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Nonlinear Dynamics and Chaos

With Applications to Physics, Biology, Chemistry, and Engineering *CRC Press*

This textbook is aimed at newcomers to nonlinear dynamics and chaos, especially students taking a first course in the subject. The presentation stresses analytical methods, concrete examples, and geometric intuition. The theory is developed systematically, starting with first-order differential equations and their bifurcations, followed by phase plane analysis, limit cycles and their bifurcations, and culminating with the Lorenz equations, chaos, iterated maps, period doubling, renormalization, fractals, and strange attractors.

Nonlinear Dynamics and Chaos

With Applications to Physics, Biology, Chemistry, and Engineering *Hachette UK*

This textbook is aimed at newcomers to nonlinear dynamics and chaos, especially students taking a first course in the subject. The presentation stresses analytical methods, concrete examples, and geometric intuition. The theory is developed systematically, starting with first-order differential equations and their bifurcations, followed by phase plane analysis, limit cycles and their bifurcations, and culminating with the Lorenz equations, chaos, iterated maps, period doubling, renormalization, fractals, and strange attractors. A unique feature of the book is its emphasis on applications. These include mechanical vibrations, lasers, biological rhythms, superconducting circuits, insect outbreaks, chemical oscillators, genetic control systems, chaotic waterwheels, and even a technique for using chaos to send secret messages. In each case, the scientific background is explained at an elementary level and closely integrated with mathematical theory. In the twenty years since the first edition of this book appeared, the ideas and techniques of nonlinear dynamics and chaos have found application to such exciting new fields as systems biology, evolutionary game theory, and sociophysics. This second edition includes new exercises on these cutting-edge developments, on topics as varied as the curiosities of visual perception and the tumultuous love dynamics in *Gone With the Wind*.

Nonlinear Dynamics and Chaos

Student Solutions Manual for Nonlinear Dynamics and Chaos, 2nd edition *CRC Press*

This official Student Solutions Manual includes solutions to the odd-numbered exercises featured in the second edition of Steven Strogatz's classic text *Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering*. The textbook and accompanying Student Solutions Manual are aimed at newcomers to nonlinear dynamics and chaos, especially students taking a first course in the subject. Complete with graphs and worked-out solutions, this manual demonstrates techniques for students to analyze differential equations, bifurcations, chaos, fractals, and other subjects Strogatz explores in his popular book.

Nonlinear Dynamics and Chaos

With Applications to Physics, Biology, Chemistry, and Engineering *CRC Press*

This textbook is aimed at newcomers to nonlinear dynamics and chaos, especially students taking a first course in the subject. The presentation stresses analytical methods, concrete examples, and geometric intuition. The theory is developed systematically, starting with first-order differential equations and their bifurcations, followed by phase plane analysis, limit cycles and their bifurcations, and culminating with the Lorenz equations, chaos, iterated maps, period doubling, renormalization, fractals, and strange attractors.

Nonlinear Dynamical Systems and Chaos *Birkhäuser*

Symmetries in dynamical systems, "KAM theory and other perturbation theories", "Infinite dimensional systems", "Time series analysis" and "Numerical continuation and bifurcation analysis" were the main topics of the December 1995 Dynamical Systems Conference held in Groningen in honour of Johann Bernoulli. They now form the core of this work which seeks to present the state of the art in various branches of the theory of dynamical systems. A number of articles have a survey character whereas others deal with recent results in current research. It contains interesting material for all members of the dynamical systems community, ranging from geometric and analytic aspects from a mathematical point of view to applications in various sciences.

Chaos and Nonlinear Dynamics

An Introduction for Scientists and Engineers *Oxford University Press on Demand*

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.

Nonlinear Dynamics and Chaos with Student Solutions Manual

With Applications to Physics, Biology, Chemistry, and Engineering, Second Edition *CRC Press*

This textbook is aimed at newcomers to nonlinear dynamics and chaos, especially students taking a first course in the subject. The presentation stresses analytical methods, concrete examples, and geometric intuition. The theory is developed systematically, starting with first-order differential equations and their bifurcations, followed by phase plane analysis, limit cycles and their bifurcations, and culminating with the Lorenz equations, chaos, iterated maps, period doubling, renormalization, fractals, and strange attractors.

Introduction to Applied Nonlinear Dynamical Systems and Chaos *Springer Science & Business Media*

This introduction to applied nonlinear dynamics and chaos places emphasis on teaching the techniques and ideas that will enable students to take specific dynamical systems and obtain some quantitative information about their behavior. The new edition has been updated and extended throughout, and contains a detailed glossary of terms. From the reviews: "Will serve as one of the most eminent introductions to the geometric theory of dynamical systems." --Monatshefte für Mathematik

Nonlinear Dynamics and Chaos *John Wiley & Sons*

Nonlinear dynamics and chaos involves the study of apparent random happenings within a system or process. The subject has wide applications within mathematics, engineering, physics and other physical sciences. Since the bestselling first edition was published, there has been a lot of new research conducted in the area of nonlinear dynamics and chaos. * Expands on the bestselling, highly regarded first edition * A new chapter which will cover the new research in the area since first edition * Glossary of terms and a bibliography have been added * All figures and illustrations will be 'modernised' * Comprehensive and systematic account of nonlinear dynamics and chaos, still a fast-growing area of applied mathematics * Highly illustrated * Excellent introductory text, can be used for an advanced undergraduate/graduate course text

Nonlinear Systems *Cambridge University Press*

This book introduces the mathematical properties of nonlinear systems, mostly difference and differential equations, as an integrated theory, rather than presenting isolated fashionable topics.

A First Course In Chaotic Dynamical Systems

Theory And Experiment *CRC Press*

A First Course in Chaotic Dynamical Systems: Theory and Experiment is the first book to introduce modern topics in dynamical systems at the undergraduate level. Accessible to readers with only a background in calculus, the book integrates both theory and computer experiments into its coverage of contemporary ideas in dynamics. It is designed as a gradual introduction to the basic mathematical ideas behind such topics as chaos, fractals, Newton's method, symbolic dynamics, the Julia set, and the Mandelbrot set, and includes biographies of some of the leading researchers in the field of dynamical systems. Mathematical and computer experiments are integrated throughout the text to help illustrate the meaning of the theorems presented. Chaotic Dynamical Systems Software, Labs 1-6 is a supplementary laboratory software package, available separately, that allows a more intuitive understanding of the mathematics behind dynamical systems theory. Combined with A First Course in Chaotic Dynamical Systems , it leads to a rich understanding of this emerging field.

An Introduction To Chaotic Dynamical Systems *CRC Press*

The study of nonlinear dynamical systems has exploded in the past 25 years, and Robert L. Devaney has made these advanced research developments accessible to undergraduate and graduate mathematics students as well as researchers in other disciplines with the introduction of this widely praised book. In this second edition of his best-selling text, Devaney includes new material on the orbit diagram fro maps of the interval and the Mandelbrot set, as well as striking color photos illustrating both Julia and Mandelbrot sets. This book assumes no prior acquaintance with advanced mathematical topics such as measure theory, topology, and differential geometry. Assuming only a knowledge of calculus, Devaney introduces many of the basic concepts of modern dynamical systems theory and leads the reader to the point of current research in several areas.

Sync

How Order Emerges from Chaos In the Universe, Nature, and Daily Life *Hachette UK*

At the heart of the universe is a steady, insistent beat, the sound of cycles in sync. Along the tidal

rivers of Malaysia, thousands of fireflies congregate and flash in unison; the moon spins in perfect resonance with its orbit around the earth; our hearts depend on the synchronous firing of ten thousand pacemaker cells. While the forces that synchronize the flashing of fireflies may seem to have nothing to do with our heart cells, there is in fact a deep connection. Synchrony is a science in its infancy, and Strogatz is a pioneer in this new frontier in which mathematicians and physicists attempt to pinpoint just how spontaneous order emerges from chaos. From underground caves in Texas where a French scientist spent six months alone tracking his sleep-wake cycle, to the home of a Dutch physicist who in 1665 discovered two of his pendulum clocks swinging in perfect time, this fascinating book spans disciplines, continents, and centuries. Engagingly written for readers of books such as Chaos and The Elegant Universe, Sync is a tour-de-force of nonfiction writing.

Chaos

An Introduction to Dynamical Systems *Springer*

BACKGROUND Sir Isaac Newton brought to the world the idea of modeling the motion of physical systems with equations. It was necessary to invent calculus along the way, since fundamental equations of motion involve velocities and accelerations, of position. His greatest single success was his discovery that which are derivatives the motion of the planets and moons of the solar system resulted from a single fundamental source: the gravitational attraction of the hodies. He demonstrated that the observed motion of the planets could be explained by assuming that there is a gravitational attraction between any two objects, a force that is proportional to the product of masses and inversely proportional to the square of the distance between them. The circular, elliptical, and parabolic orbits of astronomy were no longer fundamental determinants of motion, but were approximations of laws specified with differential equations. His methods are now used in modeling motion and change in all areas of science. Subsequent generations of scientists extended the method of using differential equations to describe how physical systems evolve. But the method had a limitation. While the differential equations were sufficient to determine the behavior in the sense that solutions of the equations did exist-it was frequently difficult to figure out what that behavior would be. It was often impossible to write down solutions in relatively simple algebraic expressions using a finite number of terms. Series solutions involving infinite sums often would not converge beyond some finite time.

Instabilities, Chaos and Turbulence *World Scientific*

This book (2nd edition) is a self-contained introduction to a wide body of knowledge on nonlinear dynamics and chaos. Manneville emphasises the understanding of basic concepts and the nontrivial character of nonlinear response, contrasting it with the intuitively simple linear response. He explains the theoretical framework using pedagogical examples from fluid dynamics, though prior knowledge of this field is not required. Heuristic arguments and worked examples replace most esoteric technicalities. Only basic understanding of mathematics and physics is required, at the level of what is currently known after one or two years of undergraduate training: elementary calculus, basic notions of linear algebra and ordinary differential calculus, and a few fundamental physical equations (specific complements are provided when necessary). Methods presented are of fully general use, which opens up ample windows on topics of contemporary interest. These include complex dynamical processes such as patterning, chaos control, mixing, and even the Earth's climate. Numerical simulations are proposed as a means to obtain deeper understanding of the intricacies induced by nonlinearities in our everyday environment, with hints on adapted modelling strategies and their implementation.

Nonlinear Dynamics and Chaos, 2nd ed. SET with Student Solutions Manual *Westview Press*

Steven H. Strogatz's Nonlinear Dynamics and Chaos, second edition, is aimed at newcomers to nonlinear dynamics and chaos, especially students taking a first course in the subject. The presentation stresses analytical methods, concrete examples, and geometric intuition. The theory is developed systematically, starting with first-order differential equations and their bifurcations, followed by phase plane analysis, limit cycles and their bifurcations, and culminating with the Lorenz equations, chaos, iterated maps, period doubling, renormalization, fractals, and strange attractors. The Student Solutions Manual, by Mitchal Dichter, includes solutions to the odd-numbered exercises featured in Nonlinear Dynamics and Chaos, second edition. Complete with graphs and worked-out solutions, the Student Solutions Manual demonstrates techniques for students to analyze differential equations, bifurcations, chaos, fractals, and other subjects explored in Strogatz's popular book.

Ordinary Differential Equations

An Elementary Textbook for Students of Mathematics, Engineering, and the Sciences *Courier Corporation*

Skillfully organized introductory text examines origin of differential equations, then defines basic terms and outlines the general solution of a differential equation. Subsequent sections deal with integrating factors; dilution and accretion problems; linearization of first order systems; Laplace Transforms; Newton's Interpolation Formulas, more.

Chaos in Dynamical Systems *Cambridge University Press*

Over the past two decades scientists, mathematicians, and engineers have come to understand that a large variety of systems exhibit complicated evolution with time. This complicated behavior is known as chaos. In the new edition of this classic textbook Edward Ott has added much new material and has significantly increased the number of homework problems. The most important change is the addition of a completely new chapter on control and synchronization of chaos. Other changes include new material on riddled basins of attraction, phase locking of globally coupled oscillators, fractal aspects of fluid advection by Lagrangian chaotic flows, magnetic dynamos, and strange nonchaotic attractors. This new edition will be of interest to advanced undergraduates and graduate students in science, engineering, and mathematics taking courses in chaotic dynamics, as well as to researchers in the subject.

Dark Matter and Dark Energy

The Hidden 95% of the Universe *Icon Books*

All the matter and light we can see in the universe makes up a trivial 5 per cent of everything. The rest is hidden. This could be the biggest puzzle that science has ever faced. Since the 1970s, astronomers have been aware that galaxies have far too little matter in them to account for the way they spin around: they should fly apart, but something concealed holds them together. That 'something' is dark matter – invisible material in five times the quantity of the familiar stuff of stars and planets. By the 1990s we also knew that the expansion of the universe was accelerating. Something, named dark energy, is pushing it to expand faster and faster. Across the universe, this requires enough energy that the equivalent mass would be nearly fourteen times greater than all

the visible material in existence. Brian Clegg explains this major conundrum in modern science and looks at how scientists are beginning to find solutions to it.

An Introduction to Complex Systems

Society, Ecology, and Nonlinear Dynamics Springer

This undergraduate text explores a variety of large-scale phenomena - global warming, ice ages, water, poverty - and uses these case studies as a motivation to explore nonlinear dynamics, power-law statistics, and complex systems. Although the detailed mathematical descriptions of these topics can be challenging, the consequences of a system being nonlinear, power-law, or complex are in fact quite accessible. This book blends a tutorial approach to the mathematical aspects of complex systems together with a complementary narrative on the global/ecological/societal implications of such systems. Nearly all engineering undergraduate courses focus on mathematics and systems which are small scale, linear, and Gaussian. Unfortunately there is not a single large-scale ecological or social phenomenon that is scalar, linear, and Gaussian. This book offers students insights to better understand the large-scale problems facing the world and to realize that these cannot be solved by a single, narrow academic field or perspective. Instead, the book seeks to emphasize understanding, concepts, and ideas, in a way that is mathematically rigorous, so that the concepts do not feel vague, but not so technical that the mathematics get in the way. The book is intended for undergraduate students in a technical domain such as engineering, computer science, physics, mathematics, and environmental studies.

Dynamical Systems for Biological Modeling

An Introduction CRC Press

Dynamical Systems for Biological Modeling: An Introduction prepares both biology and mathematics students with the understanding and techniques necessary to undertake basic modeling of biological systems. It achieves this through the development and analysis of dynamical systems. The approach emphasizes qualitative ideas rather than explicit computations. Some technical details are necessary, but a qualitative approach emphasizing ideas is essential for understanding. The modeling approach helps students focus on essentials rather than extensive mathematical details, which is helpful for students whose primary interests are in sciences other than mathematics need or want. The book discusses a variety of biological modeling topics, including population biology, epidemiology, immunology, intraspecies competition, harvesting, predator-prey systems, structured populations, and more. The authors also include examples of problems with solutions and some exercises which follow the examples quite closely. In addition, problems are included which go beyond the examples, both in mathematical analysis and in the development of mathematical models for biological problems, in order to encourage deeper understanding and an eagerness to use mathematics in learning about biology.

Nonlinear Dynamics

Techniques and Applications in Psychology Psychology Press

Additional Resource Materials Human behavior would not be interesting to us if it remained the same from one moment to the next. Moreover, we tend to be sensitive to changes in people's behavior, especially when such change impacts on our own, and other's, behavior. This book describes a variety of techniques for investigating change in behavior. It employs conventional time series methods, as well as recently developed methodology using nonlinear dynamics, including chaos, a term that is not easy to define, nor to confirm. Although nonlinear methods are being used more frequently in psychology, a comprehensive coverage of methods, theory and applications, with a particular focus on human behavior, is needed. Between these covers, the reader is led through various procedures for linear and nonlinear time series analysis, including some novel procedures that allow subtle temporal aspects of human cognition to be detected. Analyses of reaction times, heart-rate, psychomotor skill, decision making, and EEG are supplemented by a contemporary review of recent dynamical research in developmental psychology, psychopathology, and human cognitive processes. A consideration of nonlinear dynamics assists our understanding of deep issues such as: Why is our short-term memory capacity limited? Why do chronic disorders, and also cognitive development, progress through stage-like transitions? Why do people make irrational decisions? This book will be of particular interest to researchers, practitioners, and advanced students in a variety of areas in psychology, particularly in human experimental and physiological psychology. Data analyses are performed using the latest nonlinear dynamics computer packages. A comprehensive WWW resource of software and supplementary information is provided to assist the reader's understanding of the novel, and potentially revolutionary, procedures described in the book.

Infinite Powers

How Calculus Reveals the Secrets of the Universe Eamon Dolan Books

From preeminent math personality and author of The Joy of x, a brilliant and endlessly appealing explanation of calculus - how it works and why it makes our lives immeasurably better. Without calculus, we wouldn't have cell phones, TV, GPS, or ultrasound. We wouldn't have unraveled DNA or discovered Neptune or figured out how to put 5,000 songs in your pocket. Though many of us were scared away from this essential, engrossing subject in high school and college, Steven Strogatz's brilliantly creative, down-to-earth history shows that calculus is not about complexity; it's about simplicity. It harnesses an unreal number--infinity--to tackle real-world problems, breaking them down into easier ones and then reassembling the answers into solutions that feel miraculous. Infinite Powers recounts how calculus tantalized and thrilled its inventors, starting with its first glimmers in ancient Greece and bringing us right up to the discovery of gravitational waves (a phenomenon predicted by calculus). Strogatz reveals how this form of math rose to the challenges of each age: how to determine the area of a circle with only sand and a stick; how to explain why Mars goes "backwards" sometimes; how to make electricity with magnets; how to ensure your rocket doesn't miss the moon; how to turn the tide in the fight against AIDS. As Strogatz proves, calculus is truly the language of the universe. By unveiling the principles of that language, Infinite Powers makes us marvel at the world anew.

Differential Dynamical Systems, Revised Edition SIAM

Differential equations are the basis for models of any physical systems that exhibit smooth change. This book combines much of the material found in a traditional course on ordinary differential equations with an introduction to the more modern theory of dynamical systems. Applications of this theory to physics, biology, chemistry, and engineering are shown through examples in such areas as population modeling, fluid dynamics, electronics, and mechanics.? Differential Dynamical Systems begins with coverage of linear systems, including matrix algebra; the focus then shifts to

foundational material on nonlinear differential equations, making heavy use of the contraction-mapping theorem. Subsequent chapters deal specifically with dynamical systems concepts?flow, stability, invariant manifolds, the phase plane, bifurcation, chaos, and Hamiltonian dynamics. This new edition contains several important updates and revisions throughout the book. Throughout the book, the author includes exercises to help students develop an analytical and geometrical understanding of dynamics. Many of the exercises and examples are based on applications and some involve computation; an appendix offers simple codes written in Maple?, Mathematica?, and MATLAB? software to give students practice with computation applied to dynamical systems problems.

Sync

The Emerging Science of Spontaneous Order Penguin UK

'SYNC' IS A STORY OF A DAZZLING KIND OF ORDER IN THE UNIVERSE, THE HARMONY THAT COMES FROM CYCLES IN SYNC. THE TENDENCY TO SYNCHRONIZE IS ONE OF THE MOST FAR- REACHING DRIVES IN ALL OF NATURE. IT EXTENDS FROM PEOPLE TO PLANETS, FROM ANIMALS TO ATOMS. IN 'SYNC' PROFESSOR STEVEN STROGATZ CONSIDERS A RANGE OF APPLICATIONS - HUMAN SLEEP AND CIRCADIAN RHYTHMS, MENSTRUAL SYNCHRONY, INSECT OUTBREAKS, SUPERCONDUCTORS, LASERS, SECRET CODES, HEART ARRHYTHMIAS AND FADS - CONNECTING ALL TRTHOUGH AN EXPLORATION OF THE SAME MATHEMATICAL THEME: SELF- ORGANISATION, OR THE SPONTANEOUS EMERGENCE OF ORDER OUT OF CHAOS. FOCUSED ENOUGH TO PRESENT A COHERENT WORLD UNTO THEMSELVES, STROGATZ'S CHOSEN TOPICS TOUCH ON SEVERAL OF THE HOTTEST DIRECTIONS IN CONTEMPORARY SCIENCE.

The Joy of X

A Guided Tour of Math, from One to Infinity Houghton Mifflin Harcourt

A comprehensive tour of leading mathematical ideas by an award-winning professor and columnist for the New York Times Opinionator series demonstrates how math intersects with philosophy, science and other aspects of everyday life. By the author of The Calculus of Friendship. 50,000 first printing.

Pattern Formation in Continuous and Coupled Systems

A Survey Volume Springer Science & Business Media

This IMA Volume in Mathematics and its Applications PATTERN FORMATION IN CONTINUOUS AND COUPLED SYSTEMS is based on the proceedings of a workshop with the same title, but goes be yond the proceedings by presenting a series of mini-review articles that sur vey, and provide an introduction to, interesting problems in the field. The workshop was an integral part of the 1997-98 IMA program on "EMERG ING APPLICATIONS OF DYNAMICAL SYSTEMS." I would like to thank Martin Golubitsky, University of Houston (Math ematics) Dan Luss, University of Houston (Chemical Engineering), and Steven H. Strogatz, Cornell University (Theoretical and Applied Mechan ics) for their excellent work as organizers of the meeting and for editing the proceedings. I also take this opportunity to thank the National Science Foundation (NSF), and the Army Research Office (ARO), whose financial support made the workshop possible. Willard Miller, Jr., Professor and Director v PREFACE Pattern formation has been studied intensively for most of this cen tury by both experimentalists and theoreticians, and there have been many workshops and conferences devoted to the subject. In the IMA workshop on Pattern Formation in Continuous and Coupled Systems held May 11-15, 1998 we attempted to focus on new directions in the patterns literature.

Problems and Solutions

Nonlinear Dynamics, Chaos and Fractals World Scientific Publishing Company

This book presents a collection of problems for nonlinear dynamics, chaos theory and fractals. Besides the solved problems, supplementary problems are also added. Each chapter contains an introduction with suitable definitions and explanations to tackle the problems. The material is self-contained, and the topics range in difficulty from elementary to advanced. While students can learn important principles and strategies required for problem solving, lecturers will also find this text useful, either as a supplement or text, since concepts and techniques are developed in the problems.

Chaos and Nonlinear Dynamics

An Introduction for Scientists and Engineers Oxford University Press, USA

Mathematics of Computing -- Miscellaneous.

Dynamics and Bifurcations Springer Science & Business Media

In recent years, due primarily to the proliferation of computers, dynamical systems has again returned to its roots in applications. It is the aim of this book to provide undergraduate and beginning graduate students in mathematics or science and engineering with a modest foundation of knowledge. Equations in dimensions one and two constitute the majority of the text, and in particular it is demonstrated that the basic notion of stability and bifurcations of vector fields are easily explained for scalar autonomous equations. Further, the authors investigate the dynamics of planar autonomous equations where new dynamical behavior, such as periodic and homoclinic orbits appears.

Exploring Chaos

Theory And Experiment CRC Press

This book presents elements of the theory of chaos in dynamical systems in a framework of theoretical understanding coupled with numerical and graphical experimentation. It describes the theory of fractals, focusing on the importance of scaling and ordinary differential equations.

Nonlinear Dynamics and Chaos

With Applications to Physics, Biology, Chemistry and Engineering

Chaos, Fractals, and Dynamics

Computer Experiments in Mathematics Addison Wesley Publishing Company

Introduces the mathematical topics of chaos, fractals, and dynamics using a combination of hands-on computer experimentation and precalculus mathmetics. A series of experiments produce

fascinating computer graphics images of Julia sets, the Mandelbrot set, and fractals. The basic ideas of dynamics--chaos, iteration, and stability--are illustrated via computer projects.

Visual Differential Geometry and Forms

A Mathematical Drama in Five Acts *Princeton University Press*
An inviting, intuitive, and visual exploration of differential geometry and forms Visual Differential Geometry and Forms fulfills two principal goals. In the first four acts, Tristan Needham puts the geometry back into differential geometry. Using 235 hand-drawn diagrams, Needham deploys Newton's geometrical methods to provide geometrical explanations of the classical results. In the fifth act, he offers the first undergraduate introduction to differential forms that treats advanced topics in an intuitive and geometrical manner. Unique features of the first four acts include: four distinct geometrical proofs of the fundamentally important Global Gauss-Bonnet theorem, providing a stunning link between local geometry and global topology; a simple, geometrical proof of Gauss's famous Theorema Egregium; a complete geometrical treatment of the Riemann curvature tensor of an n-manifold; and a detailed geometrical treatment of Einstein's field equation, describing gravity as curved spacetime (General Relativity), together with its implications for gravitational waves, black holes, and cosmology. The final act elucidates such topics as the unification of all the integral theorems of vector calculus; the elegant reformulation of Maxwell's equations of electromagnetism in terms of 2-forms; de Rham cohomology; differential geometry via Cartan's method of moving frames; and the calculation of the Riemann tensor using curvature 2-forms. Six of the seven chapters of Act V can be read completely independently from the rest of the book. Requiring only basic calculus and geometry, Visual Differential Geometry and Forms provocatively rethinks the way this important area of mathematics should be considered and taught.

The Mathematical Structure of the Human Sleep-Wake Cycle *Springer Science & Business Media*
Over the past three years I have grown accustomed to the puzzled look which appears on people's faces when they hear that I am a mathematician who studies sleep. They wonder, but are usually too polite to ask, what does mathematics have to do with sleep? Instead they ask the questions that fascinate us all: Why do we have to sleep? How much sleep do we really need? Why do we dream? These questions usually spark a lively discussion leading to the exchange of anecdotes, last night's

dreams, and other personal information. But they are questions about the function of sleep and, interesting as they are, I shall have little more to say about them here. The questions that have concerned me deal instead with the timing of sleep. For those of us on a regular schedule, questions of timing may seem vacuous. We go to bed at night and get up in the morning, going through a cycle of sleeping and waking every 24 hours. Yet to a large extent, the cycle is imposed by the world around us.

Chaos and Fractals

New Frontiers of Science *Springer Science & Business Media*
For almost ten years chaos and fractals have been enveloping many areas of mathematics and the natural sciences in their power, creativity and expanse. Reaching far beyond the traditional bounds of mathematics and science to the realms of popular culture, they have captured the attention and enthusiasm of a worldwide audience. The fourteen chapters of the book cover the central ideas and concepts, as well as many related topics including, the Mandelbrot Set, Julia Sets, Cellular Automata, L-Systems, Percolation and Strange Attractors, and each closes with the computer code for a central experiment. In the two appendices, Yuval Fisher discusses the details and ideas of fractal image compression, while Carl J.G. Evertsz and Benoit Mandelbrot introduce the foundations and implications of multifractals.

Modeling Love Dynamics

World Scientific

A First Course in Graph Theory *Courier Corporation*
Written by two prominent figures in the field, this comprehensive text provides a remarkably student-friendly approach. Its sound yet accessible treatment emphasizes the history of graph theory and offers unique examples and lucid proofs. 2004 edition.

Introduction to Dynamics *Cambridge University Press*
In this book, the subject of dynamics is introduced at undergraduate level through the elementary qualitative theory of differential equations, the geometry of phase curves and the theory of stability. The text is supplemented with over a hundred exercises.