

Solitons in Mathematics and Physics

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Solitons In Mathematics And Physics

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Solitons In Mathematics And Physics:

Solitons in Mathematics and Physics Alan C. Newell, 1985-01-01 The soliton is a dramatic concept in nonlinear science What makes this book unique in the treatment of this subject is its focus on the properties that make the soliton physically ubiquitous and the soliton equation mathematically miraculous Here on the classical level is the entity field theorists have been postulating for years a local traveling wave pulse a lump like coherent structure the solution of a field equation with remarkable stability and particle like properties It is a fundamental mode of propagation in gravity driven surface and internal waves in atmospheric waves in ion acoustic and Langmuir waves in plasmas in some laser waves in nonlinear media and in many biologic contexts such as alpha helix proteins [Solitons in Mathematics and Physics](#) Alan C. Newell, 1985-06-01 The soliton is a dramatic concept in nonlinear science What makes this book unique in the treatment of this subject is its focus on the properties that make the soliton physically ubiquitous and the soliton equation mathematically miraculous Here on the classical level is the entity field theorists have been postulating for years a local traveling wave pulse a lump like coherent structure the solution of a field equation with remarkable stability and particle like properties It is a fundamental mode of propagation in gravity driven surface and internal waves in atmospheric waves in ion acoustic and Langmuir waves in plasmas in some laser waves in nonlinear media and in many biologic contexts such as alpha helix proteins [Basic Methods Of Soliton Theory](#) Ivan V Cherednik, 1996-08-22 In the 25 years of its existence Soliton Theory has drastically expanded our understanding of integrability and contributed a lot to the reunification of Mathematics and Physics in the range from deep algebraic geometry and modern representation theory to quantum field theory and optical transmission lines The book is a systematic introduction to the Soliton Theory with an emphasis on its background and algebraic aspects It is the first one devoted to the general matrix soliton equations which are of great importance for the foundations and the applications Differential algebra local conservation laws Bäcklund Darboux transforms algebraic geometry theta and Baker functions and the inverse scattering method Riemann Hilbert problem with well grounded preliminaries are applied to various equations including principal chiral fields Heisenberg magnets Sin Gordon and Nonlinear Schrödinger equation **Solitons in Physics, Mathematics, and Nonlinear Optics** Peter J. Olver, David H. Sattinger, 2012-12-06 This IMA Volume in Mathematics and its Applications SOLITONS IN PHYSICS MATHEMATICS AND NONLINEAR OPTICS is based on the proceedings of two workshops which were an integral part of the 1988-89 IMA program on NONLINEAR WAVES The workshops focussed on the main parts of the theory of solitons and on the applications of solitons in physics biology and engineering with a special concentration on nonlinear optics We thank the Coordinating Committee James Glimm Daniel Joseph Barbara Keyfitz An Majda Alan Newell Peter Olver David Sattinger and David Schaeffer for drew planning and implementing the stimulating year long program We especially thank the Workshop Organizers for Solitons in Physics and Mathematics Alan Newell Peter Olver and David Sattinger and for Nonlinear Optics

and Plasma Physics David Kaup and Yuji Kodama for their efforts in bringing together many of the major figures in those research fields in which solitons in physics mathematics and nonlinear optics theories are used

A vner Friedman Willard Miller Jr PREFACE This volume includes some of the lectures given at two workshops Solitons in Physics and Mathematics and Solitons in Nonlinear Optics and Plasma Physics held during the 1988 89 LM A year on Nonlinear Waves Since their discovery by Kruskal and Zabusky in the early 1960 s solitons have had a profound impact on many fields ranging from engineering and physics to algebraic geometry

Solitons P. G. Drazin,1986 **Soliton Theory and Its Applications** Chao hao Gu,2013-03-14 Soliton theory is an important branch of applied mathematics and mathematical physics An active and productive field of research it has important applications in fluid mechanics nonlinear optics classical and quantum fields theories etc This book presents a broad view of soliton theory It gives an expository survey of the most basic ideas and methods such as physical background inverse scattering Backl nd transformations finite dimensional completely integrable systems symmetry Kac moody algebra solitons and differential geometry numerical analysis for nonlinear waves and gravitational solitons Besides the essential points of the theory several applications are sketched and some recent developments partly by the authors and their collaborators are presented

Solitons R. MacKenzie,M.B. Paranjape,W.J. Zakrzewski,2000 Solitons were discovered by John Scott Russel in 1834 and have intrigued scientists and mathematicians ever since They have been the subject of a large body of research not only in mathematics and physics but also engineering biology and other disciplines This volume comprises the presentations at an interdisciplinary workshop held at Querns University in Kingston Ontario It includes chapters on mathematical and numerical aspects of solitons recent developments in string theory and applications of solitons in such areas as nuclear and particle physics cosmology and condensed matter physics

Solitons Boling Guo,Xiao-Feng Pang,Yu-Feng Wang,Nan Liu,2018-03-19 This book provides an up to date overview of mathematical theories and research results on solitons presenting related mathematical methods and applications as well as numerical experiments Different types of soliton equations are covered along with their dynamical behaviors and applications from physics making the book an essential reference for researchers and graduate students in applied mathematics and physics

Contents Introduction Inverse scattering transform Asymptotic behavior to initial value problems for some integrable evolution nonlinear equations Interaction of solitons and its asymptotic properties Hirota method B cklund transformations and the infinitely many conservation laws Multi dimensional solitons and their stability Numerical computation methods for some nonlinear evolution equations The geometric theory of solitons Global existence and blow up for the nonlinear evolution equations The soliton movements of elementary particles in nonlinear quantum field The theory of soliton movement of superconductive features The soliton movements in condensed state systemsontents

The Versatile Soliton Alexandre T. Filippov,2000-09-21 In this engaging book the concept of the soliton is traced from the beginning of the last century to modern times with its recent applications

Solitons, Instantons, and Twistors Maciej

Dunajski,2009-12-10 Most nonlinear differential equations arising in natural sciences admit chaotic behaviour and cannot be solved analytically Integrable systems lie on the other extreme They possess regular stable and well behaved solutions known as solitons and instantons These solutions play important roles in pure and applied mathematics as well as in theoretical physics where they describe configurations topologically different from vacuum While integrable equations in lower space time dimensions can be solved using the inverse scattering transform the higher dimensional examples of anti self dual Yang Mills and Einstein equations require twistor theory Both techniques rely on an ability to represent nonlinear equations as compatibility conditions for overdetermined systems of linear differential equations The book provides a self contained and accessible introduction to the subject It starts with an introduction to integrability of ordinary and partial differential equations Subsequent chapters explore symmetry analysis gauge theory gravitational instantons twistor transforms and anti self duality equations The three appendices cover basic differential geometry complex manifold theory and the exterior differential system

Solitons G. Eilenberger,2012-12-06 1 1 Why Study Solitons The last century of physics which was initiated by Maxwell s completion of the theory of electromagnetism can with some justification be called the era of linear physics With few exceptions the methods of theoretical physics have been dominated by linear equations Maxwell Schrodinger linear mathematical objects vector spaces in particular Hilbert spaces and linear methods Fourier transforms perturbation theory linear response theory Naturally the importance of nonlinearity beginning with the Navier Stokes equations and continuing to gravitation theory and the interactions of particles in solids nuclei and quantized fields was recognized However it was hardly possible to treat the effects of nonlinearity except as a perturbation to the basis solutions of the linearized theory During the last decade it has become more widely recognized in many areas of field physics that nonlinearity can result in qualitatively new phenomena which cannot be constructed via perturbation theory starting from linearized equations By field physics we mean all those areas of theoretical physics for which the description of physical phenomena leads one to consider field equations or partial differential equations of the form $\partial_t \psi + \mathcal{H}(\psi, \partial_x \psi) = 0$ or $\partial_t \psi + \mathcal{H}(\psi, \partial_x \psi) = F(\psi)$ for one or many component fields $\psi(x, y, z, t)$ or their quantum analogs

Hamiltonian Methods in the Theory of Solitons Ludwig Faddeev, Leon Takhtajan,2007-08-10 This book presents the foundations of the inverse scattering method and its applications to the theory of solitons in such a form as we understand it in Leningrad The concept of soliton was introduced by Kruskal and Zabusky in 1965 A soliton a solitary wave is a localized particle like solution of a nonlinear equation which describes excitations of finite energy and exhibits several characteristic features propagation does not destroy the profile of a solitary wave the interaction of several solitary waves amounts to their elastic scattering so that their total number and shape are preserved Occasionally the concept of the soliton is treated in a more general sense as a localized solution of finite energy At present this concept is widely spread due to its universality and the abundance of applications in the analysis of various processes in nonlinear media The inverse scattering method which is the mathematical basis of soliton theory has developed into a powerful tool of

mathematical physics for studying nonlinear partial differential equations almost as vigorous as the Fourier transform. The book is based on the Hamiltonian interpretation of the method, hence the title *Methods of differential geometry and Hamiltonian formalism*, in particular, are very popular in modern mathematical physics. It is precisely the general Hamiltonian formalism that presents the inverse scattering method in its most elegant form. Moreover, the Hamiltonian formalism provides a link between classical and quantum mechanics.

Soliton Equations And Hamiltonian Systems (Second Edition) Leonid A Dickey, 2003-01-17. The theory of soliton equations and integrable systems has developed rapidly during the last 30 years with numerous applications in mechanics and physics. For a long time, books in this field have not been written, but the flood of papers was overwhelming, many hundreds, maybe thousands of them. All this output followed one single work by Gardner, Green, Kruskal, and Mizura on the Korteweg-de Vries equation (KdV), which had seemed to be merely an unassuming equation of mathematical physics describing waves in shallow water. Besides its obvious practical use, this theory is attractive also because it satisfies the aesthetic need in a beautiful formula, which is so inherent to mathematics. The second edition is up to date and differs from the first one considerably. One third of the book, five chapters, is completely new, and the rest is refreshed and edited.

Solitons P. G. Drazin, R. S. Johnson, 1989-02-09. *Solitons: An Introduction* discusses the theory of solitons and its diverse applications to nonlinear systems that arise in the physical sciences. Drazin and Johnson explain the generation and properties of solitons, introducing the mathematical technique known as the Inverse Scattering Transform. Their aim is to present the essence of inverse scattering clearly, rather than rigorously or completely. Thus, the prerequisites are merely what is found in standard courses on mathematical physics, and more advanced material is explained in the text with useful references to further reading given at the end of each chapter. Worked examples are frequently used to help the reader follow the various ideas, and the exercises at the end of each chapter not only contain applications but also test understanding. Answers or hints to their solution are given at the end of the book. Sections and exercises that contain more difficult material are indicated by asterisks.

Glimpses of Soliton Theory Alex Kasman, 2010. Solitons are explicit solutions to nonlinear partial differential equations exhibiting particle-like behavior. This is quite surprising, both mathematically and physically. Waves with these properties were once believed to be impossible by leading mathematical physicists, yet they are now not only accepted as a theoretical possibility but are regularly observed in nature and form the basis of modern fiber optic communication networks. *Glimpses of Soliton Theory* addresses some of the hidden mathematical connections in soliton theory, which have been revealed over the last half century. It aims to convince the reader that, like the mirrors and hidden pockets used by magicians, the underlying algebraic-geometric structure of soliton equations provides an elegant and surprisingly simple explanation of something seemingly miraculous. Assuming only multivariable calculus and linear algebra as prerequisites, this book introduces the reader to the KdV Equation and its multisoliton solutions, elliptic curves, and Weierstrass w_p functions, the algebra of differential operators, Lax Pairs, and their use in discovering other soliton

equations wedge products and decomposability the KP Equation and Sato's theory relating the Bilinear KP Equation to the geometry of Grassmannians Notable features of the book include careful selection of topics and detailed explanations to make this advanced subject accessible to any undergraduate math major numerous worked examples and thought provoking but not overly difficult exercises footnotes and lists of suggested readings to guide the interested reader to more information and use of the software package Mathematica to facilitate computation and to animate the solutions under study This book provides the reader with a unique glimpse of the unity of mathematics and could form the basis for a self study one semester special topics or capstone course Solitons are explicit solutions to nonlinear partial differential equations exhibiting particle like behavior This is quite surprising both mathematically and physically Waves with these properties were once believed to be impossible by leading mathematical physicists yet they are now not only accepted as a theoretical possibility but are regularly observed in nature and form the basis of modern fiber optic communication networks Glimpses of Soliton Theory addresses some of the hidden mathematical connections in soliton theory which have been revealed over the last half century It aims to convince the reader that like the mirrors and hidden pockets used by magicians the underlying algebro geometric structure of soliton equations provides an elegant and surprisingly simple explanation of something seemingly miraculous Assuming only multivariable calculus and linear algebra as prerequisites this book introduces the reader to the KdV Equation and its multisoliton solutions elliptic curves and Weierstrass wp functions the algebra of differential operators Lax Pairs and their use in discovering other soliton equations wedge products and decomposability the KP Equation and Sato's theory relating the Bilinear KP Equation to the geometry of Grassmannians Notable features of the book include careful selection of topics and detailed explanations to make this advanced subject accessible to any undergraduate math major numerous worked examples and thought provoking but not overly difficult exercises footnotes and lists of suggested readings to guide the interested reader to more information and use of the software package Mathematica to facilitate computation and to animate the solutions under study This book provides the reader with a unique glimpse of the unity of mathematics and could form the basis for a self study one semester special topics or capstone course

Introduction to Soliton Theory:

Applications to Mechanics Ligia Munteanu, Stefania Donescu, 2006-07-06 This monograph is planned to provide the application of the soliton theory to solve certain practical problems selected from the fields of solid mechanics fluid mechanics and biomechanics The work is based mainly on the authors research carried out at their home institutes and on some specified significant results existing in the published literature The methodology to study a given evolution equation is to seek the waves of permanent form to test whether it possesses any symmetry properties and whether it is stable and solitonic in nature Students of physics applied mathematics and engineering are usually exposed to various branches of nonlinear mechanics especially to the soliton theory The soliton is regarded as an entity a quasi particle which conserves its character and interacts with the surroundings and other solitons as a particle It is related to a strange phenomenon which

consists in the propagation of certain waves without attenuation in dissipative media This phenomenon has been known for about 200 years it was described for example by the Jules Verne's novel Les histoires de Jean Marie Cabidoulin d Hetzel but its detailed quantitative description became possible only in the last 30 years due to the exceptional development of computers The discovery of the physical soliton is attributed to John Scott Russell In 1834 Russell was observing a boat being drawn along a narrow channel by a pair of horses

Soliton Equations and Hamiltonian Systems Leonid A. Dickey,1991

The theory of soliton equations and integrable systems has developed rapidly during the last 20 years with numerous applications in mechanics and physics For a long time books in this field have not been written but the flood of papers was overwhelming many hundreds maybe thousands of them All this followed one single work by Gardner Greene Kruskal and Miura about the Korteweg de Vries equation KdV which had seemed to be merely an unassuming equation of mathematical physics describing waves in shallow water This branch of science is attractive because it is one of those which revives the interest in the basic principles of mathematics a beautiful formula

Topics in Soliton Theory Robert Wayne Carroll,1991

When soliton theory based on water waves plasmas fiber optics etc was developing in the 1960 1970 era it seemed that perhaps KdV and a few other equations were really rather special in the set of all interesting partial differential equations As it turns out although integrable systems are still special the mathematical interaction of integrable systems theory with virtually all branches of mathematics and with many currently developing areas of theoretical physics illustrates the importance of this area This book concentrates on developing the theme of the tau function KdV and KP equations are treated extensively with material on NLS and AKNS systems and in following the tau function theme one is led to conformal field theory strings and other topics in physics The extensive list of references contains about 1000 entries

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

Soliton Equations and Hamiltonian Systems L.A. Dickey,1991

The theory of soliton equations and integrable systems has developed rapidly during the last 20 years with

numerous applications in mechanics and physics For a long time books in this field have not been written but the flood of papers was overwhelming many hundreds maybe thousands of them All this followed one single work by Gardner Greene Kruskal and Miura about the Korteweg de Vries equation KdV which had seemed to be merely an unassuming equation of mathematical physics describing waves in shallow water

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Solitons In Mathematics And Physics Introduction

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