Nonlinear waves, solitons and chaos

Eryk Infeld and George Rowlands

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Stephen Nettel

Nonlinear Waves Solitons And Chaos:

Nonlinear Waves, Solitons and Chaos Eryk Infeld,George Rowlands,2000-07-13 This revised and updated second edition of a highly successful book is the only text at this level to embrace a universal approach to three major developments in classical physics namely nonlinear waves solitons and chaos The authors now include new material on biology and laser theory and go on to discuss important recent developments such as soliton metamorphosis A comprehensive treatment of basic plasma and fluid configurations and instabilities is followed by a study of the relevant nonlinear structures Each chapter concludes with a set of problems This text will be particularly valuable for students taking courses in nonlinear aspects of physics In general it will be of value to final year undergraduates and beginning graduate students studying fluid dynamics plasma physics and applied mathematics **Nonlinear Waves, Solitons And Chaos** G. Rowlands,

Nonlinear Waves and Solitons on Contours and Closed Surfaces Andrei Ludu,2022-11-04 This new edition has been thoroughly revised expanded and contain some updates function of the novel results and shift of scientific interest in the topics The book has a Foreword by Jerry L Bona and Hongqiu Chen The book is an introduction to nonlinear waves and soliton theory in the special environment of compact spaces such a closed curves and surfaces and other domain contours It assumes familiarity with basic soliton theory and nonlinear dynamical systems The first part of the book introduces the mathematical concept required for treating the manifolds considered providing relevant notions from topology and differential geometry An introduction to the theory of motion of curves and surfaces as part of the emerging field of contour dynamics is given The second and third parts discuss the modeling of various physical solitons on compact systems such as filaments loops and drops made of almost incompressible materials thereby intersecting with a large number of physical disciplines from hydrodynamics to compact object astrophysics This book is intended for graduate students and researchers in mathematics physics and engineering **Ray Methods for Nonlinear Waves in Fluids and Plasmas** Marcelo Anile,P Pantano,G Russo,J Hunter,2021-06-24 Presents in a systematic and unified manner the ray method in its various forms for studying nonlinear wave propagation in situations of physical interest essentially fluid dynamics and plasma physics

Nonlinear Waves in Elastic Crystals Gérard A. Maugin,1999 The mathematical modelling of changing structures in materials is of increasing importance to industry where applications of the theory are found in subjects as diverse as aerospace and medicine This book deals with aspects of the nonlinear dynamics of deformable ordered solids known as elastic crystals where the nonlinear effects combine or compete with each other Physical and mathematical models are discused and computational aspects are also included Different models are considered on discrete as well as continuum scales applying heat electricity or magnetism to the crystal structure and these are analysed using the equations of rational mechanics In this way the student is introduced to the important equations of nonlinear science that describe shock waves solitons and chaos and also the non exactly integrable systems or partial differential equations A large number of problems

and examples are included many taken from recent research and involving both one dimensional and two dimensional problems as well as some coupled degress of freedom <u>Nonlinear Waves: A Geometrical Approach</u> Petar Radoev Popivanov,Angela Slavova,2018-11-16 This volume provides an in depth treatment of several equations and systems of mathematical physics describing the propagation and interaction of nonlinear waves as different modifications of these the KdV equation Fornberg Whitham equation Vakhnenko equation Camassa Holm equation several versions of the NLS equation Kaup Kupershmidt equation Boussinesq paradigm and Manakov system amongst others as well as symmetrizable quasilinear hyperbolic systems arising in fluid dynamics Readers not familiar with the complicated methods used in the theory of the equations of mathematical physics functional analysis harmonic analysis spectral theory topological methods a priori estimates conservation laws can easily be acquainted here with different solutions of some nonlinear PDEs written in a sharp form waves with their geometrical visualization and their interpretation In many cases explicit solutions waves having specific physical interpretation solitons kinks peakons ovals loops rogue waves are found and their interactions are studied and geometrically visualized To do this classical methods coming from the theory of ordinary differential equations the dressing method Hirota s direct method and the method of the simplest equation are introduced and applied At the end the paradifferential approach is used This volume is self contained and equipped with simple proofs It contains many exercises and examples arising from the applications in mechanics physics optics and quantum mechanics **Symmetry, Phase Modulation and Nonlinear Waves** Thomas J. Bridges,2017-07-03 Nonlinear waves are pervasive in nature but are often elusive when they are modelled and analysed This book develops a natural approach to the problem based on phase modulation It is both an elaboration of the use of phase modulation for the study of nonlinear waves and a compendium of background results in mathematics such as Hamiltonian systems symplectic geometry conservation laws Noether theory Lagrangian field theory and analysis all of which combine to generate the new theory of phase modulation While the build up of theory can be intensive the resulting emergent partial differential equations are relatively simple A key outcome of the theory is that the coefficients in the emergent modulation equations are universal and easy to calculate This book gives several examples of the implications in the theory of fluid mechanics and points to a wide range of new applications <u>Nonlinear Waves</u> Emmanuel Kengne,WuMing Liu,2023-02-23 This book highlights the methods to engineer dissipative and magnetic nonlinear waves propagating in nonlinear systems In the first part of the book the authors present methodologically mathematical models of nonlinear waves propagating in one and two dimensional nonlinear transmission networks without with dissipative elements Based on these models the authors investigate the generation and the transmission of nonlinear modulated waves in general and solitary waves in particular in networks under consideration In the second part of the book the authors develop basic theoretical results for the dynamics matter wave and magnetic wave solitons of nonlinear systems and of Bose Einstein condensates trapped in external potentials combined with the time

modulated nonlinearity The models treated here are based on one two and three component non autonomous Gross Pitaevskii equations Based on the Heisenberg model of spin spin interactions the authors also investigate the dynamics of magnetization in ferromagnet with or without spin transfer torque This research book is suitable for physicists mathematicians engineers and graduate students in physics mathematics and network and information engineering

Wave Physics Stephen Nettel,2008-11-21 This textbook gives a detailed explanation of waves and oscillations in classical physics These classical phenomena are dealt with at a more advanced level than is customary for second year courses All aspects of classical wave physics are presented including the mathematical and physical basis needed for extended understanding Finally several chapters are devoted to important topics in current wave physics Special attention is given to nonlinear waves solitons chaotic behavior and associated phenomena The new edition contains improvements such as full development of Greens functions a broadening of the treatment of wave mechanics and a closer integration with classical mechanics plus more examples and problems **Mathematics of Complexity and Dynamical Systems** Robert A. Meyers,2011-10-05 Mathematics of Complexity and Dynamical Systems is an authoritative reference to the basic tools and concepts of complexity systems theory and dynamical systems from the perspective of pure and applied mathematics Complex systems are systems that comprise many interacting parts with the ability to generate a new quality of collective behavior through self organization e g the spontaneous formation of temporal spatial or functional structures These systems are often characterized by extreme sensitivity to initial conditions as well as emergent behavior that are not readily predictable or even completely deterministic The more than 100 entries in this wide ranging single source work provide a comprehensive explication of the theory and applications of mathematical complexity covering ergodic theory fractals and multifractals dynamical systems perturbation theory solitons systems and control theory and related topics Mathematics of Complexity and Dynamical Systems is an essential reference for all those interested in mathematical complexity from undergraduate and graduate students up through professional researchers *Recent Mathematical Methods in Nonlinear Wave Propagation* Guy Boillat,Constantin M. Dafermos,Peter D. Lax,Tai-Ping Liu,2006-11-14 These lecture notes of the courses presented at the first CIME session 1994 by leading scientists present the state of the art in recent mathematical methods in Nonlinear Wave Propagation **Traveling Wave Analysis of Partial Differential Equations** Graham Griffiths,William E. Schiesser,2010-12-09 Although the Partial Differential Equations PDE models that are now studied are usually beyond traditional mathematical analysis the numerical methods that are being developed and used require testing and validation This is often done with PDEs that have known exact analytical solutions The development of analytical solutions is also an active area of research with many advances being reported recently particularly traveling wave solutions for nonlinear evolutionary PDEs Thus the current development of analytical solutions directly supports the development of numerical methods by providing a spectrum of test problems that can be used to evaluate numerical methods This book

surveys some of these new developments in analytical and numerical methods and relates the two through a series of PDE examples The PDEs that have been selected are largely named since they carry the names of their original contributors These names usually signify that the PDEs are widely recognized and used in many application areas The authors intention is to provide a set of numerical and analytical methods based on the concept of a traveling wave with a central feature of conversion of the PDEs to ODEs The Matlab and Maple software will be available for download from this website shortly www pdecomp net Includes a spectrum of applications in science engineering applied mathematics Presents a combination of numerical and analytical methods Provides transportable computer codes in Matlab and Maple   <u>Wave Physics</u> Stephen Nettel,2013-04-17 This is a text for the third semester of undergraduate physics for students in accelerated programs who typically are preparing for advanced degrees in science or engineering The third semester is often the only opportunity for physics departments to present to students who are not physics majors a coherent background in the physics of waves required later for confident handling of applied problems especially applications based on quantum mechanics Physics is a coherent subject It is often found that the going gets easier as one goes deeper learning the mathematical connections tying together the various phenomena Even so the steps that took us from classical wave physics to Heisenberg s Physical Principles of Quantum Theory were as a matter of history harder to take than later steps dealing with detailed applications With these considerations in mind the classical physics of os cillations and waves is developed here at a more advanced mathematical level than is customary in second year courses This is done to explain the classical phenomena but also to provide background for the introductory wave mechanics leading to a logical integration of the latter subject into the presentation Concurrently detailed applications of quantum mechanics are beyond the mission of the text The concluding chapters on nonlinear waves solitons and chaos broaden the previously established concepts of wave behavior while introducing the reader to important topics in current wave physics   **Advances In Coastal And Ocean Engineering, Vol 4** Philip L-f Liu,Norden E Huang,Costas Synolakis,Pablo Blondeaux,Giovanna Vittori,B Mutlu Sumer,Jorgen Fredsoe,1999-06-17 This volume consists of five excellent review papers In the first paper A Review of Coastal Wave Modeling The Physical and Mathematical Problems N E Huang presents a summary of the state of the art of wave modeling in deep waters He points out several shortcomings in existing modeling approaches and expresses the urgent need for developing a statistical theory of surface waves in shallow waters Huang believes that the statistical theory can be formulated as the soliton turbulence He also points out other important issues in wave modeling including the air sea interaction processes and the physics of the wave current and dissipation processes In the second paper A C Radder focuses his discussion on the Hamiltonian Dynamics of Water Waves He demonstrates that the Hamiltonian theory of surface waves can be formulated in terms of surface elevation and the velocity potential at the free surface as canonical variables Several evolution equations can be readily obtained Radder also points out the need to develop a stochastic wave model in the

shallow water environment The maximum runup is arguably the single most important parameter in the design of coastal structures and for the evaluation of the inundation potential of storm surges and tsunamis C E Synolakis presents a thorough review of the Exact Solutions of Shallow Water Wave Equations For a single sloping beach the evolution and runup of solitary dipole N and cnoidal waves are discussed These solutions are then extended to more practical problems The last two papers concern the flow and sediment motions near the seafloor In their paper Boundary Layer and Sediment Dynamics Under Sea Waves P Blondeaux and G Vittori give an expert review of the recent contributions on the understanding of the interaction of the coherent vortex with cohesionless or partially cohesive sediments in a boundary layer The formation and development of small scale bedforms in the coastal regions are also discussed Finally in Wave Scour Around Structures B M Sumer and J Freds e review the scouring processes around various types of structures Many recent experimental data and theoretical developments are presented **Advances in Coastal and Ocean Engineering** Philip L. F. Liu,1999 This volume consists of five excellent review papers In the first paper A Review of Coastal Wave Modeling The Physical and Mathematical Problems N E Huang presents a summary of the state of the art of wave modeling in deep waters He points out several shortcomings in existing modeling approaches and expresses the urgent need for developing a statistical theory of surface waves in shallow waters Huang believes that the statistical theory can be formulated as the soliton turbulence He also points out other important issues in wave modeling including the air sea interaction processes and the physics of the wave current and dissipation processes In the second paper A C Radder focuses his discussion on the Hamiltonian Dynamics of Water Waves He demonstrates that the Hamiltonian theory of surface waves can be formulated in terms of surface elevation and the velocity potential at the free surface as canonical variables Several evolution equations can be readily obtained Radder also points out the need to develop a stochastic wave model in the shallow water environment The maximum runup is arguably the single most important parameter in the design of coastal structures and for the evaluation of the inundation potential of storm surges and tsunamis C E Synolakis presents a thorough review of the Exact Solutions of Shallow Water Wave Equations For a single sloping beach the evolution and runup of solitary dipole N and cnoidal waves are discussed These solutions are then extended to more practical problems The last two papers concern the flow and sediment motions near the seafloor In their paper Boundary Layer and Sediment Dynamics Under Sea Waves P Blondeaux and G Vittori give an expert review of the recent contributions on the understanding of the interaction of the coherent vortex with cohesionless or partially cohesive sediments in a boundary layer The formation and development of small scale bedforms in the coastal regions are also discussed Finally in Wave Scour Around Structures B M Sumer and J Freds e review the scouring processes around various types of structures Many recent experimental data and theoretical developments are presented

Integrable Hamiltonian Hierarchies Vladimir Gerdjikov,Gaetano Vilasi,Alexandar Borisov Yanovski,2008-12-02 This book presents a detailed derivation of the spectral properties of the Recursion Operators allowing one to derive all the

fundamental properties of the soliton equations and to study their hierarchies **Advances in Applied Mechanics** ,1996-05-09 This highly acclaimed series provides survey articles on the present state and future direction of research in important branches of applied mechanics **Asymptotic Modelling of Fluid Flow Phenomena** Radyadour Kh. Zeytounian,2006-04-10 for the fluctuations around the means but rather fluctuations and appearing in the following incompressible system of equations on any wall at initial time and are assumed known This contribution arose from discussion with J P Guiraud on attempts to push forward our last co signed paper 1986 and the main idea is to put a stochastic structure on fluctuations and to identify the large eddies with a part of the probability space The Reynolds stresses are derived from a kind of Monte Carlo process on equations for fluctuations Those are themselves modelled against a technique using the Guiraud and Zeytounian 1986 The scheme consists in a set of like equations considered as random because they mimic the large eddy fluctuations The Reynolds stresses are got from stochastic averaging over a family of their solutions Asymptotics underlies the scheme but in a rather loose hidden way We explain this in relation with homogenizati localization processes described within the 3 4 ofChapter 3 Ofcourse the mathematical well posedness of the scheme is not known and the numerics would be formidable Whether this attempt will inspire researchers in the field of highly complex turbulent flows is not foreseeable and we have hope that the idea will prove useful *Asymptotic Perturbation Methods* Attilio Maccari,2023-01-10 Asymptotic Perturbation Methods Cohesive overview of powerful mathematical methods to solve differential equations in physics Asymptotic Perturbation Methods for Nonlinear Differential Equations in Physics addresses nonlinearity in various fields of physics from the vantage point of its mathematical description in the form of nonlinear partial differential equations and presents a unified view on nonlinear systems in physics by providing a common framework to obtain approximate solutions to the respective nonlinear partial differential equations based on the asymptotic perturbation method Aside from its complete coverage of a complicated topic a noteworthy feature of the book is the emphasis on applications There are several examples included throughout the text and crucially the scientific background is explained at an elementary level and closely integrated with the mathematical theory to enable seamless reader comprehension To fully understand the concepts within this book the prerequisites are multivariable calculus and introductory physics Written by a highly qualified author with significant accomplishments in the field Asymptotic Perturbation Methods for Nonlinear Differential Equations in Physics covers sample topics such as Application of the various flavors of the asymptotic perturbation method such as the Maccari method to the governing equations of nonlinear system Nonlinear oscillators limit cycles and their bifurcations iterated nonlinear maps continuous systems and nonlinear partial differential equations NPDEs Nonlinear systems such as the van der Pol oscillator with advanced coverage of plasma physics quantum mechanics elementary particle physics cosmology and chaotic systems Infinite period bifurcation in the nonlinear Schrodinger equation and fractal and chaotic solutions in NPDEs Asymptotic Perturbation Methods for Nonlinear Differential Equations in Physics

is ideal for an introductory course at the senior or first year graduate level It is also a highly valuable reference for any professional scientist who does not possess deep knowledge about nonlinear physics   Optical Remote Sensing of Ocean Hydrodynamics Victor Raizer,2019-03-04 Optical Remote Sensing is one of the main technologies used in sea surface monitoring Optical Remote Sensing of Ocean Hydrodynamics investigates and demonstrates capabilities of optical remote sensing technology for enhanced observations and detection of ocean environments It provides extensive knowledge of physical principles and capabilities of optical observations of the oceans at high spatial resolution 1 4m and on the observations of surface wave hydrodynamic processes It also describes the implementation of spectral statistical and fusion algorithms for analyses of multispectral optical databases and establishes physics based criteria for detection of complex wave phenomena and hydrodynamic disturbances including assessment and management of optical databases This book explains the physical principles of high resolution optical imagery of the ocean surface discusses for the first time the capabilities of observing hydrodynamic processes and events and emphasizes the integration of optical measurements and enhanced data analysis It also covers both the assessment and the interpretation of dynamic multispectral optical databases and includes applications for advanced studies and nonacoustic detection This book is an invaluable resource for researches industry professionals engineers and students working on cross disciplinary problems in ocean hydrodynamics optical remote sensing of the ocean and sea surface remote sensing Readers in the fields of geosciences and remote sensing applied physics oceanography satellite observation technology and optical engineering will learn the theory and practice of optical interactions with the ocean

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