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Nonlinear wavefront shaping with optically induced three-dimensional nonlinear photonic crystals

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Generation of coherent light with desirable amplitude and phase profiles throughout the optical spectrum is a key issue in optical technologies. Nonlinear wavefront shaping offers an exceptional way to achieve this goal by converting an incident light beam into the beam (or beams) of different frequency with spatially modulated amplitude and phase. The realization of such frequency conversion and shaping processes critically depends on the matching of phase velocities of interacting waves, for which nonlinear photonic crystals (NPCs) with spatially modulated quadratic nonlinearity have shown great potential. Here, we present the first experimental demonstration of nonlinear wavefront shaping with three-dimensional (3D) NPCs formed by ultrafast-light-induced ferroelectric domain inversion approach. Compared with those previously used low-dimensional structures, 3D NPCs provide all spatial degrees of freedom for the compensation of phase mismatch in nonlinear interactions and thereby constitute an unprecedented system for the generation and control of coherent light at new frequencies.

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Nonlinear Photonic Crystals Nonlinear Photonic Crystals

Arthur R. McGurn



Nonlinear Photonic Crystals Nonlinear Photonic Crystals:

Nonlinear Photonic Crystals Richart E. Slusher, Benjamin J. Eggleton, 2013-06-29 Nonlinear optical studies of periodic dielectric structures have blossomed in the past two decades New fabrication techniques are producing fiber grating and multidimensional photonic crystals in materials where the refractive index can be varied by light pulses and beams Gap solitons that can propagate at any velocity from zero to the speed of light and spatial solitons that prevent the diffractive spread of light in waveguide arrays are two examples of the new phenomena described in this book Microstructured optical fibers allow control of the guided mode dispersion for broadband light generation and new soliton phenomena Many new materials and structures are being developed that will impact new optical devices with applications in optical communications and optical data processing All the above topics are addressed in detail in this book

Parametric Interactions in Ordered and Disordered Nonlinear Photonic Crystals Ksawery Kajetan Kalinowski, 2013 Parametric interactions are one of the oldest studied phenomenon in nonlinear optics The nonlinear light matter light interaction allows one to generate light at any wavelength within the transmission band of a nonlinear crystal It is known that the efficiency of the harmonic generation process strongly depends on the phase mismatch between interacting waves and in order to observe harmonic generation some technique has to be implemented The spatially periodic modulation of the sign of nonlinearity is one of the solutions to this phase mismatch problem Such structures called nonlinear photonic crystals are nowadays widely realized Proper design of the nonlinearity modulation gives one a great control over the properties of a newly generated harmonic The purpose of this thesis is the theoretical analysis of possible phase matching schemes and the experimental investigation of nonlinear scattering processes The nonlinear structures under consideration in this work are periodic and strongly disordered 1D nonlinear gratings 2D random nonlinear photonic crystals and a single boundary between two regions of different nonlinearity Chapter 1 provides a general introduction to aspects of frequency conversion relevant to the topic of this thesis Basic terms used in quadratic parametric processes are defined The fundamental theory of harmonic generation in nonlinear crystals is presented Phase matching techniques in homogeneous and periodic structures are reviewed followed by an introduction to nonlinear diffraction mechanisms in one and two dimensional nonlinear gratings Chapter 2 contains a theoretical study of parametric wave interaction in nonlinear optical media with a randomized distribution of quadratic nonlinearity In particular it shows how the transition from an ideal periodic structure to a fully random structure affects properties of the second and cascaded third harmonic generation Analytical formulas describing properties of such harmonics in the presence of nonlinearity disorder are derived In chapter 3 we study theoretically and numerically the second harmonic generation in a two dimensional nonlinear crystal with a random distribution of ferroelectric domains We numerically generate a disordered structure composed of semi circular ferroelectric domains of random size and random position Aside from presenting numerical simulations we show that the strict model presented in chapter 2 can be

successfully applied to 2D random structures We show that the specific features of disordered domain structures greatly affect the emission pattern of the generated harmonics In chapter 4 and chapter 5 we study experimentally and theoretically the Cerenkov type second harmonic generation in a one dimensional nonlinear photonic crystal We demonstrate that the power of emitted second harmonic can be enhanced by varying the angle of incidence of the fundamental beam such that the reciprocal lattice vectors of the crystal can be used to compensate for the phase mismatch in the transverse direction We also experimentally investigate the Cerenkov second harmonic tuning response to a wavelength and the position of the incident beam We reveal that in contrast to the classic second harmonic generation whose tuning response is determined by the superlattice itself the sensitivity of the Cerenkov harmonic intensity depends strongly on the width of the incident beam

Nonlinear Optics of Photonic Crystals and Meta-Materials Arthur R. McGurn, 2015-09-30 The study of dark matter in both astrophysics and particle physics has emerged as one of the most active and exciting topics of research in recent years This book reviews the history behind the discovery of missing mass or unseen mass in the Universe and ties this into the proposed extensions to the Standard Model of Particle Physics such as Supersymmetry which were being proposed within the same time frame This book is written as an introduction to these problems at the forefront of astrophysics and particle physics with the goal of conveying the physics of dark matter to beginning undergraduate majors in scientific fields The book goes on to describe existing and upcoming experiments and techniques which will be used to detect dark matter either directly or indirectly

Generation and Manipulation of Light in Nonlinear Photonic Crystals Tal Ellenbogen, 2009

Introduction Nonlinear Optics Photonics MCGURN, 2021-11 Introduction to Nonlinear Optics of Photonic Crystals and Metamaterials Second Edition presents concise examples illustrating the basic principles of the field embedding a discussion of current and future device applications in a theoretical account of the non linear behaviour of light at nanoscale to produce an informative and authoritative introduction to the subject for students trying to advance rapidly amongst the vanguard of modern applied physics and engineering Pitched at an accessible level this survey of some of the most important fundamentals of the field is ideal for researchers undergraduate and graduate students as well as self taught students looking to expand their field of interest Key Features Provides reference to the current research literature to facilitate the reader with pursuing topics within the field Suitable for self study students Includes concise presentations which focus on the essential basic principle of the field Discusses a review of current device applications Presents the principles of photonic crystals and metamaterials and their applications at a basic level

Arbeiten aus dem sexualpsychologischen Seminar, 1924

All-optical Processing in Nonlinear Photonic Crystals Ayelet Ganany-Padowicz, 2012

Optical Solitons Yuri S. Kivshar, Govind P. Agrawal, 2003-06-12 The current research into solitons and their use in fiber optic communications is very important to the future of communications Since the advent of computer networking and high speed data transmission technology people have been striving to develop faster and more reliable communications media Optical pulses tend to

broaden over relatively short distances due to dispersion but solitons on the other hand are not as susceptible to the effects of dispersion and although they are subject to losses due to attenuation they can be amplified without being received and retransmitted This book is the first to provide a thorough overview of optical solitons The main purpose of this book is to present the rapidly developing field of Spatial Optical Solitons starting from the basic concepts of light self focusing and self trapping It will introduce the fundamental concepts of the theory of nonlinear waves and solitons in non integrated but physically realistic models of nonlinear optics including their stability and dynamics Also it will summarize a number of important experimental verification of the basic theoretical predictions and concepts covering the observation of self focusing in the earlier days of nonlinear optics and the most recent experimental results on spatial solitons vortex solitons and soliton interaction spiraling Introduces the fundamental concepts of the theory of nonlinear waves and solitons through realistic models Material is based on authors years of experience actively working in and researching the field Summarizes the most important experimental verification of the basic theories predictions and concepts of this ever evolving field from the earliest studies to the most recent

Nonlinearities in Periodic Structures and Metamaterials Cornelia Denz,Sergej Flach,Yuri S. Kivshar,2010-03-11 Optical information processing of the future is associated with a new generation of compact nanoscale optical devices operating entirely with light Moreover adaptive features such as self guiding reconfiguration and switching become more and more important Nonlinear devices offer an enormous potential for these applications Consequently innovative concepts for all optical communication and information technologies based on nonlinear effects in photonic crystal physics and nanoscale devices as metamaterials are of high interest This book focuses on nonlinear optical phenomena in periodic media such as photonic crystals optically induced adaptive lattices atomic lattices or metamaterials The main purpose is to describe and overview new physical phenomena that result from the interplay between nonlinearities and structural periodicities and is a guide to actual and future developments for the expert reader in optical information processing as well as in the physics of cold atoms in optical lattices

Efficient Frequency Conversion in Engineered Nonlinear Photonic Crystals Roy Shiloh,2011 *Nonlinear Photonics* Jia-Ming Liu,2022-01-06 Suitable for both graduate and senior undergraduate students this textbook offers a logical progression through the underlying principles and practical applications of nonlinear photonics Building up from essential physics general concepts and fundamental mathematical formulations it provides a robust introduction to nonlinear optical processes and phenomena and their practical applications in real world devices and systems Over 45 worked problems illustrate key concepts and provide hands on models for students and over 160 end of chapter exercises supply students with plenty of scope to master the material Accompanied by a complete solutions manual for instructors including detailed explanations of each result and drawing on the author s 35 years of teaching experience this is the ideal introduction to nonlinear photonics for students in electrical engineering

Modelling of Photonic Components Based on ÷(3)nonlinear Photonic Crystals Ivan Maksymov,Universitat Rovira

i Virgili. Departament d'Enginyeria Electrònica, Elèctrica i Automàtica, 2010 **Photonic Crystals: Physics and Technology** Concita Sibilia, Trevor M. Benson, Marian Marciniak, Tomasz Szoplik, 2009-02-03 The aim of the work is give an overview of the activity in the field of Photonic Crystal developed in the frame of COST P11 action The main objective of the COST P11 action was to unify and coordinate national efforts aimed at studying linear and nonlinear optical interactions with Photonic Crystals PCs without neglecting an important aspect related to the material research as idea and methods of realizations of 3D PC together with the development and implementation of measurement techniques for the experimental evaluation of their potential applications in different area as for example telecommunication with novel optical fibers lasers nonlinear multi functionality display devices opto electronics sensors The book contains contributions from authors who gave their lecture at the Cost P11 Training School *Modelling of Photonic Components Based on $\div(3)$ nonlinear Photonic Crystals* Ivan Maksymov, Universitat Rovira i Virgili. Departament d'Enginyeria Electrònica, Elèctrica i Automàtica, Universitat Rovira i Virgili. Escola Tècnica Superior d'Enginyeria de Tarragona, 2006 **Nonlinear Photonics and Novel Optical Phenomena** Zhigang Chen, Roberto Morandotti, 2012-06-27 Nonlinear Photonics and Novel Optical Phenomena contains contributed chapters from leading experts in nonlinear optics and photonics and provides a comprehensive survey of fundamental concepts as well as hot topics in current research on nonlinear optical waves and related novel phenomena The book covers self accelerating airy beams integrated photonics based on high index doped silica glass linear and nonlinear spatial beam dynamics in photonic lattices and waveguide arrays the theory of polariton solitons in semiconductor microcavities and Terahertz waves **Recent Advances and Trends in Photonic Crystal Technology** Ajay Kumar, Amit Kumar Goyal, 2024-03-06 This book presents recent advances and trends in photonic crystal technology making it a useful resource for students researchers and faculty in the field It consists of five chapters that present in depth knowledge of numerical methods and different applications of photonic crystal technology The chapters discuss photonic crystals for energy sensing and digital devices They also examine advanced applications of photonic crystals like holography and photonic spin hall effect Each chapter presents a detailed background on the considered application recent work in the area possible solutions to challenges and future aspects **Nonlinear optical polymeric photonic crystals** Markus Schmidt, 2006 Introduction to Nonlinear Optics of Photonic Crystals and Metamaterials (Second Edition) Arthur R. McGurn, 2021-11 Introduction to Nonlinear Optics of Photonic Crystals and Metamaterials Second Edition presents concise examples illustrating some of the basic principles of nanophotonics embedding a discussion of current and future device applications in a theoretical account of the non linear behaviour of light at nanoscale It is an excellent access point for the current literature on nanophotonics ideal for researchers undergraduate and graduate students *Advances in Nonlinear Photonics* Giancarlo C. Righini, Luigi Sirleto, 2023-05-03 Advances in Nonlinear Photonics combines fundamental principles with an overview of the latest developments The book is suitable for the multidisciplinary audience of photonics researchers

and practitioners in academia and R D including materials scientists and engineers applied physicists chemists etc As nonlinear phenomena are at the core of photonic devices and may enable future applications such as all optical switching all optical signal processing and quantum photonics this book provides an overview of key concepts In addition the book reviews the most important advances in the field and how nonlinear processes may be exploited in different photonic applications Introduces fundamental principles of nonlinear phenomena and their application in materials and devices Reviews and provides definitions of the latest research directions in the field of nonlinear photonics Discusses the most important developments in materials and applications including future prospects

Nonlinear Optical Crystals: A Complete Survey David N. Nikogosyan, 2006-03-21 Nonlinear optical techniques are now recognized as the most efficient means available to generate laser radiation at wavelengths that are presently inaccessible via conventional sources This technology uses nonlinear optical crystals for the frequency conversion of laser light The book contains the most complete and up to date reference material on properties of nonlinear optical crystals describes their applications both traditional and specific and provides the main mathematical formulas necessary for the calculation of the frequency conversion process It is a vital source of information for scientists and engineers dealing with modern applications of nonlinear optical crystals in quantum electronics optoelectronics and laser physics

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