

Peter J. Olver  
David H. Sattinger  
Editors

# Solitons in Physics, Mathematics, and Nonlinear Optics



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# Solitons In Physics Mathematics And Nonlinear Optics

**Anjan Biswas, Swapan Konar**



## **Solitons In Physics Mathematics And Nonlinear Optics:**

*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 in Physics, Mathematics, and Nonlinear Optics* Peter J. Olver, David H. Sattinger, 1990-06-26 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

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

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### **Mathematical Theory of Dispersion-Managed Optical Solitons**

Anjan Biswas, Daniela Milovic, Matthew Edwards, 2010-07-07 Mathematical Theory of Dispersion Managed Optical Solitons discusses recent advances covering optical solitons, soliton perturbation, optical cross talk, Gabitov-Turitsyn Equations, quasi-linear pulses and higher order Gabitov-Turitsyn Equations. Focusing on a mathematical perspective, the book bridges the gap between concepts in engineering and mathematics and gives an outlook to many new topics for further research. The book is intended for researchers and graduate students in applied mathematics, physics and engineering and also it will be of interest to those who are conducting research in nonlinear fiber optics. Dr Anjan Biswas is an Associate Professor at the Department of Applied Mathematics. Dr Daniela Milovic is an Associate Professor at the Department of Telecommunications Faculty of Electronic Engineering, University of Nis, Serbia. Dr Matthew Edwards is the Dean of the School of Arts and Sciences at Alabama A M University in Huntsville, AL, USA.

### **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

**Parallel Solution of Partial Differential Equations** Petter Bjorstad, Mitchell Luskin, 2012-12-06 This IMA Volume in Mathematics and its Applications PARALLEL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS is based on the proceedings of a workshop with the same title The work shop was an integral part of the 1996 97 IMA program on MATHEMATICS IN HIGH PERFORMANCE COMPUTING I would like to thank Petter Bjorstad of the Institutt for Informatikk University of Bergen and Mitchell Luskin of the School of Mathematics University of Minnesota for their excellent work as organizers of the meeting and for editing the proceedings I also take this opportunity to thank the National Science Foundation NSF Department of Energy DOE and the Army Research Office ARO whose financial support made the workshop possible Willard Miller Jr Professor and Director

**PREFACE** The numerical solution of partial differential equations has been of major importance to the development of many technologies and has been the target of much of the development of parallel computer hardware and software Parallel computers offer the promise of greatly increased performance and the routine calculation of previously intractable problems The papers in this volume were presented at the IMA workshop on the Parallel Solution of PDE held during June 9 13 1997 The workshop brought together leading numerical analysts computer scientists and engineers to assess the state of the art and to consider future directions

**Stochastic Models in Geosystems** Stanislav A. Molchanov, Wojbor A. Woyczynski, 2012-12-06 This IMA Volume in Mathematics and its Applications STOCHASTIC MODELS IN GEOSYSTEMS is based on the proceedings of a workshop with the same title and was an integral part of the 1993 94 IMA program on Emerging Applications of Probability We would like to thank Stanislav A Molchanov and Wojbor A Woyczynski for their hard work in organizing this meeting and in editing the proceedings We also take this opportunity to thank the National Science Foundation the Office of Naval Research the Army Research Office and the National Security Agency whose financial support made this workshop possible

**PREFACE** A workshop on Stochastic Models in Geosystems was held during the week of May 16 1994 at the Institute for Mathematics and Its Applications at the University of Minnesota It was part of the Special Year on Emerging Applications of Probability program put together by an organizing committee chaired by J Michael Steele The invited speakers represented a broad interdisciplinary spectrum including mathematics statistics physics geophysics astrophysics atmospheric physics fluid mechanics seismology and oceanography The common underlying theme was stochastic modeling of geophysical phenomena and papers appearing in this volume reflect a number of research directions that are currently pursued in these areas

**Environmental Studies** Mary F. Wheeler, 2012-12-06 Environmental protection has become a universal issue with world wide support Environmental studies have now bridged the realms of academic research and societal applications Mathematical modeling and large scale

data collection and analysis lie at the core of all environmental studies Unfortunately scientists mathematicians and engineers immersed in developing and applying environmental models computational methods statistical techniques and computational hardware advance with separate and often discordant paces The volume is based on recent research designed to provide a much needed interdisciplinary forum for joint exploration of recent advances in this field **Large-Scale**

**Optimization with Applications** Lorenz T. Biegler,1997-08-07 A three week workshop on Large Scale Optimization was held at the IMA from July 10 to July 28 1995 as part of its summer program These workshops brought together some of the world s leading experts in the areas of optimization inverse problems optimal design optimal control and molecular structures The content of these volumes represent a majority of the presentations at the three workshops The presentations and the subsequent articles published here are intended to be useful and accessible to both the mathematical programmers and those working in the applications Perhaps somewhat optimistically the hope is that the workshops and the proceedings will also initiate some long term research projects and impart to new researchers the excitement vitality and importance of this kind of cooperation to the applications and to applied mathematics *Particulate Flows* Donald A. Drew,Daniel D.

Joseph,Stephen L. Passman,2012-12-06 This IMA Volume in Mathematics and its Applications PARTICULATE FLOWS PROCESSING AND RHEOLOGY is based on the proceedings of a very successful one week workshop with the same title which was an integral part of the 1995 1996 IMA program on Mathematical Methods in Materials Science We would like to thank Donald A Drew Daniel D Joseph and Stephen L Passman for their excellent work as organizers of the meeting We also take this opportunity to thank the National Science Foundation NSF the Army Research Office ARO and the Office of Naval Research ONR whose financial support made the workshop possible A vner Friedman Robert Gulliver v PREFACE The workshop on Particulate Flows Processing and Rheology was held January 8 12 1996 at the Institute for Mathematics and its Applications on the University of Minnesota Twin Cities campus as part of the 1995 96 Program on Mathematical Methods in Materials Science There were about forty participants and some lively discussions in spite of the fact that bad weather on the east coast kept some participants from attending and caused scheduling changes throughout the workshop Heterogeneous materials can behave strangely even in simple flow situations For example a mixture of solid particles in a liquid can exhibit behavior that seems solid like or fluid like and attempting to measure the viscosity of such a mixture leads to contradictions and unrepeatable experiments Even so such materials are commonly used in manufacturing and processing **Image**

**Models (and their Speech Model Cousins)** Stephen Levinson,Larry Shepp,2012-12-06 This IMA Volume in Mathematics and its Applications IMAGE MODELS AND THEIR SPEECH MODEL COUSINS is based on the proceedings of a workshop that was an integral part of the 1993 94 IMA program on Emerging Applications of Probability We thank Stephen E Levinson and Larry Shepp for organizing the workshop and for editing the proceedings We also take this opportunity to thank the National Science Foundation the Army Research Office and the National Security Agency whose financial support made the

workshop possible A vner Friedman Willard Miller Jr v PREFACE This volume is an attempt to explore the interface between two diverse areas of applied mathematics that are both customers of the maximum likelihood methodology emission tomography on the one hand and hid den Markov models as an approach to speech understanding on the other hand There are other areas where maximum likelihood is used some of which are represented in this volume parsing of text Jelinek microstruc ture of materials Ji and DNA sequencing Nelson Most of the partici pants were in the main areas of speech or emission density reconstruction Of course there are many other areas where maximum likelihood is used that are not represented here

**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 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

*Mathematical Approaches to Biomolecular Structure and Dynamics* Jill P. Mesirov,Klaus Schulten,De Witt Sumners,2012-12-06 This IMA Volume in Mathematics and its Applications MATHEMATICAL APPROACHES TO BIOMOLECULAR STRUCTURE AND DYNAMICS is one of the two volumes based on the proceedings of the 1994 IMA Summer Program on Molecular Biology and comprises Weeks 3 and 4 of the four week program Weeks 1 and 2 appeared as Volume 81 Genetic Mapping and DNA Sequencing We thank Jill P Mesirov Klaus Schulten and De Witt Sumners for organizing Weeks 3 and 4 of the workshop and for editing the proceedings We also take this opportunity to thank the National Institutes of Health NIH National Center for Human Genome Research the National Science Foundation NSF Biological Instrumen tation and Resources and the Department of Energy DOE whose fi nancial support made the summer program possible A vner Friedman Robert Gulliver v PREFACE The revolutionary progress in molecular biology within the last 30 years opens the way to full understanding of the molecular structures and mech anisms of living organisms Interdisciplinary research in mathematics and molecular biology is driven by ever growing experimental theoretical and computational power The mathematical sciences accompany and support much of the progress achieved by experiment and computation as well as provide insight into geometric and topological properties of biomolecular structure and processes This volume consists of a representative sample of the papers presented during the last two weeks of the month long Institute for Mathematics and Its Applications Summer 1994 Program in Molecular Biology *Surveys in Applied Mathematics* Mark I. Freidlin,Sergey Gredeskul,John K. Hunter,Andrew Marchenko,Leonid Pastur,2012-12-06 Volume 2 offers three in depth articles covering significant areas in applied mathematics research Chapters feature numerous

illustrations extensive background material and technical details and abundant examples The authors analyze nonlinear front propagation for a large class of semilinear partial differential equations using probabilistic methods examine wave localization phenomena in one dimensional random media and offer an extensive introduction to certain model equations for nonlinear wave phenomena

**Physics Briefs**, 1993 *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

Solitons In Multidimensions: Inverse Spectral Transform Method B G Konopelchenko, 1993-04-30 The book is devoted to the mathematical theory of soliton phenomena on the plane The inverse spectral transform method which is a main tool for the study of the 2 1 dimensional soliton equation is reviewed The problem and the Riemann Hilbert problem method are discussed Several basic examples of soliton equations are considered in detail This volume is addressed both to the nonexpert and to the researcher in the field This is the first literature dealing specifically with multidimensional soliton equations

**q-Series and Partitions** Dennis Stanton, 2012-12-06 This IMA Volume in Mathematics and its Applications q Series and Partitions is based on the proceedings of a workshop which was an integral part of the 1987 88 IMA program on APPLIED COMBINATORICS We are grateful to the Scientific Committee Victor Klee Chairman Daniel Kleitman Dijen Ray Chaudhuri and Dennis Stanton for planning and implementing an exciting and stimulating year long program We especially thank the Workshop Organizer Dennis Stanton for organizing a workshop which brought together many of the major figures in a variety of research fields in which q series and partitions are used A vner Friedman Willard Miller Jr PREFACE This volume contains the Proceedings of the Workshop on q Series and Parti tions held at the IMA on March 7 11 1988 Also included are papers by Goodman and O Hara Macdonald and Zeilberger on unimodality This work was of substan tial interest and discussed by many participants in the Workshop The papers have been grouped into four parts identities unimodality of Gaus sian polynomials constant term problems and related integrals and orthogonal polynomials They represent a cross section of the recent work on q series includ ing partitions combinatorics Lie algebras analysis and mathematical physics I



would like to thank the staff of the IMA and its directors Avner Friedman and Willard Miller Jr for providing a wonderful environment for the Workshop Patricia Brick and Kaye Smith prepared the manuscripts

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