Quantum Theory Of The Optical And Electronic Prop

#quantum theory #optical properties #electronic properties #quantum optics #light-matter interaction

This comprehensive resource explores the fundamental quantum theory governing the optical and electronic properties of various materials. It delves into the intricate interactions between light and electrons at a quantum level, providing essential insights for understanding advanced phenomena in fields like quantum optics and solid-state physics.

Quantum Theory of the Optical and Electronic Properties of Semiconductors

This invaluable textbook presents the basic elements needed to understand and research into semi-conductor physics. It deals with elementary excitations in bulk and low-dimensional semiconductors, including quantum wells, quantum wires and quantum dots. The basic principles underlying optical non-linearities are developed, including excitonic and many-body plasma effects. Fundamentals of optical bistability, semiconductor lasers, femtosecond excitation, the optical Stark effect, the semiconductor photon echo, magneto-optic effects, as well as bulk and quantum-confined Franz-Keldysh effects, are covered. The material is presented in sufficient detail for graduate students and researchers with a general background in quantum mechanics.

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Quantum Theory of the Optical and electronic Properties of Semiconductors

A Festschrift in honor of Professor Marvin L. Cohen This volume is a Festschrift in honor of Professor Marvin L. Cohen. The articles, contributed by leading researchers in condensed matter physics, high-light recent advances in the use of quantum theory to explain and predict properties of real materials. The invention of quantum mechanics in the 1920's provided detailed descriptions of the electronic structure of atoms. However, a similar understanding of solids has been achieved only in the past 30 years, owing to the complex electron-ion and electron electron interactions in these systems. Professor Cohen is a central figure in this achievement. His development of the pseudopotential and total energy methods provided an alternate route using computers for the exploration of solids and new materials even when they have not yet been synthesized. Professor Cohen's contributions to materials theory have been both fundamental and encompassing. The corpus of his work consists of over 500 papers and a textbook. His band structures for semiconductors are used worldwide by researchers in solid state physics and chemistry and by device engineers. Professor Cohen's own use of his theories has resulted in the determination of the electronic structure, optical properties, structural and vibrational properties, and superconducting properties of numerous condensed matter systems including semiconductors, metals, surfaces, interfaces, defects in solids, clusters, and novel materials such as the fullerides and nanotubes.

Quantum Theory of Real Materials

Quantum Aspects of Light Propagation provides an overview of spatio-temporal descriptions of the electromagnetic field in linear and nonlinear dielectric media, appropriate to macroscopic and microscopic theories. Readers will find an introduction to canonical quantum descriptions of light propagation in a nonlinear dispersionless dielectric medium, and an approach to linear and nonlinear dispersive dielectric media. Illustrated by optical processes, these descriptions are simplified by a transition to one-dimensional propagation. Quantum theories of light propagation in optical media are generalized from dielectric media to magnetodielectrics, in addition to a presentation of classical and nonclassical properties of radiation propagating through negative-index media. Valuable analyses of quantization in waveguides, photonic crystals, and propagation in strongly scattering media are also included, along with various optical resonator properties. The theories are utilized for the quantum electrodynamical effects to be determined in periodic dielectric structures which are known to be a basis of new schemes for lasing and a control of light field state. Quantum Aspects of Light Propagation is a valuable reference for researchers and engineers involved with general optics, quantum optics and electronics, nonlinear optics, and photonics.

Quantum Aspects of Light Propagation

This monograph forms an interdisciplinary study in atomic, molecular, and quantum information (QI) science. Here a reader will find that applications of the tools developed in QI provide new physical insights into electron optics as well as properties of atoms & molecules which, in turn, are useful in studying QI both at fundamental and applied levels. In particular, this book investigates entanglement properties of flying electronic qubits generated in some of the well known processes capable of taking place in an atom or a molecule following the absorption of a photon. Here, one can generate Coulombic or fine-structure entanglement of electronic qubits. The properties of these entanglements differ not only from each other, but also from those when spin of an inner-shell photoelectron is entangled with the polarization of the subsequent fluorescence. Spins of an outer-shell electron and of a residual photoion can have free or bound entanglement in a laboratory.

Quantum Entanglement in Electron Optics

This textbook, based on the authors’ class-tested material, is accessible to students at the advanced undergraduate and graduate level in physics and engineering. While its primary function is didactic, this book’s comprehensive choice of topics and its clear and authoritative synthesis of ideas make it a useful reference for researchers, device engineers, and course instructors who wish to consolidate their knowledge of this field. The book takes the semi-classical approach where light is treated as a wave in accordance with the classical Maxwell equations, while matter is governed by quantum theory. It begins by introducing the postulates and mathematical framework of quantum theory, followed by the formalism of the density matrix which allows the transition from microscopic (quantum) quantities to macroscopic (classical) ones. Consequently, the equations describing the reaction of matter to the electromagnetic field in the form of polarization, magnetization, and current are derived. These equations (together with the Maxwell equations) form the complete system of equations sufficient to model a wide class of problems surrounding linear and nonlinear interactions of electromagnetic fields with matter. The nonlinear character of the governing equations determines parameters of the steady-state mode of the quantum generator and is also demonstrated in harmonic generation via propagation of laser radiation in various media. The touchstone description of magnetic phenomena will be of interest to scientists who deal with applications of magneto-resonance phenomena in biology and medicine. Other advanced topics covered include electric dipole transitions, magnetic dipole transitions, plasma transitions, and the devices that can be based on these and other electro-optical and nonlinear-optical systems. This textbook features numerous exercises, some of which are investigatory and some of which require computational solutions.

Introduction to Quantum Electronics and Nonlinear Optics

Special focus is given to the optical and electronic properties of single quantum dots due to their potential applications in devices operating with single electrons and/or single photons. This includes quantum dots in electric and magnetic fields, cavity-quantum electrodynamics, nonclassical light generation, and coherent optical control of excitons.

Single Quantum Dots

Principles of Quantum Electronics focuses on the concept of quantum electronics as the application of quantum theory to engineering problems. It examines the principles that govern specific quantum electronics devices and presents their theoretical applications to typical problems. Comprised of 10 chapters, this book starts with an overview of the Dirac formulation of quantum mechanics. This text then considers the derivation of the formalism of field quantization and discusses the properties of photons and phonons. Other chapters examine the interaction between the electromagnetic field and charged particles. This book discusses as well the interaction of radiation with free and bound electrons, with focus on the spontaneous and stimulated emission of radiation by bound electrons. The final chapter provides the investigation that Maxwell's theory can be regarded as the quantum theory of a single photon. This book is a valuable resource for graduate students, specialists, and engineers who are interested in the field of quantum electrodynamics.

Principles of Quantum Electronics

Quantum mechanics has evolved from a subject of study in pure physics to one with a wide range of applications in many diverse fields. The basic concepts of quantum mechanics are explained in this book in a concise and easy-to-read manner, leading toward applications in solid-state electronics and optics. Following a logical sequence, the book focuses on key ideas and is conceptually and mathematically self-contained. The fundamental principles of quantum mechanics are illustrated by showing their application to systems such as the hydrogen atom, multi-electron ions and atoms, the formation of simple organic molecules and crystalline solids of practical importance. It leads on from these basic concepts to discuss some of the most significant applications in semiconductor electronics and optics. Containing many homework problems, the book is suitable for senior-level undergraduate and graduate-level students in electrical engineering, material sciences, applied physics and chemistry.

Fundamentals of Quantum Mechanics

This graduate-level text presents the fundamental physics of solid-state lasers, including the basis of laser action and the optical and electronic properties of laser materials. After an overview of the topic, the first part begins with a review of quantum mechanics and solid-state physics, spectroscopy, and crystal field theory; it then treats the quantum theory of radiation, the emission and absorption of radiation, and nonlinear optics; concluding with discussions of lattice vibrations and ion-ion interactions, and their effects on optical properties and laser action. The second part treats specific solid-state laser materials, the prototypical ruby and Nd-YAG systems being treated in greatest detail; and the book concludes with a discussion of novel and non-standard materials. Some knowledge of quantum mechanics and solid-state physics is assumed, but the discussion is as self-contained as possible, making this an excellent reference, as well as useful for independent study.

Physics of Solid-State Laser Materials

This textbook presents the basic elements needed to understand and engage in research in semiconductor physics. It deals with elementary excitations in bulk and low-dimensional semiconductors, including quantum wells, quantum wires and quantum dots. The basic principles underlying optical nonlinearities are developed, including excitonic and many-body plasma effects. The fundamentals of optical bistability, semiconductor lasers, femtosecond excitation, optical Stark effect, semiconductor photon echo, magneto-optic effects, as well as bulk and quantum-confined Franz-Keldysh effects are covered. The material is presented in sufficient detail for graduate students and researchers who have a general background in quantum mechanics. Request Inspection Copy

Quantum Theory of the Optical and Electronic Properties of Semiconductors

have advances in of The last few seen our understanding revolutionary years heterostructures. An amount the electronic of enormous properties quantum undertaken both the and the theoretical of research has been on experimental in nanostructures. The field vast of electronic now covers a aspects transport and extensive number of review of an books, articles, spectrum topics, papers and conference continue to be in this area. published Complete proceedings of this and field is the of this book. beyond exciting evolving scope coverage We refer the interested reader to of the excellent and some comprehensive books and conference on this proceedings subject. Much has been made in our of confined understanding quantum progress A's is well it is to construct heterostruc known, possible quantum systems. tures which well as one dimensional are approximated quasi two dimensional, zero dimensional Our interest here is in the of or properties particles systems. We brief andfields in two dimensional a intro quasi (2 D) systems. provide duction to the of 2 D in to motion in 2 D systems, particular systems physics the confined within finite For we will assume that a area. simplicity, generally Such confined is defined an infinite hard wall a by potential. system boundary We will 2 D will be referred to as a or as a wire.

Binding and Scattering in Two-Dimensional Systems

This graduate-level text presents the fundamental physics of solid-state lasers, including the basis of laser action and the optical and electronic properties of laser materials. After an overview of the topic, the first part begins with a review of quantum mechanics and solid-state physics, spectroscopy, and crystal field theory; it then treats the quantum theory of radiation, the emission and absorption of radiation, and nonlinear optics; concluding with discussions of lattice vibrations and ion-ion interactions, and their effects on optical properties and laser action. The second part treats specific solid-state laser materials, the prototypical ruby and Nd-YAG systems being treated in greatest detail; and the book concludes with a discussion of novel and non-standard materials. Some knowledge of quantum mechanics and solid-state physics is assumed, but the discussion is as self-contained as possible, making this an excellent reference, as well as useful for independent study.

Physics of Solid-State Laser Materials

Semiconductor structures containing zero-dimensional objects — quantum dots — are the subject of intensive research worldwide. This monograph describes a detailed theory of the electronic band structure and optical properties of semiconductor quantum dots.The author provides a comprehensive description of an original approach based on a combination of the Fourier transform, the Green's function and plane-wave expansion techniques in the framework of multiband 8x8 kp theory. The calculated band structure, optical properties and device applications are analyzed in line with available experiments for a large number of realistic quantum dot structures and various combinations of materials, such as InGaN, GaN/AlN, ZnSe, InGaAs (including dots-in-the-well), ZnSe/CdSe, and lead salts.

Theory of Semiconductor Quantum Dots

Excellent bridge between general solid-state physics textbook and research articles packed with providing detailed explanations of the electronic, vibrational, transport, and optical properties of semiconductors "The most striking feature of the book is its modern outlook ... provides a wonderful foundation. The most wonderful feature is its efficient style of exposition ... an excellent book." Physics Today "Presents the theoretical derivations carefully and in detail and gives thorough discussions of the experimental results it presents. This makes it an excellent textbook both for learners and for more experienced researchers wishing to check facts. I have enjoyed reading it and strongly recommend it as a text for anyone working with semiconductors ... I know of no better text ... I am sure most semiconductor physicists will find this book useful and I recommend it to them." Contemporary Physics Offers much new material: an extensive appendix about the important and by now well-established, deep center known as the DX center, additional problems and the solutions to over fifty of the problems at the end of the various chapters.

Fundamentals of Semiconductors

This third edition, like its two predecessors, provides a detailed account of the basic theory needed to understand the properties of light and its interactions with atoms, in particular the many nonclassical effects that have now been observed in quantum-optical experiments. The earlier chapters describe the quantum mechanics of various optical processes, leading from the classical representation of the electromagnetic field to the quantum theory of light. The later chapters develop the theoretical descriptions of some of the key experiments in quantum optics. Over half of the material in this third edition is new. It includes topics that have come into prominence over the last two decades, such as the beamsplitter theory, squeezed light, two-photon interference, balanced homodyne detection, travelling-wave attenuation and amplification, quantum jumps, and the ranges of nonliner optical processes important in the generation of nonclassical light. The book is written as a textbook, with the treatment as a whole appropriate for graduate or postgraduate students, while earlier chapters are also suitable for final- year undergraduates. Over 100 problems help to intensify the understanding of the material presented.

The Quantum Theory of Light

Remarkable recent progress in quantum optics has given rise to extremely precise quantum measurements that are used in the research into the fundamentals of quantum physics, and in different branches of physics such as optical spectroscopy. This progress stimulates new technologies in the field of optical communications, optical computation and information systems. This state-of-the-art volume presents work from a Summer School on Advances in Quantum Optics and Spectroscopy of Solids, held in Ankara, Turkey, in 1995. The various contributions written by leading scientists in the field cover a wide range of subjects in this exciting area of physics, and report new and important results and ideas. Topics dealt with include the interaction of quantum light with trapped atoms and condensed matter; quantum tomography and phase analysis; and many applications of quantum optics from mesoscopic physics to correlation spectroscopy of non-classical states, which are of major importance in understanding the nature of collective excitations in solids. Audience: This book will be of interest to postgraduate students and researchers whose work involves quantum optics, solid state spectroscopy and its applications.

Quantum Optics and the Spectroscopy of Solids

This book is intended for those who are interested in understanding the electronic structure and properties of polymers. The scope of the book is to provide the non-specialist reader with a comprehensive and unified description: (i) of quantum mechanical methods, mainly originating from quantum chemistry, to calculate the electronic properties of polymers, (ii) of their use for interpreting and predicting results in fields where the electronic structure is playing an important role, like the electrical conductivity and the non linear optical properties of conjugated polymers. It will also serve as a reference book to lecture graduate students on the electronic structure of polymers or more generally of quasi-one dimensional materials. In this framework, it is worth stressing that the quantum theory of polymers bridges the gap between chemistry and physics. Since no book of this kind involving a strong interaction between theoretical and experimental concepts is available at the moment, it will also meet a need for a timely monograph in a field of important and fast growing interest. Contents:The Band Theory of PolymersThe Computational Machinery of Band Theory of PolymersQuantum Approach to Electrical Conduction Phenomena in Conjugated Organic PolymersQuantum Chemistry Aided Design of Chains for Optoelectronics Readership: Theoretical chemists, physicists, materials scientists, solid state physicists, condensed matter physicists and physical chemists. Keywords:Quantum Chemistry;Polymers;Ab Initio Calculations;Novel Materials;Conducting Polymers;Semiconducting Polymers;Nonlinear Optics;Electron Spectroscopy;Organic Solid State;Electronic Structure of Polymers;Conjugated Polymers;Ab Initio Methods;Semiempirical Methods;Band Structure Calculations;Valence Effective Hamiltonian Method-Review: “… offers a good review of quantum mechanics as applied to the study of the electronic and optical properties of polymers … the discussions are clear and concise and easily understood. As high-performance computers become more available, calculations of the type described in this book will become an integral part of advanced materials research.” American Scientist

Quantum Chemistry Aided Design of Organic Polymers

This book provides an introduction to band theory and the electronic properties of materials at a level suitable for final-year undergraduates or first-year graduate students. It sets out to provide the vocabulary and quantum-mechanical training necessary to understand the electronic, optical and structural properties of the materials met in science and technology and describes some of the experimental techniques which are used to study band structure today. In order to leave space for recent developments, the Drude model and the introduction of quantum statistics are treated synoptically. However, Bloch's theorem and two tractable limits, a very weak periodic potential and the tight-binding model, are developed rigorously and in three dimensions. Having introduced the ideas of bands, effective masses and holes, semiconductor and metals are treated in some detail, along with the newer ideas of artificial structures such as super-lattices and quantum wells, layered organic substances and oxides. Some recent `hot topics' in research are covered, e.g. the fractional Quantum Hall Effect and nano-devices, which can be understood using the techniques developed in the book. In illustrating examples of e.g. the de Haas-van Alphen effect, the book focuses on recent experimental data, showing that the field is a vibrant and exciting one. References to many recent review articles are provided, so that the student can conduct research into a chosen topic at a deeper level. Several appendices treating topics such as phonons and crystal structure make the book self-contained introduction to the fundamentals of band theory and electronic properties in condensed matter physic today.

Band Theory and Electronic Properties of Solids

This book presents an overview of the current understanding of the physics of zero-dimensional semiconductors. It concentrates mainly on quantum dots of wide-gap semiconductors, but touches also on zero-dimensional systems based on silicon and III-V materials. After providing the reader with a theoretical background, the author illustrates the specific properties of three-dimensionally confined semiconductors, such as the size dependence of energy states, optical transitions, and dephasing mechanisms with the results from numerous experiments in linear and nonlinear spectroscopy. Technological concepts of the growth concepts and the potential of this new class of semiconductor materials for electro-optic and nonlinear optical devices are also discussed.

Optical Properties of Semiconductor Quantum Dots

The quantum theory is the first theoretical approach that helps one to successfully understand the atomic and sub-atomic worlds which are too far from the cognition based on the common intuition or the experience of the daily-life. This is a very coherent theory in which a good system of hypotheses and appropriate mathematical methods allow one to describe exactly the dynamics of the quantum systems whose measurements are systematically affected by objective uncertainties. Thanks to the quantum theory we are able now to use and control new quantum devices and technologies in quantum optics and lasers, quantum electronics and quantum computing or in the modern field of nano-technologies.

Advances in Quantum Theory

Advances in Quantum Electronics, Volume 2 deals with the effects of quantum mechanics on the behavior of electrons in matter. This book is divided into three chapters. Chapter 1 reviews the statistical properties of optical fields and spectral processing techniques, including the use of photon correlation techniques to measure scattering effects in a number of different media. The use of optical E.P.R. and excitation spectroscopic techniques and techniques for establishing the location of impurity ions in the chalcogenides are describe in Chapter 2. The last chapter surveys the field of mode locked lasers, the theory of mode locking, techniques, and applications. This publication is beneficial to graduate students and researchers conducting work on quantum electronics.

Advances in Quantum Electronics

In recent years, progress in the generation of squeezed states of light, mainly characterized by a reduced noise property, has stimulated important work in relation to their potential use to improve the sensitivity of optical communication systems. These notes are devoted to the detection and information processing of optical signals at very low levels of power. A survey of recent developments from the quantum and classical points of view is presented. Ultimate limits of performance under the criteria of detection and information are established. Some of the results are detailed and may be utilized for the design of practical systems of communication using present technology. The book addresses physicists and engineers interested in present and future developments in optical communications.

Introduction to Photon Communication

This book is unique in covering phenomena in photon- matter interactions in a unified way over a range of many orders in energy. The quantum field theoretic approach to the fully relativistic theory of quantum electrodynamics (QED) is presented together with the non- relativistic theory in both confined and unconfined geometries. The predictions of QED have been verified to a greater accuracy than any other physical theory. Moreover QED is a paradigm for other gauge theories and is presented in such a way that the generalisation to other gauge theories is natural. Gauge and Poincare symmetry properties and the non-existence of a photon wave function are thoroughly discussed. Starting from the Dirac equation the non-relativistic interaction of the electron with the electromagnetic field is derived as an effective Hamiltonian of multipole expansions. Much of quantum optics is based on the lowest order dipole approximation. From this point on the treatment of fully relativistic QED and quantum optics is done in parallel. Applications of perturbation theory such as Compton and Moller scattering and the theory photdetection are given. After the impressive successes of QED, the limitation of the theory and the necessity of electroweak theory and quantumchromodynamics are discussed. The remaining chapters are devoted to quantum optics inside cavaties. Various approaches to open systems such as master equations are discussed within the context of active systems (e.g. the laser) and passive systems. Semi- classical approximarions are shown to imply a rich non- linear dynamics including chaos for certain parameter regimes. The effect of fluctuations on such non-linear dynamics is also studied. The final chapter is devoted to highly non- classical states of the light field such as photon number, squeezed and two photon entangled states. The latter are studied for the important system of parametric down conversion and the localisation properties of photons are characterised in terms of asympotic tails in photodetection probabilities as a function of time delay. The range of the book has wider benefits. Workers in quantum optics will gain a deeper understanding of the foundations of their subject and field theorists will see concrete examples of open systems, which are beginning to impinge on fundamental theories.

The Quantum Theory of Radiation

This topical and timely textbook is a collection of problems for students, researchers, and practitioners interested in state-of-the-art material and device applications in quantum mechanics. Most problem are relevant either to a new device or a device concept or to current research topics which could spawn new technology. It deals with the practical aspects of the field, presenting a broad range of essential topics currently at the leading edge of technological innovation. Includes discussion on: Properties of Schroedinger Equation Operators Bound States in Nanostructures Current and Energy Flux Densities in Nanostructures Density of States Transfer and Scattering Matrix Formalisms for Modelling Diffusive Quantum Transport Perturbation Theory, Variational Approach and their Applications to Device Problems Electrons in a Magnetic or Electromagnetic Field and Associated Phenomena Time-dependent Perturbation Theory and its Applications Optical Properties of Nanostructures Problems in Quantum Mechanics: For Material Scientists, Applied Physicists and Device Engineers is an ideal companion to engineering, condensed matter physics or materials science curricula. It appeals to future and present engineers, physicists, and materials scientists, as well as professionals in these fields needing more in-depth understanding of nanotechnology and nanoscience.

Problem Solving in Quantum Mechanics

The energy band theory of a perfect crystal. Optical properties of semiconductors. Electronic states at defects and impurities.

Modern Semiconductor Quantum Physics

Examines the optical properties of low-dimensional semiconductor structures, a hot research area - for graduate students and researchers.

Optical Properties of Semiconductor Nanocrystals

This book reflects the current status of theoretical and experimental research of graphene based nanostructures, in particular quantum dots, at a level accessible to young researchers, graduate students, experimentalists and theorists. It presents the current state of research of graphene quantum dots, a single or few monolayer thick islands of graphene. It introduces the reader to the electronic and optical properties of graphite, intercalated graphite and graphene, including Dirac fermions, Berry's phase associated with sublattices and valley degeneracy, covers single particle properties of graphene quantum dots, electron-electron interaction, magnetic properties and optical properties of gated graphene nanostructures. The electronic, optical and magnetic properties of the graphene quantum dots as a function of size, shape, type of edge and carrier density are considered. Special attention is paid to the understanding of edges and the emergence of edge states for zigzag edges. Atomistic tight binding and effective mass approaches to single particle calculations are performed. Furthermore, the theoretical and numerical treatment of electron-electron interactions at the mean-field, HF, DFT and configuration-interaction level is described in detail.

Graphene Quantum Dots

This volume on Advanced Electronic Technologies and Systems based on Low Dimensional Quantum Devices closes a three years series of NATO -AS!' s. The first year was focused on the fundamental properties and applications. The second year was devoted to Devices Based on Low-Dimensional Semiconductor Structures. The third year is covering Systems Based on Low-Dimensional Quantum Semiconductor Devices. The three volumes containing the lectures given at the three successive NATO -ASI's constitute a complete review on the latest advances in semiconductor Science and Technology from the methods of fabrication of the quantum structures through the fundamental physics am basic knowledge of properties and projection of performances to the technology of devices and systems. In the first volume: " Fabrication, Properties and Application of Low Dimensional Semiconductors" are described the practical ways in which quantum structures are produced, the present status of the technology, difficulties encountered, and advances to be expected. The basic theory of Quantum Wells, Double Quantum Wells and Superlattices is introduced and the fundamental aspects of their optical properties are presented. The effect of reduction of dimensionality on lattice dynamics of quantum structures is also discussed. In the second volume: " Devices Based on Low Dimensional Structures" the fundamentals of quantum structures and devices in the two major fields: Electro-Optical Devices and Pseudomorphic High Eectron Mobility Transistors are extensively discussed.

Advanced Electronic Technologies and Systems Based on Low-Dimensional Quantum Devices

Written primarily for advanced undergraduate and Master's level students in physics, this text includes a broad range of topics in applied quantum optics such as laser cooling, Bose-Einstein condensation and quantum information processing.

Quantum Optics

This book deals with a new class of materials, quantum rings. Innovative recent advances in experimental and theoretical physics of quantum rings are based on the most advanced state-of-the-art fabrication and characterization techniques as well as theoretical methods. The experimental efforts allow to obtain a new class of semiconductor quantum rings formed by capping self-organized quantum dots grown by molecular beam epitaxy. Novel optical and magnetic properties of quantum rings are associated with non-trivial topologies at the nanoscale. An adequate characterization of quantum rings is possible on the basis of modern characterization methods of nanostructures, such as Scanning Tunneling Microscopy. A high level of complexity is demonstrated to be needed for a dedicated theoretical model to adequately represent the specific features of quantum rings. The findings presented in this book contribute to develop low-cost high-performance electronic, spintronic, optoelectronic and information processing devices based on quantum rings.

Physics of Quantum Rings

This book fills a gap between many of the basic solid state physics and materials sciencebooks that are currently available. It is written for a mixed audience of electricalengineering and applied physics students who have some knowledge of elementaryundergraduate quantum mechanics and statistical mechanics. This book, based on asuccessful course taught at MIT, is divided pedagogically into three parts: (I) ElectronicStructure, (II) Transport Properties, and (III) Optical Properties. Each topic is explainedin the context of bulk materials and then extended to low-dimensional materials whereapplicable. Problem sets review the content of each chapter to help students to understandthe material described in each of the chapters more deeply and to prepare them to masterthe next chapters.

Solid State Properties

Electronic materials provide the basis for many high tech industries that have changed rapidly in recent years. In this fully revised and updated second edition, the author discusses the range of available materials and their technological applications. Introduction to the Electronic Properties of Materials, 2nd Edition presents the principles of the behavior of electrons in materials and develops a basic understanding with minimal technical detail. Broadly based, it touches on all of the key issues in the field and offers a multidisciplinary approach spanning physics, electrical engineering, and materials science. It provides an understanding of the behavior of electrons within materials, how electrons determine the magnetic thermal, optical and electrical properties of materials, and how electronic properties are controlled for use in technological applications. Although some mathematics is essential in this area, the mathematics that is used is easy to follow and kept to an appropriate level for the reader. An excellent introductory text for undergraduate students, this book is a broad introduction to the topic and provides a careful balance of information that will be appropriate for physicists, materials scientists, and electrical engineers.

Introduction to the Electronic Properties of Materials

This book provides a clear and logical path to understanding what quantum mechanics is about. It will be accessible to undergraduates with minimal mathematical preparation: all that is required is an open mind, a little algebra, and a first course in undergraduate physics. Quantum mechanics is arguably the most successful physical theory. It makes predictions of incredible accuracy. It provides the structure underlying all of our electronic technology, and much of our mastery overmaterials. But compared with Newtonian mechanics, or even relativity, its teachings seem obscure--they have no counterpart in everyday experience, and they sometimes contradict our simplest notions of how the world works. A full understanding of the theory requires prior mastery of very advancedmathematics. This book aims at a different goal: to teach the reader, step by step, how the theory came to be and what, fundamentally, it is about. Most students learn physics by learning techniques and formulas. This is especially true in a field like quantum mechanics, whose content often contradicts our common sense, and where it's tempting to retreat into mathematical formalism. This book goes behind the formalism to explain in direct language the conceptual content and foundations ofquantum mechanics: the experiments that forced physicists to construct such a strange theory, and the essential elements of its strangeness.

The Conceptual Foundations of Quantum Mechanics

The quantum statistical properties of radiation represent an important branch of modern physics with rapidly increasing applications in spectroscopy, quantum generators of radiation, optical communication, etc. They have also an increasing role in fields other than pure physics, such as biophysics, psychophysics, biology, etc. The present monograph represents an extension and continuation of the previous monograph of this author entitled Coherence of Light (Van Nostrand Reinhold Company, London 1972, translated into Russian in the Publishing House Mir, Moscow 1974) and of a review chapter in Progress in Optics, Vol. 18 (E. Wolf (Ed.), North-Holland Publishing Company, Amsterdam 1980), published just recently. It applies the fundamental tools of the coherent-state technique, as described in Coherence of Light, to particular studies of the quantum statistical properties of radiation in its interaction with matter. In particular, nonlinear optical processes are considered, and purely quantum phenomena such as antibunching of photons are discussed. This book will be useful to research workers in the fields of quantum optics and electronics, quantum generators, optical communication and solid-state physics, as well as to students of physics, optical engineering and opto-electronics.

Quantum Statistics of Linear and Nonlinear Optical Phenomena

Provides a semi-quantitative approach to recent developments in the study of optical properties of condensed matter systems Featuring contributions by noted experts in the field of electronic and optoelectronic materials and photonics, this book looks at the optical properties of materials as well as their physical processes and various classes. Taking a semi-quantitative approach to the subject, it presents a summary of the basic concepts, reviews recent developments in the study of optical properties of materials and offers many examples and applications. Optical Properties of Materials and Their Applications, 2nd Edition starts by identifying the processes that should be described in detail and follows with the relevant classes of materials. In addition to featuring four new chapters on optoelectronic properties of organic semiconductors, recent advances in electroluminescence, perovskites, and ellipsometry, the book covers: optical properties of disordered condensed matter and glasses; concept of excitons; photoluminescence, photoinduced changes, and electroluminescence in noncrystalline semiconductors; and photoinduced bond breaking and volume change in chalcogenide glasses. Also included are chapters on: nonlinear optical properties of photonic glasses; kinetics of the persistent photoconductivity in crystalline III-V semiconductors; and transparent white OLEDs. In addition, readers will learn about excitonic processes in quantum wells; optoelectronic properties and applications of quantum dots; and more. Covers all of the fundamentals and applications of optical properties of materials Includes theory, experimental techniques, and current and developing applications Includes four new chapters on optoelectronic properties of organic semiconductors, recent advances in electroluminescence, perovskites, and ellipsometry Appropriate for materials scientists, chemists, physicists and electrical engineers involved in development of electronic materials Written by internationally respected professionals working in physics and electrical engineering departments and government laboratories Optical Properties of Materials and Their Applications, 2nd Edition is an ideal book for senior undergraduate and postgraduate students, and teaching and research professionals in the fields of physics, chemistry, chemical engineering, materials science, and materials engineering.

Optical Properties of Materials and Their Applications

The perovskite family of oxides includes a vast array of insulators, metals, and semiconductors. Current intense scientific interest stems from the large number of diverse phenomena exhibited by these materials including pseudo two-dimensional electronic energy bands, high temperature superconductivity, metal-insulator transitions, piezoelectricity, magnetism, photochromic, and catalytic activity. This book is the first text devoted to a comprehensive theory of the solid-state properties of these fascinating materials. The text includes complete descriptions of the important energy bands, photoemission, surface states, and the chapter on high-temperature superconductors explores the electronic states in typical copper-oxide materials. Theoretical results are compared to experiment and discussed throughout the book. With problem sets included, this is a unified, logical treatment of fundamental perovskite solid-state chemistry which will appeal to graduate students and researchers alike.

Electronic and Optical Properties of d-Band Perovskites

The NATO Advanced Research Workshop on Quantum Measurements in Optics was held in Cortina d'Ampezzo, Italy, January 21-25, 1991. This workshop was attended by 70 participants from 16 different countries. The subjects discussed at this workshop concentrated on quantum measurements in optics made possible by the recent advances in the generation and detection of light with low quantum noise. These advances have occurred simultaneously with the development of atomic traps capable of trapping a single atom for a considerable period of time. The interaction of a single two level atom with the single mode of the electromagnetic field is now possible in high Q microcavities. A new field of cavity QED has developed studying the properties of Rydberg atoms in microwave cavities. At this meeting we heard the first report of an atomic interferometer where a single atom passing through the two slits exhibits wave like interference phenomena. This new field involving the transfer of momentum from photons to atoms has lead to new possibilities for quantum nondemolition measurements on an optical field. We heard suggestions for such measurements at this meeting. With the new light sources available the possibility of using low quantum noise light in optical communications becomes close to reality. The problem of the propagation of quantum light field in optical fibres was actively discussed at this meeting.

Quantum Measurements in Optics

The fundamental concept of quantum coherence plays a central role in quantum physics, cutting across disciplines of quantum optics, atomic and condensed matter physics. Quantum coherence represents a universal property of the quantum s- tems that applies both to light and matter thereby tying together materials and p- nomena. Moreover, the optical coherence can be transferred to the medium through the light-matter interactions. Since the early days of quantum mechanics there has been a desire to control dynamics of quantum systems. The generation and c- trol of quantum coherence in matter by optical means, in particular, represents a viable way to achieve this longstanding goal and semiconductor nanostructures are the most promising candidates for controllable quantum systems. Optical generation and control of coherent light-matter states in semiconductor quantum nanostructures is precisely the scope of the present book. Recently, there has been a great deal of interest in the subject of quantum coh- ence. We are currently witnessing parallel growth of activities in different physical systems that are all built around the central concept of manipulation of quantum coherence. The burgeoning activities in solid-state systems, and semiconductors in particular, have been strongly driven by the unprecedented control of coherence that previously has been demonstrated in quantum optics of atoms and molecules, and is now taking advantage of the remarkable advances in semiconductor fabrication technologies. A recent impetus to exploit the coherent quantum phenomena comes from the emergence of the quantum information paradigm.

Optical Generation and Control of Quantum Coherence in Semiconductor Nanostructures