

A Course on Nonlinear Waves

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Course On Nonlinear Waves

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Course On Nonlinear Waves:

A Course on Nonlinear Waves S.S. Shen, 2012-12-06 The aim of this book is to give a self contained introduction to the mathematical analysis and physical explanations of some basic nonlinear wave phenomena This volume grew out of lecture notes for graduate courses which I gave at the University of Alberta the University of Saskatchewan and Texas A yet practical methodology as well as some of the more important results obtained since the 1950 s Although the primary purpose of this volume is to serve as a textbook it should be useful to anyone who wishes to understand or conduct research into nonlinear waves Here for the first time materials on X ray crystallography and the forced Korteweg de Vries equation are incorporated naturally into a textbook on nonlinear waves Another characteristic feature of the book is the inclusion of four symbolic calculation programs written in MATHEMATICA They emphasize outcomes rather than numerical methods and provide certain symbolic and numerical results related to solitons Requiring only one or two commands to run these programs have user friendly interfaces For example to get the explicit expression of the 2 soliton of the Korteweg de Vries equation one only needs to type in soliton 2 when using the program solipac m

Nonlinear Periodic Waves And Their Modulations: An Introductory Course Anatoly M Kamchatnov, 2000-09-05 Although the mathematical theory of nonlinear waves and solitons has made great progress its applications to concrete physical problems are rather poor especially when compared with the classical theory of linear dispersive waves and nonlinear fluid motion The Whitham method which describes the combining action of the dispersive and nonlinear effects as modulations of periodic waves is not widely used by applied mathematicians and physicists though it provides a direct and natural way to treat various problems in nonlinear wave theory Therefore it is topical to describe recent developments of the Whitham theory in a clear and simple form suitable for applications in various branches of physics This book develops the techniques of the theory of nonlinear periodic waves at elementary level and in great pedagogical detail It provides an introduction to a Whitham s theory of modulation in a form suitable for applications The exposition is based on a thorough analysis of representative examples taken from fluid mechanics nonlinear optics and plasma physics rather than on the formulation and study of a mathematical theory Much attention is paid to physical motivations of the mathematical methods developed in the book The main applications considered include the theory of collisionless shock waves in dispersive systems and the nonlinear theory of soliton formation in modulationally unstable systems Exercises are provided to amplify the discussion of important topics such as singular perturbation theory Riemann invariants the finite gap integration method and Whitham equations and their solutions

Nonlinear Waves in Waveguides Sergei B. Leble, 2013-11-11 S B Leble s book deals with nonlinear waves and their propagation in metallic and dielectric waveguides and media with stratification The underlying nonlinear evolution equations NEEs are derived giving also their solutions for specific situations The reader will find new elements to the traditional approach Various dispersion and relaxation laws for different guides are considered as well as the explicit form of projection

operators NEEs quasi solitons and of Darboux transforms Special points relate to 1 the development of a universal asymptotic method of deriving NEEs for guide propagation 2 applications to the cases of stratified liquids gases solids and plasmas with various nonlinearities and dispersion laws 3 connections between the basic problem and soliton like solutions of the corresponding NEEs 4 discussion of details of simple solutions in higher order nonsingular perturbation theory

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

Lectures on the Energy Critical Nonlinear Wave Equation Carlos E. Kenig, 2015-04-14 This monograph deals with recent advances in the study of the long time asymptotics of large solutions to critical nonlinear dispersive equations The first part of the monograph describes in the context of the energy critical wave equation the concentration compactness rigidity theorem method introduced by C Kenig and F Merle This approach has become the canonical method for the study of the global regularity and well posedness conjecture defocusing case and the ground state conjecture focusing case in critical dispersive problems The second part of the monograph describes the channel of energy method introduced by T Duyckaerts C Kenig and F Merle to study soliton resolution for nonlinear wave equations This culminates in a presentation of the proof of the soliton resolution conjecture for the three dimensional radial focusing energy critical wave equation It is the intent that the results described in this book will be a model for what to strive for in the study of other nonlinear dispersive equations A co publication of the AMS and CBMS

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

Nonlinear Elastic Waves in Materials Jeremiah J. Rushchitsky, 2014-04-23 The main goal of the book is a coherent treatment of the theory of propagation in materials of nonlinearly elastic waves of displacements which corresponds to one modern line of development of the nonlinear theory of elastic waves The book is divided on five basic parts the necessary information on waves and materials the necessary information on nonlinear theory of elasticity and elastic materials analysis of one dimensional nonlinear elastic waves of displacement longitudinal vertically and horizontally polarized transverse plane nonlinear elastic waves of displacement analysis of one dimensional nonlinear elastic waves of displacement cylindrical and torsional nonlinear elastic waves of displacement analysis of two dimensional nonlinear elastic waves of displacement Rayleigh and Love nonlinear elastic surface waves The book is addressed first of all to people working in solid mechanics from the students at an advanced undergraduate and graduate level to the scientists professionally interesting in waves But mechanics is understood in the broad sense when it includes mechanical and other engineering material science applied mathematics and physics and so forth The genesis of this book can be found in author s years of research and teaching while a head of department at SP Timoshenko Institute of Mechanics National Academy of Sciences of Ukraine a member of Center for Micro and Nanomechanics at Engineering School of University of Aberdeen Scotland and a professor at Physical Mathematical Faculty of National Technical University of Ukraine KPI The book comprises 11 chapters Each chapter is complemented by exercises which can be used for the next development of the theory of nonlinear waves

Quantum Mechanics and Nonlinear Waves Philip Barnes Burt, 1981

Handbook of Dynamical Systems B. Fiedler, 2002-02-21 This handbook is volume II in a series collecting mathematical state of the art surveys in the field of dynamical systems Much of this field has developed from interactions with other areas of science and this volume shows how concepts of dynamical systems further the understanding of mathematical issues that arise in applications Although modeling issues are addressed the central theme is the mathematically rigorous investigation of the resulting differential equations and their dynamic behavior However the authors and editors have made an effort to ensure readability on a non technical level for mathematicians from other fields and for other scientists and engineers The eighteen surveys collected here do not aspire to encyclopedic completeness but present selected paradigms The surveys are grouped into those emphasizing finite dimensional methods numerics topological methods and partial differential equations Application areas include the dynamics of neural networks fluid flows nonlinear optics and many others While the survey articles can be read independently they deeply share recurrent themes from dynamical systems Attractors bifurcations center manifolds dimension reduction ergodicity homoclinicity hyperbolicity invariant and inertial manifolds normal forms recurrence shift dynamics stability to name just a few are ubiquitous dynamical concepts throughout the articles

The Effect of Charge Separation on Nonlinear Waves in a Collision-free Plasma Fred Alan Wolf, 1962

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

An Introduction to the Mathematical Theory of Waves Roger Knobel, 2000 This book is based on an undergraduate course taught at the IAS Park City Mathematics Institute Utah on linear and nonlinear waves The first part of the text overviews the concept of a wave describes one dimensional waves using functions of two variables provides an introduction to partial differential equations and discusses computer aided visualization techniques The second part of the book discusses traveling waves leading to a description of solitary waves and soliton solutions of the Klein Gordon and Korteweg deVries equations The wave equation is derived to model the small vibrations of a taut string and solutions are constructed via d'Alembert's formula and Fourier series The last part of the book discusses waves arising from conservation laws After deriving and discussing the scalar conservation law its solution is described using the method of characteristics leading to the formation of shock and rarefaction waves Applications of these concepts are then given for models of traffic flow The intent of this book is to create a text suitable for independent study by undergraduate students in mathematics engineering and science The content of the book is meant to be self contained requiring no special reference material Access to computer software such as Mathematica[®] MATLAB[®] or Maple[®] is recommended but not necessary Scripts for MATLAB applications will be available via the Web Exercises are given within the text to allow further practice with selected topics

Nonlinear Waves: Classical and Quantum Aspects Fatkhulla Abdullaev, Vladimir V. Konotop, 2006-03-02 Leading scientists discuss the most recent physical and experimental results in the physics of Bose Einstein condensate theory the theory of nonlinear lattices including quantum and nonlinear lattices and nonlinear optics and photonics Classical and quantum aspects of the dynamics of nonlinear waves are considered The contributions focus on the Gross Pitaevskii equation and on the quantum nonlinear Schrödinger equation Recent experimental results on atomic condensates and hydrogen bonded systems are reviewed Particular attention is given to nonlinear matter waves in periodic potential

Introduction to the Mathematical Physics of Nonlinear Waves Minoru Fujimoto, 2014-03-01 Nonlinear physics is a well established

discipline in physics today and this book offers a comprehensive account of the basic soliton theory and its applications. Although primarily mathematical, the theory for nonlinear phenomena in practical environment.

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 is 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.

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.

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.

Wave Momentum And Quasi-particles In Physical Acoustics Gerard A. Maugin, Martine Rousseau, 2015-03-26. This unique volume presents an original approach to physical acoustics with additional emphasis on the most useful surface acoustic waves on solids. The study is based on foundational work of L. Brillouin and application of the celebrated invariance theorem of Emmy Noether to an element of volume that is representative of the wave motion. This approach provides an easy interpretation of typical wave motions of physical acoustics in bulk, at surfaces, and across interfaces in the form of the motion of associated quasi-particles. This type of motion, Newtonian or not, depends on the wave motion considered and on the original modeling of the continuum that supports it. After a thoughtful review of Brillouin's fundamental ideas related to radiative stresses, wave momentum, and action, and the necessary reminder on modern nonlinear continuum thermomechanics, invariance theory, and techniques of asymptotics, a variety of situations and models illustrates the power and richness of the approach and its strong potential in applications: Elasticity, piezoelectricity, and new models of

continua with nonlinearity viscosity and some generalized features microstructure weak or strong nonlocality or unusual situations bounding surface with energy elastic thin film glued on a surface waveguide are considered exhibiting thus the versatility of the approach This original book offers an innovative vision and treatment of the problems of wave propagation in deformable solids It opens up new horizons in the theoretical and applied facets of physical acoustics *Linear And Nonlinear Wave Propagation* Spencer P Kuo,2021-04-16 Waves are essential phenomena in most scientific and engineering disciplines such as electromagnetism and optics and different mechanics including fluid solid structural quantum etc They appear in linear and nonlinear systems Some can be observed directly and others are not The features of the waves are usually described by solutions to either linear or nonlinear partial differential equations which are fundamental to the students and researchers Generic equations describing wave and pulse propagation in linear and nonlinear systems are introduced and analyzed as initial boundary value problems These systems cover the general properties of non dispersive and dispersive uniform and non uniform with without dissipations Methods of analyses are introduced and illustrated with analytical solutions Wave wave and wave particle interactions ascribed to the nonlinearity of media such as plasma are discussed in the final chapter This interdisciplinary textbook is essential reading for anyone in above mentioned disciplines It was prepared to provide students with an understanding of waves and methods of solving wave propagation problems The presentation is self contained and should be read without difficulty by those who have adequate preparation in classic mechanics The selection of topics and the focus given to each provide essential materials for a lecturer to cover the bases in a linear nonlinear wave course **Nonlinear Dynamics** Muthusamy Lakshmanan,Shanmuganathan Rajaseekar,2012-12-06 Integrability chaos and patterns are three of the most important concepts in nonlinear dynamics These are covered in this book from fundamentals to recent developments The book presents a self contained treatment of the subject to suit the needs of students teachers and researchers in physics mathematics engineering and applied sciences who wish to gain a broad knowledge of nonlinear dynamics It describes fundamental concepts theoretical procedures experimental and numerical techniques and technological applications of nonlinear dynamics Numerous examples and problems are included to facilitate the understanding of the concepts and procedures described In addition to 16 chapters of main material the book contains 10 appendices which present in depth mathematical formulations involved in the analysis of various nonlinear systems

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