

# Solitons in Mathematics and Physics

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# Solitons In Mathematics And Physics

**Muthusamy Lakshmanan**



## **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

**Solitons** R. MacKenzie, M.B. Paranjape, W.J. Zakrzewski, 2012-12-06 Solitons were discovered by John Scott Russel in 1834 and have interested scientists and mathematicians ever since They have been the subject of a large body of research in a wide variety of fields of physics and mathematics not to mention engineering and other branches of science such as biology This volume comprises the written versions of the talks presented at a workshop held at Queen s University in 1997 an interdisciplinary meeting wherein top researchers from many fields could meet interact and exchange ideas Topics covered include mathematical and numerical aspects of solitons as well as applications of solitons to nuclear and particle physics cosmology and condensed matter physics The book should be of interest to researchers in any field in which solitons are encountered

**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 systems

**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 Theory and Its Applications* Chaohao 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 Backlund 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

Soliton Equations And Hamiltonian Systems Leonid A Dickey, 1991-09-02 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

*The Versatile Soliton* Alexandre T. Filippov, 2010-05-18 If you have not already heard about solitons you will sooner or later encounter them The soliton a solitary wave impulse preserving its shape and strikingly similar to a particle is one of the most fascinating and beautiful phenomena in the physics of nonlinear waves In this engaging book the concept of the soliton is traced from the beginning of the last century to modern times with recent applications in biology oceanography solid state physics electronics elementary particle physics and cosmology The main concepts and results of theoretical physics related to solitons can be explained without using much mathematics Indeed on the descriptive and historical level only some knowledge of high school physics and mathematics is needed At a higher level for understanding the elementary theory of oscillations and waves the reader can intuit much from the numerous illustrations and perhaps skip the formulas presented But to appreciate the deep connections in this book between apparently different and diverse phenomena and ideas the reader must be able to follow elementary mathematical computations Still more advanced mathematics is required for the appendices

**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.

Physics of Solitons Thierry Dauxois, Michel Peyrard, 2006-03-09 This textbook gives an instructive view of solitons and their applications for advanced students of physics. **Solitons and the Inverse Scattering Transform** Mark J. Ablowitz, Harvey Segur, 2006-05-15 A study by two of the major contributors to the theory of the inverse scattering transform and its application to problems of nonlinear dispersive waves that arise in fluid dynamics, plasma physics, nonlinear optics, particle physics, crystal lattice theory, nonlinear circuit theory and other areas. A soliton is a localised pulse like nonlinear wave that possesses remarkable stability properties. Typically problems that admit soliton solutions are in the form of evolution equations that describe how some variable or set of variables evolve in time from a given state. The equations may take a variety of forms for example PDEs, differential difference equations, partial difference equations and integrodifferential equations as well as coupled ODEs of finite order. What is surprising is that although these problems are nonlinear the general solution that evolves from almost arbitrary initial data may be obtained without approximation. *Solitons in Molecular Systems* Davydov, 2013-03-09 Approach your problems from the It isn't that they can't see the end and begin with the answers solution. It is that they can't. Then one day perhaps you will see the problem find the final question. G. K. Chesterton. The Scandal of The Hermit Clad in Crane. Father Brown. The Point of a Pin. Feathers in R. van Gulik's The Chinese Maze Murders. Growing specialization and diversification have brought a host of monographs and textbooks on increasingly topics. However the tree of knowledge of mathematics and related fields does not grow only by putting forth new branches. It also happens quite often in fact that branches which were thought to be completely disparate are suddenly seen to be related. Further the kind and level of sophistication of mathematics applied in various sciences has changed drastically in recent years. Measure theory is used non trivially in regional and theoretical economics. Algebraic geometry interacts with physics. The Minkowski lemma, coding theory and the structure of water meet one another in packing and covering theory. Quantum fields, crystal defects and mathematical programming profit from homotopy theory. Lie algebras are relevant to filtering and prediction and electric engineering can use Stein spaces. And in addition to this there are such new emerging subdisciplines as complete integrable systems, chaos, synergetics and large scale order which are almost impossible to fit into the existing classification schemes. They draw upon widely different sections of mathematics. **Solitons in Molecular Systems**

Aleksandr Sergeevich Davydov, 1985-08-31 Approach your problems from the It isn't that they can't see the end and begin with the answers solution It is that they can't Then one day perhaps you will see the problem find the final question G K Chesterton The Scandal of The Hermit Clad in Crane Father Brown The Point of a Pin Feathers in R van Gulik's The Chinese Maze Murders Growing specialization and diversification have brought a host of monographs and textbooks on increasingly topics However the tree of knowledge of mathematics and related fields does not grow only by putting forth new branches It also happens quite often in fact that branches which were thought to be completely disparate are suddenly seen to be related Further the kind and level of sophistication of mathematics applied in various sciences has changed drastically in recent years measure theory is used non trivially in regional and theoretical economics algebraic geometry interacts with physics the Minkowsky lemma coding theory and the structure of water meet one another in packing and covering theory quantum fields crystal defects and mathematical programming profit from homotopy theory Lie algebras are relevant to filtering and prediction and electric engineering can use Stein spaces And in addition to this there are such new emerging subdisciplines as complete integrable systems chaos synergetics and large scale order which are almost impossible to fit into the existing classification schemes The draw upon widely different sections of mathematics *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  $\frac{1}{c^2} \frac{\partial^2 \phi}{\partial t^2} = \nabla^2 \phi$  or  $\nabla \cdot \mathbf{F} = \rho$  for one or many component fields  $\mathbf{H}(\mathbf{x}, \mathbf{y})$  or their quantum analogs

**Soliton Phenomenology** V.G. Makhankov, 2012-12-06 Et moi si j'avais S'il comment en revemr One service mathematics has rendered the journey would point alle human race It has put common sense back Jules Verne where it belongs on the topmost shelf next to the dusty canister labelled discarded non sense The series is divergent therefore we may be able to do something with it Eric T Bell O Heavieside Mathematics is a tool for thought A highly necessary tool in a world where both feedback and nonlinearities abound Similarly all kinds of parts of mathematics serve as tools for other parts and for other sciences Applying a simple rewriting rule to the quote on the right above one finds such statements as One service topology

has rendered mathematical physics One service logic has rendered computer science One service category theory has rendered mathematics All arguably true And all statements obtainable this way form part of the *raison d'être* of this series

*Solitons* Mohamed Atef Helal, 2022-11-12 This newly updated volume of the Encyclopedia of Complexity and Systems Science ECSS presents several mathematical models that describe this physical phenomenon including the famous nonlinear equation Korteweg de Vries KdV that represents the canonical form of solitons Also there exists a class of nonlinear partial differential equations that led to solitons e.g. Kadomtsev Petviashvili KP Klein Gordon KG Sine Gordon SG Non Linear Schrödinger NLS Korteweg de Vries Burger's KdVB etc Different linear mathematical methods can be used to solve these models analytically such as the Inverse Scattering Transformation IST Adomian Decomposition Method Variational Iteration Method VIM Homotopy Analysis Method HAM and Homotopy Perturbation Method HPM Other non-analytic methods use the computational techniques available in such popular mathematical packages as Mathematica Maple and MATLAB The main purpose of this volume is to provide physicists engineers and their students with the proper methods and tools to solve the soliton equations and to discover the new possibilities of using solitons in multi-disciplinary areas ranging from telecommunications to biology cosmology and oceanographic studies

*Solitons* Muthusamy Lakshmanan, 2012-12-06 A good deal of the material presented in this book has been prepared by top experts in the field lecturing in January 1987 at the Winter School on Solitons in Tiruchirapalli India The lectures begin at an elementary level but go on to include even the most recent developments in the field The book makes a handy introduction to the various facets of the soliton concept and will be useful both to newcomers to the field and to researchers who are interested in developments in new branches of physics and mathematics



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