and at different scales, with the aim of helping practitioners to understand collective behaviours and create learning environments to improve performance. Showcasing the latest research from scientists and academics, this collection of studies examines how and why interpersonal coordination is crucial for success in sport and the performing arts. It explains the complex science of interpersonal coordination in relation to a variety of activities including competitive team sports, outdoor sports, racket sports, and martial arts, as well as dance. Divided into four sections, this book offers insight into: the nature, history and key concepts of interpersonal coordination factors that influence interpersonal coordination within social systems interpersonal coordination in competitive and cooperative performance contexts methods, tools and devices for improving performance through interpersonal coordination. This book will provide fascinating insights for students, researchers and educators interested in movement science, performance analysis, sport science and psychology, as well as for those working in the performing arts.

The purpose of this book is to illustrate the fundamental concepts of complexity and complex behavior and the best methods to characterize this behavior by means of their applications to some current research topics from within the fields of fusion, earth and solar plasmas. In this sense, it is a departure from the many books already available that discuss general features of complexity. The book is divided in two parts. In the first part the most important properties and features of complex systems are introduced, discussed and illustrated. The second part discusses several instances of possible complex phenomena in magnetized plasmas and some of the analysis tools that were introduced in the first part are used to characterize the dynamics in these systems. A list of problems is proposed at the end of each chapter. This book is intended for graduate and post-graduate students with a solid college background in mathematics and classical physics, who intend to work in the field of plasma physics and, in particular, plasma turbulence. It will also be of interest to senior scientists who have so far approached these systems and problems from a different perspective and want a new fresh angle.

In many aspects science becomes conducted nowadays through technology and preferential criteria of economy. Thus investigation and knowledge is evidently linked to a speci?c purpose. Especially Earth science is confronted with two major human perspectives concerning our natural environment:sustainability of resources and assessment of risks. Both aspects are expressing urgent needs of the living society, but in the same way those needs are addressing a long lasting fundamental challenge which has so far not been met. Following on the patterns of economy and technology, the key is presumed to be found through a devel- mentoffeasibleconceptsforamanagement ofbothournaturalenvironmentand in one or the other way the realm of life. Although new techniques for obser- tion and analysis led to an increase of rather speci?c knowledge about particular phenomena, yet we fail now even more frequently to avoid unforeseen impli- tions and sudden changes of a situation. Obviously the improved technological tools and the assigned expectations on a management of nature still exceed our traditional scienti?c experience and accumulated competence. Earth- and Life- Sciences are nowadays exceedingly faced with the puzzling nature of an almost boundless network of relations, i. e. , the complexity of phenomena with respect to their variability. The disciplinary notations and their particular approaches arethusnolongeraccountingsu?cientlyfortherecordedcontextofphenomena, for their permanent variability and their unpredictable implications. The large environmental changes of glacial climatic cycles, for instance, demonstrate this complexity of such a typical phenomenology.

A clear and concise introduction to this new, cross-disciplinary field.

This book presents a collection of research findings and proposals on computer science and computer engineering, introducing readers to essential concepts, theories, and applications. It also shares perspectives on how cutting-edge and established methodologies and techniques can be used to obtain new and interesting results. Each chapter focuses on a specific aspect of computer science or computer engineering, such as: software engineering, complex systems, computational intelligence, embedded systems, and systems engineering. As such, the book will bring students and professionals alike up to date on key advances in these areas.

This book presents studies of complexity in the context of nonequilibrium phenomena using theory, modeling, simulations, and experiments, both in the laboratory and in nature.

A truly Galilean-class volume, this book introduces a new method in theory formation, completing the tools of epistemology. It covers a broad spectrum of theoretical and mathematical physics by researchers from over 20 nations from four continents. Like Vigier himself, the Vigier symposia are noted for addressing avant-garde, cutting-edge topics in contemporary physics. Among the six proceedings honoring J.-P. Vigier, this is perhaps the most exciting one as several important breakthroughs are introduced for the first time. The most interesting breakthrough in view of the recent NIST experimental violations of QED is a continuation of the pioneering work by Vigier on tight bound states in hydrogen. The new experimental protocol described not only promises empirical proof of large-scale extra dimensions in conjunction with avenues for testing string theory, but also implies the birth of the field of unified field mechanics, ushering in a new age of discovery. Work on quantum computing redefines the qubit in a manner that the uncertainty principle may be routinely violated. Other breakthroughs occur in the utility of quaternion algebra in extending our understanding of the nature of the fermionic singularity or point particle. There are several other discoveries of equal magnitude, making this volume a must-have acquisition for the library of any serious forward-looking researchers.

This book presents a new concept of General Systems Theory and its application to atmospheric physics. It reveals that energy input into the atmospheric eddy continuum, whether natural or manmade, results in enhancement of fluctuations of all scales, manifested immediately in the intensification of high-frequency fluctuations such as the Quasi-Biennial Oscillation and the El-Nino–Southern Oscillation cycles. Atmospheric flows exhibit self-organised criticality, i.e. long-range correlations in space and time manifested as fractal geometry to the spatial pattern concomitant with an inverse power law form for fluctuations of meteorological parameters such as temperature, pressure etc. Traditional meteorological theory cannot satisfactorily explain the observed self-similar space time structure of atmospheric flows. A recently developed general systems theory for fractal space-time fluctuations shows that the larger-scale fluctuation can be visualised to emerge from the space-time averaging of enclosed small-scale fluctuations, thereby generating a hierarchy of self-similar fluctuations manifested as the observed eddy continuum in power spectral analyses of fractal fluctuations. The interconnected network of eddy circulations responds as a unified whole to local perturbations such as global-scale response to El-Nino events. The general systems theory model predicts an inverse power law form incorporating the golden mean ? for the distribution of space-time fluctuation patterns and for the power (variance) spectra of the fluctuations. Since the probability distributions of amplitude and variance are the same, atmospheric flows exhibit quantumlike chaos. Long-range correlations inherent to power law distributions of fluctuations are identified as nonlocal connection or entanglement exhibited by quantum systems such as electrons or photons. The predicted distribution is close to the Gaussian distribution for small-scale fluctuations, but exhibits a fat long tail for large-scale fluctuations. Universal inverse power law for fractal fluctuations rules out unambiguously linear secular trends in climate parameters.

Complex Systems Science in Biomedicine Thomas S. Deisboeck and J. Yasha Kresh Complex Systems Science in Biomedicine covers the emerging field of systems science involving the application of physics, mathematics, engineering and computational methods and techniques to the study of biomedicine including nonlinear dynamics at the molecular, cellular, multi-cellular tissue, and organismic level. With all chapters helmed by leading scientists in the field, Complex Systems Science in Biomedicine's goal is to offer its audience a timely compendium of the ongoing research directed to the understanding of biological processes as whole systems instead of as isolated component parts. In Parts I & II, Complex Systems Science in Biomedicine provides a general systems thinking perspective and presents some of the fundamental theoretical underpinnings of this rapidly emerging field. Part III then follows with a multi-scaled approach, spanning from the molecular to macroscopic level, exemplified by studying such diverse areas as molecular networks and developmental processes, the immune and nervous systems, the heart, cancer and multi-organ failure. The volume concludes with Part IV that addresses methods and techniques driven in design and development by this new understanding of biomedical science. Key Topics Include: • Historic Perspectives of General Systems Thinking • Fundamental Methods and Techniques for Studying Complex Dynamical Systems • Applications from Molecular Networks to Disease Processes • Enabling Technologies for Exploration of Systems in the Life Sciences Complex Systems Science in Biomedicine is essential reading for experimental, theoretical, and interdisciplinary scientists working in the biomedical research field interested in a comprehensive overview of this rapidly emerging field. About the Editors: Thomas S. Deisboeck is currently Assistant Professor of Radiology at Massachusetts General Hospital and Harvard Medical School in Boston. An expert in interdisciplinary cancer modeling, Dr. Deisboeck is Director of the Complex Biosystems Modeling Laboratory which is part of the Harvard-MIT Martinos Center for Biomedical Imaging. J. Yasha Kresh is currently Professor of Cardiothoracic Surgery and Research Director, Professor of Medicine and Director of Cardiovascular Biophysics at the Drexel University College of Medicine. An expert in dynamical systems, he holds appointments in the School of Biomedical Engineering and Health Systems, Dept. of Mechanical Engineering and Molecular Pathobiology Program. Prof. Kresh is Fellow of the American College of Cardiology, American Heart Association, Biomedical Engineering Society, American Institute for Medical and Biological Engineering.

Markus Aschwanden introduces the concept of self-organized criticality (SOC) and shows that due to its universality and ubiquity it is a law of nature for which he derives the theoretical framework and specific physical models in this book. He begins by providing an overview of the many diverse phenomena in nature which may be attributed to SOC behaviour. The author then introduces the classic lattice-based SOC models that may be explored using numerical computer simulations. These simulations require an in-depth knowledge of a wide range of mathematical techniques which the author introduces and describes in subsequent chapters. These include the statistics of random processes, time series analysis, time scale distributions, and waiting time distributions. Such mathematical techniques are needed to model and understand the power-law-like occurrence frequency distributions of SOC phenomena. Finally, the author discusses fractal geometry and scaling laws before looking at a range of physical SOC models which may be applicable in various aspects of astrophysics. Problems, solutions and a glossary will enhance the pedagogical usefulness of the book. SOC has been receiving growing attention in the astrophysical and solar physics community. This book will be welcomed by students and researchers studying complex critical phenomena.

Chaos and Nonlinear Dynamics is a comprehensive introduction to the exciting scientific field of nonlinear dynamics for students, scientists, and engineers, and requires only minimal prerequisites in physics and mathematics. The book treats all the important areas in the field and provides an extensive and up-to-date bibliography of applications in all fields of science, social science, economics, and even the arts.