The CMV bispectral problem

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Abstract

A classical result due to Bochner classifies the orthogonal polynomials on the real line which are common eigenfunctions of a second order linear differential operator. We settle a natural version of the Bochner problem on the unit circle which answers a similar question concerning orthogonal Laurent polynomials and can be formulated as a bispectral problem involving CMV matrices. We solve this CMV bispectral problem in great generality proving that, except the Lebesgue measure, no other one on the unit circle yields a sequence of orthogonal Laurent polynomials which are eigenfunctions of a linear differential operator of arbitrary order. Actually, we prove that this is the case even if such an eigenfunction condition is imposed up to finitely many orthogonal Laurent polynomials.

1   Introduction

The motivation for the problem we address here can be traced to work in signal processing started by C. Shannon [39]. Addressing his problem required finding and exploiting some remarkable mathematical miracles and was accomplished in a series of papers by three workers at Bell Labs in the 1960's: David Slepian, Henry Landau and Henry Pollak, see [32, 33, 42–46]. The most important of these miracles is the existence of a second order *differential* operator that commutes with Shannon's time-and-band limiting *integral* operator.

In an effort to understand and extend the range of applicability of these miracles one of us introduced the so called "bispectral problem", see [5]. For connections of this notion with the "time-and-band limiting problem" of Shannon see for instance

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Bispectral Problem

Joaquin Bustoz,Mourad E.H. Ismail,Sergei Suslov

Bispectral Problem:

   The Bispectral Problem John P. Harnad,Alex Kasman,1998 Comprises 16 papers from the March 1997 meeting on the subject in Montreal The focus is on the search for solutions to eigenvalue problems that satisfy additional equations in the spectral parameter such as pairs of eigenvalue equations Among the topics automorphisms of the weyl algebra and bispectral operators Huygens Principle beyond the classical orthogonal polynomials dual isomonodromic deformations Darboux transformations explicit formulas for the Airy and Bessel bispectral involutions in terms of Calogero Moser pairs Baker Akhiezer functions and the bispectral problem in many dimensions and the geometry of spinors and the multicomponent BKP and DKP hierarchies Annotation copyrighted by Book News Inc Portland OR   Partial Differential Equations and Inverse Problems Carlos Conca,2004 This proceedings volume is a collection of articles from the Pan American Advanced Studies Institute on partial differential equations nonlinear analysis and inverse problems held in Santiago Chile Interactions among partial differential equations nonlinear analysis and inverse problems have produced remarkable developments over the last couple of decades This volume contains survey articles reflecting the work of leading experts who presented minicourses at the event Contributors include J Busca Y Capdeboscq M S Vogelius F A Grunbaum L F Matusevich M de Hoop and P Kuchment The volume is suitable for graduate students and researchers interested in partial differential equations and their applications in nonlinear analysis and inverse problems   **The Kowalevski Property** Vadim B. Kuznetsov, This book is a collection of survey articles on several topics related to the general notion of integrability It stems from a workshop on Mathematical Methods of Regular Dynamics dedicated to Sophie Kowalevski Leading experts introduce corresponding areas in depth The book provides a broad overview of research from the pioneering work of the nineteenth century to the developments of the 1970s through the present The book begins with two historical papers by R L Cooke onKowalevski s life and work Following are 15 research surveys on integrability issues in differential and algebraic geometry classical complex analysis discrete mathematics spinning tops Painleve equations global analysis on manifolds special functions etc It concludes with Kowalevski s famouspaper published in Acta Mathematica in 1889 Sur le probleme de la rotation d un corps solide autour d un point fixe The book is suitable for graduate students in pure and applied mathematics the general mathematical audience studying integrability and research mathematicians interested in differential and algebraic geometry analysis and special functions   **Special Functions 2000: Current Perspective and Future Directions** Joaquin Bustoz,Mourad E.H. Ismail,Sergei Suslov,2012-12-06 The Advanced Study Institute brought together researchers in the main areas of special functions and applications to present recent developments in the theory review the accomplishments of past decades and chart directions for future research Some of the topics covered are orthogonal polynomials and special functions in one and several variables asymptotic continued fractions applications to number theory combinatorics and mathematical physics integrable systems harmonic analysis and quantum groups Painlev classification   Algebraic Methods and Q-special

<u>Functions</u> Jan Felipe Van Diejen,Luc Vinet,1999-01-01 There has been revived interest in recent years in the study of special functions Many of the latest advances in the field were inspired by the works of R A Askey and colleagues on basic hypergeometric series and I G Macdonald on orthogonal polynomials related to root systems Significant progress was made by the use of algebraic techniques involving quantum groups Hecke algebras and combinatorial methods The CRM organized a workshop for key researchers in the field to present an overview of current trends This volume consists of the contributions to that workshop Topics include basic hypergeometric functions algebraic and representation theoretic methods combinatorics of symmetric functions root systems and the connections with integrable systems **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 Painlev 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 **Calogero—Moser— Sutherland** <u>Models</u> 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 Schr dinger 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 **Mathematical Reviews** ,2006 <u>CRM Proceedings & Lecture Notes</u> ,2001 **Rapport** ,2002 <u>Séminaire de mathématique</u> ,2002-03 *Physics Letters* ,1996 General physics atomic physics molecular physics and solid state physics **Methods and Applications of Analysis** ,1999 <u>Differential Equations in the Spectral Parameter for Matrix Differential Operations of</u>

AKNS Type Jorge Passamani Zubelli,1989 Serdica Mathematical Journal ,1997 Proceedings of the American Mathematical Society American Mathematical Society,1998 Contains the material formerly published in even numbered issues of the Bulletin of the American Mathematical Society *Pacific Journal of Mathematics* ,2002-05 Solitons, Geometry, and Topology ,1999 Higher-order Spectra Analysis Chrysostomos L. Nikias,Athina P. Petropulu,1993 This manual will be valuable to practicing engineers who need an introduction to polyspectra from a signal processing perspective In response to the recent growth of interest in polyspectra this timely text provides an introduction to signal processing methods that are based on polyspectra and cumulants concepts The emphasis of the book is placed on the presentation of signal processing tools for use in situations where the more common power spectrum estimation techniques fall short

New Trends in Quantum Field Theory A. Ganchev,R. Kerner,L. T. Todorov,1996 The first part of the volume contains the invited and contributed lectures at the Workshop covering such modern topics of Mathematical Physics as conformal field theory non cumulative geometry integrable models duality in string theory and gauge theory The second part contains an extended version of the contribution of Victor Kac based on a mecture course at MIT

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