

## 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  $v(x) = -j(j+1)/\cosh^2 x$ . 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,  $-2 \leq k \leq 2$ , 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

**Frank W. J. Olver**



## Continuous And Discrete Q Orthogonal Polynomials:

**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 *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 *Symmetries and Integrability of Difference Equations* Decio Levi, Luc Vinet, Pavel Winternitz, **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 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 Even better 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 *Algebraic Structures and Their Representations* José Antonio de la Peña, Ernesto Vallejo, Natig 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

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**CRM Proceedings & Lecture Notes** ,1999    **Orthogonal Polynomials for Engineers and Physicists** Petr Beckmann,1973    **Special Functions** Masaki Kashiwara,1991    *MRC Technical Summary Report* Mathematics Research Center (United States. Army),1978    **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  $q$  analogue and the case  $q=1$  of the associated continuous  $q$  ultraspherical polynomials For each polynomial set we obtain generating functions derive explicit representations as ordinary or basic hypergeometric functions and determine their asymptotic behavior

**Transactions of the American Mathematical Society** American Mathematical Society,1994    **Quantum Groups**

**and Quantum Spaces** Robert Budzyński, Wiesław Pusz, Stanisław Zakrzewski, 1997  
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