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This book is an introduction to the dynamics of reaction-diffusion systems, with a focus on fronts and stationary spatial patterns. Emphasis is on systems that are non-standard in the sense that either the transport is not simply classical diffusion (Brownian motion) or the system is not homogeneous. A important feature is the derivation of the basic phenomenological equations from the mesoscopic system properties.

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We strongly recommend such a mesoscopic approach to ensure that the reaction–transport equations studied are physically and mathematically sound.We present a comprehensive review of the mesoscopic foundations of reaction–transport equations in Chap. 3, which is at the heart of Part I. Part II focuses on front propagation. Chapter 4 provides an overview of front propagation in standard reaction–diffusion systems.

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reaction-transport equation should have a sound macroscopic or mesoscopic foundation. Second, if the state of the reaction-transport system is spatially uniform, the characteristics of the transport process should play no role in the evolution of the density. For (x,t) (t), the reaction-transport equation

Growth and dispersal with inertia: Hyperbolic reaction ...

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This book is an introduction to the dynamics of reaction-diffusion systems, with a focus on fronts and stationary spatial patterns. Emphasis is on systems that are non-standard in the sense that either the transport is not simply classical diffusion (Brownian motion) or the system is not homogeneous. A important feature is the derivation of the basic phenomenological equations from the mesoscopic system properties. Topics addressed include transport with inertia, described by persistent random walks and hyperbolic reaction-transport equations and transport by anomalous diffusion, in particular subdiffusion, where the mean square displacement grows sublinearly with time. In particular reaction-diffusion systems are studied where the medium is in turn either spatially inhomogeneous, compositionally heterogeneous or spatially discrete. Applications span a vast range of interdisciplinary fields and the systems considered can be as different as human or animal groups migrating under external influences, population ecology and evolution, complex chemical reactions, or networks of biological cells. Several chapters treat these applications in detail.

This book presents generalized heat-conduction laws which, from a mesoscopic perspective, are relevant to new applications (especially in nanoscale heat transfer, nanoscale thermoelectric phenomena, and in diffusive-to-ballistic regime) and at the same time keep up with the pace of current microscopic research. The equations presented in the book are compatible with generalized formulations of nonequilibrium thermodynamics, going beyond the local-equilibrium. The book includes six main chapters, together with a preface and a final section devoted to the future perspectives, as well as an extensive bibliography.

This book presents the fundamental theory for non-standard diffusion problems in movement ecology. Lévy processes and anomalous diffusion have shown to be both powerful and useful tools for qualitatively and quantitatively describing a wide variety of spatial population ecological phenomena and dynamics, such as invasion fronts and search strategies. Adopting a self-contained, textbook-style approach, the authors provide the elements of statistical physics and stochastic processes on which the modeling of movement ecology is based and systematically introduce the physical characterization of ecological processes at the microscopic, mesoscopic and macroscopic levels. The explicit definition of these levels and their interrelations is particularly suitable to coping with the broad spectrum of space and time scales involved in bio-ecological problems. Including numerous exercises (with solutions), this text is aimed at graduate students and newcomers in this field at the interface of theoretical ecology, mathematical biology and physics.

The book provides an introduction to deterministic (and some stochastic) modeling of spatiotemporal phenomena in ecology, epidemiology, and neural systems. A survey of the classical models in the fields with up to date applications is given. The book begins with detailed description of how spatial dynamics/diffusive processes influence the dynamics of biological populations. These processes play a key role in understanding the outbreak and spread of pandemics which help us in designing the control strategies from the public health perspective. A brief discussion on the functional mechanism of the brain (single neuron models and network level) with classical models of neuronal dynamics in space and time is given. Relevant phenomena and existing modeling approaches in ecology, epidemiology and neuroscience are introduced, which provide examples of pattern formation in these models. The analysis of patterns enables us to study the dynamics of macroscopic and microscopic behaviour of underlying systems and travelling wave type patterns observed in dispersive systems. Moving on to virus dynamics, authors present a detailed analysis of different types models of infectious diseases including two models for influenza, five models for Ebola virus and seven models for Zika virus with diffusion and time delay. A Chapter is devoted for the study of Brain Dynamics (Neural systems in space and time). Significant advances made in modeling the reaction-diffusion systems are presented and spatiotemporal patterning in the systems is reviewed. Development of appropriate mathematical models and detailed analysis (such as linear stability, weakly nonlinear analysis, bifurcation analysis, control theory, numerical simulation) are presented. Key Features Covers the fundamental concepts and mathematical skills required to analyse reaction-diffusion models for biological populations. Concepts are introduced in such a way that readers with a basic knowledge of differential equations and numerical methods can understand the analysis. The results are also illustrated with figures. Focuses on mathematical modeling and numerical simulations using basic conceptual and classic models of population dynamics, Virus and Brain dynamics. Covers wide range of models using spatial and non-spatial approaches. Covers single, two and multispecies reaction-diffusion models from ecology and models from bio-chemistry. Models are analysed for stability of equilibrium points, Turing instability, Hopf bifurcation and pattern formations. Uses Mathematica for problem solving and MATLAB for pattern formations. Contains solved Examples and Problems in Exercises. The Book is suitable for advanced undergraduate, graduate and research students. For those who are working in the above areas, it provides information from most of the recent works. The text presents all the fundamental concepts and mathematical skills needed to build models and perform analyses.

The fast progress in many areas of research related to non-equilibrium ther- dynamics has prompted us to write a fourth edition of this book. Like in the previous editions, our main concern is to open the subject to the widest au- ence, including students, teachers, and researchers in physics, chemistry, engine- ing, biology, and materials sciences. Our objective is to present a general view on several open problems arising in non-equilibrium situations, and to afford a wide perspective of applications illustrating their practical outcomes and con- quences. A better comprehension of the foundations is generally correlated to an increase of the range of applications, implying mutual feedback and cross fert- ization. Truly, thermodynamic methods are widely used in many areas of science but, surprisingly, the active dynamism of thermodynamics as a ?eld on its own is not suf?ciently perceived outside a relatively reduced number of specialized researchers. Extended irreversible thermodynamics (EIT) goes beyond the classical f- malisms based on the local equilibrium hypothesis; it was also referred to in an earlier publication by the authors (Lebon et al. 1992) as a thermodynamics of the third type, as it provides a bridge between classical irreversible thermodynamics and rational thermodynamics, enlarging at the same time their respective range of application. The salient feature of the theory is that the ?uxes are incorporated into the set of basic variables.

This book presents cutting-edge research on the use of physical and mathematical formalisms to model and quantitatively analyze biological phenomena ranging from microscopic to macroscopic systems. The systems discussed in this compilation cover protein folding pathways, gene regulation in prostate cancer, quorum sensing in bacteria to mathematical and physical descriptions to analyze anomalous diffusion in patchy environments and the physical mechanisms that drive active motion in large sets of particles, both fundamental descriptions that can be applied to different phenomena in biology. All chapters are written by well-known experts on their respective research fields with a vast amount of scientific discussion and references in order the interested reader can pursue a further reading. Given these features, we consider Quantitative Models for Microscopic to Macroscopic Biological Macromolecules and Tissues as an excellent and up-to-date resource and reference for advanced undergraduate students, graduate students and junior researchers interested in the latest developments at the intersection of physics, mathematics, molecular biology, and computational sciences. Such research field, without hesitation, is one of the most interesting, challenging and active of this century and the next.

This book is a printed edition of the Special Issue "Progress in Mathematical Ecology" that was published in Mathematics

Partial differential equations (PDEs) have been used in theoretical ecology research for more than eighty years. Nowadays, along with a variety of different mathematical techniques, they remain as an efficient, widely used modelling framework; as a matter of fact, the range of PDE applications has even become broader. This volume presents a collection of case studies where applications range from bacterial systems to population dynamics of human riots.

This is the second edition of the book "Thermodynamics of Fluids under Flow," which was published in 2000 and has now been corrected, expanded and updated. This is a companion book to our other title Extended irreversible thermodynamics (D. Jou, J. Casas-Vázquez and G. Lebon, Springer, 4th edition 2010), and of the textbook Understanding non-equilibrium thermodynamics (G. Lebon, D. Jou and J. Casas-Vázquez, Springer, 2008. The present book is more specialized than its counterpart, as it focuses its attention on the non-equilibrium thermodynamics of flowing fluids, incorporating non-trivial thermodynamic contributions of the flow, going beyond local equilibrium theories, i.e., including the effects of internal variables and of external forcing due to the flow. Whereas the book's first edition was much more focused on polymer solutions, with brief glimpses into ideal and real gases, the present edition covers a much wider variety of systems, such as: diluted and concentrated polymer solutions, polymer blends, laminar and turbulent superfluids, phonon hydrodynamics and heat transport in nanosystems, nuclear collisions, far-from-equilibrium ideal gases, and molecular solutions. It also deals with a variety of situations, emphasizing the non-equilibrium flow contribution: temperature and entropy in flowing ideal gases, shear-induced effects on phase transitions in real gases and on polymer solutions, stress-induced migration and its application to flow chromatography, Taylor dispersion, anomalous diffusion in flowing systems, the influence of the flow on chemical reactions, and polymer degradation. The new edition is not only broader in scope, but more educational in character, and with more emphasis on applications, in keeping with our times. It provides many examples of how a deeper theoretical understanding may bring new and more efficient applications, forging links between theoretical progress and practical aims. This updated version expands on the trusted content of its predecessor, making it more interesting and useful for a larger audience.

The book contains review articles on recent advances in first-passage phenomena and applications contributed by leading international experts. It is intended for graduate students and researchers who are interested in learning about this intriguing and important topic. Contents:Arrival Statistics and Exploration Properties of Mortal Walkers (S B Yuste, E Abad and K Lindenberg)First Passage of a Randomly Accelerated Particle (T W Burkhardt)First Passage Problems in Anomalous Diffusion (A Rosso and A Zoia)First-Passage Times of Intermittent Random Walks (O Bénichou and R Voituriez)First-Passage Phenomena on Finite Inhomogeneous Networks (E Agliari and D Cassi)Effective Spectral Dimension in Scale-Free Networks (S Hwang, D-S Lee and B Kahng)First-Passage Statistics for Random Walks in Bounded Domains (R Voituriez and O Bénichou)First Passage Behavior of Multi-Dimensional Fractional Brownian Motion and Application to Reaction Phenomena (J-H Jeon, A V Chechkin and R Metzler)Trajectory-to-Trajectory Fluctuations in First-Passage Phenomena in Bounded Domains (T G Mattos, C Mejía-Monasterio, R Metzler, G Oshanin and G Schehr)Exact Record and Order Statists of Random Walk via First-Passage Ideas (G Schehr and S N Majumdar)First Passage in a Conical Geometry and Ordering of Brownian Particles (E Ben-Naim and P L Krapivsky)First Passage Time Problems in Biophysical Jump Processes with Fast Kinetics (P C Bressloff and J M Newby)First Passage Problems in Biology (T Chou and M R D'Orsogna)The Effect of Detection Mechanisms on Spatial Search and Foraging (D Campos and V Méndez)Search in Random Media with Lévy Flights (E Gelenbe and O H Abdelrahman)Exit Strategies: Visual Search and the Quitting Time Problem (T S Horowitz)Statistical Physics of Evolutionary Trajectories on Fitness Landscapes (M Manhart and A V Morozov)Some Applications of First-Passage Ideas to Finance (R

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