

Discrete Reflectionless Potentials, Quantum Algebras, and q -Orthogonal Polynomials

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Received January 28, 1994

Using Darboux transformations for the lattice Schrödinger equation, we construct two families of discrete reflectionless potentials with j and $2j$ bound states (solitons). These potentials are related to the exceptional Askey-Wilson polynomials. In the continuous limit they are reduced to the well-known solvable potential $u(x) = -j(j+1)/\cosh^2 x$. The limit $j \rightarrow \infty$ for the lattice systems may be defined in two different ways. In the first case, discrete spectrum grows exponentially fast, and the continuous spectrum band, $-2 \leq \lambda \leq 2$, is preserved. In the second case, the limiting potentials are related to the q^{-1} -Hermite polynomials. Their spectra are purely discrete and consist of one or two geometric series accumulating near the zero. These series are generated by the q -Weyl algebra and its "square root" version. In contrast to the continuous reflectionless potentials with quantum algebraic symmetries, the derived discrete potentials are expressed in terms of the elementary functions. © 1995 Academic Press, Inc.

1. INTRODUCTION

Reflectionless potentials for the ordinary Schrödinger equation were considered by Bargmann a long time ago [1]. An intensive study of them began much later due to the connection with soliton solutions of the Korteweg-de Vries hierarchy of equations [2, 3]. The scattering theory for discrete Schrödinger equations has been investigated as well, but the number of works devoted to discrete reflectionless potentials is much less than for the continuous counterparts. Partially this is caused by the similarity of procedures used for the construction of reflectionless potentials with a finite number of bound states in two cases. Indeed, such potentials can be constructed exhaustively with the help of an inverse scattering method which

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Continuous And Discrete Q Orthogonal Polynomials

D. Levi, Decio Levi



Continuous And Discrete Q Orthogonal Polynomials:

Hypergeometric Orthogonal Polynomials and Their q-Analogues Roelof Koekoek, Peter A. Lesky, René F.

Swarttouw, 2010-03-18 The present book is about the Askey scheme and the q Askey scheme which are graphically displayed right before chapter 9 and chapter 14 respectively. The families of orthogonal polynomials in these two schemes generalize the classical orthogonal polynomials Jacobi, Laguerre and Hermite polynomials and they have properties similar to them. In fact they have properties so similar that I am inclined following Andrews Askey [34] to call all families in the q Askey scheme classical orthogonal polynomials and to call the Jacobi, Laguerre and Hermite polynomials very classical orthogonal polynomials. These very classical orthogonal polynomials are good friends of mine since most the beginning of my mathematical career. When I was a fresh PhD student at the Mathematical Centre now CWI in Amsterdam Dick Askey spent a sabbatical there during the academic year 1969-1970. He lectured to us in a very stimulating

way about hypergeometric functions and classical orthogonal polynomials. Eventually he gave us problems to solve which might be worth a PhD. He also pointed out to us that there was more than just Jacobi, Laguerre and Hermite polynomials for instance Hahn polynomials and that it was one of the merits of the Higher Transcendental Functions Bateman project that it included some newer stuff like the Hahn polynomials. See [198, 10-23].

Classical and Quantum Orthogonal Polynomials in One Variable Mourad Ismail, 2005-11-21 The first modern treatment of orthogonal polynomials from the viewpoint of special functions is now available in paperback.

Orthogonal Polynomials Mama Foupouagnigni, Wolfram Koepf, 2020-03-11 This book presents contributions of international and local experts from the African Institute for Mathematical Sciences (AIMS) Cameroon and also from other local universities in the domain of orthogonal polynomials and applications. The topics addressed range from univariate to multivariate orthogonal polynomials from multiple orthogonal polynomials and random matrices to orthogonal polynomials and Painlevé equations. The contributions are based on lectures given at the AIMS Volkswagen Stiftung Workshop on Introduction of Orthogonal Polynomials and Applications held on October 5-12, 2018 in Douala, Cameroon. This workshop funded within the framework of the Volkswagen Foundation Initiative Symposia and Summer Schools was aimed globally at promoting capacity building in terms of research and training in orthogonal polynomials and applications, discussions and development of new ideas as well as development and enhancement of networking including south-south cooperation.

Symmetries and Integrability of Difference Equations Decio Levi, Luc Vinet, Pavel Winternitz, Special Functions and Generalized Sturm-Liouville Problems Mohammad

Masjed-Jamei, 2020-01-25 This book discusses theoretical and applied aspects of Sturm-Liouville theory and its generalization. It introduces and classifies generalized Sturm-Liouville problems in three different spaces: continuous, discrete, and q-discrete spaces, focusing on special functions that are solutions of a regular or singular Sturm-Liouville problem. Further, it describes the conditions under which the usual Sturm-Liouville problems with symmetric solutions can be extended to a larger class.

particularly highlighting the solutions of generalized problems that result in new orthogonal sequences of continuous or discrete functions Sturm Liouville theory is central to problems in many areas such as engineering mathematics physics and biology This accessibly written book on the topic is a valuable resource for a broad interdisciplinary readership from novices to experts *Hypergeometry, Integrability and Lie Theory* Erik Koelink, Stefan Kolb, Nicolai Reshetikhin, Bart

Vlaar, 2022-08-30 This volume contains the proceedings of the virtual conference on Hypergeometry Integrability and Lie Theory held from December 7 11 2020 which was dedicated to the 50th birthday of Jasper Stokman The papers represent recent developments in the areas of representation theory quantum integrable systems and special functions of hypergeometric type **Recurrence Relations, Continued Fractions and Orthogonal Polynomials** Richard

Askey, Mourad Ismail, 1984 We address the question of recovering the distribution function of a set of orthogonal polynomials from the three term recurrence relation satisfied by the polynomials We investigate four sets of orthogonal polynomials the Al Salam Chihara polynomials random walk polynomials and their *italic q* analogue and the case *italic q* 1 of the associated continuous *italic q* ultraspherical polynomials For each polynomial set we obtain generating functions derive explicit representations as ordinary or basic hypergeometric functions and determine their asymptotic behavior *Orthogonal*

Polynomials and Special Functions SPRINGER, **Lectures on Orthogonal Polynomials and Special Functions** Howard S. Cohl, Mourad E. H. Ismail, 2020-10-15 Contains graduate level introductions by international experts to five areas of research in orthogonal polynomials and special functions **Contemporary Problems In Mathematical Physics -**

Proceedings Of The Second International Workshop Jan Govaerts, M Norbert Hounkonnou, Alfred Z Msezane, 2002-10-18 The following topics are discussed in this volume recent developments in operator theory coherent states and wavelet analysis geometric and topological methods in theoretical physics and quantum field theory and applications of these methods of mathematical physics to problems in atomic and molecular physics as well as the world of the elementary particles and their fundamental interactions Two extensive sets of lecture notes on quantization techniques in general and quantum gauge theories and strings as an avenue towards quantum geometry are also included The volume should be of interest to anyone working in a field using the mathematical methods associated with any of these topics **Basic**

Hypergeometric Series George Gasper, Mizan Rahman, 2011-02-25 Significant revision of classic reference in special functions *Polynomial Based Iteration Methods for Symmetric Linear Systems* Bernd Fischer, 2011-07-28 Originally

published Chichester New York Wiley Stuttgart Teubner c1996 **Orthogonal Polynomials** Paul Nevai, 2012-12-06 This volume contains the Proceedings of the NATO Advanced Study Institute on Orthogonal Polynomials and Their Applications held at The Ohio State University in Columbus Ohio U S A between May 22 1989 and June 3 1989 The Advanced Study Institute primarily concentrated on those aspects of the theory and practice of orthogonal polynomials which surfaced in the past decade when the theory of orthogonal polynomials started to experience an unparalleled growth This progress started

with Richard Askey's Regional Conference Lectures on Orthogonal Polynomials and Special Functions in 1975 and subsequent discoveries led to a substantial reevaluation of one's perceptions as to the nature of orthogonal polynomials and their applicability. The recent popularity of orthogonal polynomials is only partially due to Louis de Branges's solution of the Bieberbach conjecture which uses an inequality of Askey and Gasper on Jacobi polynomials. The main reason lies in their wide applicability in areas such as Padé approximations, continued fractions, Tauberian theorems, numerical analysis, probability theory, mathematical statistics, scattering theory, nuclear physics, solid state physics, digital signal processing, electrical engineering, theoretical chemistry, and so forth. This was emphasized and convincingly demonstrated during the presentations by both the principal speakers and the invited special lecturers. The main subjects of our Advanced Study Institute included complex orthogonal polynomials, signal processing, the recursion method, combinatorial interpretations of orthogonal polynomials, computational problems, potential theory, Padé approximations, Julia sets, special functions, quantum groups, weighted approximations, orthogonal polynomials associated with root systems, matrix orthogonal polynomials, operator theory, and group representations.

SIDE III -- Symmetries and Integrability of Difference Equations D. Levi, Decio Levi, 2000. This volume contains the proceedings of the third meeting on Symmetries and Integrability of Difference Equations. SIDE III. The collection includes original results not published elsewhere and articles that give a rigorous but concise overview of their subject and provides a complete description of the state of the art. Research in the field of difference equations, often referred to more generally as discrete systems, has undergone impressive development in recent years. In this collection, the reader finds the most important new developments in a number of areas including Lie type symmetries of differential difference and difference difference equations, integrability of fully discrete systems such as cellular automata, the connection between integrability and discrete geometry, the isomonodromy approach to discrete spectral problems and related discrete Painlevé equations, difference and q difference equations and orthogonal polynomials, difference equations and quantum groups and integrability, and chaos in discrete time dynamical systems. The proceedings will be valuable to mathematicians and theoretical physicists interested in the mathematical aspects and/or in the physical applications of discrete nonlinear dynamics, with special emphasis on the systems that can be integrated by analytic methods or at least admit special explicit solutions. The research in this volume will also be of interest to engineers working in discrete dynamics as well as to theoretical biologists and economists.

Algebraic Structures and Their Representations José Antonio de la Peña, Ernesto Vallejo, Natiq M. Atakishiyev, 2005. The Latin American conference on algebra, the XV Coloquio Latinoamericano de Algebra, Cocoyoc, Mexico, consisted of plenary sessions of general interest and special sessions on algebraic combinatorics, associative rings, cohomology of rings and algebras, commutative algebra, group representations, Hopf algebras, number theory, quantum groups, and representation theory of algebras. This proceedings volume contains original research papers related to talks at the colloquium. In addition, there are several surveys presenting important topics to a

broad mathematical audience There are also two invited papers by Raymundo Bautista and Roberto Martinez founders of the Mexican school of representation theory of algebras The book is suitable for graduate students and researchers interested in algebra

Mathematical Models and Integration Methods Oleg V. Kaptsov, Evgeniy I. Kaptsov, 2024-09-23 The book compiles works presented at a seminar aiming to attract global experts in differential equations mathematical modeling and integration methods It covers classical and contemporary integration techniques for partial differential equations including Monge and Darboux's approaches and their extensions Additionally it introduces a novel theoretical model for plane turbulent flows presents gravitational equations derived from the principle of least action and explores symmetry preserving conservative finite difference schemes for hydrodynamic type equations Analytical solutions for Maxwell's equations in incompressible viscoelastic mediums are examined alongside theoretical group analysis of wake mathematical models and reduction to ordinary differential equations The book also delves into special classes of two dimensional ideal fluid motion and advancements in discrete orthogonal polynomial theory showcasing rapid decay properties near interval boundaries In conclusion this comprehensive collection is indispensable for researchers and practitioners in applied mathematics fluid dynamics and computational modeling providing valuable insights into cutting edge methods and solutions in the field

Hypergeometric Summation Wolfram Koepf, 2014-06-10 Modern algorithmic techniques for summation most of which were introduced in the 1990s are developed here and carefully implemented in the computer algebra system Maple™ The algorithms of Fasenmyer Gosper Zeilberger Petkov ek and van Hoeij for hypergeometric summation and recurrence equations efficient multivariate summation as well as q analogues of the above algorithms are covered Similar algorithms concerning differential equations are considered An equivalent theory of hyperexponential integration due to Almkvist and Zeilberger completes the book The combination of these results gives orthogonal polynomials and hypergeometric and q hypergeometric special functions a solid algorithmic foundation Hence many examples from this very active field are given The materials covered are suitable for an introductory course on algorithmic summation and will appeal to students and researchers alike

Computational Methods in Physics Simon Ćirca, Martin Horvat, 2018-06-21 This book is intended to help advanced undergraduate graduate and postdoctoral students in their daily work by offering them a compendium of numerical methods The choice of methods pays significant attention to error estimates stability and convergence issues as well as optimization of program execution speeds Numerous examples are given throughout the chapters followed by comprehensive end of chapter problems with a more pronounced physics background while less stress is given to the explanation of individual algorithms The readers are encouraged to develop a certain amount of skepticism and scrutiny instead of blindly following readily available commercial tools The second edition has been enriched by a chapter on inverse problems dealing with the solution of integral equations inverse Sturm Liouville problems as well as retrospective and recovery problems for partial differential equations The revised text now includes an introduction to sparse matrix methods

the solution of matrix equations and pseudospectra of matrices it discusses the sparse Fourier non uniform Fourier and discrete wavelet transformations the basics of non linear regression and the Kolmogorov Smirnov test it demonstrates the key concepts in solving stiff differential equations and the asymptotics of Sturm Liouville eigenvalues and eigenfunctions Among other updates it also presents the techniques of state space reconstruction methods to calculate the matrix exponential generate random permutations and compute stable derivatives *Acta Numerica 2009* Arieh Iserles,2009-05-28

A high impact prestigious annual publication featuring invited surveys by subject leaders essential reading for all practitioners and researchers *Orthogonal Polynomials and Special Functions* Kenier Castillo, Antonio J. Durán,2024-12-27

The aim of this book is to honor the memory of Professor Jos Carlos Petronilho and hence focuses on his main research areas Special Functions Orthogonal Polynomials Approximation Theory It is a collaborative book and among the contributing authors are outstanding leaders in the field The book addresses different topics exploring the connection between the areas already mentioned and their applications from different perspectives and using several tools both analytical and algebraic Beside the researches working in these topics the book potentially interests the readers working in areas of Mathematics Science and Technology where Approximation Theory Special Functions and Orthogonality are potentially useful tools

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