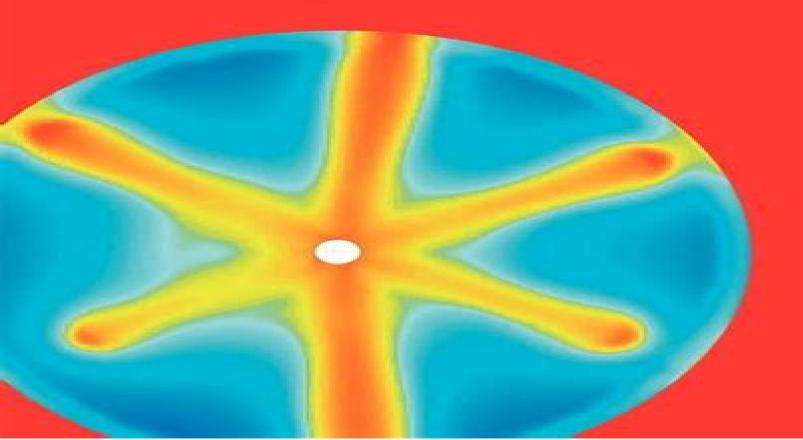
# Nonlinear Spatio-Temporal Dynamics and Chaos in Semiconductors

**Eckehard Schöll** 



# **Nonlinear Dynamics And Chaos In Semiconductors**

**Vladimir Semenov** 

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

Nonlinear Dynamics and Chaos in Semiconductors K Aoki, 2000-12-07 The field of nonlinear dynamics and low dimensional chaos has developed rapidly over the past twenty years. The principal advances have been in theoretical aspects but more recent applications in a wide variety of the sciences have been made Nonlinear Dynamics and Chaos in Semiconductors is the first book to concentrate on specific physical and experimental situations in semiconductors as well as examine how to use chaos theory to explain semiconductor phenomena Written by a well respected researcher of chaos in semiconductors Nonlinear Dynamics and Chaos in Semiconductors provides a rich and detailed account of progress in research on nonlinear effects in semiconductor physics Discussing both theory and experiment the author shows how this powerful combination has lead to real progress with difficult nonlinear problems in this technologically important field Nonlinear carrier dynamics caused by low temperature impact ionization avalanche of impurities in extrinsic semiconductors and the emergence of intractable chaos are treated in detail The book explores impact ionization models linear stability analysis bifurcation theory fractal dimensions and various analytical methods in chaos theory It also describes spatial and spatiotemporal evolution of the current density filament formed by the impact ionization avalanche and Chaos in Semiconductors K. Aoki, 2001 This text uses chaos theory and nonlinear dynamic systems to explain specific physical phenomena both intrinsic to the materials used and caused by external factors **Nonlinear Dynamics and** Chaos in Semiconductors K Aoki, 2000-12-07 The field of nonlinear dynamics and low dimensional chaos has developed rapidly over the past twenty years The principal advances have been in theoretical aspects but more recent applications in a wide variety of the sciences have been made Nonlinear Dynamics and Chaos in Semiconductors is the first book to concentrate on specific physical and ex 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 **Nonlinear Dynamics and Pattern Formation in Semiconductors** to examine semiconductor transport phenomena and Devices Franz-Josef Niedernostheide, 2013-03-08 In Nonlinear Dynamics and Pattern Formation in Semiconductors and Devices the contributions of the International Conference on Nonlinear Dynamics and Pattern Formation in the Natural Environment ICPF 94 in Noordwijkerhout held by many internationally reknown experts are compiled To connect the field of semiconductor physics with the theory of nonequilibrium dissipative systems the emphasis lies on the study of localized structures their stability and bifurcation behaviour A point of special interest is the evolution of dynamic structures and the investigation of more complex structures arising from interactions between these structures Possible applications of nonlinear effects and self organization phenomena with respect to signal processing are discussed Physics of **Semiconductors 2002** J.H Davies, A.R Long, 2003-05-01 The 26th International Conference on the Physics of Semiconductors was held from 29 July to 2 August 2002 at the Edinburgh International Conference Centre It is the premier

meeting in the field of semiconductor physics and attracted over 1000 participants from leading academic governmental and industrial institutions in some 50 countries around the world Plenary and invited papers 34 have been printed in the paper volume and all submitted papers 742 are included on the CD ROM These proceedings provide an international perspective on the latest research and a review of recent developments in semiconductor physics Topics range from growth and properties of bulk semiconductors to the optical and transport properties of semiconductor nanostructures. There are 742 papers mostly arranged in chapters on Bulk dynamics defects and impurities growth 147 Heterostructures quantum wells superlattices optical 138 Heterostructures quantum wells superlattices transport 97 Quantum nanostructures optical 120 Quantum nanostructures transport 85 New materials and concepts 52 Novel devices 43 and Spin and magnetic effects 48 A number of trends were identified in setting up the overall programme of the conference There were significant contributions from new directions of research such as nanostructures and one dimensional physics spin effects and ferromagnetism and terahertz and subband physics These complemented areas in which the conference has traditional strengths such as defects and bulk materials crystal growth quantum transport and optical properties As a record of a conference that covers the whole range of semiconductor physics this book is an essential reference for researchers working on semiconductor physics device physics materials science chemistry and electronic and electrical engineering **Nonlinear Dynamics of Nanosystems** Günter Radons, Benno Rumpf, Heinz Georg Schuster, 2010-01-12 A discussion of the fundamental changes that occur when dynamical systems from the fields of nonlinear optics solids hydrodynamics and biophysics are scaled down to nanosize The authors are leading scientists in the field and each of their contributions provides a broader introduction to the specific area of research In so doing they include both the experimental and theoretical point of view focusing especially on the effects on the nonlinear dynamical behavior of scaling stochasticity and quantum mechanics For everybody working on the synthesis and integration of nanoscopic devices who sooner or later will have to learn how to deal with nonlinear effects Negative Differential Resistance and Instabilities in 2-D Semiconductors N. Balkan, B.K. Ridley, A.J. Vickers, 2012-12-06 Instabilities associated with hot electrons in semiconductors have been investigated from the beginning of transistor physics in the 1940s The study of NDR and impact ionization in bulk material led to devices like the Gunn diode and the avalanche photo diode In layered semiconductors domain formation in HEMTs can lead to excess gate leakage and to excess noise The studies of hot electron transport parallel to the layers in heterostructures single and multiple have shown abundant evidence of electrical instability and there has been no shortage of suggestions concerning novel NDR mechanisms such as real space transfer scattering induced NDR inter sub band transfer percolation effects etc Real space transfer has been exploited in negative resistance PETs NERFETs and in the charge injection transistor CHINT and in light emitting logic devices but far too little is known and understood about other NDR mechanisms with which quantum well material appears to be particularly well endowed for these to be similarly exploited The aim of this book is therefore to collate what is known and what is not

known about NDR instabilities and to identify promising approaches and techniques which will increase our understanding of the origin of these instabilities which have been observed during the last decade of investigations into high field longitudinal transport in layered semiconductors. The book covers the fundamental properties of hot carrier transport and the associated instabilities and light emission in 2 dimensional semiconductors dealing with both theory and experiment Modelling of Deterministic and Stochastic Oscillators Vladimir Semenov, 2025-01-28 This book presents advanced methods for the electronic modeling of dynamical systems governed by ordinary differential equations It offers a comprehensive toolkit and practical solutions for specialists in nonlinear dynamics who seek experimental validation of their mathematical models The aim is to empower readers without an extensive background in electronics or circuit theory to translate their theoretical concepts into real world devices facilitating the rapid experimental confirmation of numerical and theoretical findings For experts in electronic engineering the book showcases how a wide range of non electronic systems and their unique characteristics can be effectively modeled using electronic circuits Bridging the gap between theory and practice the book serves as a valuable resource on electronics for theorists and mathematicians and on nonlinear dynamics for experimentalists and engineers Its audience includes a broad spectrum of readers from students and engineers to scientists and researchers across various fields **The Physics of Traffic** Boris S. Kerner, 2012-12-06 This monograph is devoted to a new approach to an old field of scientific investigation freeway traffic research Freeway traffic is an extremely complex spatiotemporal nonlinear dynamic process For this reason it is not surprising that empirical traffic pattern features have only recently been sufficiently understood Such empirical features are in serious conflict with almost all earlier theoretical and model results Consequently the author introduced a new traffic flow theory called three phase traffic theory which can explain these empirical spatiotemporal traffic patterns. The main focus of this book is a consideration of empirical spatiotemporal traffic pattern features their engineering applications and explanations based on the three phase traffic theory The book consists of four parts In Part I empirical studies of traffic flow patterns earlier traffic flow theories and mathematical models are briefly reviewed Three phase traffic theory is considered as well This theory is a qualitative theory Main ideas and results of the three phase traffic flow the ory will be introduced and explained without complex mathematical models This should be suitable for a very broad audience of practical engineers physicists and other readers who may not necessarily be specialists in traffic flow problems and who may not necessarily have worked in the field of spatiotemporal pattern formation In Part II empirical spatiotemporal traffic pattern features are considered A microscopic three phase traffic theory of these patterns and results of an application of the pattern features to engineering applications are pre sented in Part III and Part IV respectively *Electro-Optical Effects to Visualize Field and Current Distributions in Semiconductors* Karl W. Böer, 2010-02-02 This book describes the basic principles that relate to field and current inhomogeneities in semiconductors and their kinetics that occur in the regime of negative differential conductances of semiconductors

Semiconductor Lasers Junji Ohtsubo, 2007-10-24 Prefaceforthesecondedition Chaos research in laser physics especially in semiconductor lasers has veloped further even after completion of the rst edition of this book in the late summer of 2004 and it is still growing rapidly For example various forms of chaotic dynamics have been applied in newly developed semic ductor lasers such as in vertical cavitysurface emitting semiconductor lasers and broad area semiconductor lasers Chaotic dynamics plays an important role in these new lasers even for their solitary oscillations and control of the dynamics is currently an important issue for practical applications other signi cant advance has been made in the area of chaotic optical secure communications Chaotic secure communications using existing public opt al communications links have been tested and successful results have been obtained In this second edition I have lled in the gaps in the explanation of chaotic laser dynamics in the previous edition and I have alsoadded s eral important topics that have been developed recently In particular a new chapter on laser stabilizations has been added and a number of misprints in the rst edition have been corrected I believe this book will be of interest not only to researchers in the eld of laser chaos but also to those working in nonlinear science and technology Hamamatsu Spring 2007 Junji Ohtsubo Preface

The aim of this book is the description of the state of the art of chaos research in semiconductor lasers and their applications and the future perspective of this eld Encounter with Chaos Joachim Peinke, Jürgen Parisi, Otto E. Rössler, Ruedi Stoop, 2012-12-06 Our life is a highly nonlinear process It starts with birth and ends with death in between there are a lot of ups and downs Quite often we believe that stable and steady situations probably easy to capture by linearization are paradisiacal but already after a short period of everyday routine we usually become bored and seek change that is nonlinearities If we reflect for a while we notice that our life and our perceptions are mainly determined by nonlinear phenomena for example events occurring suddenly and unexpectedly One may be surprised by how long scientists tried to explain our world by models based on a linear ansatz Due to the lack of typical nonlinear patterns although everybody experienced nonlinearities nobody could classify them and thus study them further The discoveries of the last few decades have finally provided access to the world of nonlinear phenomena and have initiated a unique inter disciplinary field of research nonlinear science In contrast to the general tendency of science to become more branched out and specialized as the result of any progress nonlinear science has brought together many different disciplines This has been motivated not only by the immense importance of nonlinearities for science but also by the wonderful simplicity ohhe concepts Models like the logistic map can be easily understood by high school students and have brought revolutionary new insights into our scientific under standing 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 **Optical Nonlinearities and Instabilities in Semiconductors** Hartmut Haug, 2012-12-02 Optical Nonlinearities and Instabilities in Semiconductors deals with various aspects of nonlinear optical phenomena and related optical instabilities in semiconductors Measurements and explanations of the optical nonlinearities of various semiconductor materials and structures are presented along with optical bistability and diode laser thresholds self oscillations and chaos This text consists of 17 chapters and begins with an introductory chapter to the historical background of investigations of the resonance enhanced nonlinear optical properties of semiconductors and their manifestations in optical instabilities. The discussion then turns to the experimentally observed optical nonlinearities in homogeneous semiconductors and the microscopic theory of the optical band edge nonlinearities This book considers the studies of the spectral region close to the band gap meant to exploit the resonance enhancement of the nonlinear optical behavior The remaining chapters focus on nonlinear optical properties of semiconductor quantum wells dense nonequilibrium excitations in gallium arsenide optical decay and spatial relaxation and optical bistability in semiconductor laser amplifiers A chapter that describes instabilities in semiconductor lasers concludes the book This book is intended for research students and active research workers who are interested in the basic physics or in the device applications of optical nonlinearities and instabilities in semiconductors Hot Electrons in Semiconductors N. Balkan, 1998 Since the arrival of the transistor in 1947 research in hot electrons like any field in semiconductor research has grown at a stunning rate From a physicist's point of view the understanding of hot electrons and their interactions with the lattice has always been a challenging problem of condensed matter physics Recently with the advent of novel fabrication techniques such as electron beam or plasma etching and the advanced growth techniques such as the molecular beam epitaxy MBE and metallo organic chemical vapour deposition MOCVD it has become possible to fabricate semiconductor devices with sub micron dimensions where the electrons are confined to two quantum well one quantum wire or zero quantum dot dimensions In devices of such dimensions a few volts applied to the device result in the setting up of very high electric fields hence a substantial heating of electrons Thus electronic transport in the device becomes non linear and can no longer be described using the simple equations of Ohm s law The understanding of the operations of such devices and the realisations of more advanced ones make it necessary to understand the dynamics of hot electrons There is an obvious lack of good reference

books on hot electrons in semiconductors. The few that exist either cover a very narrow field or are becoming quite outdated This book is therefore written with the aim of filling the vacuum in an area where there is much demand for a comprehensive reference book The book is intended for both established researchers and graduate students and gives a complete account of the historical development of the subject together with current research interests and future trends The contributions are written by leading scientists in the field They cover the physics of hot electrons in bulk and low dimensional device technology The material is organised into subject area that can be classified broadly into five groups 1 introduction and overview 2 hot electron phonon interactions and the ultra fast phenomena in bulk and two dimensional structures 3 hot electrons in both long and short quantum wires and quantum dots 4 hot electron tunnelling and hot electron transport in superlattices and 5 novel devices based on hot electron transport The chapters are grouped according to subject matter as far as possible However although there is much overlap of ideas and concepts each chapter is essentially independent of the Nonlinear Dynamics in Solids Harry Thomas, 2012-12-06 This volume contains the notes of lectures given at the school on Nonlinear Dy namics in Solids held at the Physikzentrum Bad Honnef 2 6 October 1989 under the patronage of the Deutsche Physikalische Gesellschaft Nonlinear dynamics has become a highly active research area owing to many interesting developments during the last three decades in the theoretical analysis of dynamical processes in both Hamiltonian and dissipative systems Research has been focused on a variety of problems such as the characteristics of regular and chaotic motion in Hamiltonian dynamics the problem of quantum chaos the formation and properties of solitary spatio temporal structures the occurrence of strange attractors in dissipative systems and the bifurcation scenarios leading to complex time behaviour Until recently predictions of the theory have been tested predominantly on insta bilities in hydrodynamic systems where many interesting experiments have provided valuable input and have ledto a fruitful interaction between experiment and theory Fluid systems are certainly good candidates for performing clean experiments free from disturbing influences with fluids compared to solids it is simpler to prepare good samples the relevant length and time scales are in easily accessible ranges and it is possible to do measurements inside the fluid because it can be filled in after the construction of the apparatus Further the theory describing the macroscopic dynamics of fluids is well established and contains only very few parameters all of which have well known values Microcavity Semiconductor Lasers Yong-zhen Huang, Yue-de Yang, 2021-05-24 Microcavity Semiconductor Lasers Explore this thorough overview of integrable microcavity semiconductor lasers and their applications from two leading voices in the field Attracting a great deal of attention over the last decades for their promising applications in photonic integration and optical interconnects microcavity semiconductor lasers continue to develop via advances in fundamental physics theoretical analysis and numerical simulations In a new work that will be of interest to researchers and practitioners alike Microcavity Semiconductor Lasers Principles Design and Applications delivers an application oriented and highly relevant exploration of the theory fabrication and applications of these practical devices

The book focuses on unidirectional emission microcavity lasers for photonic integrated circuits including polygonal microresonators microdisk and microring lasers After an introductory overview of optical microcavities for microlasers and detailed information of the lasers themselves including mode structure control and characteristics and lasing properties the distinguished authors discuss fabrication and applications of different microcavity lasers Prospects for future research and potential new applications round out the book Readers will also benefit from the inclusion of A thorough introduction to multilayer optical waveguides the FDTD Method and Pad Approximation and deformed chaos and unidirectional emission microdisk lasers An exploration of mode analysis for triangle and square microresonators similar as FP Cavity Practical discussions of mode analysis and control for deformed square microlasers An examination of hexagonal microcavity lasers and polygonal microcavities along with vertical radiation loss for 3D microcavities Perfect for laser specialists semiconductor physicists and solid state physicists Microcavity Semiconductor Lasers Principles Design and Applications will also earn a place in the libraries of materials scientists and professionals working in the semiconductor and optical industries seeking a one stop reference for integrable microcavity semiconductor lasers Memoirs of the Faculty of Engineering, Kobe **University** Kōbe Daigaku. Kōgakubu,1990 3rd International Conference on Nanotechnologies and Biomedical **Engineering** Victor Sontea, Ion Tiginyanu, 2015-09-23 This volume presents the proceedings of the 3rd International Conference on Nanotechnologies and Biomedical Engineering which was held on September 23 26 2015 in Chisinau Republic of Moldova ICNBME 2015 continues the series of International Conferences in the field of nanotechnologies and biomedical engineering It aims at bringing together scientists and engineers dealing with fundamental and applied research for reporting on the latest theoretical developments and applications involved in the fields Topics include Nanotechnologies and nanomaterials Plasmonics and metamaterials Bio micro nano technologies Biomaterials Biosensors and sensors systems Biomedical instrumentation Biomedical signal processing Biomedical imaging and image processing Molecular cellular and tissue engineering Clinical engineering health technology management and assessment Health informatics e health and telemedicine Biomedical engineering education Nuclear and radiation safety and security Innovations and technology transfer

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