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Chemical Oscillations Waves And Turbulence Dover B *2023-07-18*

CAMILLE MONTGOMERY

Dissipative Structures and Weak Turbulence John Wiley & Sons
Many chemical and biological processes take place in fluid environments in constant motion OCo chemical reactions in the atmosphere, biological population dynamics in the ocean, chemical reactors, combustion, and microfluidic devices. Applications of concepts from the field of nonlinear dynamical systems have led to significant progress over the last decade in the theoretical understanding of complex phenomena observed in such systems. This book introduces the theoretical approaches for describing mixing and transport in fluid flows. It reviews the basic concepts of dynamical phenomena arising from the nonlinear interactions in chemical and biological systems. The coverage includes a comprehensive overview of recent results on the effect of mixing on spatial structure and the dynamics of chemically and biologically active components in fluid flows, in particular oceanic plankton dynamics. Sample Chapter(s). Chapter 1: Fluid Flows (248 KB). Contents: Fluid Flows; Mixing and Dispersion in Fluid Flows; Chemical and Ecological Models; Reaction-Diffusion Dynamics; Fast Binary Reactions and the Lamellar Approach; Decay-Type and Stable Reaction Dynamics in Flows; Mixing in Autocatalytic-Type Processes; Mixing in Oscillatory Media; Further Reading. Readership: Physicists, applied mathematicians, chemical engineers and marine ecologists.
Advances in Chemical Physics, Volume 100 World Scientific
By establishing an alternative foundation of control theory, this thesis represents a significant advance in the theory of control systems, of interest to a broad range of scientists and engineers. While common control strategies for dynamical systems center on the system state as the object to be controlled, the approach developed here focuses on the state trajectory. The concept of precisely realizable trajectories identifies those trajectories that can be accurately achieved by applying appropriate control signals. The resulting simple expressions for the control signal lend themselves to immediate application in science and technology. The approach permits the generalization of many well-known results from the control theory of linear systems, e.g. the Kalman rank condition to nonlinear systems. The relationship between controllability, optimal control and trajectory tracking are clarified. Furthermore, the existence of linear structures underlying nonlinear optimal control is revealed, enabling the derivation of exact analytical solutions to an entire class of nonlinear optimal trajectory tracking problems. The clear and self-contained presentation focuses on a general and mathematically rigorous analysis of controlled dynamical systems. The concepts developed are visualized with the help of particular dynamical systems motivated by physics and chemistry.
Chemical Oscillations, Waves, and Turbulence Academic Press
The concept of macroscopic waves and patterns developing from chemical reaction coupling with diffusion was presented, apparently for the first time, at the Main Meeting of the Deutsche Bunsengesellschaft fur Angewandte Physikalische Chemie, held in Dresden, Germany from May 21 to 24, 1906. Robert Luther, Director of the Physical Chemistry Laboratory in Leipzig, read his paper on the discovery and analysis of propagating reaction-diffusion fronts in autocatalytic chemical reactions [1, 2]. He presented an equation for the velocity of these new waves, V = a(KDC)1/2, and asserted that they might have features in common with propagating action potentials in nerve cell axons. During the discussion period, a skeptic in the audience voiced his objections to this notion. It was none other than the great physical chemist Walther Nernst, who believed that nerve impulse propagation was far too rapid to be akin to the propagating fronts. He was also not willing to accept Luther's wave velocity equation without a derivation. Luther stood his ground, saying his equation was "a simple consequence of the corresponding differential equation. " He described several different autocatalytic reactions that exhibit propagating fronts (recommending gelling the solution to prevent convection) and even presented a demonstration: the autocatalytic permanganate oxidation of oxalate was carried out in a test tube with the image of the front projected onto a screen for the audience.
Modern Plasma Physics: Volume 1, Physical Kinetics of Turbulent Plasmas Springer Science & Business Media
This book systematically presents the consolidated findings of the phenomenon of self-organization observed during the onset of thermoacoustic instability using approaches from dynamical systems and complex systems theory. Over the last decade, several complex dynamical states beyond limit cycle oscillations such as quasiperiodicity, frequency-locking, period-n, chaos, strange non-chaos, and intermittency have been discovered in thermoacoustic systems operated in laminar and turbulent flow regimes. During the onset of thermoacoustic instability in turbulent systems, an ordered acoustic field and large coherent vortices emerge from the background of turbulent combustion. This emergence of order from disorder in both temporal and spatiotemporal dynamics is explored in the contexts of synchronization, pattern formation, collective interaction, multifractality, and complex networks. For the past six decades, the spontaneous emergence of large amplitude, self-sustained, tonal oscillations in confined combustion systems, characterized as thermoacoustic instability, has remained one of the most challenging areas of research. The presence of such instabilities continues to hinder the development and deployment of high-performance combustion systems used in power generation and propulsion applications. Even with the advent of sophisticated measurement techniques to aid experimental investigations and vast improvements in computational power necessary to capture flow physics in high fidelity simulations, conventional reductionist approaches have not succeeded in explaining the plethora of dynamical behaviors and the associated complexities that arise in practical combustion systems. As a result, models and theories based on such approaches are limited in their application to mitigate or evade thermoacoustic instabilities, which continue to be among the biggest concerns for engine manufacturers today. This book helps to overcome these limitations by providing appropriate methodologies to deal with nonlinear thermoacoustic oscillations, and by developing control strategies that can mitigate and forewarn thermoacoustic instabilities. The book is also beneficial to scientists and engineers studying the occurrence of several other instabilities, such as flow-induced vibrations, compressor surge, aeroacoustics and aeroelastic instabilities in diverse fluid-mechanical environments, to graduate students who intend to apply dynamical systems and complex systems approach to their areas of research, and to physicists who look for experimental applications of their theoretical findings on nonlinear and complex systems.
Pattern Formations and Oscillatory Phenomena World Scientific
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.
Solar to Chemical Energy Conversion Springer Science & Business Media
"Waves and Structures in Nonlinear Nondispersive Media: General Theory and Applications to Nonlinear Acoustics” is devoted completely to nonlinear structures. The general theory is given here in parallel with mathematical models. Many concrete examples illustrate the general analysis of Part I. Part II is devoted to applications to nonlinear acoustics, including specific nonlinear models and exact solutions, physical mechanisms of nonlinearity, sawtooth-shaped wave propagation, self-action phenomena, nonlinear resonances and engineering application (medicine, nondestructive testing, geophysics, etc.). This book is designed for graduate and postgraduate students studying the theory of nonlinear waves of various physical nature. It may also be useful as a handbook for engineers and researchers who encounter the necessity of taking nonlinear wave effects into account of their work. Dr. Gurbatov S.N. is the head of Department, and Vice Rector for Research of Nizhny Novgorod State University. Dr. Rudenko O.V. is the Full member of Russian Academy of Sciences, the head of Department at Moscow University and Professor at BTH (Sweden). Dr. Saichev A.I. is the Professor at the Faculty of Radiophysics of Nizhny Novgorod State University, Professor of ETH Zürich.
Natural Computing Cambridge University Press
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.
The Geometry of Biological Time Springer
This book presents a new theoretical approach to phase resetting and stimulation-induced synchronization and desynchronization in a population of oscillators. The author uses stochastic methods from statistical mechanics and applies his theory to models of practical importance in physiology and neuroscience. The book is accessible to readers not familiar with the mathematical formalism. The author also proposes improvements to stimulation techniques as used by neurologists and neurosurgeons in the context of Parkinson's disease and MEG/EEG data analysis.
Chemical and Biological Processes in Fluid Flows Springer Science & Business Media
This volume contains the lectures and contributions presented at the International Symposium on Temporal Order held in Bremen, September 17-22, 1984. Temporal order, such as a more or less regularly repeated temporal sequence of events, can evol ve in open systems far removed from equi 1 i bri um. Progress duri ng the last decade in the analysis and the modelling of this complex phenomenon in both biological and chemical systems gave rise to the idea of a joint conference. The purpose of the symposium was to stimulate future work by enhancing the exchange of experimental and theoretical results between neighbouring disciplines. Theoretical work in general, and mathematical models in particular, provided the basis for a mutual discussion and, thus, helped to overcome difficulties in under standing the results of different experimental fields. Chemical systems, for examp le, are more rigorously controllable through their experimental conditions in com parison to biological systems, which maintain highly effective autonomous control against environmental influences. Therefore, different states such as bistability, oscillations and chaos can be defined and, hence, described better in chemical sy stems. Chemical systems may thus provide some insights into functional structures that also exist in more complex biological systems.
Fluid Sciences and Materials Science in Space Springer
Proceedings of a NATO ARW held in Leeds, UK, September 11-15, 1989
Turbulence, Strange Attractors and Chaos Springer Science & Business Media
Nonlinear resonance analysis is a unique mathematical tool that can be used to study resonances in relation to, but independently of, any single area of application. This is the first book to present the theory of nonlinear resonances as a new scientific field, with its own theory, computational

methods, applications and open questions. The book includes several worked examples, mostly taken from fluid dynamics, to explain the concepts discussed. Each chapter demonstrates how nonlinear resonance analysis can be applied to real systems, including large-scale phenomena in the Earth's atmosphere and novel wave turbulent regimes, and explains a range of laboratory experiments. The book also contains a detailed description of the latest computer software in the field. It is suitable for graduate students and researchers in nonlinear science and wave turbulence, along with fluid mechanics and number theory. Colour versions of a selection of the figures are available at www.cambridge.org/9780521763608.

Foundations of Complex Systems Cambridge University Press

This book is the refereed proceedings of the Second International Workshop on Natural Computing, IWNC 2007, held in Noyori Conference Hall, Nagoya University in December 2007. IWNC aims to bring together computer scientists, biologists, mathematicians, electronic engineers, physicists, and humanitarians, to critically assess present findings in the field, and to outline future developments in nature-inspired computing.

Wave Turbulence Springer Science & Business Media

The authors explore the origin of multidimensional strange attractors and their role in describing turbulence. It includes an analytical estimation of the deminsions of strange attractors for models described by differential-difference equations and discusses the conditions in which space-homogeneous chaos is stable with respect to random perturbations in flow systems.

Measures of Complexity and Chaos Springer Science & Business Media

The present volume comprises the contributions of some of the participants of the NATO Advance Studies Institute "Turbulence, Weak and Strong", held in Cargese, in August 1994. More than 70 scientists, from seniors to young students, have joined to gether to discuss and review new (and not so new) ideas and developments in the study of turbulence. One of the objectives of the School was to incorporate, in the same meeting, two aspects of turbulence, which are obviously linked, and which are often treated sep arately: fully developed turbulence (in two and three dimensions) and weak turbulence (essentially one and two-dimensional systems). The idea of preparing a dictionary rather than ordinary proceedings started from the feeling that the terminology of turbulence includes many long, technical, poorly evocative words, which are usually not understood by people exterior to the field, and which might be worth explaining. Students who start working in the field of turbulence face a sort of curious situation: on one side, they are aware that turbulence is related to the disordered, churning flows of torrents, the pow erful movements of water in the oceans, the violent jet streams in the troposphere, the solar eruptions, and they are certainly excited to pierce the mystery of this fascinating, omnipresent phenomenon.

Turbulence and Diffusion Springer Science & Business Media

This long-awaited revised second edition of the standard reference on the subject has been considerably expanded to include such recent developments as novel control schemes, control of chaotic space-time patterns, control of noisy nonlinear systems, and communication with chaos, as well as promising new directions in research. The contributions from leading international scientists active in the field provide a comprehensive overview of our current level of knowledge on chaos control and its applications in physics, chemistry, biology, medicine, and engineering. In addition, they show the overlap with the traditional field of control theory in the engineering community. An interdisciplinary approach of interest to scientists and engineers working in a number of areas.

Handbook of Chaos Control Oxford University Press

The peaceful use of space flight systems for research and technological devel opments in the context of promoting European and international cooperation represents the essential motivation for the programmes of the European Space Agency (ESA). One of ESA's programmes is dedicated to microgravity research, which is now an established discipline in Europe, with a dedicated group of scientists participating. The Challenger disaster has resulted in a serious dis continuity of flight opportunities in the next few years but the forthcoming International Space Station, new launchers and reentry vehicles are expected to provide ample opportunities for microgravity research in the long term. Meanwhile parabolic aircraft flights, sounding rockets as well as the delayed Shuttle-dependent missions, Spacelab D-2, the IML-missions and EURECA I, will be employed to keep microgravity experimenters reasonably busy in the interim period. To prepare the ground for these activities, both regarding research and experiment facilities, an in-depth analysis of the state of the art is an essential requirement at this time. Such an analysis is presented in this volume. It ad dresses all of the topics that have been identified to be of relevance. Besides a presentation of the fundamental aspects justifying microgravity research, the results of experiments already performed are reviewed and recommendations for future activities are made. Close to fifty European scientists have cooper ated in the preparation of this volume and their dedicated and concerted effort is greatly appreciated.

Chemical Waves and Patterns Springer Science & Business Media

This volume serves as a general introduction to the state of the art of quantitatively characterizing chaotic and turbulent behavior. It is the outgrowth of an international workshop on "Quantitative Measures of Dynamical Complexity and Chaos" held at Bryn Mawr College, June 22-24, 1989. The workshop was co-sponsored by the Naval Air Development Center in Warminster, PA and by the NATO Scientific Affairs Programme through its special program on Chaos and Complexity. Meetings on this subject have occurred regularly since the NATO workshop held in June 1983 at Haverford College only two kilometers distant from the site of this latest in the series. At that first meeting, organized by J. Gollub and H. Swinney, quantitative tests for nonlinear dynamics and chaotic behavior were debated and promoted [1). In the six years since, the methods for dimension, entropy and Lyapunov exponent calculations have been applied in many disciplines and the procedures have been refined. Since then it has been necessary to demonstrate quantitatively that a signal is chaotic rather than it being acceptable to observe that "it looks chaotic". Other related meetings have included the Pecos River Ranch meeting in September 1985 of G. Mayer Kress [2) and the reflective and forward looking gathering near Jerusalem organized by M. Shapiro and I. Procaccia in December 1986 [3). This meeting was proof that interest in measuring chaotic and turbulent signals is widespread.

Temporal Order Springer Nature

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.

Patterns and Dynamics in Reactive Media John Wiley & Sons

Dealing with dynamics of processes that repeat themselves regularly, this revised and updated edition extends the thread from 1980 to the present day, concentrating on areas of interest where there will be much activity in the future. This involves going through spatial biochemical, electrophysiological, and organismic dynamical systems and patterns that were discovered by pursuing the theme of phase singularities introduced in the original book. In particular the work on excitability in cell membranes will be thoroughly updated as will the references throughout the book.

Temporal Disorder in Human Oscillatory Systems Springer Science & Business Media

This volume contains the papers presented at the workshop on Statistical The ories and Computational Approaches to Turbulence: Modern Perspectives and Applications to Global-Scale Flows, held October 10-13, 2001, at Nagoya Uni versity, Nagoya, Japan. Because of recent developments in computational capabilities, the compu tational approach is showing the potential to resolve a much wider range of length and time scales in turbulent physical systems. Nevertheless, even with the largest supercomputers of the foreseeable future, development of adequate modeling techniques for at least some scales of motion will be necessary for practical computations of important problems such as weather forecasting and the prediction and control of global pollution. The more powerful the available machines become, the more demand there will be for precise prediction of the systems. This means that more precise and reliable knowledge of the underlying dynamics will become important, and that more efficient and precise numerical methods best adapted to the new generation of computers will be necessary. The understanding of the nature of unresolved scales then will playa key role in the modeling of turbulent motion. The challenge to turbulence theory here is to elucidate the physics or dynamics of those scales, in particular their sta tistical aspects, and thereby develop models on sound bases to reduce modeling ambiguity. The challenge to the computational method is to develop efficient algorithms suitable for the problems, the machines, and the developed models.