

Nonlinear Optical Materials Principles And Applications Proceedings Of The International School Of Physics

This textbook presents a systematic and unifying viewpoint for a wide class of nonlinear spectroscopic techniques in time domain and frequency domain. It is directed towards active researchers in physics, optics, chemistry, and materials science, as well as graduate students who enter this complex and rapidly developing field. Nonlinear optical interactions of laser fields with matter provide powerful spectroscopic tools for the understanding of microscopic interactions and dynamic processes. One of the major obstacles facing researchers in this field, however, is the flood of experimental techniques and terminologies, which create a serious language barrier. The general microscopic correlation function approach to the nonlinear optical response developed in this book is essential for understanding the relationships among different techniques and a comparison of their information content, the design of new measurements, and for a systematic comparison of the optical response of different systems such as dyes in solutions, atoms and molecules in the gas phase, liquids, molecular aggregates and superlattices, and semiconductor nanostructures. The approach is based on formulating the nonlinear response by representing the state of matter by the density matrix and following its evolution on Liouville space. Current active research areas such as femtosecond time-domain techniques, semi-classical and wave-packet dynamics, pulse shaping, pulse locking, exciton confinement, and the interplay of electronic, nuclear and field coherence are emphasized. The material has been developed from the author's highly successful interdisciplinary course at the University of Rochester attended by science and engineering graduate students.

Electronic materials are a dominant factor in many areas of modern technology. The need to understand them is paramount; this book addresses that need. The main aim of this volume is to provide a broad unified view of electronic materials, including key aspects of their science and technology and also, in many cases, their commercial implications. It was considered important that much of the contents of such an overview should be intelligible by a broad audience of graduates and industrial scientists, and relevant to advanced undergraduate studies. It should also be up to date and even looking forward to the future. Although more extensive, and written specifically as a text, the resulting book has much in common with a short course of the same name given at Coventry Polytechnic. The interpretation of the term "electronic materials" used in this volume is a very broad one, in line with the initial aim. The principal restriction is that, with one or two minor exceptions relating to aspects of device processing, for example, the materials dealt with are all active materials. Materials such as simple insulators or simple conductors, playing only a passive role, are not singled out for consideration. Active materials might be defined as those involved in the processing of signals in a way that depends crucially on some specific property of those materials, and the immediate question then concerns the types of signals that might be considered.

Organic Nonlinear Optical Materials provides an extensive description of the preparation and characterization of organic materials for applications in nonlinear and electro-optics. The book discusses the fundamental optimization and practical limitations of a number of figures of merit for various optical parameters and gives a clinical appraisal of the potential of organic materials for applications in optical technology. Among the topics addressed are the basic molecular design of nonlinear optical chromophores, fundamentals and novel techniques of organic crystal growth, preparation and characterization of Langmuir-Blodgett and polymer films, experimental methods for determining microscopic and macroscopic optical properties. Also included is a discussion of first results of the photorefractive effect in organic crystals and the potential of organics for photorefractive applications, as well as an extensive review of published linear and nonlinear optical measurement of organic materials.

This book deals with basic physical properties related to the nonlinear interaction of light and matter. Nonlinear effects in atomic (molecular) systems and condensed matter are described, and classical phenomena as well as phenomena requiring a field-quantised description are covered. Leading authorities in nonlinear optics have reviewed themes of current interest in the research literature, and described general principles of importance for newcomers to the field.

Principles of Nonlinear Optical Spectroscopy

Susceptibility Tensors for Nonlinear Optics

Organic Nonlinear Optical Materials

Nonlinear Optics and Laser Spectroscopy

Nonlinear Optical Materials and Devices for Applications in Information Technology takes the reader from fundamental interactions of laser light in materials to the latest developments of digital optical information processing. The book emphasises nonlinear optical interactions in bulk and low-dimensional semiconductors, liquid crystals and optical fibres. After establishing the basic laser-material interactions in these materials, it goes on to assess applications in soliton propagation, integrated optics, smart pixel arrays and digital optical computing.

This is a monograph/text devoted to a detailed treatment of the optical, electro-optical and nonlinear optical properties of all the mesophases of liquid crystals and related processes, phenomena and application principles. Quantitative data on material and optical parameters spanning the ultraviolet, visible, infrared as well as the microwave regimes are presented along with detailed theoretical treatments of basic liquid crystal physics, material properties and nonlinear optics. Starting with a discussion on the basic building blocks of liquid crystalline molecules, the authors proceed to present in a pedagogical manner current theories, experiments, and applications of these unique and important optical properties of liquid crystals. Numerous tables of hard-to-find liquid crystalline parameters, a self-contained chapter on general nonlinear optics, and comprehensive literature review are also included.

Nonlinear optics is a topic of much current interest that exhibits a great diversity. Some publications on the subject are clearly physics, while others reveal an engineering bias; some appear to be accessible to the chemist, while others may appeal to biological understanding. Yet all purport to be non linear optics so where is the underlying unity? The answer is that the unity lies in the phenomena and the devices that exploit them, while the diversity lies in the materials used to express the phenomena. This book is an attempt to show this unity in diversity by bringing together contributions covering an unusually wide range of materials, preceded by accounts of the main phenomena and important devices. Because of the diversity, individual materials are treated in separate chapters by different expert authors, while as editors we have considered the task of providing the unifying initial chapters. Most main classes of nonlinear optical solids are treated: semiconductors, glasses, ferroelectrics, molecular crystals, polymers, and Langmuir-Blodgett films. (However, liquid crystals are not covered.) Each class of material is enough for a monograph in itself, and this book is designed to be an introduction suitable for graduate students and those in industry entering the area of nonlinear optics. It is also suitable in parts for final-year undergraduates on project work. It aims to provide a bridge between traditional fields of expertise and the broader field of nonlinear optics.

Nonlinear optical materials play a pivotal role in the future evolution of nonlinear optics in general and its impact in technology and industrial applications in particular. The progress in nonlinear optics has been tremendous since the first demonstration of an all-optical nonlinear effect in the early sixties, but until recently the main visible emphasis was on the physical aspects of the nonlinear radiation matter interaction. In the last decade, however, this effort has also brought its fruits in applied aspects of nonlinear optics. This can be essentially traced to the improvement of the performances of the nonlinear optical materials. Our understanding of the nonlinear polarization mechanisms and their relation to the structural characteristics of the materials has been considerably improved. In addition, the new development of techniques for the fabrication and growth of artificial materials has dramatically contributed to this evolution. The goal is to find and develop materials presenting large nonlinearities and satisfying at the same time all the technological requirements for applications such as wide transparency range, fast response, high damage threshold but also processability, adaptability and interfacing with other materials. Improvements, besides rendering possible the implementation of nonlinear effects in devices, open the way to the study of new nonlinear optical effects and the introduction of new concepts. This book describes new concepts which are emerging in the field of nonlinear optical materials, concentrating the attention on materials which seem more promising for applications in the technology of information transmission and processing.

Materials, Properties, and Applications

Principles and Applications - Varenna on Lake Como, Villa Monastero, 20-30 July 1993

The Principles of Nonlinear Optics

Notions And Perspectives Of Nonlinear Optics - Proceedings Of The Third International Aalborg Summer School On Nonlinear Optics

Nonlinear Optical Parametric Processes in Liquids and Gases focuses on the parametric processes that occur in liquids and gases. This book examines the mathematical results that are intended mainly for their usefulness in quantifying the physical interpretations of the various concepts to actual systems. Comprised of six chapters, this text starts with a discussion on the nonlinear optical processes, and then explores the basis for nonlinear optical interactions. This book describes the various third-order frequency mixing processes and the basic properties of nonlinear interactions, including phase matching and resonant enhancement. Other chapters consider the processes of frequency mixing and harmonic generation that are used as illustrations of the basic principles. The final chapter explores the applications of several nonlinear optical interactions, with a focus on the use of nonlinear optical processes to control the propagation of optical waves or to obtain information about a material system. This book is intended for researchers and readers engaged in the study of university-level mathematics, electromagnetic theory, and atomic physics.

This is a brief introduction to the ideas and phenomena that occur in the nonlinear optics of photonic crystals and metamaterials. These are illustrated within the context of simple models which provide an easy understanding of the physical phenomena that are important in these two rapidly developing areas of nano-photonic technology. An introduction and discussion of some of the basic principles of linear and nonlinear optical nano-systems are given. The focus is on engineered optical systems that have been of recent interest in physics, engineering, and applied mathematics for their opto-electronic applications. These include photonic crystals and meta-materials, and in the following discussions the operating principles of photonic crystals and meta-materials are outlined.

Nonlinear Optical Properties of Organic Molecules and Crystals, Volume 2 deals with the nonlinear optical properties of organic molecules and crystals, with emphasis on cubic nonlinear optical effects and the intermolecular bond. Topics covered include the basic structural and electronic properties of polydiacetylenes; cubic effects in polydiacetylene solutions and films; and degenerate third-order nonlinear optical susceptibility of polydiacetylenes. Dimensionality effects and scaling laws in nonlinear optical susceptibilities are also considered. This volume is comprised of seven chapters divided into two sections and begins with a discussion on the basic structural and electronic properties of polydiacetylenes as well as their methods of preparation. Cubic nonlinearities in polydiacetylene solutions and films are then examined, paying particular attention to polarization in one-dimensional media; multiple reflections of fundamental and harmonic waves; and harmonic generation in an absorbing medium. The following chapters focus on degenerate third-order nonlinear optical susceptibility of polydiacetylenes; dimensionality effects and scaling laws in nonlinear optical susceptibilities; polarizabilities and hyperpolarizabilities of long molecules; and resonant molecular optics. The final chapter analyzes the nonlinear optics of a wide range of compounds that are held together by intermolecular bonding and form supramolecular assemblies. This monograph will be a useful resource for physicists, physical and organic chemists, and those in the field of quantum electronics.

Partial contents: Linear and Nonlinear Polarizability: A Primer; Second-Order Nonlinear Optical Processes in Molecules and Solids; Third-Order Nonlinear Optical Effects in Molecular and Polymeric Materials; Nonlinear Optical Properties of Molecules and Materials; Electronic Hyperpolarizability and Chemical Structure; Electrooptic Polymer Waveguide Devices: Status and Applications;

Waveguiding and Waveguide Applications of Nonlinear Organic materials; Nonlinear Optical materials: The Great and Near Great; Donor- and Acceptor-Substituted Organic and Organometallic Compounds; Second-Order Nonlinear Optical Properties; Use of a Sulfonyl Group in Materials for Nonlinear Optical Materials: A Bifunctional Electron Acceptor.

Nonlinear Optical Materials

Principles and Applications of Nonlinear Optical Materials

Linear and Nonlinear Optics

Materials, Physics, and Devices

*Nonlinear Optics is an advanced textbook for courses dealing with nonlinear optics, quantum electronics, laser physics, contemporary and quantum optics, and electrooptics. Its pedagogical emphasis is on fundamentals rather than particular, transitory applications. As a result, this textbook will have lasting appeal to a wide audience of electrical engineering, physics, and optics students, as well as those in related fields such as materials science and chemistry. Key Features * The origin of optical nonlinearities, including dependence on the polarization of light * A detailed treatment of the quantum theory of the nonlinear susceptibility * An explication of dressed-atomic states of two-level atoms * A complete development of spontaneous and stimulated light scattering * A clear discussion of the photorefractive effect * An introduction to applications including laser frequency modification, optical phase conjugation, optical bistability, and propagation of optical soliton*

Mathematical methods play a significant role in the rapidly growing field of nonlinear optical materials. This volume discusses a number of successful or promising contributions. The overall theme of this volume is twofold: (1) the challenges faced in computing and optimizing nonlinear optical material properties; and (2) the exploitation of these properties in important areas of application. These include the design of optical amplifiers and lasers, as well as novel optical switches. Research topics in this volume include how to exploit the magneto-optic effect, how to work with the nonlinear optical response of materials, how to predict laser-induced breakdown in efficient optical devices, and how to handle electron cloud distortion in femtosecond processes. This volume begins with a brief up-date of "Laser Sources" and "Spectroscopic Instrumentation and Practice." Non Linear Optics section contains reviews of the fundamental value concerning "Intense Laser Beam Instabilities" and "Atoms and Molecules in Intense Laser Fields" as well as topics of recent interest including Pattern Formation, Optical Phase Conjugation, Solitonic Propagation and Photo-refractive crystals. Laser Spectroscopy section includes a detailed review of Molecular Spectroscopy principles and concise review of Group Theory. Many topics of contemporary interest include Bosonic Effects in Raman Spectroscopy, Resonant Raman Spectroscopy of Low Dimensional Semiconductors, Dynamic Light Scattering Study of Turbulence and Laser Brillouin from Polymeric Gels and Networks. The class-room type coverage of selected topics would encourage young scientists in taking up challenging research projects in areas of Non-linear Optics and Laser Spectroscopy.

Explores the Fundamental Aspects of Nonlinear Optics As nonlinear optics further develops as a field of research in electromagnetic wave propagation, its state-of-the-art technologies will continue to strongly impact real-world applications in a variety of fields useful to the practicing scientist and engineer. From basic principles to examples of applications, Nonlinear Optics: Principles and Applications effectively bridges physics and mathematics with relevant applied material for real-world use. The book progresses naturally from fundamental aspects to illustrative examples, and presents a strong theoretical foundation that equips the reader with enough knowledge to recognize, understand, and evaluate nonlinear optical phenomena. Structured so that the first five chapters are dedicated to the description of the fundamental formalism of nonlinear optics, and the last five chapters are devoted to a description of practical devices based on nonlinear phenomena, it describes nonlinear wave propagation in bulk and in waveguiding structures, and includes specific examples of applied nonlinear wave propagation through crystals, optical waveguides, and optical fibers. Providing a theoretical description of nonlinear interaction between light and matter, this text focuses on the physical understanding of nonlinear optics, and explores optical material response functions in the time and frequency domain. This pivotal work contains ten chapters and the main applications include: Optical signal processing; parametric amplification, modulators Transmission of optical signals; optical solitons, cross-phase modulation, four-wave mixing, phase conjugation, Raman scattering Sensing: temperature sensors, spectroscopy, and imaging Lasers: pulse compression and generation of super continuum Nonlinear Optics: Principles and Applications describes the fundamental aspects of nonlinear optics and serves as a reference for nonlinear optics professionals as well as graduate students specializing in nonlinear optics.

Principles and Applications

Electronic Materials

Nonlinear Optical Systems

Chemical Perspectives

This comprehensive and didactic overview explores the nonlinear effects from a physical point of view and discusses the implications for signal capacity. Enriched with practical considerations and experimental results, the book offers special chapters dealing with applications of nonlinear effects for signal processing, ultrafast-optical switching, wavelength conversion, nonlinear amplification, and optical phase-conjugation. Equipped with chapter-end summaries and problems, this valuable reference can also serve as a graduate-level textbook.

This book reflects the latest advances in nonlinear optics. Besides the simple, strict mathematical deduction, it also discusses the experimental verification and possible future applications, such as the all-optical switches. It consistently uses the practical unit system throughout. It employs simple physical images, such as "light waves" and "photons" to systematically explain the main principles of nonlinear optical effects. It uses the first-order nonlinear wave equation in frequency domain under the condition of "slowly varying amplitude approximation" and the classical model of the interaction between the light and electric dipole. At the same time, it also uses the rate equations based on the energy-level transition of particle systems excited by photons and the energy and momentum conservation principles to explain the phenomenon. The book is intended for researchers, engineers and graduate students in the field of optics, optoelectronics, fiber communication, information technology and materials etc.

Nonlinear Optical Systems: Principles, Phenomena, and Advanced Signal Processing is a simplified overview of the evolution of technology associated with nonlinear systems and advanced signal processing. This book 's coverage ranges from fundamentals to phenomena to the most cutting-edge aspects of systems for next-generation biomedical monitoring and nonlinear optical stimulation. The authors address how these systems are applied through photonic signal processing in contemporary optical systems for communications and/or laser systems. They include a concise but sufficient explanation of mathematical representation of nonlinear equations to provide insight into nonlinear dynamics at different phases. The book also describes advanced aspects of solitons and bound solitons for passive- and active-mode locked fiber lasers, in which higher-order differential equations can be employed to represent the dynamics of amplitude evolution in the current or voltages of lightwaves in such systems. Covering a wide range of topics, this book: Introduces nonlinear systems and some mathematical representations, particularly the routes to chaos and bifurcation Describes nonlinear fiber lightwave lasing systems Covers nonlinear phenomena in fiber lasers, including both passive and active energy storage Cavities Experimentally and theoretically demonstrates soliton pulses, in which lightwaves are the carrier under their envelopes Assembles and demonstrates sequences of both single and multiple solitons in a group and then assesses their dynamics in detail Examines the evolution of bound solitons, which are transmitted through single-mode optical fibers that compose a phase variation system This text outlines the theory and techniques used in nonlinear physics and applications for physical systems. It also illustrates the use of MATLAB® and Simulink® computer models and processing techniques for nonlinear signals. Building on readers' newly acquired fundamental understanding of nonlinear systems and associated signal processing, the book then demonstrates the use of such applications in real-world, practical environments.

Intended for readers with a background in classical electromagnetism theory, this book develops the basic principles that underlie nonlinear optical phenomena in matter. It begins with a discussion of linear wave propagation in dispersive media, moves into weak nonlinearities which can be discussed in a perturbative manner, then it examines strong nonlinear effects (solitons, chaos). The emphasis is on the macroscopic description on nonlinear phenomena, within a semiclassical framework. Two new chapters cover surface optics and magneto-optic phenomena. The book is aimed at the student or researcher who is not a specialist in optics but needs an introduction to the principal concepts.

Materials for Nonlinear Optics

Nonlinear Optics in Telecommunications

Nonlinear Optics

Nonlinear Optics: Materials and Devices

The field of nonlinear optics has witnessed a tremendous evolution since its beginnings in the early sixties. Its frontiers have been extended in many directions and its techniques have intruded upon many areas of both fundamental and practical interest. The field itself has been enriched with many new phenomena and concepts that have further extended its scope and strengthened its connection with other areas. As a consequence, it is becoming increasingly unrealistic to expect to cover the different facets and trends of this field in the lectures or proceed ings of a summer school, however advanced these may be. However much of the current progress and interest in this field springs to a large extent from the promise and expectation that highly performing all-optical devices that exploit and operate on the principles of nonlinear optics will constitute an important branch of future technology and will provide new alternatives in information processing and transmission. The conception of new devices, in general, requires an intricate and bold combination of facts and methods from most diverse fields, in order to perform functions and operations that fit into the overall technological ensemble.

Contemporary Nonlinear Optics discusses the different activities in the field of nonlinear optics. The book is comprised of 10 chapters. Chapter 1 presents a description of the field of nonlinear guided-wave optics. Chapter 2 surveys a new branch of nonlinear optics under the heading optical solitons. Chapter 3 reviews recent progress in the field of optical phase conjugation. Chapter 4 discusses ultrafast nonlinear optics, a field that is growing rapidly with the ability of generating and controlling femtosecond optical pulses. Chapter 5 examines a branch of nonlinear optics that may be termed ...

In recent years, optical properties of the unique atomic and molecular structures of materials have drawn great scientific interest. Linear optical properties of materials such as metals, metal oxides, magnetic oxides, and organic materials are based on energy transfer and find applications in wastewater treatment, forensic science, biomedical science, photovoltaics, nuclear technology, and LED displays. Nonlinear optical properties of materials are based on the nonlinear medium and find more advanced applications in frequency mixing generations and optical parametric oscillations. This book presents the underlying principles, implementation, and applications of the linear and nonlinear optical properties of materials and has been divided into two parts emphasizing these properties. The first part of the book, Linear Optics, discusses bimetallic nanoparticles in dielectric media and their integration to dye molecules to detect trace amounts of heavy metals in the nanometer level, as well as the enhanced Raman scattering and imaging of bimetallic nanoparticles into a ZnO matrix promotes broadening of the absorption spectrum from the ultraviolet to the visible wavelength. It explains the role of surface adsorption and photocatalytic degradation in dye-removal kinetics by Fe3O4 magnetic nanoparticles under pulsed white light. It also discusses the double-layer shielding tank design to safely store radioactive waste and photon propagation through the multilayer structures of a human tissue model. The second part of the book, Nonlinear Optics, presents general concepts such as electromagnetic theory, nonlinear medium, and wave propagation, as well as more advanced concepts such as second harmonic generation, phase matching, optical parametric interactions, different frequency generation, sum frequency generation, tunable laser, and optical resonant oscillator.

This volume brings together contributions from world renowned researchers on molecular nonlinear optics. It takes as its impetus work done over the last five years in which newly developed optoelectronic devices have deepened our understanding of the fundamental physics and chemistry underlying these materials.

Organic materials involving thin films, polymers, and resonating devices will be emphasized.

Nonlinear Optic Processes in Liquids and Gases

Fundamentals of Nonlinear Optics

From Silicon to Organics

Optics and Nonlinear Optics of Liquid Crystals

Molecular Dynamics in Restricted Geometries Edited by Joseph Klafter and J. M. Drake This investigation of the chemistry and physics of complex systems focuses on the role of spatial restrictions on molecular movement. A practical source-book for researchers in chemical physics, chemical engineering, and condensed matter physics, and for graduate students in these fields, it covers a broad range of topics and critically evaluates methods as they are employed. Among the many topics it covers are: relaxation and diffusion in restricted geometries, excitation energy transfer and photoinduced electron transfer phenomena in some confined systems, electron excitation transport in micelles, polymers and multilayers, and electron excitation transport on polymer chains. 1989 (0 471-60176-4) 437 pp.

This book is a self-contained account of the most important principles of nonlinear optics. Assuming a familiarity with basic mathematics, the fundamentals of nonlinear optics are developed from the basic concepts, introducing and explaining the essential quantum mechanical apparatus as it arises. Later chapters deal with the materials used and the constructions that are necessary to induce the effects.

Modern Optics is a fundamental study of the principles of optics using a rigorous physical approach based on Maxwell's Equations. The treatment provides the mathematical foundations needed to understand a number of applications such as laser optics, fiber optics and medical imaging covered in an engineering curriculum as well as the traditional topics covered in a physics based course in optics. In addition to treating the fundamentals in optical science, the student is given an exposure to actual optics engineering problems such as paraxial matrix optics, aberrations with experimental examples, Fourier transform optics (Fresnel-Kirchhoff formulation), Gaussian waves, thin films, photonic crystals, surface plasmons, and fiber optics. Through its many pictures, figures, and diagrams, the text provides a good physical insight into the topics covered. The course content can be modified to reflect the interests of the instructor as well as the student, through the selection of optional material provided in appendices.

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