

# Solitons

Properties, Dynamics, Interactions,  
Applications

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# Solitons Properties Dynamics Interactions Applications

**S.E. Trullinger, V.E. Zakharov, V.L.  
Pokrovsky**



## **Solitons Properties Dynamics Interactions Applications:**

**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

**Lectures on Fluid Dynamics** Roman Jackiw, 2013-03-09 The Centre de recherches mathématiques CRM was created in 1968 by the Université de Montréal to promote research in the mathematical sciences It is now a national institute that hosts several groups and holds special theme years summer schools workshops and a post doctoral program The focus of its scientific activities ranges from pure to applied mathematics and includes statistics theoretical computer science mathematical methods in biology and life sciences and mathematical and theoretical physics The CRM also promotes collaboration between mathematicians and industry It is subsidized by the Natural Sciences and Engineering Research Council of Canada the Fonds FCAR of the Province of Quebec the Canadian Institute for Advanced Research and has private endowments Current activities fellowships and annual reports can be found on the CRM Web page at [www.crm.umontreal.ca](http://www.crm.umontreal.ca) The CRM Series in Mathematical Physics includes monographs lecture notes and proceedings based on research pursued and on events held at the CRM Yvan Saint Aubin Montreal Preface This monograph is derived from a series of six lectures which were given at the Centre de recherches mathématiques CRM in Montreal in March and June 2000 while the author was holder of the Aisenstadt Chair Precis During the March 2000 meeting of the Workshop on Strings Duality and Geometry in Montreal Canada three lectures were delivered on topics in fluid mechanics while the author was holder of the Aisenstadt Chair

**The sine-Gordon Model and its Applications** Jesús Cuevas-Maraver, Panayotis G. Kevrekidis, Floyd Williams, 2014-07-22 The sine Gordon model is a ubiquitous model of Mathematical Physics with a wide range of applications extending from coupled torsion pendula and Josephson junction arrays to gravitational and high energy physics models The purpose of this book is to present a summary of recent developments in this field incorporating both introductory background material but also with a strong view towards modern applications recent experiments developments regarding the existence stability dynamics and asymptotics of nonlinear waves that arise in the model This book is of particular interest to a wide range of researchers in this field but serves as an introductory text for young researchers and students interested in the topic The book consists of well selected thematic chapters on diverse mathematical and physical aspects of the equation carefully chosen and assigned

**Introduction to non-Kerr Law Optical Solitons** Anjan Biswas, Swapan Konar, 2006-11-10 Despite

remarkable developments in the field a detailed treatment of non Kerr law media has not been published Introduction to non Kerr Law Optical Solitons is the first book devoted exclusively to optical soliton propagation in media that possesses non Kerr law nonlinearities After an introduction to the basic features of fiber optic com     Current Trends in Analysis and Its Applications Vladimir V. Mityushev, Michael V. Ruzhansky, 2015-02-04 This book is a collection of papers from the 9th International ISAAC Congress held in 2013 in Krak w Poland The papers are devoted to recent results in mathematics focused on analysis and a wide range of its applications These include up to date findings of the following topics Differential Equations Complex and Functional Analytic Methods Nonlinear PDE Qualitative Properties of Evolution Models Differential and Difference Equations Toeplitz Operators Wavelet Theory Topological and Geometrical Methods of Analysis Queueing Theory and Performance Evaluation of Computer Networks Clifford and Quaternion Analysis Fixed Point Theory M Frame Constructions Spaces of Differentiable Functions of Several Real Variables Generalized Functions Analytic Methods in Complex Geometry Topological and Geometrical Methods of Analysis Integral Transforms and Reproducing Kernels Didactical Approaches to Mathematical Thinking Their wide applications in biomathematics mechanics queueing models scattering geomechanics etc are presented in a concise but comprehensible way such that further ramifications and future directions can be immediately seen     **Algebraic Methods in Physics** Yvan Saint-Aubin, Luc Vinet, 2012-12-06 This book pays tribute to two pioneers in the field of Mathematical physics Jiri Patera and Pavel Winternitz of the CRM Each has contributed more than forty years to the subject of mathematical physics particularly to the study of algebraic methods

**Theoretical Physics at the End of the Twentieth Century** Yvan Saint-Aubin, Luc Vinet, 2013-03-14 The Centre de recherches mathématiques CRM was created in 1968 by the Université de Montréal to promote research in the mathematical sciences It is now a national institute that hosts several groups and holds special theme years summer schools workshops and a postdoctoral program The focus of its scientific activities ranges from pure to applied mathematics and includes statistics theoretical computer science mathematical methods in biology and life sciences and mathematical and theoretical physics The CRM also promotes collaboration between mathematicians and industry It is subsidized by the Natural Sciences and Engineering Research Council of Canada the Fonds FCAR of the Province de Québec and the Canadian Institute for Advanced Research and has private endowments Current activities fellowships and annual reports can be found on the CRM Web page at [www.crm.umontreal.ca](http://www.crm.umontreal.ca) The CRM Series in Mathematical Physics includes monographs lecture notes and proceedings based on research pursued and events held at the Centre de recherches mathématiques     **Calogero—Moser—Sutherland Models** Jan F. van Diejen, Luc Vinet, 2012-12-06 In the 1970s F Calogero and D Sutherland discovered that for certain potentials in one dimensional systems but for any number of particles the Schrödinger eigenvalue problem is exactly solvable Until then there was only one known nontrivial example of an exactly solvable quantum multi particle problem J Moser subsequently showed that the classical counterparts to these models is also amenable to an exact analytical approach

The last decade has witnessed a true explosion of activities involving Calogero Moser Sutherland models and these now play a role in research areas ranging from theoretical physics such as soliton theory quantum field theory string theory solvable models of statistical mechanics condensed matter physics and quantum chaos to pure mathematics such as representation theory harmonic analysis theory of special functions combinatorics of symmetric functions dynamical systems random matrix theory and complex geometry The aim of this volume is to provide an overview of the many branches into which research on CMS systems has diversified in recent years The contributions are by leading researchers from various disciplines in whose work CMS systems appear either as the topic of investigation itself or as a tool for further applications

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

Fundamentals of Classical Fourier Analysis Shashank Tiwari, 2025-02-20 Fundamentals of Classical Fourier Analysis is a comprehensive guide to understanding fundamental concepts techniques and applications of Fourier analysis in classical mathematics This book provides a thorough exploration of Fourier analysis from its historical origins to modern day applications offering readers a solid foundation in this essential area of mathematics Classical Fourier analysis has been a cornerstone of mathematics and engineering for centuries playing a vital role in solving problems in fields like signal processing differential equations and quantum mechanics We delve into the rich history of Fourier analysis tracing its development from Joseph Fourier's groundbreaking work to modern digital signal processing applications Starting with an overview of fundamental concepts and motivations behind Fourier analysis we introduce Fourier series and transforms exploring their properties convergence and applications We discuss periodic and non periodic functions convergence phenomena and important theorems such as Parseval's identity and the Fourier inversion theorem Throughout the book we emphasize both theoretical insights and practical applications providing a balanced understanding of Fourier analysis and its relevance to real world problems Topics include harmonic analysis orthogonal functions Fourier integrals and Fourier transforms with applications in signal processing data compression and partial differential equations Each chapter includes examples illustrations and

exercises to reinforce key concepts Historical insights into key mathematicians and scientists contributions are also provided Whether you are a student researcher or practitioner in mathematics engineering or related fields Fundamentals of Classical Fourier Analysis is a comprehensive and accessible resource for mastering Fourier analysis principles and techniques

*The Painlevé Property* Robert Conte, 2012-12-06 The subject this volume is explicit integration that is the analytical as opposed to the numerical solution of all kinds of nonlinear differential equations ordinary differential partial differential finite difference Such equations describe many physical phenomena their analytic solutions particular solutions first integral and so forth are in many cases preferable to numerical computation which may be long costly and worst subject to numerical errors In addition the analytic approach can provide a global knowledge of the solution while the numerical approach is always local Explicit integration is based on the powerful methods based on an in depth study of singularities that were first used by Poincaré and subsequently developed by Painlevé in his famous Leçons de Stockholm of 1895 The recent interest in the subject and in the equations investigated by Painlevé dates back about thirty years ago arising from three apparently disjoint fields the Ising model of statistical physics and field theory propagation of solitons and dynamical systems The chapters in this volume based on courses given at Cargèse 1998 alternate mathematics and physics they are intended to bring researchers entering the field to the level of present research

**Spatial Solitons** Stefano Trillo, William Torruellas, 2013-06-05 Soliton based concepts open the road for newly designed laser sources new frequency converters and high intensity laser material interactions Optical solitons as stable spatial patterns of complex nonlinear systems allow for the control of the diffraction of optical beams Solitons also prevent unwanted chaotic behavior Thus solitary wave physics plays a significant role from modern optical physics to optical communication optical switching and optical storage The book gives an updated overview of optical solitons and can serve as a reference and guide for advanced students and scientists working in the field and related areas of science where solitons are observed

**Zeitschrift Für Kristallographie**, 2001 **Mathematical Reviews**, 2001

**Some Musings on Theta, Eta, and Zeta** Floyd L. Williams, 2023-11-02 This book continues the applications of mathematics more specifically of theta eta and zeta functions and modular forms to various areas of theoretical physics It is a follow up and extension in some sense of the author's earlier book entitled A window into zeta and modular physics Some of the main topics are 1 A new approach to logarithmic corrections to black hole entropy 2 My recent work that provides for an explicit cold plasma black hole connection 3 Generalization of work of physicists on certain asymptotic problems relating to string theory for example by way of the general theory of modular forms of non positive weight 4 A construction of the E8 root lattice its theta function and its relevance for heterotic string theory 5 Applications of elliptic functions to KdV nonlinear Schrödinger and Duffing equations for example including a discussion of Lax pairs and the Miura transformation 6 Finite temperature zeta functions and partition functions for quantum fields in thermal equilibrium on various curved background spacetimes 7 Exact solutions of the Einstein gravitational field equations for Lemaitre and inhomogeneous cosmological

models with a special focus on the Szekeres Szafron exact solutions by way of the Weierstrass elliptic function 8 Elementary particles and my zeta function formula for higher spin fermionic particles this covers in particular the gravitino particle of spin  $3/2$  and bosons with integral spin  $s = 2, 3, 4, 5$  These are some sample topics Others include the continuous Heisenberg model reaction diffusion systems Dirichlet and Hecke L functions the modular  $j$  invariant the computation of the one loop effective potential for non compact symmetric spaces the BTZ black hole Jacobi inversion formulas etc Thus there is a very large range of material with the first 9 chapters of preliminary expositional background for mathematicians and physicists

**Solitons** S.E. Trullinger, V.E. Zakharov, V.L. Pokrovsky, 2012-12-02 In the twenty years since Zabusky and Kruskal coined the term soliton this concept changed the outlook on certain types of nonlinear phenomena and found its way into all branches of physics The present volume deals with a great variety of applications of the new concept in condensed matter physics which is particularly reached in experimentally observable occurrences The presentation is not centred around the mathematical aspects the emphasis is on the physical nature of the nonlinear phenomena occurring in particular situations With its emphasis on concrete mostly experimentally verifiable cases Solitons constitutes a very readable and instructive introduction to the subject as well as an up to date account of current developments in a field of research reaching maturity

Shaping Light in Nonlinear Optical Fibers Sonia Boscolo, Christophe Finot, 2017-03-08 This book is a contemporary overview of selected topics in fiber optics It focuses on the latest research results on light wave manipulation using nonlinear optical fibers with the aim of capturing some of the most innovative developments on this topic The book's scope covers both fundamentals and applications from both theoretical and experimental perspectives with topics including linear and nonlinear effects pulse propagation phenomena and pulse shaping solitons and rogue waves novel optical fibers supercontinuum generation polarization management optical signal processing fiber lasers optical wave turbulence light propagation in disordered fiber media and slow and fast light With contributions from leading edge scientists in the field of nonlinear photonics and fiber optics they offer an overview of the latest advances in their own research area The listing of recent research papers at the end of each chapter is useful for researchers using the book as a reference As the book addresses fundamental and practical photonics problems it will also be of interest to and benefit broader academic communities including areas such as nonlinear science applied mathematics and physics and optical engineering It offers the reader a wide and critical overview of the state of the art within this practical as well as fundamentally important and interesting area of modern science providing a useful reference which will encourage further research and advances in the field

Synergetics of Molecular Systems Lev N. Lupichev, Alexander V. Savin, Vasily N. Kadantsev, 2014-08-19 Synergetics is the quantitative study of multicomponent systems that exhibit nonlinear dynamics and cooperativity This book specifically considers basic models of the nonlinear dynamics of molecular systems and discusses relevant applications in biological physics and the polymer sciences Emphasis is placed on specific solutions to the dynamical equations that correspond to the

coherent formation of spatial temporal structures such as solitons kinks and breathers in particular The emergence of these patterns in molecular structures provides a variety of information on their structural properties and plays a significant part in energy transfer processes topological defects dislocations and related structure transitions Real media in which solitons take the form of solitary waves are also considered In this context the formation of nonlinear waves in a continuous medium described by nonlinear equations is associated with spontaneous breaking of the local symmetry of the homogeneous system which produces a range of interesting phenomena A particular feature of this text is its combination of analytic and computational strategies to tackle difficult nonlinear problems at the molecular level of matter

Nonlinear Waves and Solitons on Contours and Closed Surfaces Andrei Ludu, 2007-09-09 Everything the Power of the World does is done in a circle The sky is round and I have heard that the earth is round like a ball and so are all the stars The wind in its greatest power whirls Birds make their nests in circles for theirs is the same religion as ours The sun comes forth and goes down again in a circle The moon does the same and both are round Even the seasons form a great circle in their changing and always come back again to where they were The life of a man is a circle from childhood to childhood And so it is everything where power moves Black Elk 1863 1950 Nonlinearity is a captivating manifestation of the observable Universe whose importance has increased over the decades and has found more and more elds of application ranging from elementary particles nuclear physics biology wave dynamics at any scale uids plasmas to astrophysics The central character of this 172 year old story is the soliton Namely a localized pulse traveling without spreading and having particle like properties plus an in nite number of conservation laws associated to its dynamics In general solitons arise as exact solutions of approximative models There are di ent explanation at di erent levels for the existence of solitons From the experimentalist point of view solitons can be created if the propagation c guration is long enough narrow enough like long and shallow channels ber optics electric lines etc

Nonlinear Photonic Crystals Richard E. Slusher, Benjamin J. Eggleton, 2013-06-29 Nonlinear optical studies of periodic dielectric structures have blossomed in the past two decades New fabrication techniques are producing fiber grating and multidimensional photonic crystals in materials where the refractive index can be varied by light pulses and beams Gap solitons that can propagate at any velocity from zero to the speed of light and spatial solitons that prevent the diffractive spread of light in waveguide arrays are two examples of the new phenomena described in this book Microstructured optical fibers allow control of the guided mode dispersion for broadband light generation and new soliton phenomena Many new materials and structures are being developed that will impact new optical devices with applications in optical communications and optical data processing All the above topics are addressed in detail in this book



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