

Dynamics of Solitary Waves and Periodic Waves in a $(3 + 1)$ -dimensional Nonlinear Evolution Equation

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Abstract. The Hirota bilinear method is applied to a generalised $(3 + 1)$ -dimensional nonlinear evolution equation. Using the Riemann theta function, we construct periodic wave solutions of the Eq. (1.1) and discuss their properties. Graphic examples show the propagation of the corresponding waves for different sets of parameters. We also study the asymptotic of periodic waves and their relation with solution solutions.

AMS subject classifications: 35Q51, 35Q53, 35C99, 68W30, 74J35

Key words: $(3 + 1)$ -dimensional generalized nonlinear evolution equation, exact solutions, solitary waves, periodic waves, asymptotic properties.

1. Introduction

Nonlinear evolution equations (NLEEs) represent various phenomena in physics. Finding exact solutions of such equations is an important and tough problem. There are several approaches to NLEEs, including Hirota bilinear method [17], Darboux transformation [23], inverse scattering transformation [3], Lie group method [2] and so on. Further development of these methods allows to study the integrability of various classes of NLEEs and to derive their exact solutions – cf. Refs. [5, 16, 18, 21, 25, 26, 55, 58]. In 1980, Nakamura [31] proposed a method to construct quasi-periodic solutions of NLEEs. Lambert

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Nonlinear Waves 1 Dynamics And Evolution

**Alexandr A. Ovchinnikov, Ivan I.
Ukrainskii**



Nonlinear Waves 1 Dynamics And Evolution:

Nonlinear Waves 1 Andrei V. Gaponov-Grekhov, Mikhail I. Rabinovich, Jüri Engelbrecht, 2012-12-06 Since 1972 the Schools on Nonlinear Physics in Gorky have been a meeting place for Soviet scientists working in this field Instead of producing for the first time English proceedings it has been decided to present a good cross section of nonlinear physics in the USSR Thus the participants at the last School were invited to provide English reviews and research papers for these two volumes which in the years to come will be followed by the proceedings of forthcoming schools The first volume starts with a historical overview of nonlinear dynamics from Poincaré to the present day and touches topics like attractors nonlinear oscillators and waves turbulence pattern formation and dynamics of structures in nonequilibrium dissipative media It then deals with structures bistabilities instabilities chaos dynamics of defects in 1d systems self organizations solitons spatio temporal structures and wave collapse in optical systems lasers plasmas reaction diffusion systems and solids Nonlinear Waves Andrej V. Gaponov-Grekhov, Mikhail I. Rabinovich, Jürj K. Engelbrecht, 1989

Nuclear Data for Science and Technology Syed M. Qaim, 2012-12-06 This book describes the Proceedings of the International Conference on Nuclear Data for Science and Technology held at Jilich in May 1991 The conference was in a series of application oriented nuclear data conferences organized in the past under the auspices of the Nuclear Energy Agency Nuclear Data Committee NEANDC and with the support of the Nuclear Energy Agency Committee on Reactor Physics NEACRP It was the first international conference on nuclear data held in Germany with the scientific responsibility entrusted to the Institute of Nuclear Chemistry of the Research Centre Jilich The scientific programme was established by the International Programme Committee in consultation with the International Advisers and the NEA and IAEA cooperated in the organization A total of 328 persons from 37 countries and five international organizations participated The scope of these Proceedings extends to a wide range of interdisciplinary topics dealing with measurement calculation evaluation and application of nuclear data with a major emphasis on numerical data Both energy and non energy related applications are considered and due attention is given to some fundamental aspects relevant to the understanding of nuclear data

Solitons and Chaos Ioannis Antoniou, Franklin J. Lambert, 2012-12-06 Solitons and Chaos is a response to the growing interest in systems exhibiting these two complementary manifestations of nonlinearity The papers cover a wide range of topics but share common mathematical notions and investigation techniques An introductory note on eight concepts of integrability has been added as a guide for the uninitiated reader Both specialists and graduate students will find this update on the state of the art useful Key points chaos vs integrability solitons theory and applications dissipative systems Hamiltonian systems maps and cascades direct vs inverse methods higher dimensions Lie groups Painlevé analysis numerical algorithms perturbation methods

Nonlinear Wave Dynamics of Materials and Structures Holm Altenbach, Victor A. Eremeyev, Igor S. Pavlov, Alexey V. Porubov, 2020-04-22 This book marks the 60th birthday of Prof Vladimir Erofeev a well known specialist in the field of wave

processes in solids fluids and structures Featuring a collection of papers related to Prof Erofeev s contributions in the field it presents articles on the current problems concerning the theory of nonlinear wave processes in generalized continua and structures It also discusses a number of applications as well as various discrete and continuous dynamic models of structures and media and problems of nonlinear acoustic diagnostics

Nuclear Physics at the Borderlines Jose M. Arias, Maria I. Gallardo, Manuel Lozano, 2012-12-06 This volume contains the lectures presented by invited speakers at the IV La Rlibida International Summer School on Nuclear Physics This was the IV edition of a summer school organized by our group every three years on topics related to nuclear physics This Summer School was aimed mainly at young nuclear physicists both theoreticians and experimentalists engaged in research work at predoctoral or recent postdoctoral level The topics treated in the three previous editions of the School were Heavy Ion Collisions Theory of Nuclear Structure and Reactions and Nuclear Astrophysics This year s School was entitled Nuclear Physics at the Borderlines Special emphasis was placed on those topics along which nuclear physics is expected to develop in the next few years The aim of the School was to provide the attendants with an opportunity to get into close contact with experienced researchers and listen to their account of the present state of the art in nuclear physics and the main future lines of development

Electron-Electron Correlation Effects in Low-Dimensional Conductors and Superconductors Alexandr A. Ovchinnikov, Ivan I. Ukrainskii, 2012-12-06 Advances in the physics and chemistry of low dimensional systems have been really magnificent in the last few decades Hundreds of quasi one dimensional and quasi two dimensional systems have been synthesized and studied The most popular representatives of quasi one dimensional materials are polyacetylenes CH₁ and conducting donor acceptor molecular crystals TTF z TCNQ Examples of quasi two dimensional systems are high temperature superconductors HTSC based on copper oxides La₂CuO₄ YBa₂Cu₃O_{6-y} and organic superconductors based on BEDT-TTF molecules The properties of such one and two dimensional materials are not yet fully understood On the one hand the equations of motion of one dimensional systems are rather simple which facilitates rigorous solutions of model problems On the other hand manifestations of various interactions in one dimensional systems are rather peculiar This refers in particular to electron-electron and electron-phonon interactions Even within the limit of a weak coupling constant electron-electron correlations produce an energy gap in the spectrum of one dimensional metals implying a Mott transition from metal to semiconductor state In all these cases perturbation theory is inapplicable Which is one of the main difficulties on the way towards a comprehensive theory of quasi one dimensional systems This meeting held at the Institute for Theoretical Physics in Kiev May 15-18 1990 was devoted to related problems The papers selected for this volume are grouped into three sections

Foundations of Synergetics II Alexander S. Mikhailov, Alexander Yu. Loskutov, 2012-12-06 This textbook is based on a lecture course in synergetics given at the University of Moscow In this second of two volumes we discuss the emergence and properties of complex chaotic patterns in distributed active systems Such patterns can be produced autonomously by a system or can result from selective

amplification of fluctuations caused by external weak noise Although the material in this book is often described by refined mathematical theories we have tried to avoid a formal mathematical style Instead of rigorous proofs the reader will usually be offered only demonstrations the term used by Prof V I Arnold to encourage intuitive understanding of a problem and to explain why a particular statement seems plausible We also refrained from detailing concrete applications in physics or in other scientific fields so that the book can be used by students of different disciplines While preparing the lecture course and producing this book we had intensive discussions with and asked the advice of Prof V I Arnold Prof S Grossmann Prof H Haken Prof Yu L Klimontovich Prof R L Stratonovich and Prof Ya

Quark—Gluon Plasma Bikash Sinha, Santanu Pal, Sibaji Raha, 2012-12-06 Quark Gluon Plasma QGP is a state of matter predicted by the theory of strong interactions Quantum Chromodynamics QCD The area of QGP lies at the interface of particle physics field theory nuclear physics and many body theory statistical physics cosmology and astrophysics In its brief history about a decade QGP has seen a rapid convergence of ideas from these previously diverging disciplines This volume includes the lectures delivered by eminent specialists to students without prior experience in QGP Each course thus starts from the basics and takes the students by steps to the current problems The chapters are self contained and pedagogic in style The book may therefore serve as an introduction for advanced graduate students intending to enter this field or for physicists working in other areas Experts in QGP may also find this volume a handy reference Specific examples used to elucidate how theoretical predictions and experimentally accessible quantities may not always correspond to one another make this book ideal for self study for beginners This feature will also make the volume thought provoking for QGP practitioners

High-Tc Superconductivity Aleksandr S. Davydov, Vadim M. Loktev, 2012-12-06 High Tc Superconductivity is based on a meeting held in Kiev and contains contributions discussing the most recent achievements in this field The book includes reviews and original papers covering theoretical and experimental aspects of the subject Keywords electronic and magnetic properties metallization processes emission and optic spectra levitation pinning frustration and fluctuations thin films

Problems of Modern Quantum Field Theory Aleksandr A. Belavin, Anatolii U. Klimyk, Aleksandr B. Zamolodchikov, 2012-12-06 This volume contains the invited lectures of a school on modern quantum field theory held at Alushta USSR in May 1989 The development of this subject including string theories attempting to model elementary particles is closely interwoven with modern mathematical physics The lectures presented by experts in the field provide an overview of the research pursued in different branches of this rapidly evolving field and draw attention to particular interconnections and problems Topics covered include geometrical quantization and finite size effects in conformal field theory quasi Hopf Kac Moody current and Lie super algebras quantum groups Wess Zumino Witten models Nizhnik Zamolodchikov equations non archimedean strings string dynamics KdV and KP super equations and calculations on super riemannian surfaces 2d Ising model and 2d electron motion on surfaces in external magnetic fields

Signal Transduction in Photoreceptor Cells Paul A. Hargrave, Klaus P. Hofmann, U. Benjamin

Kaupp,2013-04-09 This book deals with the mechanism of signal transduction in vertebrate and invertebrate photoreceptors It contains contributions on the structure and function of rhodopsin or other G coupled receptors on the regulation of second messengers by enzyme cascade the role of Ca^{2+} in light adaptation control of ionic channels in photoreceptor cells

Superconducting Quantum Electronics Volkmar Kose,2012-12-06 With the surprising discovery of superconductivity at temperatures above 100 K this field was not only brought into the public eye but also stimulated research in universities scientific institutions and industry thus continuing the fascinating development which began with the discovery of the Josephson effect in the sixties Cryoelectronics has become a special branch of cryophysics and cryotechnics and today plays a prominent role whenever high resolution and precision measurements are required Motivated by this development seven years ago scientists working in cryoelectronics in the Federal Republic of Germany felt the necessity for regular meetings allowing a free exchange of ideas and results achieved Seminars under the title of Kryoelektronische Bauelemente were held for the first time at the Physikalisch Technische Bundesanstalt in Braunschweig in 1982 on the occasion of the 100th anniversary of the birth of Walther Meißner a pioneer in superconductivity Since then meetings have been held every year at different venues in Germany It is now felt that the status of this field necessitates a review of the results of the past a description of the current state of the art and a discussion of future perspectives This book entitled SUPERCONDUCTING QUANTUM ELECTRONICS is a collection of invited lectures and contributions which will inform the reader on the most interesting problems involving fundamentals sensitive detectors and precision metrology being studied by different groups

Autosolitons B.S. Kerner,V.V. Osipov,2013-06-29 This monograph is devoted to an entirely new branch of nonlinear physics solitary intrinsic states or autosolitons which form in a broad class of physical chemical and biological dissipative systems Autosolitons are often observed as highly nonequilibrium regions in slightly nonequilibrium systems in many ways resembling ball lightning which occurs in the atmosphere We develop a new approach to problems of self organization and turbulence treating these phenomena as a result of spontaneous formation and subsequent evolution of autosolitons Scenarios of self organization involve sophisticated interactions between autosolitons whereas turbulence is regarded as a pattern of autosolitons which appear and disappear at random in different parts of the system This monograph is the first attempt to provide a comprehensive summary of the theory of autosolitons as developed by the authors over the years of research The monograph is comprised of three more or less autonomous parts Part I deals with the physical nature and experimental studies of autosolitons and self organization in various physical systems semiconductor and gas plasma heated gas mixture semiconductor structures composite superconductors optical and magnetic media systems with uniformly generated combustion matter distributed gas discharge and electronic systems We discuss feasibility of autosolitons in the form of highly nonequilibrium regions in slightly nonequilibrium gases and semiconductors hot and cold regions in semiconductor and gas plasmas static pulsating and traveling combustion fronts *Optical Solitons in Fibers* Akira

Hasegawa,2006-04-11 Latest developments associated with two currently active and very important theoretical and practical topics in nonlinear optics namely solitons and fibers are considered in this volume Solitons as analytical solutions of nonlinear partial differential equations were established in 1967 and only five years later Hasegawa and Tappert predicted for the first time theoretically that solitons could be generated in a dielectric fiber In practical terms this work pursued mainly at the AT T Bell Laboratories points to technological advances allowing for an economic and undistorted propagation of signals which will revolutionize telecommunications Starting from an elementary level readily accessible to undergraduates the author a pioneer in the field provides a clear and up to date exposition of both the theoretical background and the most recent experimental results in this new and rapidly evolving field This well written book is well suited for undergraduate or graduate lecture courses and makes easy reading not only for the researcher but also for the interested physicist mathematician and engineer **Nonlinear Waves I** Andrej V. Gaponov-Grechov,1989 *Nonlinear Wave Dynamics* J. Engelbrecht,2013-04-17 At the end of the twentieth century nonlinear dynamics turned out to be one of the most challenging and stimulating ideas Notions like bifurcations attractors chaos fractals etc have proved to be useful in explaining the world around us be it natural or artificial However much of our everyday understanding is still based on linearity i e on the additivity and the proportionality The larger the excitation the larger the response this seems to be carved in a stone tablet The real world is not always reacting this way and the additivity is simply lost The most convenient way to describe such a phenomenon is to use a mathematical term nonlinearity The importance of this notion i e the importance of being nonlinear is nowadays more and more accepted not only by the scientific community but also globally The recent success of nonlinear dynamics is heavily biased towards temporal characterization widely using nonlinear ordinary differential equations Nonlinear spatio temporal processes i e nonlinear waves are seemingly much more complicated because they are described by nonlinear partial differential equations The richness of the world may lead in this case to coherent structures like solitons kinks breathers etc which have been studied in detail Their chaotic counterparts however are not so explicitly analysed yet The wavebearing physical systems cover a wide range of phenomena involving physics solid mechanics hydrodynamics biological structures chemistry etc Nonlinear Waves 3 Andrei V. Gaponov-Grekhov,Mikhail I. Rabinovich,Jüri Engelbrecht,2012-12-06 Since 1972 the Schools on Nonlinear Physics in Gorky have been a meeting place for Soviet Scientists working in this field Since 1989 the proceedings appear in English They present a good cross section of nonlinear physics in the USSR This third volume emerged from material presented at the 1989 School It contains sections dealing with nonlinear problems in physics and astrophysics quantum and solid state physics dynamical chaos and self organization **Advances in Dynamics, Patterns, Cognition** Igor S. Aranson,Arkady Pikovsky,Nikolai F. Rulkov,Lev S. Tsimring,2017-05-02 This book focuses on recent progress in complexity research based on the fundamental nonlinear dynamical and statistical theory of oscillations waves chaos and structures far from equilibrium Celebrating seminal

contributions to the field by Prof M I Rabinovich of the University of California at San Diego this volume brings together perspectives on both the fundamental aspects of complexity studies as well as in applications in different fields ranging from granular patterns to understanding of the cognitive brain and mind dynamics The slate of world class authors review recent achievements that together present a broad and coherent coverage of modern research in complexity greater than the sum of its parts **Naval Research Reviews** ,1996

Reviewing **Nonlinear Waves 1 Dynamics And Evolution**: Unlocking the Spellbinding Force of Linguistics

In a fast-paced world fueled by information and interconnectivity, the spellbinding force of linguistics has acquired newfound prominence. Its capacity to evoke emotions, stimulate contemplation, and stimulate metamorphosis is really astonishing. Within the pages of "**Nonlinear Waves 1 Dynamics And Evolution**," an enthralling opus penned by a highly acclaimed wordsmith, readers attempt an immersive expedition to unravel the intricate significance of language and its indelible imprint on our lives. Throughout this assessment, we shall delve in to the book is central motifs, appraise its distinctive narrative style, and gauge its overarching influence on the minds of its readers.

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