

F. X. Kärtner  
(Ed.)

# Few-Cycle Laser Pulse Generation and Its Applications

# Fewcycle Laser Pulse Generation And Its Applications

**Wei Gao, Yuki Shimizu**



## **Fewcycle Laser Pulse Generation And Its Applications:**

**Few-Cycle Laser Pulse Generation and Its Applications** Franz X. Kärtner, 2004-09-14 This book covers the physics technology and applications of short pulse laser sources that generate pulses with durations of only a few optical cycles The basic design considerations for the different systems such as lasers parametric amplifiers and external compression techniques which have emerged over the last decade are discussed to give researchers and graduate students a thorough introduction to this field The existence of these sources has opened many new fields of research that were not possible before These are UV and EUV generation from table top systems using high harmonic generation frequency metrology enabling optical frequency counting high resolution optical coherence tomography strong field ultrafast solid state processes and ultrafast spectroscopy to mention only a few Many new applications will follow The book attempts to give a comprehensive while not excessive introduction to this exciting new field that serves both experienced researchers and graduate students entering the field The first half of the book covers the current physical principles processes and design guidelines to generate pulses in the optical range comprising only a few cycles of light Such as the generation of relatively low energy pulses at high repetition rates directly from the laser parametric generation of medium energy pulses and high energy pulses at low repetition rates using external compression in hollow fibers The applications cover the revolution in frequency metrology and high resolution laser spectroscopy to electric field synthesis in the optical range as well as the emerging field of high harmonic generation and attosecond science high resolution optical imaging and novel ultrafast dynamics in semiconductors These fields benefit from the strong electric fields accompanying these pulses in solids and gases during events comprising only a few cycles of light

**Laser Spectroscopy** Wolfgang Demtröder, 2008-07-23 Keeping abreast of the latest techniques and applications this new edition of the standard reference and graduate text on laser spectroscopy has been completely revised and expanded While the general concept is unchanged the new edition features a broad array of new material This new edition has been completely revised especially the chapters on non linear spectroscopy ion trapping ultra short laser pulses and new developments Fifty new figures illustrate the newest developments and results The author is one of the most renowned experts in this area and no other book with this broad scope is available

### **Towards a Compact**

**Thin-Disk-Based Femtosecond XUV Source** Oleg Pronin, 2013-09-03 This thesis provides unique information on the Kerr lens mode locking KLM technique applied to a thin disk laser It describes in detail cavity geometry the qualitative approach to KLM and self starting behavior in the regime of both negative and positive dispersion Comprehensive comparative analysis of KLM and semiconductor saturable absorber techniques is also carried out Recent successful experiments on carrier envelope phase stabilization spectral broadening and compression of output of this oscillator underline the importance of this new emerging technology

*Laser Spectroscopy 2* Wolfgang Demtröder, 2015-01-07 Keeping abreast of the latest techniques and applications this new edition of the standard reference and graduate text on laser spectroscopy has been

completely revised and expanded While the general concept is unchanged the new edition features a broad array of new material e g ultrafast lasers atto and femto second lasers coherent matter waves Doppler free Fourier spectroscopy interference spectroscopy quantum optics and gravitational waves and still more applications in chemical analysis medical diagnostics and engineering

**Optical Frequency Combs** Auro Michele Perego, Andrew Ellis, 2024-11-27 Optical Frequency Combs Trends in Sources and Applications offers an overview of the recent advances on the physics sources and applications of optical frequency comb technology one of the most exciting and fast developing research fields in photonics The book aims at showcasing recent advances through contributions by key players in a multifaceted research ecosystem and at the same time at providing a valuable service to the community by offering an as much comprehensive as possible review which at the same time highlights challenges to be solved and promising future directions The main topics covered include i an overview of different platforms for optical frequency combs generation as fibre lasers quantum cascade lasers integrated microresonators and waveguides fibre resonators electro optic modulators and nonlinear fibres multicore fibres ii a selection of applications in different technologies including sensing spectroscopy precision metrology and optical clocks microscopy radio frequency generation distance ranging and optical communications iii a diverse range of physical methods for frequency comb generation such as modulation laser mode locking techniques dissipative solitons and parametric gain in nonlinear resonators nonlinear spectral broadening and supercontinuum formation in waveguides This book will be a valuable resource for academics researchers and postgraduate students working and interested in the field optical frequency combs and more broadly in photonic technologies too Key Features Edited by authorities in the field with chapter contributions from subject area leading experts in academia and industry Up to date with the latest technological developments applications and fundamental research from the field Describes comb properties depending on source and generation platform and comb specifications matching to application needs

**Ultrafast Nonlinear Optics** Robert Thomson, Christopher Leburn, Derryck Reid, 2013-03-20 The field of ultrafast nonlinear optics is broad and multidisciplinary and encompasses areas concerned with both the generation and measurement of ultrashort pulses of light as well as those concerned with the applications of such pulses Ultrashort pulses are extreme events both in terms of their durations and also the high peak powers which their short durations can facilitate These extreme properties make them powerful experiment tools On one hand their ultrashort durations facilitate the probing and manipulation of matter on incredibly short timescales On the other their ultrashort durations can facilitate high peak powers which can drive highly nonlinear light matter interaction processes Ultrafast Nonlinear Optics covers a complete range of topics both applied and fundamental in nature within the area of ultrafast nonlinear optics Chapters 1 to 4 are concerned with the generation and measurement of ultrashort pulses Chapters 5 to 7 are concerned with fundamental applications of ultrashort pulses in metrology and quantum control Chapters 8 and 9 are concerned with ultrafast nonlinear optics in optical fibres Chapters 10 to 13 are concerned with

the applications of ultrashort pulses in areas such as particle acceleration microscopy and micromachining The chapters are aimed at graduate student level and are intended to provide the student with an accessible self contained and comprehensive gateway into each subject

**Biophysical Techniques in Photosynthesis** Thijs Aartsma,Jörg Matysik,2008-02-01 Since the first volume on Biophysical Techniques in Photosynthesis Research published in 1996 new experimental techniques and methods have been devised at a rapid pace The present book is a sequel which complements the first volume by providing a comprehensive overview of the most important new techniques developed over the past ten years especially those that are relevant for research on the mechanism and fundamental aspects of photosynthesis The contributions are written by leading scientists in their field The book is divided into 5 sections on Imaging Structure Optical and laser spectroscopy Magnetic resonance and on Theory respectively Each chapter describes the basic concepts of the technique practical applications and some of the scientific results Possibilities and limitations from a technical as well as a scientific point of view are addressed allowing the reader not only to recognize the potential of a particular method for his her own quest but to assess the resources that are required for implementation

**Optical Techniques for Solid-State Materials Characterization** Rohit P. Prasankumar,Antoinette J. Taylor,2016-04-19 Over the last century numerous optical techniques have been developed to characterize materials giving insight into their optical electronic magnetic and structural properties and elucidating such diverse phenomena as high temperature superconductivity and protein folding Optical Techniques for Solid State Materials Characterization provides

**Attosecond and XUV Physics** Thomas Schultz,Marc Vrakking,2013-11-13 This book provides fundamental knowledge in the fields of attosecond science and free electron lasers based on the insight that the further development of both disciplines can greatly benefit from mutual exposure and interaction between the two communities With respect to the interaction of high intensity lasers with matter it covers ultrafast lasers high harmonic generation attosecond pulse generation and characterization Other chapters review strong field physics free electron lasers and experimental instrumentation Written in an easy accessible style the book is aimed at graduate and postgraduate students so as to support the scientific training of early stage researchers in this emerging field Special emphasis is placed on the practical approach of building experiments allowing young researchers to develop a wide range of scientific skills in order to accelerate the development of spectroscopic techniques and their implementation in scientific experiments The editors are managers of a research network devoted to the education of young scientists and this book idea is based on a summer school organized by the ATTOFEL network

**Fundamentals of Photonics** Bahaa E. A. Saleh,Malvin Carl Teich,2020-03-04 Fundamentals of Photonics A complete thoroughly updated full color third edition Fundamentals of Photonics Third Edition is a self contained and up to date introductory level textbook that thoroughly surveys this rapidly expanding area of engineering and applied physics Featuring a blend of theory and applications coverage includes detailed accounts of the primary theories of light including ray optics wave optics electromagnetic optics and photon optics as well as

the interaction of light and matter Presented at increasing levels of complexity preliminary sections build toward more advanced topics such as Fourier optics and holography photonic crystal optics guided wave and fiber optics LEDs and lasers acousto optic and electro optic devices nonlinear optical devices ultrafast optics optical interconnects and switches and optical fiber communications The third edition features an entirely new chapter on the optics of metals and plasmonic devices Each chapter contains highlighted equations exercises problems summaries and selected reading lists Examples of real systems are included to emphasize the concepts governing applications of current interest Each of the twenty four chapters of the second edition has been thoroughly updated

**A New Generation of Ultrafast Oscillators for Mid-Infrared Applications** Nathalie Nagl, 2022-02-01 This thesis presents the first successful realization of a compact low noise and few cycle light source in the mid infrared wavelength region By developing the technology of pumping femtosecond chromium doped II VI laser oscillators directly with the emission of broad stripe single emitter laser diodes coherent light was generated with exceptionally low amplitude noise crucial for numerous applications including spectroscopy at high sensitivities Other key parameters of the oscillator s output such as pulse duration and output power matched and even surpassed previous state of the art systems As a demonstration of its unique capabilities the oscillator s powerful output was used to drive without further amplification the nonlinear generation of coherent mid infrared light spanning multiple octaves The resulting table top system uniquely combines high brilliance and ultrabroad spectral bandwidth in the important mid infrared spectral range The rapid development of this technology is comprehensively and lucidly documented in this PhD thesis Together with a thorough review of literature and applications and an extensive analysis of the theoretical foundations behind ultrafast laser oscillators the thesis will serve as a valuable reference for the construction of a new generation of mid infrared light sources

**Handbook of High-resolution Spectroscopy** Martin Quack, Frederic Merkt, 2011-09-26 The field of High Resolution Spectroscopy has been considerably extended and even redefined in some areas Combining the knowledge of spectroscopy laser technology chemical computation and experiments Handbook of High Resolution Spectroscopy provides a comprehensive survey of the whole field as it presents itself today with emphasis on the recent developments This essential handbook for advanced research students graduate students and researchers takes a systematic approach through the range of wavelengths and includes the latest advances in experiment and theory that will help and guide future applications The first comprehensive survey in high resolution molecular spectroscopy for over 15 years Brings together the knowledge of spectroscopy laser technology chemical computation and experiments Brings the reader up to date with the many advances that have been made in recent times Takes the reader through the range of wavelengths covering all possible techniques such as Microwave Spectroscopy Infrared Spectroscopy Raman Spectroscopy VIS UV and VUV Combines theoretical computational and experimental aspects Has numerous applications in a wide range of scientific domains Edited by two leaders in this field Provides an overview of rotational vibration electronic and photoelectron

spectroscopy Volume 1 Introduction Fundamentals of Molecular Spectroscopy Volume 2 High Resolution Molecular Spectroscopy Methods and Results Volume 3 Special Methods Applications      **Physics of Ferroelectrics** Karin M.

Rabe, Charles H. Ahn, Jean-Marc Triscone, 2007-07-20 During the past two decades revolutionary breakthroughs have occurred in the understanding of ferroelectric materials both from the perspective of theory and experiment First principles approaches including the Berry phase formulation of ferroelectricity now allow accurate quantitative predictions of material properties and single crystalline thin films are now available for fundamental studies of these materials In addition the need for high dielectric constant insulators and nonvolatile memories in semiconductor applications has motivated a renaissance in the investigation of these materials This book addresses the paradigmatic shifts in understanding brought about by these breakthroughs including the consideration of novel fabrication methods and nanoscale applications of these materials and new theoretical methods such as the effective Hamiltonian approach and density functional theory      **Introduction to**

**Ultrafast Phenomena** Guo-ping Zhang, Georgios Lefkidis, Mitsuko Murakami, Wolfgang Hübner, Thomas F.

George, 2020-12-08 This book the first of this kind provides a comprehensive introduction to ultrafast phenomena covering the fundamentals of ultrafast spin and charge dynamics femtosecond magnetism all optical spin switching and high harmonic generation It covers the experimental tools including ultrafast pump probe experiments and theoretical methods including quantum chemistry and density functional theory both time independent and time dependent The authors explain in clear language how an ultrafast laser pulse is generated experimentally how it can induce rapid responses in electrons and spins in molecules nanostructures and solids magnetic materials and superconductors and how it can create high harmonic generation from atoms and solids on the attosecond timescale They also show how this field is driving the next generation of magnetic storage devices through femtomagnetism all optical spin switching in ferrimagnets and beyond magnetic logic in magnetic molecules and ultrafast intense light sources incorporating numerous computer programs examples and problems throughout to show how the beautiful research can be done behind the scene Key features Provides a clear introduction to modern ultrafast phenomena and their applications in physics chemistry materials sciences and engineering Presents in detail how high harmonic generation occurs in atoms and solids Explains ultrafast demagnetization and spin switching a new frontier for development of faster magnetic storage devices Includes numerous worked out examples and problems in each chapter with real research codes in density functional theory and quantum chemical calculations provided in the chapters and in the Appendices This book is intended for undergraduate and graduate students researchers in physics chemistry biology materials sciences and engineering      **Quantum Computation and Information** Hiroshi Imai, Masahito

Hayashi, 2008-09-12 Recently the field of quantum computation and information has been developing through a fusion of results from various research fields in theoretical and practical areas This book consists of the reviews of selected topics characterized by great progress and cover the field from theoretical areas to experimental ones It contains fundamental areas

quantum query complexity quantum statistical inference quantum cloning quantum entanglement additivity It treats three types of quantum security system quantum public key cryptography quantum key distribution and quantum steganography A photonic system is highlighted for the realization of quantum information processing      **Progress in Ultrafast Intense Laser Science I** See Leang Chin, Pierre Agostini, Gaetano Ferrante, 2006-10-03 This is the first of a series of books on Ultrafast Intense Laser Science a newly emerging interdisciplinary research field that spans atomic and molecular physics molecular science and optical science It covers intense VUV laser cluster interaction resonance and chaos assisted tunneling and the effects of the carrier envelope phase on high order harmonic generation      *Sputtering by Particle Bombardment* Rainer Behrisch, Wolfgang Eckstein, 2007-07-30 This book provides a long needed survey of new results Especially welcome is a new summary of the measured and calculated sputtering yields with an algebraic approximation formula for the energy and angular dependence of the yields which is useful for researchers who need sputtering yields for physics research or applied problems The book offers a critical review of computational methods for calculating sputtering yields and also includes molecular dynamics calculations      *Cryogenic Particle Detection* Hans-Christian Stahl, 2005-06-22 The development of cryogenic devices for particle detection has reached a stage at which many interesting applications are conceivable and already have been demonstrated The book provides a comprehensive review of the field of cryogenic particle detection It introduces the different detection techniques and gives an overview of the important areas in which these detectors are successfully applied      The Supercontinuum Laser Source Robert R. Alfano, 2023-01-01 This book now in its fourth edition is a well known classic on the ultrafast nonlinear and linear processes responsible for supercontinuum generation The book begins with chapters reviewing the experimental and theoretical understanding of the field along with key applications developed since the discovery of the supercontinuum effect The chapters that follow cover recent research activity on supercontinuum phenomena novel applications and advances achieved since the publication of the previous edition The new chapters focus on filamentation in gases air and condensed media conical emission by four wave mixing and X waves electronic self phase mechanism higher harmonics generation attosecond laser pulses complex vector beam supercontinuum higher order self phase modulation and cross phase modulation nonlinear supercontinuum interference in uniaxial crystals new nonlinear microscopes involving supercontinuum and ultrafast lasers with biomedical applications and other current supercontinuum applications in communications The Supercontinuum Laser Source is a definitive work by one of the discoverers of the white light effect It is indispensable reading for any researcher or student working in the field of ultrafast laser physics Chapter 6 is available open access under a Creative Commons Attribution 4.0 International License via link [springer.com](https://www.springer.com)      *Optical Metrology for Precision Engineering* Wei Gao, Yuki Shimizu, 2021-11-22 This book provides readers the fundamentals of optical metrology for precision engineering The next generation measurement technologies based on ultrashort pulse laser and optical frequency comb are also presented making it an essential reference book for various

engineering fields Introduces fundamental theories and techniques Combines theories with practical applications Presents technologies in an easy to understand way

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