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# Mode-Locking in Solid-State and Semiconductor Lasers

M. S. Demokan

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# Mode Locking In Solid State And Semiconductor Lasers

**John E. Carroll, J. E. Carroll**



## **Mode Locking In Solid State And Semiconductor Lasers:**

**Mode-locking in Solid-state and Semiconductor Lasers** M. S. Demokan, 1982-01-01      **Mode-Locking in Solid-State and Semiconductor Lasers** M. S. Demokan,      **Spatio-Temporal Modeling and Device Optimization of Passively Mode-Locked Semiconductor Lasers** Stefan Meinecke, 2022-03-26 This thesis investigates passively mode locked semiconductor lasers by numerical methods The understanding and optimization of such devices is crucial to the advancement of technologies such as optical data communication and dual comb spectroscopy The focus of the thesis is therefore on the development of efficient numerical models which are able both to perform larger parameter studies and to provide quantitative predictions Along with that visualization and evaluation techniques for the rich spatio temporal laser dynamics are developed these facilitate the physical interpretation of the observed features The investigations in this thesis revolve around two specific semiconductor devices namely a monolithically integrated three section tapered quantum dot laser and a V shaped external cavity laser In both cases the simulations closely tie in with experimental results which have been obtained in collaboration with the TU Darmstadt and the ETH Zurich Based on the successful numerical reproduction of the experimental findings the emission dynamics of both lasers can be understood in terms of the cavity geometry and the active medium dynamics The latter in particular highlights the value of the developed simulation tools since the fast charge carrier dynamics are generally not experimentally accessible during mode locking operation Lastly the numerical models are used to perform laser design explorations and thus to derive recommendations for further optimizations      **Solid-State Lasers and Applications** Alphan Sennaroglu, 2017-12-19 Because of the favorable characteristics of solid state lasers they have become the preferred candidates for a wide range of applications in science and technology including spectroscopy atmospheric monitoring micromachining and precision metrology Presenting the most recent developments in the field Solid State Lasers and Applications focuses on the design and applications of solid state laser systems With contributions from leading international experts the book explores the latest research results and applications of solid state lasers as well as various laser systems The beginning chapters discuss current developments and applications of new solid state gain media in different wavelength regions including cerium doped lasers in the ultraviolet range ytterbium lasers near 1  $\mu$ m rare earth ion doped lasers in the eye safe region and tunable Cr<sup>2+</sup> ZnSe lasers in the mid infrared range The remaining chapters study specific modes of operation of solid state laser systems such as pulsed microchip lasers high power neodymium lasers ultrafast solid state lasers amplification of femtosecond pulses with optical parametric amplifiers and noise characteristics of solid state lasers Solid State Lasers and Applications covers the most important aspects of the field to provide current comprehensive coverage of solid state lasers      *Ultrafast Lasers Based on Quantum Dot Structures* Edik U. Rafailov, Maria Ana Cataluna, Eugene A. Avrutin, 2011-04-08 In this monograph the authors address the physics and engineering together with the latest achievements of efficient and compact ultrafast lasers based on novel quantum dot structures and devices

Their approach encompasses a broad range of laser systems while taking into consideration not only the physical and experimental aspects but also the much needed modeling tools thus providing a holistic understanding of this hot topic

**Lasers and Their Applications** Phoenix Walsh, 2018-11-26 A laser is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation The term laser originated as an acronym for light amplification by stimulated emission of radiation Laser Applications provides a firm grounding in the fundamental concepts governing the field of Optics This reference book is useful for the students of B E B Tech and M Tech courses The present book is an attempt to treat the subject of Laser as an introductory course With recent major breakthroughs in ultrafast laser technology and femtosecond nonlinear spectroscopic techniques Femtosecond Laser Spectroscopy is currently a burgeoning field in many branches of science including physics chemistry biology and materials science Attempts have also been made to cover the frontline areas in the subject The development of Laser and its various applications in Communications Radiation medicine Holography etc has been given due importance

**Rate Equations in Semiconductor Electronics** John E. Carroll, J. E. Carroll, 1990-03-30 This book presents a novel approach to the teaching of dynamic aspects of the operation of semiconductor and optoelectronic devices Such dynamic aspects often determine the steady state conditions Also the dynamical operation of such devices is of increasing importance as modern methods of communicating data and information require electronic devices that switch electrical or optical signals at ever faster rates The author discusses the rates at which electrons and holes can reach equilibrium the rates at which transistors and diodes can switch and the rates at which electrons and holes can interact with photons and with protons He also applies the rate equations in a unified way to models of light emitting diodes injection lasers and photodiodes Finally the author discusses more advanced topics on the photon statistics of injection lasers mode locking and the application of rate equations and Maxwell's equations to optoelectronic devices

**Rare-Earth-Doped Fiber Lasers and Amplifiers, Revised and Expanded** Michel J.F. Digonnet, 2001-05-31 Rare Earth Doped Fiber Lasers and Amplifiers Second Edition discusses the essential principles operating characteristics and current technology of the main fiber laser and amplifier devices based on rare earth doped silica and fluorozirconate fibers Covering all aspects of this revolutionary technology the book reviews fiber fabrication methods and the basic spectroscopic properties of rare earth ions in glasses concentrates on the most important fiber laser sources examines several advances in fiber amplifiers and analyzes new findings and improvements in single frequency operation frequency tunability broadband fiber sources and blue green and far infrared fiber lasers

**Handbook of Laser Technology and Applications** Chunlei Guo, Subhash Chandra Singh, 2021-06-23 This comprehensive handbook gives a fully updated guide to lasers and laser technologies including the complete range of their technical applications The first volume outlines the fundamental components of lasers their properties and working principles Key Features Offers a complete update of the original bestselling work including many brand new chapters Deepens the introduction to

fundamentals from laser design and fabrication to host matrices for solid state lasers energy level diagrams hosting materials dopant energy levels and lasers based on nonlinear effects Covers new laser types including quantum cascade lasers silicon based lasers titanium sapphire lasers terahertz lasers bismuth doped fiber lasers and diode pumped alkali lasers Discusses the latest applications e g lasers in microscopy high speed imaging attosecond metrology 3D printing optical atomic clocks time resolved spectroscopy polarization and profile measurements pulse measurements and laser induced fluorescence detection Adds new sections on laser materials processing laser spectroscopy lasers in imaging lasers in environmental sciences and lasers in communications This handbook is the ideal companion for scientists engineers and students working with lasers including those in optics electrical engineering physics chemistry biomedicine and other relevant areas

*Scientific and Technical Aerospace Reports*, 1995      **Picosecond Optoelectronic Devices** Chi H. Lee, 2012-12-02  
Picosecond Optoelectronic Devices reviews the major developments in the field of picosecond optoelectronics This book discusses the picosecond pulse generation with semiconductor diode lasers gigabit optical pulse generation in integrated lasers and applications and picosecond photoconductors The picosecond optoelectronic devices based on optically injected electron hole plasma pulse forming with optoelectronic switches and high power picosecond switching in bulk semiconductors are also elaborated This text likewise discusses the sub picosecond electrical sampling and applications InP optoelectronic switches and picosecond chronography Other topics include the picosecond optical control of transferred electron devices optoelectronic switch for pulsed power and responses of TEDs to picosecond optical pulses This publication is a good source for electrical engineers and researchers conducting work on picosecond optoelectronics      *The Physics and Engineering of Compact Quantum Dot-based Lasers for Biophotonics* Edik U. Rafailov, 2013-12-30 Written by a team of European experts in the field this book addresses the physics the principles the engineering methods and the latest developments of efficient and compact ultrafast lasers based on novel quantum dot structures and devices as well as their applications in biophotonics Recommended reading for physicists engineers students and lecturers in the fields of photonics optics laser physics optoelectronics and biophotonics      Progress in Optics, 2004-05-20 Optics has become one of the most dynamic fields of science since the first volume of Progress in Optics was published forty years ago At the time of inception of this series the first lasers were only just becoming operational holography was in its infancy subjects such as fiber optics integrated optics and optoelectronics did not exist and quantum optics was the domain of only a few physicists The term photonics had not yet been coined Today these fields are flourishing and have become areas of specialisation for many science and engineering students and numerous research workers and engineers throughout the world Some of the advances in these fields have been recognized by awarding Nobel prizes to seven physicists in the last twenty years The volumes in this series which have appeared up to now contain 240 review articles by distinguished research workers which have become permanent records for many important developments They have helped optical scientists and optical engineers to stay

abreast of their fields There is no sign that developments in optics are slowing down or becoming less interesting We confidently expect that just like their predecessors future volumes of Progress in Optics will faithfully record the most important advances that are being made in optics and related fields      Ultrashort Pulse Laser Technology Stefan Nolte, Frank Schrempel, Friedrich Dausinger, 2015-10-19 Ultrashort laser pulses with durations in the femtosecond range up to a few picoseconds provide a unique method for precise materials processing or medical applications Paired with the recent developments in ultrashort pulse lasers this technology is finding its way into various application fields The book gives a comprehensive overview of the principles and applications of ultrashort pulse lasers especially applied to medicine and production technology Recent advances in laser technology are discussed in detail This covers the development of reliable and cheap low power laser sources as well as high average power ultrashort pulse lasers for large scale manufacturing The fundamentals of laser matter interaction as well as processing strategies and the required system technology are discussed for these laser sources with respect to precise materials processing Finally different applications within medicine measurement technology or materials processing are highlighted      **Photonics Modelling and Design** Slawomir Sujecki, 2018-09-03 Photonics Modeling and Design delivers a concise introduction to the modeling and design of photonic devices Assuming a general knowledge of photonics and the operating principles of fibre and semiconductor lasers this book Describes the analysis of the light propagation in dielectric media Discusses heat diffusion and carrier transport Applies the presented theory to develop fibre and semiconductor laser models Addresses the propagation of short optical pulses in optical fibres Puts all modeling into practical context with examples of devices currently in development or on the market Providing hands on guidance in the form of MATLAB scripts tips and other downloadable content Photonics Modeling and Design is written for students and professionals interested in modeling photonic devices either for gaining a deeper understanding of the operation or to optimize the design      Nonlinear Optics in Semiconductors II, 1998-11-09 Since its inception in 1966 the series of numbered volumes known as Semiconductors and Semimetals has distinguished itself through the careful selection of well known authors editors and contributors The Willardson and Beer Series as it is widely known has succeeded in publishing numerous landmark volumes and chapters Not only did many of these volumes make an impact at the time of their publication but they continue to be well cited years after their original release Recently Professor Eicke R Weber of the University of California at Berkeley joined as a co editor of the series Professor Weber a well known expert in the field of semiconductor materials will further contribute to continuing the series tradition of publishing timely highly relevant and long impacting volumes Some of the recent volumes such as Hydrogen in Semiconductors Imperfections in III V Materials Epitaxial Microstructures High Speed Heterostructure Devices Oxygen in Silicon and others promise that this tradition will be maintained and even expanded Reflecting the truly interdisciplinary nature of the field that the series covers the volumes in Semiconductors and Semimetals have been and will continue to be of great interest to physicists chemists

materials scientists and device engineers in modern industry      *Two-Dimensional Materials in Nanophotonics* Yuerui Lu, 2019-10-31 Two dimensional 2D materials have attracted tremendous interest since the study of graphene in the early 21st century With their thickness in the angstrom to nanometer range 2D materials including graphene transition metal dichalcogenides phosphorene silicene and other inorganic and organic materials can be an ideal platform to study fundamental many body interactions because of reduced screening and can also be further engineered for nanophotonic applications This book compiles research outcomes of leading groups in the field of 2D materials for nanophotonic physics and devices It describes research advances of 2D materials for various nanophotonic applications including ultrafast lasers atomically thin optical lenses and gratings to inelastically manipulate light propagation their integrations with photonic nanostructures and light matter interactions The book focuses on actual applications while digging into the physics underneath It targets advanced undergraduate and graduate level students of nanotechnology and researchers in nanotechnology physics and chemistry especially those with an interest in 2D materials      **Semiconductor Disk Lasers**

Oleg G. Okhotnikov, 2010-03-30 This timely publication presents a review of the most recent developments in the field of Semiconductor Disk Lasers Covering a wide range of key topics such as operating principles thermal management nonlinear frequency conversion semiconductor materials short pulse generation electrical pumping and laser applications the book provides readers with a comprehensive account of the fundamentals and latest advances in this rich and diverse field In so doing it brings together contributions from world experts at major collaborative research centers in Europe and the USA Each chapter includes a tutorial style introduction to the selected topic suitable for postgraduate students and scientists with a basic background in optics making it of interest to a wide range of scientists researchers engineers and physicists working and interested in this rapidly developing field It will also serve as additional reading for students in the field      Frequency Measurement and Control Andre N. Luiten, 2003-07-01 This text on precision frequency measurement and its key enabling techniques includes reviews written by some of the most experienced researchers in their respective fields This text should prove useful to researchers just entering the field of frequency metrology and standards or equally well to the experienced practitioner

**High Speed Diode Lasers** Sergei A. Gurevich, 1998 This book is composed of seven invited papers which present the current status of high speed diode lasers Fast carrier and photon dynamics in directly modulated MQW lasers is analyzed and novel design approaches are considered which were critical for the demonstration and record of 40 GHz modulation bandwidth Attention is centered on the challenges in creation of high speed and low chirp single mode DFB lasers Recent progress in mode locked diode lasers is covered specifically by the examples of 160 fs pulse generation and appearance of microwave pulse repetition rates Future trends in increasing of high speed laser performance are also examined

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