

# Nonlinear waves

- 2 groups: waves described by linear stability models, and waves described by nonlinear models
- Steepening timescale (Horn et al. 2001) determines when nonlinear effects are important
  - Moderate forcing
  - Layer depth ratio

# Nonlinear Waves

**Gérard A. Maugin**



## **Nonlinear Waves :**

*Linear and Nonlinear Waves* G. B. Whitham, 2011-10-18 Now in an accessible paperback edition this classic work is just as relevant as when it first appeared in 1974 due to the increased use of nonlinear waves It covers the behavior of waves in two parts with the first part addressing hyperbolic waves and the second addressing dispersive waves The mathematical principles are presented along with examples of specific cases in communications and specific physical fields including flood waves in rivers waves in glaciers traffic flow sonic booms blast waves and ocean waves from storms *Advances in Nonlinear Waves*, 1984 **Nonlinear Waves** Lokenath Debnath, 2009-01-08 The outcome of a conference held in East Carolina University in June 1982 this book provides an account of developments in the theory and application of nonlinear waves in both fluids and plasmas Twenty two contributors from eight countries here cover all the main fields of research including nonlinear water waves KdV equations solitons and inverse scattering transforms stability of solitary waves resonant wave interactions nonlinear evolution equations nonlinear wave phenomena in plasmas recurrence phenomena in nonlinear wave systems and the structure and dynamics of envelope solitons in plasmas *New Approaches to Nonlinear Waves* Elena Tobisch, 2015-08-19 The book details a few of the novel methods developed in the last few years for studying various aspects of nonlinear wave systems The introductory chapter provides a general overview thematically linking the objects described in the book Two chapters are devoted to wave systems possessing resonances with linear frequencies Chapter 2 and with nonlinear frequencies Chapter 3 In the next two chapters modulation instability in the KdV type of equations is studied using rigorous mathematical methods Chapter 4 and its possible connection to freak waves is investigated Chapter 5 The book goes on to demonstrate how the choice of the Hamiltonian Chapter 6 or the Lagrangian Chapter 7 framework allows us to gain a deeper insight into the properties of a specific wave system The final chapter discusses problems encountered when attempting to verify the theoretical predictions using numerical or laboratory experiments All the chapters are illustrated by ample constructive examples demonstrating the applicability of these novel methods and approaches to a wide class of evolutionary dispersive PDEs e g equations from Benjamin Oro Boussinesq Hasegawa Mima KdV type Klein Gordon NLS type Serre Shamel Whitham and Zakharov This makes the book interesting for professionals in the fields of nonlinear physics applied mathematics and fluid mechanics as well as students who are studying these subjects The book can also be used as a basis for a one semester lecture course in applied mathematics or mathematical physics *Nonlinear Waves* 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

**Nonlinear Waves in Solids** A. Jeffrey, J. Engelbrecht, 2014-05-04 Travelling wave processes and wave motion are of great importance in many areas of mechanics and nonlinearity also plays a decisive role there The basic mathematical models in this area involve nonlinear partial differential equations and predictability of behaviour of wave phenomena is of great importance Beside fluid dynamics and gas dynamics which have long been the traditional nonlinear sciences solid mechanics is now taking an ever increasing account of nonlinear effects Apart from plasticity and fracture mechanics nonlinear elastic waves have been shown to be of great importance in many areas such as the study of impact nondestructive testing and seismology These lectures offer a thorough account of the fundamental theory of nonlinear deformation waves and in the process offer an up to date account of the current state of research in the theory and practice of nonlinear waves in solids

**Nonlinear Waves: A Geometrical Approach** 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 paradiifferential 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

*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

**Quantum Mechanics and Nonlinear Waves** Philip Barnes Burt, 1981 **Physics of Nonlinear Waves** Mitsuhiro Tanaka, 2019-12-18 This is an introductory book about nonlinear waves It focuses on two properties that various different wave phenomena have in common the nonlinearity and dispersion and explains them in a style that is easy to understand for first time students Both of these properties have important effects on wave phenomena Nonlinearity for example makes the wave lean forward and leads to wave breaking or enables waves with different wavenumber and frequency to interact with each other and exchange their energies Dispersion for example sorts irregular waves containing various wavelengths into gentler wavetrains with almost uniform wavelengths as they propagate or cause a difference between the propagation speeds of the wave waveform and the wave energy Many phenomena are introduced and explained using water waves as an example but this is just a tool to make it easier to draw physical images Most of the phenomena introduced in this book are common to all nonlinear and dispersive waves This book focuses on understanding the physical aspects of wave phenomena and requires very little mathematical knowledge The necessary minimum knowledges about Fourier analysis perturbation method dimensional analysis the governing equations of water waves etc are provided in the text and appendices so even second or third year undergraduate students will be able to fully understand the contents of the book and enjoy the fun of nonlinear wave phenomena without relying on other books

**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

**Nonlinear Waves and Solitons** M. Toda, 1989-11-30 it is certainly a beautiful presentation very well adapted to teaching beginners I am sure this book will be successful

Nonlinear Ocean Waves and the Inverse Scattering Transform Alfred Osborne, 2010-04-07 For more than 200 years the Fourier Transform has been one of the most important mathematical tools for understanding the dynamics of linear wave trains Nonlinear Ocean Waves and the Inverse Scattering Transform presents the development of the nonlinear Fourier analysis of measured space and time series which can be found in a wide variety of physical settings including surface water

waves internal waves and equatorial Rossby waves This revolutionary development will allow hyperfast numerical modelling of nonlinear waves greatly advancing our understanding of oceanic surface and internal waves Nonlinear Fourier analysis is based upon a generalization of linear Fourier analysis referred to as the inverse scattering transform the fundamental building block of which is a generalized Fourier series called the Riemann theta function Elucidating the art and science of implementing these functions in the context of physical and time series analysis is the goal of this book Presents techniques and methods of the inverse scattering transform for data analysis Geared toward both the introductory and advanced reader venturing further into mathematical and numerical analysis Suitable for classroom teaching as well as research

*Nonlinear Waves in Integrable and Nonintegrable Systems* Jianke Yang, 2010-01-01 Presents cutting edge developments in the theory and experiments of nonlinear waves Its comprehensive coverage of analytical and numerical methods for nonintegrable systems is the first of its kind      **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 in Elastic Media** A.G. Kulikovskii, Elena I. Sveshnikova, 2021-06-30 Nonlinear Waves in Elastic Media explores the theoretical results of one dimensional nonlinear waves including shock waves in elastic media It is the first book to provide an in depth and comprehensive presentation of the nonlinear wave theory while taking anisotropy effects into account The theory is completely worked out and draws on 15 years of research by the authors one of whom also wrote the 1965 classic Magnetohydrodynamics Nonlinear Waves in Elastic Media emphasizes the behavior of quasitransverse waves and analyzes arbitrary discontinuity disintegration problems illustrating that the solution can be non unique a surprising result The solution is shown to be especially interesting when anisotropy and nonlinearity effects interact even in small amplitude waves In addition the text contains an independent mathematical chapter describing general methods to study hyperbolic systems expressing the conservation laws The theoretical results described in Nonlinear Waves in Elastic Media allow for the first time discovery and interpretation of many new peculiarities inherent to the general problem of discontinuous solutions and so provide a valuable resource for advanced students and researchers involved with continuum mechanics and partial differential equations      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 discussed 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 degrees of freedom Nonlinear Waves in Solid State Physics A.D.

Boardman,M. Bertolotti,T. Twardowski,2012-12-06 This book is based on the contributions to the 17th International School of Materials Science and Technology entitled Nonlinear Waves in Solid State Physics This was held as a NATO Advanced Study Institute at the Ettore Majorana Centre in Erice Sicily between the 1st and 15 July 1989 and attracted almost 100 participants from over 20 different countries The book covers the fundamental properties of nonlinear waves in solid state materials dealing with both theory and experiment The aim is to emphasise the methods underpinning the important new developments in this area The material is organised into subject areas that can broadly be classified into the following groups the theory of nonlinear surface and guided waves in self focusing magnetic and non magnetic materials nonlinear effects at interfaces nonlinear acoustoelectronic and surface acoustic waves Lagrangian and Hamiltonian formulations of nonlinear problems nonlinear effects in optical fibres resonance phenomena and nonlinear integrated optics The chapters have been grouped together according to these classifications as closely as possible but it should be borne in mind that although there is much overlap of ideas each chapter is essentially independent of the others We would like to acknowledge the sponsorship of the NATO Scientific Affairs Division the European Physical Society the National Science Foundation of the USA the European Research Office the Italian Ministry of Education the Italian Ministry of Scientific and Technological Research the Sicilian Regional Government and the Ugo Bordoni Foundation **Dynamical Systems and Nonlinear Waves in Plasmas**

Santo Banerjee,Asit Saha,2021-09-10 Dynamical systems and Nonlinear Waves in Plasmas is written in a clear and comprehensible style to serve as a compact volume for advanced postgraduate students and researchers working in the areas of Applied Physics Applied Mathematics Dynamical Systems Nonlinear waves in Plasmas or other nonlinear media It provides an introduction to the background of dynamical systems waves oscillations and plasmas Basic concepts of dynamical systems and phase plane analysis for the study of dynamical properties of nonlinear waves in plasmas are presented Different kinds of waves in plasmas are introduced Reductive perturbative technique and its applications to derive different kinds of nonlinear evolution equations in plasmas are discussed Analytical wave solutions of these nonlinear evolution equations are presented using the concept of bifurcation theory of planar dynamical systems in a very simple way Bifurcations of both small and

arbitrary amplitudes of various nonlinear acoustic waves in plasmas are presented using phase plots and time series plots Super nonlinear waves and its bifurcation behaviour are discussed for various plasma systems Multiperiodic quasiperiodic and chaotic motions of nonlinear plasma waves are discussed in presence of external periodic force Multistability of plasma waves is investigated Stable oscillation of plasma waves is also presented in dissipative plasmas The book is meant for undergraduate and postgraduate students studying plasma physics It will also serve a reference to the researchers scientists and faculties to pursue the dynamics of nonlinear waves and its properties in plasmas It describes the concept of dynamical systems and is useful in understanding exciting features such as solitary wave periodic wave supernonlinear wave chaotic quasiperiodic and coexisting structures of nonlinear waves in plasmas The concepts and approaches discussed in the book will also help the students and professionals to study such features in other nonlinear media

**Nonlinear Waves And Inverse Scattering Transform** Spencer P Kuo, 2023-06-26 Nonlinear waves are essential phenomena in scientific and engineering disciplines The features of nonlinear waves are usually described by solutions to nonlinear partial differential equations NLPDEs This book was prepared to familiarize students with nonlinear waves and methods of solving NLPDEs which will enable them to expand their studies into related areas The selection of topics and the focus given to each provide essential materials for a lecturer teaching a nonlinear wave course Chapter 1 introduces mode types in nonlinear systems as well as B klund transform an indispensable technique to solve generic NLPDEs for stationary solutions Chapters 2 and 3 are devoted to the derivation and solution characterization of three generic nonlinear equations nonlinear Schr dinger equation Korteweg de Vries KdV equation and Burgers equation Chapter 4 is devoted to the inverse scattering transform IST addressing the initial value problems of a group of NLPDEs In Chapter 5 derivations and proofs of the IST formulas are presented Steps for applying IST to solve NLPDEs for solitary solutions are illustrated in Chapter 6



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## **Table of Contents Nonlinear Waves**

1. Understanding the eBook Nonlinear Waves
  - The Rise of Digital Reading Nonlinear Waves
  - Advantages of eBooks Over Traditional Books
2. Identifying Nonlinear Waves
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Nonlinear Waves
  - User-Friendly Interface
4. Exploring eBook Recommendations from Nonlinear Waves
  - Personalized Recommendations
  - Nonlinear Waves User Reviews and Ratings
  - Nonlinear Waves and Bestseller Lists
5. Accessing Nonlinear Waves Free and Paid eBooks
  - Nonlinear Waves Public Domain eBooks
  - Nonlinear Waves eBook Subscription Services
  - Nonlinear Waves Budget-Friendly Options

6. Navigating Nonlinear Waves eBook Formats
  - ePub, PDF, MOBI, and More
  - Nonlinear Waves Compatibility with Devices
  - Nonlinear Waves Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Nonlinear Waves
  - Highlighting and Note-Taking Nonlinear Waves
  - Interactive Elements Nonlinear Waves
8. Staying Engaged with Nonlinear Waves
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Nonlinear Waves
9. Balancing eBooks and Physical Books Nonlinear Waves
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Nonlinear Waves
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Nonlinear Waves
  - Setting Reading Goals Nonlinear Waves
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Nonlinear Waves
  - Fact-Checking eBook Content of Nonlinear Waves
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements

- Interactive and Gamified eBooks

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