Topics in Multiple Time Scale Dynamics

Maximilian Engel
Hildeberto Jardón-Kojakhmetov
Cinzia Soresina
Editors

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Stephanie Forrest

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Multiple Time Scale Dynamics Christian Kuehn,2015-02-25 This book provides an introduction to dynamical systems with multiple time scales The approach it takes is to provide an overview of key areas particularly topics that are less available in the introductory form The broad range of topics included makes it accessible for students and researchers new to the field to gain a quick and thorough overview The first of its kind this book merges a wide variety of different mathematical techniques into a more unified framework The book is highly illustrated with many examples and exercises and an extensive bibliography The target audience of this book are senior undergraduates graduate students as well as researchers interested in using the multiple time scale dynamics theory in nonlinear science either from a theoretical or a mathematical modeling perspective

Multiple-Time-Scale Dynamical Systems Christopher K.R.T. Jones,Alexander I. Khibnik,2012-12-06 Systems with sub processes evolving on many different time scales are ubiquitous in applications chemical reactions electro optical and neuro biological systems to name just a few This volume contains papers that expose the state of the art in mathematical techniques for analyzing such systems Recently developed geometric ideas are highlighted in this work that includes a theory of relaxation oscillation phenomena in higher dimensional phase spaces Subtle exponentially small effects result from singular perturbations implicit in certain multiple time scale systems Their role in the slow motion of fronts bifurcations and jumping between invariant tori are all explored here Neurobiology has played a particularly stimulating role in the development of these techniques and one paper is directed specifically at applying geometric singular perturbation theory to reveal the synchrony in networks of neural oscillators **Multiple Time Scale Dynamics in Chemical Physics** Mark Edward Tuckerman,1993 **Topics in Multiple Time Scale Dynamics** Maximilian Engel,Hildeberto Jard¢n-Kojakhmetov,Cinzia Soresina,2024-10-21 This volume contains the proceedings of the BIRS Workshop Topics in Multiple Time Scale Dynamics held from November 27 December 2 2022 at the Banff International Research Station Banff Alberta Canada The area of multiple scale dynamics is rapidly evolving marked by significant theoretical breakthroughs and practical applications The workshop facilitated a convergence of experts from various sub disciplines encompassing topics like blow up techniques for ordinary differential equations ODEs singular perturbation theory for stochastic differential equations SDE homogenization and averaging slow fast maps numerical approaches and network dynamics including their applications in neuroscience and climate science This volume provides a wide ranging perspective on the current challenging subjects being explored in the field including themes such as novel approaches to blowing up and canard theory in unique contexts complex multi scale challenges in PDEs and the role of stochasticity in multiple scale systems **Multiple Time Scale Dynamics with Two Fast Variables and One Slow Variable** Christian Kuehn,2010 This thesis considers dynamical systems that have multiple time scales The focus lies on systems with two fast variables and one slow variable The twoparameter bifurcation structure of the FitzHugh Nagumo FHN equation is analyzed in detail A singular bifurcation diagram is constructed and invariant

manifolds of the problem are computed A boundary value approach to compute slow manifolds of saddle type is developed Interactions of classical invariant manifolds and slow manifolds explain the exponentially small turning of a homoclinic bifurcation curve in parameter space Mixed mode oscillations and maximal canards are detected in the FHN equation An asymptotic formula to find maximal canards is proved which is based on the first Lyapunov coefficient at a singular Hopf bifurcation   Multiple Time Scales Jeremiah U. Brackbill,Bruce I. Cohen,2014-05-10 Multiple Time Scales presents various numerical methods for solving multiple time scale problems The selection first elaborates on considerations on solving problems with multiple scales problems with different time scales and nonlinear normal mode initialization of numerical weather prediction models Discussions focus on analysis of observations nonlinear analysis systems of ordinary differential equations and numerical methods for problems with multiple scales The text then examines the diffusion synthetic acceleration of transport iterations with application to a radiation hydrodynamics problem and implicit methods in combustion and chemical kinetics modeling The publication ponders on molecular dynamics and Monte Carlo simulations of rare events direct implicit plasma simulation orbit averaging and subcycling in particle simulation of plasmas and hybrid and collisional implicit plasma simulation models Topics include basic moment method electron subcycling gyroaveraged particle simulation and the electromagnetic direct implicit method The selection is a valuable reference for researchers interested in pursuing further research on the use of numerical methods in solving multiple time scale problems   Emergent Computation Stephanie Forrest,1991 Researchers in several fields are exploring computational systems in which interesting global behavior emerges from local interactions among component parts an approach called emergent computation In these systems interactions among simultaneous computations are exploited to improve efficiency increase flexibility or provide more realistic models of natural phenomena These 31 essays define and explore the concept of emergent computation in such areas as artificial networks adaptive systems classifier systems connectionist learning other learning and biological networks to determine what properties are required of the supporting architectures that generate them Many of the essays share the themes of design how to construct such systems the importance of preexisting structure to learning and the role of parallelism and the tension between cooperative and competitive models of interaction In the introduction Stephanie Forrest presents several detailed examples of the kinds of problems emergent computation can address These include showing how emergent computation can lead to efficiency improvements in parallel processing establishing the connection between emergent computation and nonlinear systems and comparing two search techniques to show how the emergent computational approach to a problem differs from other more conventional approaches Stephanie Forrest is Assistant Professor in the Department of Computer Science at the University of New Mexico She is also affiliated with the Center for Nonlinear Studies and Computing Division at Los Alamos National Laboratory   **Multiple Time Scale Dynamics of Chemical Oscillators** Christopher Jon Scheper,2011 In this thesis we analyze the multiple time scale dynamics of two

chemical oscillator models the autocatalator a three dimensional two time scale vector field that satisfies the the law of mass action for an autocatalytic chemical reaction and a four dimensional model of the Belousov Zhabotinskii BZ reaction taking place in a continuous flow stirred tank called Model D For each model we concentrate on the multiple time scale nature of the reaction and the mechanisms that create mixed mode oscillations MMOs in the models In the analysis of the autocatalator we show that a Poincar return map sie multaneously exhibits full rank and rank deficient behavior for different regions of phase space Canard trajectories that follow a two dimensional repelling slow manifold separate these regions This allows us to compute a one dimensional induced map from approximations of the return maps The bifurcations of these induced maps are used to characterize the bifurcations of the mixed mode oscillations of the full three dimensional system We also analyze a four dimensional model of the BZ reaction called Model D first proposed by L Gyorgyi and R Field Using experimental parameters as model parameters we investigate the dynamic mechanisms shaping behavior in the low flow rate and high flow rate complexity regimes We use geometric singular perturbation theory to interpret the behavior of the system in regions of phase space with a clear separation of time scales At low flow rates we show that a dynamic Hopf bifurcation is responsible for the creation of the small am plitude oscillations of the MMOs At high flow rates the dynamics are shaped by interactions with an equilibrium point Finally we show that Model D is capable of replicating experimentally observed behaviors **Proceedings of the 1984 American Control Conference, Hyatt Islandia Hotel, San Diego, California, June 6-8, 1984** ,1984 Progress in Nonlinear Science Lev M. Lerman,2002 *Theoretical and Applied Mechanics Report* ,1992 **Materials of the Tutorial Course EECS 500** ,1996 *Multiple Time Scale Dynamics* Christian Kuehn,2015-03-06 This book provides an introduction to dynamical systems with multiple time scales The approach it takes is to provide an overview of key areas particularly topics that are less available in the introductory form The broad range of topics included makes it accessible for students and researchers new to the field to gain a quick and thorough overview The first of its kind this book merges a wide variety of different mathematical techniques into a more unified framework The book is highly illustrated with many examples and exercises and an extensive bibliography The target audience of this book are senior undergraduates graduate students as well as researchers interested in using the multiple time scale dynamics theory in nonlinear science either from a theoretical or a mathematical modeling perspective History-dependent Multiple Time Scale Dynamics in a Single Neuron Model Gail Gilboa,Ṭekhniyon, Makhon ṭekhnologi le-Yiśraʼel. Fakultah le-matematikah,2005 **Nonlinear Processes in Geophysics** ,2007 *Dissertation Abstracts International* ,2008 *Computer Simulation Studies in Condensed-Matter Physics XVI* David P. Landau,Steven P. Lewis,2004-09 This status report features the most recent developments in the field spanning a wide range of topical areas in the computer simulation of condensed matter materials physics Highlights of this volume include various aspects of non equilibrium statistical mechanics studies of properties of real materials using both classical model simulations and electronic structure calculations

and the use of computer simulation in teaching **Oceans '92** ,1992 **Proceedings of the 1985 American Control Conference** ,1985 *Noise and Fluctuations in Econophysics and Finance* Derek Abbott,2005 Proceedings of SPIE present the original research papers presented at SPIE conferences and other high quality conferences in the broad ranging fields of optics and photonics These books provide prompt access to the latest innovations in research and technology in their respective fields Proceedings of SPIE are among the most cited references in patent literature

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