
Spontaneous Emission and Laser Oscillation in Microcavities

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Spontaneous Emission And Laser Oscillation In Microcavities

Zhe Chuan Feng



Spontaneous Emission And Laser Oscillation In Microcavities:

Spontaneous Emission and Laser Oscillation in Microcavities Yokoyama Hiroyuki, Kikuo Ujihara, 2020-07-09 In spite of the increasing importance of microcavities device physics or the observable phenomena in optical microcavities such as enhanced or inhibited spontaneous emission and its relation with the laser oscillation has not been systematically well described until now *Spontaneous Emission and Laser Oscillation in Microcavities* presents the basics of optical microcavities The volume is divided into ten chapters each written by respected authorities in their areas The book surveys several methods describing free space spontaneous emission and discusses changes in the feature due to the presence of a cavity The effect of dephasing of vacuum fields on spontaneous emission in a microcavity and the effects of atomic broadening on spontaneous emission in an optical microcavity are examined The book details the splitting in transmission peaks of planar microcavities containing semiconductor quantum wells A simple but useful way to consider the change in the spontaneous emission rate from the viewpoint of mode density alteration by wavelength sized cavities is provided Authors also discuss the spontaneous emission in dielectric planar microcavities Spontaneous emission in microcavity surface emitting lasers is covered as are the effects of electron confinement in semiconductor quantum wells wires and boxes also given The volume extends the controlling spontaneous emission phenomenon to laser oscillation Starting from the Fermi golden rule the microcavity laser rate equations are derived and the oscillation characteristics are analyzed Recent progress in optical microcavity experiments is summarized and the applicability in massively optical parallel processing systems and demands for the device performance are explored This volume is extremely useful as a textbook for graduate and postgraduate students and works well as a unique reference for researchers beginning to study in the field *Spontaneous Emission and Laser Oscillation in Microcavities* Hiroyuki Yokoyama, Kikuo Ujihara, 2020-07-09 In spite of the increasing importance of microcavities device physics or the observable phenomena in optical microcavities such as enhanced or inhibited spontaneous emission and its relation with the laser oscillation has not been systematically well described until now *Spontaneous Emission and Laser Oscillation in Microcavities* presents the basics of optical microcavities The volume is divided into ten chapters each written by respected authorities in their areas The book surveys several methods describing free space spontaneous emission and discusses changes in the feature due to the presence of a cavity The effect of dephasing of vacuum fields on spontaneous emission in a microcavity and the effects of atomic broadening on spontaneous emission in an optical microcavity are examined The book details the splitting in transmission peaks of planar microcavities containing semiconductor quantum wells A simple but useful way to consider the change in the spontaneous emission rate from the viewpoint of mode density alteration by wavelength sized cavities is provided Authors also discuss the spontaneous emission in dielectric planar microcavities Spontaneous emission in microcavity surface emitting lasers is covered as are the effects of electron confinement in semiconductor quantum wells wires and boxes also given The volume extends the controlling

spontaneous emission phenomenon to laser oscillation Starting from the Fermi golden rule the microcavity laser rate equations are derived and the oscillation characteristics are analyzed Recent progress in optical microcavity experiments is summarized and the applicability in massively optical parallel processing systems and demands for the device performance are explored This volume is extremely useful as a textbook for graduate and postgraduate students and works well as a unique reference for researchers beginning to study in the field

Semiconductor Interfaces, Microstructures and Devices Zhe Chuan Feng,1993-01-01 A semiconductor interface is the contact between the semiconductor itself and a metal The interface is a site of change and it is imperative to ensure that the semiconducting material is sealed at this point to maintain its reliability This book examines various aspects of interfaces showing how they can affect microstructures and devices such as infrared photodetectors as used in nightsights and blue diode lasers It presents various techniques for examining different types of semiconductor material and suggests future potential commercial applications for different semiconductor devices Written by experts in their fields and focusing on metallic semiconductors Cadmium Telluride and related compounds this comprehensive overview of recent developments is an essential reference for those working in the semiconductor industry and provides a concise and comprehensive introduction to those new to the field

Ultrafast Spectroscopy of Semiconductors and Semiconductor Nanostructures Jagdeep Shah,2013-11-21 The field of ultrafast spectroscopy of semiconductors and their nanostructures continues to be an active field of research Exciting new developments have taken place since the first edition of this book was completed in 1995 This revised edition includes a discussion of many of these recent developments in the field This is accomplished by adding a chapter on Recent Developments at the end of the book This approach was selected to provide a discussion of results while they are still relatively recent Results published before the end of May 1998 were considered for inclusion in this book The objective of this revised edition remains the same as before to provide a cohesive discussion of the many diverse contributions of ultrafast spectroscopy to the field of semiconductors Extensive cross references are made to earlier chapters in order to accomplish this goal The chapter on Recent Developments begins with a brief discussion of new lasers new techniques of ultrafast spectroscopy and novel nanostructures This is followed by a section on Coherent Spectroscopy where some of the most interesting recent developments have taken place These include observation of quantum kinetic effects effects that require going beyond the mean field approach of the semiconductor Bloch equations coherent control of populations and current in semiconductors exciton continuum interactions and many diverse aspects of coherent spectroscopy including studies of microcavities Bragg structures quantum dots and quantum wires

Nonlinear Optics S. Miyata,2012-12-02 The field of nonlinear optics developed gradually with the invention of lasers After the discovery of second harmonic generation in quartz many other interesting nonlinear optical processes were rapidly discovered Simultaneously theoretical programmes for the understanding of nonlinear optical phenomena were stimulated in accordance to develop structure property relationships In

the beginning research advances were made on inorganic ferroelectric materials followed by semiconductors In the 1970 s the importance of organic materials was realised because of their nonlinear optical responses fast optical response high laser damage thresholds architectural flexibility and ease of fabrication At present materials can be classified into three categories inorganic ferroelectrics semiconductors and organic materials Advances have also been made in quantum chemistry approaches to investigate nonlinear optical susceptibilities and in the development of novel nonlinear optical devices Generally inorganic and organic nonlinear optical materials and their related optical processes are reported in separate meetings This book collects for the first time papers covering the recent developments and areas of present research in the field of nonlinear optical materials

Encyclopedia of Optical and Photonic Engineering (Print) - Five Volume Set Craig Hoffman,Ronald Driggers,2015-09-22 The first edition of the Encyclopedia of Optical and Photonic Engineering provided a valuable reference concerning devices or systems that generate transmit measure or detect light and to a lesser degree the basic interaction of light and matter This Second Edition not only reflects the changes in optical and photonic engineering that have occurred since the first edition was published but also Boasts a wealth of new material expanding the encyclopedia s length by 25 percent Contains extensive updates with significant revisions made throughout the text Features contributions from engineers and scientists leading the fields of optics and photonics today With the addition of a second editor the Encyclopedia of Optical and Photonic Engineering Second Edition offers a balanced and up to date look at the fundamentals of a diverse portfolio of technologies and discoveries in areas ranging from x ray optics to photon entanglement and beyond This edition s release corresponds nicely with the United Nations General Assembly s declaration of 2015 as the International Year of Light working in tandem to raise awareness about light s important role in the modern world Also Available Online This Taylor E mail e reference taylorandfrancis com International Tel 44 0 20 7017 6062 E mail online sales tandf co uk

Confined Electrons and Photons Elias Burstein,Claude Weisbuch,2012-12-06 The optical properties of semiconductors have played an important role since the identification of semiconductors as small bandgap materials in the thinies due both to their fundamental interest as a class of solids baving specific optical propenies and to their many important applications On the former aspect we can cite the fundamental edge absorption and its assignment to direct or indirect transitions many body effects as revealed by exciton formation and photoconductivity On the latter aspect large scale applications such as LEDs and lasers photovoltaic converters photodetectors electro optics and non linear optic devices come to mind The eighties saw a revitalization of the whole field due to the advent of heterostructures of lower dimensionality mainly two dimensional quantum wells which through their enhanced photon matter interaction yielded new devices with unsurpassed performance Although many of the basic phenomena were evidenced through the seventies it was this impact on applications which in turn led to such a massive investment in fabrication tools thanks to which many new structures and materials were studied yielding funher advances in fundamental physics

Photonic Crystals Jean-Michel Lourtioz,Henri Benisty,Vincent

Berger, Jean-Michel Gerard, Daniel Maystre, Alexei Tchel'nov, 2008-03-19 Just like the periodical crystalline potential in solid state crystals determines their properties for the conduction of electrons the periodical structuring of photonic crystals leads to envisioning the possibility of achieving a control of the photon flux in dielectric and metallic materials The use of photonic crystals as a cage for storing filtering or guiding light at the wavelength scale thus paves the way to the realisation of optical and optoelectronic devices with ultimate properties and dimensions This should contribute toward meeting the demands for a greater miniaturisation that the processing of an ever increasing number of data requires Photonic Crystals intends to provide students and researchers from different fields with the theoretical background needed for modelling photonic crystals and their optical properties while at the same time presenting the large variety of devices from optics to microwaves where photonic crystals have found applications As such it aims at building bridges between optics electromagnetism and solid state physics This book was written by six specialists of nanophotonics and was coordinated by Jean Michel Lourtioz head of the Institut d'electronique Fondamentale in Orsay and coordinator of the French Research Network in Nanophotonics

Mesoscopic Physics and Electronics Tsuneya Ando, Yasuhiko Arakawa, Kazuhito Furuya, Susumu Komiyama, Hisao Nakashima, 2012-12-06 Semiconductor technology has developed considerably during the past several decades The exponential growth in microelectronic processing power has been achieved by a constant scaling down of integrated circuits Smaller feature sizes result in increased functional density faster speed and lower costs One key ingredient of the LSI technology is the development of the lithography and microfabrication The current minimum feature size is already as small as 0.2 μm beyond the limit imposed by the wavelength of visible light and rapidly approaching fundamental limits The next generation of devices is highly likely to show unexpected properties due to quantum effects and fluctuations The device which plays an important role in LSIs is MOSFETs metal oxide semiconductor field effect transistors In MOSFETs an inversion layer is formed at the interface of silicon and its insulating oxide The inversion layer provides a unique two dimensional 2D system in which the electron concentration is controlled almost freely over a very wide range Physics of such 2D systems was born in the mid 1960s together with the development of MOSFETs The integer quantum Hall effect was first discovered in this system

Microcavities and Photonic Bandgaps: Physics and Applications J.G. Rarity, Claude Weisbuch, 2012-12-06 The control of optical modes in microcavities or in photonic bandgap PBG materials is coming of age Although these ideas could have been developed some time ago it is only recently that they have emerged due to advances in both atomic physics and in fabrication techniques be it on the high quality dielectric mirrors required for high finesse Fabry Perot resonators or in semiconductor multilayer deposition methods Initially the principles of quantum electrodynamics QED were demonstrated in elegant atomic physics experiments Now solid state implementations are being investigated with several subtle differences from the atomic case such as those due to their continuum of electronic states or the near Boson nature of their elementary excitations the exciton Research into quantum optics brings us ever newer concepts with potential

to improve system performance such as photon squeezing quantum cryptography reversible taps photonic de Broglie waves and quantum computers The possibility of implementing these ideas with solid state systems gives us hope that some could indeed find their way to the market demonstrating the continuing importance of basic research for applications be it in a somewhat more focused way than in earlier times for funding

Quantum-Dot-Based Semiconductor Optical Amplifiers for O-Band Optical Communication Holger Schmeckeber,2016-10-21 This thesis examines the unique properties of gallium arsenide GaAs based quantum dot semiconductor optical amplifiers for optical communication networks introducing readers to their fundamentals basic parameters and manifold applications The static and dynamic properties of these amplifiers are discussed extensively in comparison to conventional non quantum dot based amplifiers and their unique advantages are elaborated on such as the fast carrier dynamics and the decoupling of gain and phase dynamics In addition to diverse amplification scenarios involving single and multiple high symbol rate amplitude and phase coded data signals wide range wavelength conversion as a key functionality for optical signal processing is investigated and discussed in detail Furthermore two novel device concepts are developed and demonstrated that have the potential to significantly simplify network architectures reducing the investment and maintenance costs as well as the energy consumption of future networks

Optical Antennas Mario Agio,Andrea Alù,2013-01-03 This consistent and systematic review of recent advances in optical antenna theory and practice brings together leading experts in the fields of electrical engineering nano optics and nano photonics physical chemistry and nanofabrication Fundamental concepts and functionalities relevant to optical antennas are explained together with key principles for optical antenna modelling design and characterisation Recognising the tremendous potential of this technology practical applications are also outlined Presenting a clear translation of the concepts of radio antenna design near field optics and field enhanced spectroscopy into optical antennas this interdisciplinary book is an indispensable resource for researchers and graduate students in engineering optics and photonics physics and chemistry

Nanoscale Science and Technology Nicolás García,M. Nieto-Vesperinas,Hermann Rohrer,1998 Nanoscale Science and Technology summarizes six years of active research sponsored by NATO with the participation of the leading experts The book provides an interdisciplinary view of several aspects of physics at the atomic scale It contains an overview of the latest findings on the transport of electrons in nanowires and nanoconstrictions the role of forces in probe microscopy the control of structures and properties in the nanometer range aspects of magnetization in nanometric structures and local probes for nondestructive measurement as provided by light and metal clusters near atomic scales

Fundamentals of Semiconductor Lasers Takahiro Numai,2014-08-27 This book explains physics under the operating principles of semiconductor lasers in detail based on the experience of the author dealing with the first manufacturing of phase shifted DFB LDs and recent research on transverse modes The book also bridges a wide gap between journal papers and textbooks requiring only an undergraduate level knowledge of electromagnetism and quantum mechanics

and helps readers to understand journal papers where definitions of some technical terms vary depending on the paper Two definitions of the photon density in the rate equations and two definitions of the phase shift in the phase shifted DFB LD are explained and differences in the calculated results are indicated depending on the definitions Readers can understand the physics of semiconductor lasers and analytical tools for Fabry Perot LDs DFB LDs and VCSELs and will be stimulated to develop semiconductor lasers themselves

Vertical-Cavity Surface-Emitting Lasers Carl W. Wilmsen, Henryk

Temkin, Larry A. Coldren, 2001-11-12 One of the key advances in photonic technology in recent years is the development of vertical cavity surface emitting lasers or VCSELs These devices have a huge range of potential applications in areas such as communications printing and optical switching This book first published in 1999 provides a clear insight into the physics of VCSELs as well as describing details of their fabrication and applications All of the book's contributors are at the forefront of VCSEL research and development Together they provide complete and coherent coverage of the current state of the art The opening chapters cover VCSEL design emission from microcavities growth fabrication and characterization These are followed by chapters on long and short wavelength VCSELs optical data links and free space optical processing The book will be of great interest to graduate students and researchers in electrical engineering applied physics and materials science It will also be an excellent reference volume for practising engineers in the photonics industry

Physics of Strained Quantum

Well Lasers John P. Loehr, 2013-11-27 When this publisher offered me the opportunity to write a book some six years ago I did not hesitate to say yes I had just spent the last four years of graduate school struggling to understand the physics of strained quantum well lasers and it seemed to me the whole experience was much more difficult than it should have been For although many of the results I needed were easy to locate the underlying physical premises and intervening steps were not If only I had a book providing the derivations I could have absorbed them and gone on my way Such a book lies before you It provides a unified and self contained description of the essential physics of strained quantum well lasers starting from first principles whenever feasible The presentation I have chosen requires only the standard introductory background in quantum mechanics solid state physics and electromagnetics expected of entering graduate students in physics or electrical engineering A single undergraduate course in each of these subjects should be more than sufficient to follow the text More advanced material on quantum mechanics is developed and collected in the first chapter When possible I have presented the results in a general setting and have later applied them to specific cases of interest I find this the most satisfying way to approach the subject and it has the additional benefit of solving many problems once and for all

Analysis and Design of Vertical Cavity Surface Emitting Lasers S. F. Yu, 2003-09-04 A practical hands on guidebook for the efficient modeling of VCSELs Vertical

Cavity Surface Emitting Lasers VCSELs are a unique type of semiconductor laser whose optical output is vertically emitted from the surface as opposed to conventional edge emitting semiconductor lasers Complex in design and expensive to produce VCSELs nevertheless represent an already widely used laser technology that promises to have even more significant

applications in the future Although the research has accelerated there have been relatively few books written on this important topic Analysis and Design of Vertical Cavity Surface Emitting Lasers seeks to encapsulate this growing body of knowledge into a single comprehensive reference that will be of equal value for both professionals and academics in the field The author a recognized expert in the field of VCSELs attempts to clarify often conflicting assumptions in order to help readers achieve the simplest and most efficient VCSEL models for any given problem Highlights of the text include A clear and comprehensive theoretical treatment of VCSELs Detailed derivations for understanding the operational principles of VCSELs Mathematical models for the investigation of electrical optical and thermal properties of VCSELs Case studies on the mathematical modeling of VCSELs and the implementation of simulation programs *Electron and Photon Confinement in Semiconductor Nanostructures* Benoît Deveaud, Antonio Quattropani, Paolo Schwendimann, Società italiana di fisica, 2003 The purpose of this course was to give an overview of the physics of artificial semiconductor structures confining electrons and photons It furnishes the background for several applications in particular in the domain of optical devices lasers light emitting diodes or photonic crystals The effects related to the microactivity polaritons which are mixed electromagnetic radiation exciton states inside a semiconductor microactivity are covered The study of the characteristics of such states shows strong relations with the domain of cavity quantum electrodynamics and thus with the investigation of some fundamental theoretical concepts **Physics and Simulation of Optoelectronic Devices**, 2001 **Encyclopedia of Optical Engineering: Abe-Las, pages 1-1024** Ronald G. Driggers, 2003 PRINT ONLINE PRICING OPTIONS AVAILABLE UPON REQUEST ATe reference taylorandfrancis com

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