

Y.I. KHANIN

PRINCIPLES OF
LASER
DYNAMICS

• NORTH HOLLAND

Principles Of Laser Dynamics

Y.I. Khanin



Principles Of Laser Dynamics:

Principles of Laser Dynamics Y.I. Khanin, 2012-12-02 This monograph summarizes major achievements in laser dynamics over the past three decades The book begins with two introductory Chapters Chapter 1 offers general considerations on quantum oscillators formulates the requirements for the laser key elements and shows how these requirements are met in different laser systems The second Chapter proposes the mathematical models used in semiclassical laser theory discusses the approximations and simplifications in particular cases and specifies the range of applicability of these models In Chapters 3 5 attention is given primarily to the steady states and their stability the laser behavior in the instability domain the characteristics of regular and chaotic pulsations and the nature of their mechanisms Chapter 6 deals with the processes in a laser accompanying the time variance of laser parameters Considerable attention is given to a laser response to weak low frequency modulation of the parameters The problems addressed therein are resonant modulation enhancement transition to the nonlinear regime chaotic response to periodic impact spike like generation due to variation of the cavity geometry and a laser rod temperature drift Laser behavior is subject to qualitative changes if its optical elements exhibit nonlinear properties The action of a saturable absorber which leads to a loss of laser stability and provides passive Q modulation is investigated To a much lesser degree the researchers attention has been attracted by other nonlinear effects such as self focusing e g which may have a strong influence on laser dynamics All of these issues are covered in Chapter 7 The book is intended for researchers engineers graduate and post graduate students majoring in quantum electronics

Fundamentals of Laser Dynamics Ākov Izrailevich Khanin, 2006 The book explores the current state of laser dynamics and provides reference data and basic experimental facts for old and new generation lasers The most frequently used mathematical models are presented The author discusses the reasons for the spontaneous occurrence of pulsation of the intensity of radiation of solid state lasers and the influence of the non stationary nature of laser elements on lasing characteristics Special emphasis is placed on the problems of the low frequency dynamics of multimode lasers This book is aimed at experts in the fields of quantum electronics and laser physics

Multistability in Physical and Living Systems Alexander N. Pisarchik, Alexander E. Hramov, 2022-04-13 This book starts with an introduction to the basic concepts of multistability then illustrates how multistability arises in different systems and explains the main mechanisms of multistability emergence A special attention is given to noise which can convert a multistable deterministic system to a monostable stochastic one Furthermore the most important applications of multistability in different areas of science engineering and technology are given attention throughout the book including electronic circuits lasers secure communication and human perception The book aims to provide a first approach to multistability for readers who are interested in understanding its fundamental concepts and applications in several fields This book will be useful not only to researchers and engineers focusing on interdisciplinary studies but also to graduate students and technicians Both

theoreticians and experimentalists will rely on it in fields ranging from mathematics and laser physics to neuroscience and astronomy The book is intended to fill a gap in the literature to stimulate new discussions and bring some fundamental issues to a deeper level of understanding of the mechanisms underlying self organization of matter and world complexity

Physical Foundations Of Quantum Electronics By David Klyshko Maria Chekhova, Sergey Kulik, 2011-04-21 This concise textbook introduces a graduate student to the various fields of physics related to the interaction between radiation and matter The scope of the book is very broad ranging from nonlinear to quantum optics and from quantum transitions in atoms to the dispersion of polaritons in continuous media The author Professor David Klyshko 1929 2000 is one of the founders of modern quantum optics renowned for his theory of Spontaneous Parametric Down Conversion SPDC and its applications in quantum metrology and the optics of nonclassical light Most parts of the book contain the lecture courses taught by David Klyshko at Moscow State University namely quantum electronics nonlinear optics and quantum optics In every section the main focus is on observable effects and their physical interpretation The book emphasizes analogies and relations between seemingly different phenomena and different fields of quantum electronics Additional commentaries written by Profs Maria Chekhova and Sergey Kulik analyze more recent developments in the corresponding fields of physics

Nonlinear Optical Systems Luigi Lugiato, Franco Prati, Massimo Brambilla, 2015-03-05 Guiding graduate students and researchers through the complex world of laser physics and nonlinear optics this book provides an in depth exploration of the dynamics of lasers and other relevant optical systems under the umbrella of a unitary spatio temporal vision Adopting a balanced approach the book covers traditional as well as special topics in laser physics quantum electronics and nonlinear optics treating them from the viewpoint of nonlinear dynamical systems These include laser emission frequency generation solitons optically bistable systems pulsations and chaos and optical pattern formation It also provides a coherent and up to date treatment of the hierarchy of nonlinear optical models and of the rich variety of phenomena they describe helping readers to understand the limits of validity of each model and the connections among the phenomena It is ideal for graduate students and researchers in nonlinear optics quantum electronics laser physics and photonics Lasers Charles Blain, 2002 Developments in lasers continue to enable progress in many areas such as eye surgery the recording industry and dozens of others This book presents citations from the book literature for the last 25 years and groups them for ease of access which is also provided by subject author and titles indexes **Fundamentals Of Laser Dynamics** Ya I. Khanin, 2008-01-01

Quantum Optics of Light Scattering Alexander A. Lisiansky, Evgeny S. Andrianov, Alexey P. Vinogradov, Vladislav Yu. Shishkov, 2024-05-28 This book presents a quantum framework for understanding inelastic light scattering which is consistent with the classical descriptions of Raman phenomena and Rayleigh scattering thus creating a unified theoretical picture of light scattering The Raman effect was discovered in 1928 and has since proved to be one of the most powerful tools to study the molecular structure of gases liquids and crystals The subsequent development of new scientific disciplines

such as nonlinear optics quantum optics plasmonics metamaterials and the theory of open quantum systems has changed our views on the nature of Rayleigh and Raman scattering Today there are many excellent books on the theory and applications of light scattering but a consistent description of light scattering from a unified viewpoint is missing The authors approach has the power to re derive the results of both classical and quantum approaches while also addressing many questions that are scattered across the research literature Why is Rayleigh scattering coherent while Raman scattering is not although both phenomena are caused by the incidence of a coherent wave Why are coherent Stokes and coherent anti Stokes Raman scattering caused by two coherent incident waves both always coherent This book answers these questions and more and explains state of the art experimental results with a first principles approach that avoids phenomenological arguments Many of the results presented are appearing in book form for the first time making this book especially useful for young researchers entering the field The book reviews basic concepts of quantum mechanics and quantum optics and comes equipped with problems and solutions to develop understanding of the key mathematical techniques The rigorous approach presented in the book is elegant and readily grasped and will therefore prove useful to both theorists and experimentalists at the graduate level and above as well as engineers who use Raman scattering methods in their work

Advances in Atomic, Molecular, and Optical Physics, 1998-09-09 This series established in 1965 is concerned with recent developments in the general area of atomic molecular and optical physics The field is in a state of rapid growth as new experimental and theoretical techniques are used on many old and new problems Topics covered also include related applied areas such as atmospheric science astrophysics surface physics and laser physics Articles are written by distinguished experts who are active in their research fields The articles contain both relevant review material as well as detailed descriptions of important recent developments

Semiconductor Laser Dynamics Anele Bradley, Jack Wood, 2025 Semiconductor Laser Dynamics Fundamentals and Applications provides a comprehensive overview of the fundamental principles and practical applications of semiconductor laser dynamics Through collaboration with experts this book covers topics such as the physics of semiconductor lasers rate equations modeling nonlinear dynamics chaos synchronization phenomena and applications in various fields With theoretical insights and practical methodologies readers gain a thorough understanding of semiconductor laser dynamics Bridging theory and application this book empowers researchers and practitioners to leverage semiconductor laser dynamics for advancing science and technology in diverse domains

Coherent Optics Werner Lauterborn, Thomas Kurz, 2013-03-09 Since the advent of the laser coherent optics has developed at an ever increasing pace There is no doubt about the reason Coherent light with its properties so different from the light we are surrounded by lends itself to numerous applications in science technology and life The bandwidth of coherent optics reaches from holography and interferometry with its gravitational wave detectors to the CD player for music movies and computers from the laser scalpel which allows surgical cutting in the interior of the eye without destruction of the layers penetrated in front of it to optical information and

data processing with its great impact on society According to its importance the foundations of coherent optics should be conveyed to students of natural sciences as early as possible to better prepare them for their future careers as physicists or engineers The present book tries to serve this need to promote the foundations of coherent optics Special attention is paid to a thorough presentation of the fundamentals This should enable the reader to follow the contemporary literature from a firm basis The wealth of material of course makes necessary a restriction of the topics included Therefore from the main areas of optics wave optics and the classical description of light is given most of the space available The book starts with a quick trip through the history of physics from the viewpoint of optics **The Topology of Chaos** Robert Gilmore, Marc

Lefranc, 2008-09-26 A new approach to understanding nonlinear dynamics and strange attractors The behavior of a physical system may appear irregular or chaotic even when it is completely deterministic and predictable for short periods of time into the future How does one model the dynamics of a system operating in a chaotic regime Older tools such as estimates of the spectrum of Lyapunov exponents and estimates of the spectrum of fractal dimensions do not sufficiently answer this question In a significant evolution of the field of Nonlinear Dynamics The Topology of Chaos responds to the fundamental challenge of chaotic systems by introducing a new analysis method Topological Analysis which can be used to extract from chaotic data the topological signatures that determine the stretching and squeezing mechanisms which act on flows in phase space and are responsible for generating chaotic data Beginning with an example of a laser that has been operated under conditions in which it behaved chaotically the authors convey the methodology of Topological Analysis through detailed chapters on Discrete Dynamical Systems Maps Continuous Dynamical Systems Flows Topological Invariants Branched Manifolds The Topological Analysis Program Fold Mechanisms Tearing Mechanisms Unfoldings Symmetry Flows in Higher Dimensions A Program for Dynamical Systems Theory Suitable at the present time for analyzing strange attractors that can be embedded in three dimensional spaces this groundbreaking approach offers researchers and practitioners in the discipline a complete and satisfying resolution to the fundamental questions of chaotic systems **Asymptotic**

Representation of Relaxation Oscillations in Lasers Elena V. Grigorieva, Sergey A. Kaschenko, 2016-11-09 In this book we analyze relaxation oscillations in models of lasers with nonlinear elements controlling light dynamics The models are based on rate equations taking into account periodic modulation of parameters optoelectronic delayed feedback mutual coupling between lasers intermodal interaction and other factors With the aim to study relaxation oscillations we present the special asymptotic method of integration for ordinary differential equations and differential difference equations As a result they are reduced to discrete maps Analyzing the maps we describe analytically such nonlinear phenomena in lasers as multistability of large amplitude relaxation cycles bifurcations of cycles controlled switching of regimes phase synchronization in an ensemble of coupled systems and others The book can be fruitful for students and technicians in nonlinear laser dynamics and in differential equations **Femtosecond Optical Frequency Comb: Principle, Operation**

and Applications Jun Ye, Steven T. Cundiff, 2006-06-15 Over the last few years there has been a convergence between the fields of ultrafast science nonlinear optics optical frequency metrology and precision laser spectroscopy These fields have been developing largely independently since the birth of the laser reaching remarkable levels of performance On the ultrafast frontier pulses of only a few cycles long have been produced while in optical spectroscopy the precision and resolution have reached one part in Although these two achievements appear to be completely disconnected advances in nonlinear optics provided the essential link between them The resulting convergence has enabled unprecedented advances in the control of the electric field of the pulses produced by femtosecond mode locked lasers The corresponding spectrum consists of a comb of sharp spectral lines with well defined frequencies These new techniques and capabilities are generally known as femtosecond comb technology They have had dramatic impact on the diverse fields of precision measurement and extreme nonlinear optical physics The historical background for these developments is provided in the Foreword by two of the pioneers of laser spectroscopy John Hall and Theodor Hänsch Indeed the developments described in this book were foreshadowed by Hänsch's early work in the 1970s when he used picosecond pulses to demonstrate the connection between the time and frequency domains in laser spectroscopy This work complemented the advances in precision laser stabilization developed by Hall

Laser Spectroscopy and Laser Imaging Helmut H. Telle, Ángel González Ureña, 2018-04-17 a very valuable book for graduate students and researchers in the field of Laser Spectroscopy which I can fully recommend Wolfgang Demtröder Kaiserslautern University of Technology How would it be possible to provide a coherent picture of this field given all the techniques available today The authors have taken on this daunting task in this impressive groundbreaking text Readers will benefit from the broad overview of basic concepts focusing on practical scientific and real life applications of laser spectroscopic analysis and imaging Chapters follow a consistent structure beginning with a succinct summary of key principles and concepts followed by an overview of applications advantages and pitfalls and finally a brief discussion of seminal advances and current developments The examples used in this text span physics and chemistry to environmental science biology and medicine Focuses on practical use in the laboratory and real world applications Covers the basic concepts common experimental setups Highlights advantages and caveats of the techniques Concludes each chapter with a snapshot of cutting edge advances This book is appropriate for anyone in the physical sciences biology or medicine looking for an introduction to laser spectroscopic and imaging methodologies Helmut H Telle is a full professor at the Instituto Pluridisciplinar Universidad Complutense de Madrid Spain Ángel González Ureña is head of the Department of Molecular Beams and Lasers Instituto Pluridisciplinar Universidad Complutense de Madrid Spain

Nonlinear Systems, Vol. 1 Victoriano Carmona, Jesús Cuevas-Maraver, Fernando Fernández-Sánchez, Elisabeth García-Medina, 2018-09-15 This book is part of a two volume set which presents the analysis of nonlinear phenomena as a long standing challenge for research in basic and applied science as well as engineering It discusses nonlinear differential and differential equations bifurcation

theory for periodic orbits and global connections The integrability and reversibility of planar vector fields and theoretical analysis of classic physical models are sketched This first volume concentrates on the mathematical theory and computational techniques that are essential for the study of nonlinear science a second volume deals with real world nonlinear phenomena in condensed matter biology and optics Semiconductor Laser Dynamics Daan Lenstra, 2020 This is a collection of 18 papers two of which are reviews and seven are invited feature papers that together form the Photonics Special Issue Semiconductor Laser Dynamics Fundamentals and Applications published in 2020 This collection is edited by Daan Lenstra an internationally recognized specialist in the field for 40 years **Laser Dynamics** Tom Shinming T. K. Tarn, 1988 **Cellular Automata** Peter M.A. Soot, Bastien Chopard, Alfons G. Hoekstra, 2004-10-14 This book constitutes the refereed proceedings of the 6th International Conference on Cellular Automata for Research and Industry ACRI 2004 held in Amsterdam The Netherlands in October 2004 The 60 revised full papers and 30 poster papers presented were carefully reviewed and selected from 150 submissions The papers are devoted to methods and theory evolved cellular automata traffic networks and communication applications in science and engineering biomedical applications natural phenomena and ecology and social and economical applications Semiconductor Lasers Junji Ohtsubo, 2007-10-24

Preface for the second edition Chaos research in laser physics especially in semiconductor lasers has developed further even after completion of the first edition of this book in the late summer of 2004 and it is still growing rapidly For example various forms of chaotic dynamics have been applied in newly developed semiconductor lasers such as in vertical cavity surface emitting semiconductor lasers and broad area semiconductor lasers Chaotic dynamics plays an important role in these new lasers even for their solitary oscillations and control of the dynamics is currently an important issue for practical applications other significant advance has been made in the area of chaotic optical secure communications Chaotic secure communications using existing public optical communications links have been tested and successful results have been obtained In this second edition I have filled in the gaps in the explanation of chaotic laser dynamics in the previous edition and I have also added several important topics that have been developed recently In particular a new chapter on laser stabilizations has been added and a number of misprints in the first edition have been corrected I believe this book will be of interest not only to researchers in the field of laser chaos but also to those working in nonlinear science and technology Hamamatsu Spring 2007 Junji Ohtsubo

Preface The aim of this book is the description of the state of the art of chaos research in semiconductor lasers and their applications and the future perspective of this field

Principles Of Laser Dynamics Book Review: Unveiling the Magic of Language

In an electronic digital era where connections and knowledge reign supreme, the enchanting power of language has become more apparent than ever. Its ability to stir emotions, provoke thought, and instigate transformation is truly remarkable. This extraordinary book, aptly titled "**Principles Of Laser Dynamics**," published by a highly acclaimed author, immerses readers in a captivating exploration of the significance of language and its profound impact on our existence. Throughout this critique, we will delve into the book's central themes, evaluate its unique writing style, and assess its overall influence on its readership.

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