

Semiclassical Soliton Ensembles for the Focusing Nonlinear Schrödinger Equation

Spyridon Kamvissis

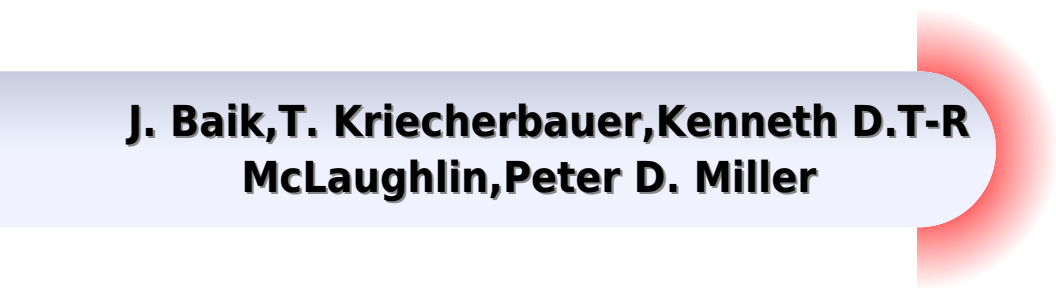
Kenneth T.-R. McLaughlin

Peter D. Miller

July 18, 2002

Semiclassical Soliton Ensembles For The Focusing Nonlinear Schrodinger Equation

**J. Baik, T. Kriecherbauer, Kenneth D.T-R
McLaughlin, Peter D. Miller**



Semiclassical Soliton Ensembles For The Focusing Nonlinear Schrodinger Equation:

Semiclassical Soliton Ensembles for the Focusing Nonlinear Schrodinger Equation (AM-154) Spyridon Kamvissis, Kenneth D. T-R McLaughlin, Peter David Miller, Peter D. Miller, 2003-09-07 Providing an asymptotic analysis via completely integrable techniques of the initial value problem for the focusing nonlinear Schrodinger equation in the semiclassical asymptotic regime this text exploits complete integrability to establish pointwise asymptotics for this problem's solution *Semiclassical Soliton Ensembles for the Focusing Nonlinear Schrödinger Equation* Spyridon Kamvissis, Kenneth T-R. McLaughlin, Peter David Miller, 2002 Semiclassical Soliton Ensembles for the Focusing Nonlinear Schrödinger Equation Spyridon Kamvissis, Kenneth D. T-R McLaughlin, Peter D. Miller, 2003-08-18 This book represents the first asymptotic analysis via completely integrable techniques of the initial value problem for the focusing nonlinear Schrödinger equation in the semiclassical asymptotic regime This problem is a key model in nonlinear optical physics and has increasingly important applications in the telecommunications industry The authors exploit complete integrability to establish pointwise asymptotics for this problem's solution in the semiclassical regime and explicit integration for the underlying nonlinear elliptic partial differential equations suspected of governing the semiclassical behavior In doing so they also aim to explain the observed gradient catastrophe for the underlying nonlinear elliptic partial differential equations and to set forth a detailed pointwise asymptotic description of the violent oscillations that emerge following the gradient catastrophe To achieve this the authors have extended the reach of two powerful analytical techniques that have arisen through the asymptotic analysis of integrable systems the Lax Levermore Venakides variational approach to singular limits in integrable systems and Deift and Zhou's nonlinear Steepest Descent Stationary Phase method for the analysis of Riemann Hilbert problems In particular they introduce a systematic procedure for handling certain Riemann Hilbert problems with poles accumulating on curves in the plane This book which includes an appendix on the use of the Fredholm theory for Riemann Hilbert problems in the Hölder class is intended for researchers and graduate students of applied mathematics and analysis especially those with an interest in integrable systems nonlinear waves or complex analysis **Nonlinear Wave Equations** Christopher W. Curtis, Anton Dzhamay, Willy A. Hereman, Barbara Prinari, 2015-03-26 This volume contains the proceedings of the AMS Special Session on Nonlinear Waves and Integrable Systems held on April 13-14 2013 at the University of Colorado Boulder Colorado The field of nonlinear waves is an exciting area of modern mathematical research that also plays a major role in many application areas from physics and fluids The articles in this volume present a diverse cross section of topics from this field including work on the Inverse Scattering Transform scattering theory inverse problems numerical methods for dispersive wave equations and analytic and computational methods for free boundary problems Significant attention to applications is also given throughout the articles with an extensive presentation on new results in the free surface problem in fluids This volume will be useful to students and researchers interested in learning current techniques in studying nonlinear dispersive systems

from both the integrable systems and computational points of view

Recent Advances in Nonlinear Partial Differential Equations and Applications

Luis López Bonilla, 2007 The articles of this book are written by leading experts in partial differential equations and their applications who present overviews here of recent advances in this broad area of mathematics The formation of shocks in fluids modern numerical computation of turbulence the breaking of the Einstein equations in a vacuum the dynamics of defects in crystals effects due to entropy in hyperbolic conservation laws the Navier Stokes and other limits of the Boltzmann equation occupancy times for Brownian motion in a two dimensional wedge and new methods of analyzing and solving integrable systems are some of this volume's subjects The reader will find an exposition of important advances without a lot of technicalities and with an emphasis on the basic ideas of this field

Integrable Systems and Random Matrices Jinho Baik, 2008 This volume contains the proceedings of a conference held at the Courant Institute in 2006 to celebrate the 60th birthday of Percy A Deift The program reflected the wide ranging contributions of Professor Deift to analysis with emphasis on recent developments in Random Matrix Theory and integrable systems The articles in this volume present a broad view on the state of the art in these fields Topics on random matrices include the distributions and stochastic processes associated with local eigenvalue statistics as well as their appearance in combinatorial models such as TASEP last passage percolation and tilings The contributions in integrable systems mostly deal with focusing NLS the Camassa Holm equation and the Toda lattice A number of papers are devoted to techniques that are used in both fields These techniques are related to orthogonal polynomials operator determinants special functions Riemann Hilbert problems direct and inverse spectral theory Of special interest is the article of Percy Deift in which he discusses some open problems of Random Matrix Theory and the theory of integrable systems

Nonlinear Dispersive Equations Christian Klein, Jean-Claude Saut, 2022-02-23 Nonlinear Dispersive Equations are partial differential equations that naturally arise in physical settings where dispersion dominates dissipation notably hydrodynamics nonlinear optics plasma physics and Bose Einstein condensates The topic has traditionally been approached in different ways from the perspective of modeling of physical phenomena to that of the theory of partial differential equations or as part of the theory of integrable systems This monograph offers a thorough introduction to the topic uniting the modeling PDE and integrable systems approaches for the first time in book form The presentation focuses on three universal families of physically relevant equations endowed with a completely integrable member the Benjamin-Ono Davey-Stewartson and Kadomtsev-Petviashvili equations These asymptotic models are rigorously derived and qualitative properties such as soliton resolution are studied in detail in both integrable and non integrable models Numerical simulations are presented throughout to illustrate interesting phenomena By presenting and comparing results from different fields the book aims to stimulate scientific interactions and attract new students and researchers to the topic To facilitate this the chapters can be read largely independently of each other and the prerequisites have been limited to introductory courses in PDE theory

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.

Numerical Methods for Hyperbolic and Kinetic Problems Stéphane Cordier, 2005
Hyperbolic and kinetic equations arise in a large variety of industrial problems. For this reason, the Summer Mathematical Research Center on Scientific Computing and its Applications CEMRACS held at the Center of International Research in Mathematics CIRM in Luminy was devoted to this topic. During a six week period, junior and senior researchers worked full time on several projects proposed by industry and academia. Most of this work was completed later on and the present book reflects these results. The articles address modelling issues as well as the development and comparisons of numerical methods in different situations. The applications include multi phase flows, plasma physics, quantum particle dynamics, radiative transfer, sprays and aeroacoustics. The text is aimed at researchers and engineers interested in applications arising from modelling and numerical simulation of hyperbolic and kinetic problems.

Peregrine Soliton and Breathers in Wave Physics: Achievements and Perspectives Bertrand Kibler, Amin Chabchoub, Heremba Bailung, 2022-08-16

Applied Asymptotic Analysis Peter David Miller, 2006 This book is a survey of asymptotic methods set in the current applied research context of wave propagation. It stresses rigorous analysis in addition to formal manipulations. Asymptotic expansions developed in the text are justified rigorously and students are shown how to obtain solid error estimates for asymptotic formulae. The book relates examples and exercises to subjects of current research interest such as the problem of locating the zeros of Taylor polynomials of entire nonvanishing functions and the problem of counting integer lattice points in subsets of the plane with various geometrical properties of the boundary. The book is intended for a beginning graduate course on asymptotic analysis in applied mathematics and is aimed at students of pure and applied mathematics as well as science and engineering. The basic prerequisite is a background in differential equations, linear algebra, advanced calculus.

and complex variables at the level of introductory undergraduate courses on these subjects The book is ideally suited to the needs of a graduate student who on the one hand wants to learn basic applied mathematics and on the other wants to understand what is needed to make the various arguments rigorous Down here in the Village this is known as the Courant point of view Percy Deift Courant Institute New York Peter D Miller is an associate professor of mathematics at the University of Michigan at Ann Arbor He earned a Ph D in Applied Mathematics from the University of Arizona and has held positions at the Australian National University Canberra and Monash University Melbourne His current research interests lie in singular limits for integrable systems

The Sine-Gordon Equation in the Semiclassical Limit: Dynamics of Fluxon

Condensates Robert J. Buckingham, Peter D. Miller, 2013-08-23 The authors study the Cauchy problem for the sine Gordon equation in the semiclassical limit with pure impulse initial data of sufficient strength to generate both high frequency rotational motion near the peak of the impulse profile and also high frequency librational motion in the tails They show that for small times independent of the semiclassical scaling parameter both types of motion are accurately described by explicit formulae involving elliptic functions These formulae demonstrate consistency with predictions of Whitham's formal modulation theory in both the hyperbolic modulationally stable and elliptic modulationally unstable cases

Discrete Orthogonal Polynomials J. Baik, T. Kriecherbauer, Kenneth D. T-R McLaughlin, Peter D. Miller, 2007-01-02 This book describes the theory and applications of discrete orthogonal polynomials polynomials that are orthogonal on a finite set Unlike other books Discrete Orthogonal Polynomials addresses completely general weight functions and presents a new methodology for handling the discrete weights case J Baik T Kriecherbauer K T R McLaughlin P D Miller focus on asymptotic aspects of general nonclassical discrete orthogonal polynomials and set out applications of current interest Topics covered include the probability theory of discrete orthogonal polynomial ensembles and the continuum limit of the Toda lattice The primary concern throughout is the asymptotic behavior of discrete orthogonal polynomials for general nonclassical measures in the joint limit where the degree increases as some fraction of the total number of points of collocation The book formulates the orthogonality conditions defining these polynomials as a kind of Riemann Hilbert problem and then generalizes the steepest descent method for such a problem to carry out the necessary asymptotic analysis

Random Matrices and the Six-Vertex Model Pavel Bleher, Karl Liechty, 2013-12-04 This book provides a detailed description of the Riemann Hilbert approach RH approach to the asymptotic analysis of both continuous and discrete orthogonal polynomials and applications to random matrix models as well as to the six vertex model The RH approach was an important ingredient in the proofs of universality in unitary matrix models This book gives an introduction to the unitary matrix models and discusses bulk and edge universality The six vertex model is an exactly solvable two dimensional model in statistical physics and thanks to the Izergin Korepin formula for the model with domain wall boundary conditions its partition function matches that of a unitary matrix model with nonpolynomial interaction The authors introduce in this book the six vertex model and include a proof of

the Izergin Korepin formula Using the RH approach they explicitly calculate the leading and subleading terms in the thermodynamic asymptotic behavior of the partition function of the six vertex model with domain wall boundary conditions in all the three phases disordered ferroelectric and antiferroelectric Titles in this series are co published with the Centre de Recherches Math matiques Algebraic and Geometric Aspects of Integrable Systems and Random Matrices Anton Dzhamay, Ken'ichi Maruno, Virgil U. Pierce, 2013-06-26 This volume contains the proceedings of the AMS Special Session on Algebraic and Geometric Aspects of Integrable Systems and Random Matrices held from January 6 7 2012 in Boston MA The very wide range of topics represented in this volume illustrates **Annals of Mathematics Studies** Spyridon Kamvissis, 1940 **Computational Approach to Riemann Surfaces** Alexander I. Bobenko TU Berlin, Christian Klein, 2011-02-03 This volume offers a well structured overview of existent computational approaches to Riemann surfaces and those currently in development The authors of the contributions represent the groups providing publically available numerical codes in this field Thus this volume illustrates which software tools are available and how they can be used in practice In addition examples for solutions to partial differential equations and in surface theory are presented The intended audience of this book is twofold It can be used as a textbook for a graduate course in numerics of Riemann surfaces in which case the standard undergraduate background i e calculus and linear algebra is required In particular no knowledge of the theory of Riemann surfaces is expected the necessary background in this theory is contained in the Introduction chapter At the same time this book is also intended for specialists in geometry and mathematical physics applying the theory of Riemann surfaces in their research It is the first book on numerics of Riemann surfaces that reflects the progress made in this field during the last decade and it contains original results There are a growing number of applications that involve the evaluation of concrete characteristics of models analytically described in terms of Riemann surfaces Many problem settings and computations in this volume are motivated by such concrete applications in geometry and mathematical physics

Moments, Monodromy, and Perversity Nicholas M. Katz, 2005-10-02 It is now some thirty years since Deligne first proved his general equidistribution theorem thus establishing the fundamental result governing the statistical properties of suitably pure algebro geometric families of character sums over finite fields and of their associated L functions Roughly speaking Deligne showed that any such family obeys a generalized Sato Tate law and that figuring out which generalized Sato Tate law applies to a given family amounts essentially to computing a certain complex semisimple not necessarily connected algebraic group the geometric monodromy group attached to that family Up to now nearly all techniques for determining geometric monodromy groups have relied at least in part on local information In Moments Monodromy and Perversity Nicholas Katz develops new techniques which are resolutely global in nature They are based on two vital ingredients neither of which existed at the time of Deligne s original work on the subject The first is the theory of perverse sheaves pioneered by Goresky and MacPherson in the topological setting and then brilliantly transposed to algebraic geometry by Beilinson Bernstein

Deligne and Gabber The second is Larsen's Alternative which very nearly characterizes classical groups by their fourth moments These new techniques which are of great interest in their own right are first developed and then used to calculate the geometric monodromy groups attached to some quite specific universal families of L functions attached to character sums over finite fields

Recent Advances in Orthogonal Polynomials, Special Functions, and Their Applications

Jorge Arves, Guillermo Lopez Lagomasino, 2012-09-11 This volume contains the proceedings of the 11th International Symposium on Orthogonal Polynomials Special Functions and their Applications held August 29 September 2 2011 at the Universidad Carlos III de Madrid in Leganes Spain The papers cover asymptotic properties of polynomials on curves of the complex plane universality behavior of sequences of orthogonal polynomials for large classes of measures and its application in random matrix theory the Riemann Hilbert approach in the study of Pade approximation and asymptotics of orthogonal polynomials quantum walks and CMV matrices spectral modifications of linear functionals and their effect on the associated orthogonal polynomials bivariate orthogonal polynomials and optimal Riesz and logarithmic energy distribution of points The methods used include potential theory boundary values of analytic functions Riemann Hilbert analysis and the steepest descent method

Rogue and Shock Waves in Nonlinear Dispersive Media

Miguel Onorato, Stefania Resitori, Fabio Baronio, 2016-09-19 This self contained set of lectures addresses a gap in the literature by providing a systematic link between the theoretical foundations of the subject matter and cutting edge applications in both geophysical fluid dynamics and nonlinear optics Rogue and shock waves are phenomena that may occur in the propagation of waves in any nonlinear dispersive medium Accordingly they have been observed in disparate settings as ocean waves in nonlinear optics in Bose Einstein condensates and in plasmas Rogue and dispersive shock waves are both characterized by the development of extremes for the former the wave amplitude becomes unusually large while for the latter gradients reach extreme values Both aspects strongly influence the statistical properties of the wave propagation and are thus considered together here in terms of their underlying theoretical treatment This book offers a self contained graduate level text intended as both an introduction and reference guide for a new generation of scientists working on rogue and shock wave phenomena across a broad range of fields in applied physics and geophysics

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