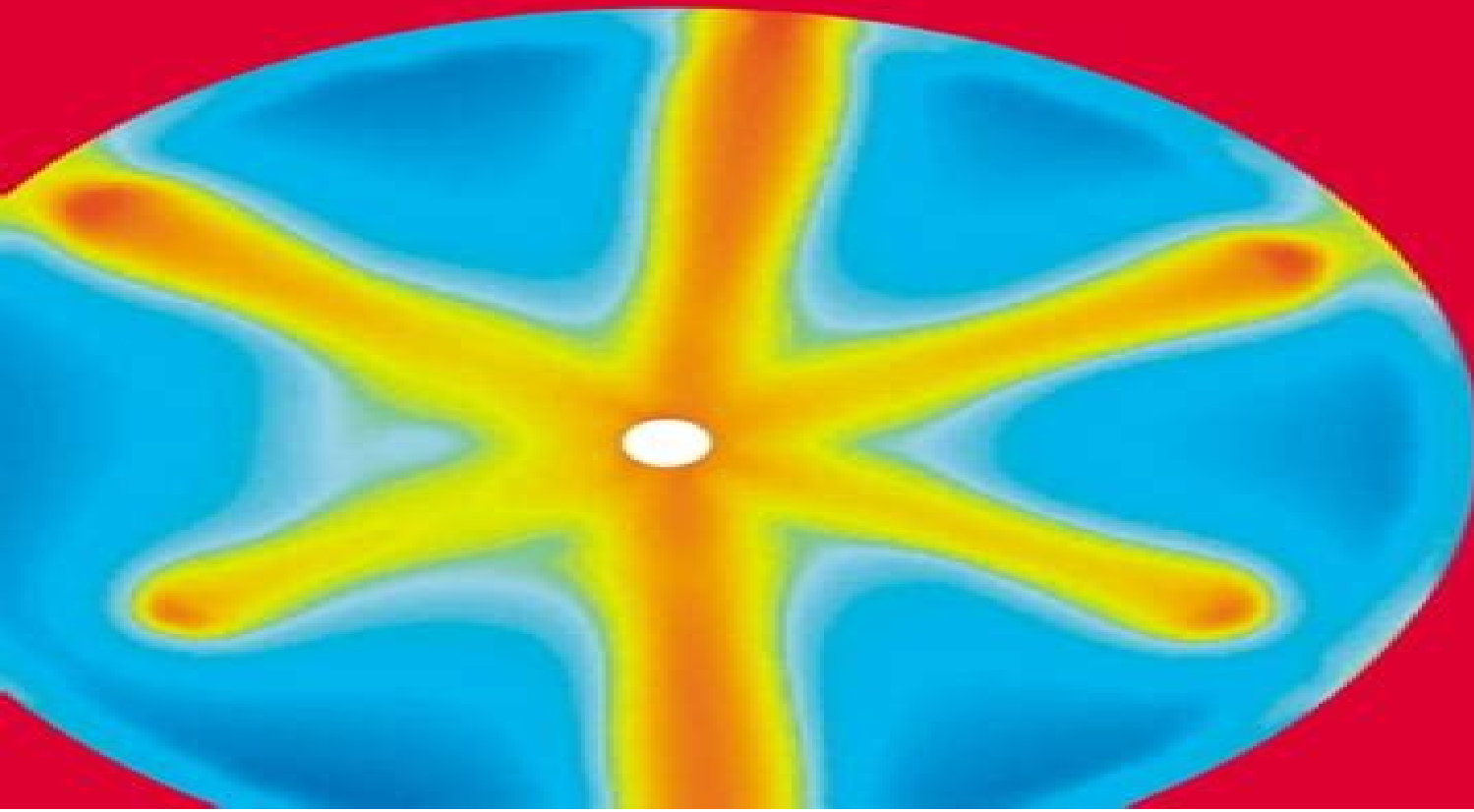


# Nonlinear Spatio-Temporal Dynamics and Chaos in Semiconductors

Eckehard Schöll

Cambridge Nonlinear Science Series 10



# Nonlinear Spatio Temporal Dynamics And Chaos In Semiconductors

**JE Gale**



## **Nonlinear Spatio Temporal Dynamics And Chaos In Semiconductors:**

**Nonlinear Spatio-Temporal Dynamics and Chaos in Semiconductors** Eckehard Schöll, 2001-02-22 This book brings together concepts from semiconductor physics nonlinear dynamics and chaos to examine semiconductor transport phenomena

**Optical Properties and Applications of Semiconductors** Inamuddin, Mohd Imran Ahamed, Rajender Boddula, Tariq Altalhi, 2022-07-18 Semiconductors with optical characteristics have found widespread use in evolving semiconductor photovoltaics where optical features are important The industrialization of semiconductors and their allied applications have paved the way for optical measurement techniques to be used in new ways Due to their unique properties semiconductors are key components in the daily employed technologies in healthcare computing communications green energy and a range of other uses This book examines the fundamental optical properties and applications of semiconductors It summarizes the information as well as the optical characteristics and applicability of semiconductors through an in depth review of the literature Accomplished experts in the field share their knowledge and examine new developments FEATURES Comprehensive coverage of all types of optical applications using semiconductors Explores relevant composite materials and devices for each application Addresses the optical properties of crystalline and amorphous semiconductors Describes new developments in the field and future potential applications Optical Properties and Applications of Semiconductors is a comprehensive reference and an invaluable resource for engineers scientists academics and industry R D teams working in applied physics

**Dissipative Solitons in Reaction Diffusion Systems** Andreas Liehr, 2013-03-27 Why writing a book about a specialized task of the large topic of complex systems And who will read it The answer is simple The fascination for a didactically valuable point of view the elegance of a closed concept and the lack of a comprehensive disquisition The fascinating part is that field equations can have localized solutions exhibiting the typical characteristics of particles Regarding the field equations this book focuses on the field phenomenon of localized solutions can be described in the context of a particle formalism which leads to a set of ordinary differential equations covering the time evolution of the position and the velocity of each particle Moreover starting from these particle dynamics and making the transition to many body systems one considers typical phenomena of many body systems as shock waves and phase transitions which themselves can be described as field phenomena Such transitions between different level of modelling are well known from conservative systems where localized solutions of quantum field theory lead to the mechanisms of elementary particle interaction and from this to field equations describing the properties of matter However in dissipative systems such transitions have not been considered yet which is adjusted by the presented book The elegance of a closed concept starts with the observation of self organized current filaments in a semiconductor gas discharge system These filaments move on random paths and exhibit certain particle features like scattering or the formation of bound states Neither the reasons for the propagation of the filaments nor the laws of the interaction between the filaments can be registered by direct

observations Therefore a model is established which is phenomenological in the first instance due to the complexity of the experimental system This model allows to understand the existence of localized structures their mechanisms of movement and their interaction at least on a qualitative level But this model is also the starting point for developing a data analysis method that enables the detection of movement and interaction mechanisms of the investigated localized solutions The topic is rounded off by applying the data analysis to real experimental data and comparing the experimental observations to the predictions of the model A comprehensive publication covering the interesting topic of localized solutions in reaction diffusion systems in its width and its relation to the well known phenomena of spirals and patterns does not yet exist and this is the third reason for writing this book Although the book focuses on a specific experimental system the model equations are as simple as possible so that the discussed methods should be adaptable to a large class of systems showing particle like structures Therefore this book should attract not only the experienced scientist who is interested in self organization phenomena but also the student who would like to understand the investigation of a complex system on the basis of a continuous description

*Dynamical Systems* René Lozi, Safwan El Assad, Mohammed-Salah Abdelouahab, 2025-06-23 This book offers a captivating exploration of the intersection between mathematics chaos theory and dynamical systems through the personal journeys of twelve renowned mathematicians and physicists from China Europe Russia and the USA The first section of the book provides an intimate look into the formative experiences and early steps of these scientists In these life stories the names of other famous mathematicians arise crisscrossing all the stories in unexpected ways The second part of the book explores the practical applications of chaotic attractors in various fields These include chaos based encryption in cryptography sensor and actuator placement in Chua circuits for control systems and chaotic dynamics in remote sensing for crop modeling It also highlights the role of chaos theory in the development of memristors following Leon Chua's 1971 discovery leading to advances in nonlinear dynamics hyperchaos and memristor based systems The chapters further examine how chaos theory addresses modern challenges such as modeling COVID 19 spread using SEIR models and optimizing mobile network design demonstrating the wide reaching impact of chaotic systems in real world applications This book will be of great value to students and researchers in mathematics physics engineering and related disciplines seeking to deepen their understanding of chaotic dynamical systems and their applications This book includes a revised introduction and a new chapter The remaining chapters were originally published in *Journal of Difference Equations and Applications*

**Dynamics of Quantum Dot Lasers** Christian Otto, 2014-01-21 This thesis deals with the dynamics of state of the art nanophotonic semiconductor structures providing essential information on fundamental aspects of nonlinear dynamical systems on the one hand and technological applications in modern telecommunication on the other Three different complex laser structures are considered in detail i a quantum dot based semiconductor laser under optical injection from a master laser ii a quantum dot laser with optical feedback from an external resonator and iii a passively mode locked quantum well semiconductor laser

with saturable absorber under optical feedback from an external resonator Using a broad spectrum of methods both numerical and analytical this work achieves new fundamental insights into the interplay of microscopically based nonlinear laser dynamics and optical perturbations by delayed feedback and injection *Cybernetical Physics* A. Fradkov, 2007-06-30 Cybernetical physics borrows methods from both theoretical physics and control engineering It deals with the control of complex systems is one of the most important aspects in dealing with systems exhibiting nonlinear behavior or similar features that defy traditional control techniques This book fully details this new discipline *Control of Complex Nonlinear Systems with Delay* Philipp Hövel, 2010-09-27 This research addresses delay effects in nonlinear systems which are ubiquitous in various fields of physics chemistry biology engineering and even in social and economic systems They may arise as a result of processing times or due to the finite propagation speed of information between the constituents of a complex system Time delay has two complementary counterintuitive and almost contradictory facets On the one hand delay is able to induce instabilities bifurcations of periodic and more complicated orbits multi stability and chaotic motion On the other hand it can suppress instabilities stabilize unstable stationary or periodic states and may control complex chaotic dynamics This thesis deals with both aspects and presents novel fundamental results on the controllability of nonlinear dynamics by time delayed feedback as well as applications to lasers hybrid mechanical systems and coupled neural systems *Encyclopedia of Nonlinear Science* Alwyn Scott, 2006-05-17 In 438 alphabetically arranged essays this work provides a useful overview of the core mathematical background for nonlinear science as well as its applications to key problems in ecology and biological systems chemical reaction diffusion problems geophysics economics electrical and mechanical oscillations in engineering systems lasers and nonlinear optics fluid mechanics and turbulence and condensed matter physics among others *High Performance Computing in Science and Engineering '02* Egon Krause, Willi Jäger, 2012-12-06 This book presents the state of the art in modeling and simulation on supercomputers Leading German research groups present their results achieved on high end systems of the High Performance Computing Center Stuttgart HLRS for the year 2002 Reports cover all fields of supercomputing simulation ranging from computational fluid dynamics to computer science Special emphasis is given to industrially relevant applications Moreover by presenting results for both vector systems and micro processor based systems the book allows to compare performance levels and usability of a variety of supercomputer architectures It therefore becomes an indispensable guidebook to assess the impact of the Japanese Earth Simulator project on supercomputing in the years to come *Delay Controlled Partial Synchronization in Complex Networks* Jakub Sawicki, 2019-11-30 The focus of this thesis are synchronization phenomena in networks and their intrinsic control through time delay which is ubiquitous in real world systems ranging from physics and acoustics to neuroscience and engineering We encounter synchronization everywhere and it can be either a helpful or a detrimental mechanism In the first part after a survey of complex nonlinear systems and networks we show that a seemingly simple system of two organ pipes gives birth to complex bifurcation and

synchronization scenarios Going from a 2 oscillator system to a ring of oscillators we encounter the intriguing phenomenon of chimera states which are partial synchrony patterns with coexisting domains of synchronized and desynchronized dynamics For more than a decade scientist have tried to solve the puzzle of this spontaneous symmetry breaking emerging in networks of identical elements We provide an analysis of initial conditions and extend our model by the addition of time delay and fractal connectivities In the second part we investigate partial synchronization patterns in a neuronal network and explain dynamical asymmetry arising from the hemispheric structure of the human brain A particular focus is on the novel scenario of partial relay synchronization in multiplex networks Such networks allow for synchronization of the coherent domains of chimera states via a remote layer whereas the incoherent domains remain desynchronized The theoretical framework is demonstrated with different generic models

**Räumliche Aspekte intrazellulärer Signalübertragung und Musterbildung in der Glykolyse** Ronny Straube, 2011 Die vorliegende Arbeit behandelt verschiedene Aspekte der raum zeitlichen Musterbildung in biologischen oder biologisch motivierten Reaktions Diffusions Systemen Die hierbei auftretenden Muster werden entweder durch die dem System auferlegten Randbedingungen oder durch diffusive Kopplung nichtlinearer biochemischer Reaktionen hervorgerufen Im ersten Teil der Arbeit werden Systeme in singular gestorten zwei oder drei dimensional Gebieten untersucht Das sind Gebiete mit kleinen Lochern im Innern oder auf dem Rand des Definitionsgebietes Mit Hilfe asymptotischer Methoden wird gezeigt dass sich die Locher wie Punktsingularitäten verhalten die durch entsprechende Greensche oder Neumann Funktionen beschrieben werden können Es werden asymptotische Lösungen für durch Signalmoleküle hervorgerufene intrazelluläre Konzentrationsgradienten sowie für die mittlere Verweilzeit diffundierender Moleküle in der Gegenwart mehrerer kleiner absorbierender Kompartimente Locher für verschiedene Gebiete konstruiert Im zweiten Teil der Arbeit wird am Beispiel der Entstehung einwärts rotierender Spiralwellen Antispiralen in der Glykolyse untersucht wie sich bestimmte molekulare Reaktionsmechanismen auf die im System entstehenden raum zeitlichen Muster auswirken Zu diesem Zweck werden die Parameter einer zugeordneten komplexen Ginzburg Landau Gleichung für verschiedene Mechanismen der Produktaktivierung der Phosphofruktokinase PFK explizit berechnet und die entsprechenden Phasendiagramme miteinander verglichen Die Analyse zeigt dass das Auftreten von Antispiralen sowohl vom PFK Aktivierungsmechanismus als auch von der Anzahl der PFK Untereinheiten abhängt

**Patterns of Synchrony in Complex Networks of Adaptively Coupled Oscillators** Rico Berner, 2021-05-31 The focus of this thesis is the interplay of synchrony and adaptivity in complex networks Synchronization is a ubiquitous phenomenon observed in different contexts in physics chemistry biology neuroscience medicine socioeconomic systems and engineering Most prominently synchronization takes place in the brain where it is associated with cognitive capacities like learning and memory but is also a characteristic of neurological diseases like Parkinson and epilepsy Adaptivity is common in many networks in nature and technology where the connectivity changes in time i.e. the strength of the coupling is continuously

adjusted depending upon the dynamic state of the system for instance synaptic neuronal plasticity in the brain This research contributes to a fundamental understanding of various synchronization patterns including hierarchical multifrequency clusters chimeras and other partial synchronization states After a concise survey of the fundamentals of adaptive and complex dynamical networks and synaptic plasticity in the first part of the thesis the existence and stability of cluster synchronization in globally coupled adaptive networks is discussed for simple paradigmatic phase oscillators as well as for a more realistic neuronal oscillator model with spike timing dependent plasticity In the second part of the thesis the interplay of adaptivity and connectivity is investigated for more complex network structures like nonlocally coupled rings random networks and multilayer systems Besides presenting a plethora of novel sometimes intriguing patterns of synchrony the thesis makes a number of pioneering methodological advances where rigorous mathematical proofs are given in the Appendices These results are of interest not only from a fundamental point of view but also with respect to challenging applications in neuroscience and technological systems

**Semiconductor Devices** Amal Banerjee, 2023-10-16 This book examines in detail how a semiconductor device is designed and fabricated to satisfy best the requirements of the target application The author presents and explains both basic and state of art semiconductor industry standards used in large small signal equivalent circuit models for semiconductor devices that electronics engineers routinely use in their design calculations The presentation includes detailed step by step information on how a semiconductor device is fabricated and the very sophisticated supporting technologies used in the process flow The author also explains how standard laboratory equipment can be used to extract useful performance metrics of a semiconductor device

**Computational Science and Its Applications - ICCSA 2004** Antonio Laganà, Marina L. Gavrilova, Vipin Kumar, Youngsong Mun, C.J. Kenneth Tan, Osvaldo Gervasi, 2004-04-29 The natural mission of Computational Science is to tackle all sorts of human problems and to work out intelligent automata aimed at alleviating the burden of working out suitable tools for solving complex problems For this reason Computational Science though originating from the need to solve the most challenging problems in science and engineering computational science is the key player in the fight to gain fundamental advances in astronomy biology chemistry environmental science physics and several other scientific and engineering disciplines is increasingly turning its attention to all fields of human activity In all activities in fact intensive computation information handling knowledge synthesis the use of ad hoc devices etc increasingly need to be exploited and coordinated regardless of the location of both the users and the various and heterogeneous computing platforms As a result the key to understanding the explosive growth of this discipline lies in two adjectives that more and more appropriately refer to Computational Science and its applications interoperable and ubiquitous Numerous examples of ubiquitous and interoperable tools and applications are given in the present four LNCS volumes containing the contributions delivered at the 2004 International Conference on Computational Science and its Applications ICCSA 2004 held in Assisi Italy May 14-17 2004 An Exploration of

Dynamical Systems and Chaos John H. Argyris, Gunter Faust, Maria Haase, Rudolf Friedrich, 2015-04-24 This book is conceived as a comprehensive and detailed text book on non linear dynamical systems with particular emphasis on the exploration of chaotic phenomena The self contained introductory presentation is addressed both to those who wish to study the physics of chaotic systems and non linear dynamics intensively as well as those who are curious to learn more about the fascinating world of chaotic phenomena Basic concepts like Poincar section iterated mappings Hamiltonian chaos and KAM theory strange attractors fractal dimensions Lyapunov exponents bifurcation theory self similarity and renormalisation and transitions to chaos are thoroughly explained To facilitate comprehension mathematical concepts and tools are introduced in short sub sections The text is supported by numerous computer experiments and a multitude of graphical illustrations and colour plates emphasising the geometrical and topological characteristics of the underlying dynamics This volume is a completely revised and enlarged second edition which comprises recently obtained research results of topical interest and has been extended to include a new section on the basic concepts of probability theory A completely new chapter on fully developed turbulence presents the successes of chaos theory its limitations as well as future trends in the development of complex spatio temporal structures This book will be of valuable help for my lectures Hermann Haken Stuttgart This text book should not be missing in any introductory lecture on non linear systems and deterministic chaos Wolfgang Kinzel Würzburg This well written book represents a comprehensive treatise on dynamical systems It may serve as reference book for the whole field of nonlinear and chaotic systems and reports in a unique way on scientific developments of recent decades as well as important applications Joachim Peinke Institute of Physics Carl von Ossietzky University Oldenburg Germany

Synergetics Hermann Haken, 2013-11-11 This book is a reprint edition that comprises two titles namely Synergetics An Introduction Nonequilibrium Phase Transitions and Self Organization in Physics Chemistry and Biology and Advanced Synergetics Instability Hierarchies of Self Organizing Systems and Devices The reason for this publication is two fold Since synergetics is a new type of interdisciplinary field initiated by the author in 1969 the basic ideas developed in these volumes are of considerable theoretical interest But much more than this the methods and even the concrete examples presented in these books are still highly useful for graduate students professors and even for researchers in this fascinating field The reason lies in the following facts Synergetics deals with complex systems i e systems that are composed of many individual parts that are able to spontaneously form spatial temporal or functional structures by means of self organization Such phenomena occur in many fields ranging from physics chemistry and biology to economy and sociology More recent areas of application have been found in medicine and psychology where the great potential of the basic principles of synergetics can be unearthed Further applications have become possible in informatics for instance the designing of new types of computers and in other fields of engineering

*The Statistical Mechanics of Irreversible Phenomena* Pierre Gaspard, 2022-07-28 This book provides a comprehensive and self contained overview of recent progress in nonequilibrium statistical mechanics in



particular the discovery of fluctuation relations and other time reversal symmetry relations The significance of these advances is that nonequilibrium statistical physics is no longer restricted to the linear regimes close to equilibrium but extends to fully nonlinear regimes These important new results have inspired the development of a unifying framework for describing both the microscopic dynamics of collections of particles and the macroscopic hydrodynamics and thermodynamics of matter itself The book discusses the significance of this theoretical framework in relation to a broad range of nonequilibrium processes from the nanoscale to the macroscale and is essential reading for researchers and graduate students in statistical physics theoretical chemistry and biological physics

*Music Psychology—Balance of Relations* Jakub Sawicki, 2025-08-13 Offering a groundbreaking interdisciplinary perspective this book explores the fundamental mechanisms behind music perception by bridging music psychology with computational neuroscience It models how adaptation and synchronization shape neural responses to music revealing insights unattainable through traditional brain localization theories By applying complex systems theory it shifts the focus from isolated brain regions to dynamic network interactions providing a holistic and predictive framework with relevance across a broad spectrum of natural sciences Ideal for researchers across musicology psychology neuroscience as well as complexity and computational science it opens new paths for understanding the brain's response to music through scientific precision and cross disciplinary integration

**Basic Properties of Semiconductors** P.T. Landsberg, 2016-04-19 Since Volume 1 was published in 1982 the centres of interest in the basic physics of semiconductors have shifted Volume 1 was called Band Theory and Transport Properties in the first edition but the subject has broadened to such an extent that Basic Properties is now a more suitable title Seven chapters have been rewritten by the original authors However twelve chapters are essentially new with the bulk of this work being devoted to important current topics which give this volume an almost encyclopaedic form The first three chapters discuss various aspects of modern band theory and the next two analyze impurities in semiconductors Then follow chapters on semiconductor statistics and on surfaces interfaces and band offsets as they occur in heterojunctions Chapters 8 to 19 report on newer topics though a survey of transport properties of carriers is also included Among these are transport of hot electrons and thermoelectric effects including here and elsewhere properties of low dimensional and mesoscopic structures The electron hole liquid the quantum Hall effect localisation ballistic transport coherence in superlattices current ideas on tunnelling and on quantum confinement and scattering processes are also covered

Stochastic Processes in Physics, Chemistry, and Biology Jan A. Freund, Thorsten Pöschel, 2008-01-11 The theory of stochastic processes originally grew out of efforts to describe Brownian motion quantitatively Today it provides a huge arsenal of methods suitable for analyzing the influence of noise on a wide range of systems The credit for acquiring all the deep insights and powerful methods is due mainly to a handful of physicists and mathematicians Einstein Smoluchowski Langevin Wiener Stratonovich etc Hence it is no surprise that until recently the bulk of basic and applied stochastic research was devoted to purely mathematical

and physical questions. However, in the last decade we have witnessed an enormous growth of results achieved in other sciences, especially chemistry and biology, based on applying methods of stochastic processes. One reason for this stochastic boom may be that the realization that noise plays a constructive rather than the expected deteriorating role has spread to communities beyond physics. Besides their aesthetic appeal, these noise-induced, noise-supported, or noise-enhanced effects sometimes offer an explanation for so far open problems: information transmission in the nervous system and information processing in the brain, processes at the cell level, enzymatic reactions, etc. They may also pave the way to novel technological applications: noise-enhanced reaction rates, noise-induced transport and separation on the nanoscale, etc. Key words to be mentioned in this context are stochastic resonance, Brownian motors or ratchets, and noise-supported phenomena in excitable systems.

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