Orthogonal Polynomials and Special Functions

SIAM Activity Group on Orthogonal Polynomials and Special Functions

★ ★ ★ ★ **Newsletter** ★ ★ ★ ★

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Contents

From the Editor

On the occasion of the election for officers of the *SIAM Activity Group on Orthogonal Polynomials and Special Functions* one year ago the following suggestion was made by a member of our group:

- Define a program of self-study for a non-mathematician, e.g., a mathematically-inclined engineer who uses OP and SF. In other words, could the group indicate a limited set of books and papers (including survey papers) that could give an adequate basis to understand current trends and needs in OP-SF?

Indeed, there is a need for such a list for the non-professional user of orthogonal polynomials and special functions. Hence, in cooperation with the other officers of the Activity Group, I have compiled such a list which you will find on page 12–14. I hope that nobody feels embarrassed by a missing item. Obviously the given list can be neither complete nor perfect. If somebody feels that an important item is missing, please let me know.

Furthermore a collection of interesting and important electronic services, including WWW sites, is given at the same place. I am sure that these lists are of help to our readers.

Following this item, you are introduced to the book *Bibliography on Orthogonal Polynomials* which represents an early attempt to simplify the classification and retrieval of information on our subject.

Searching through WWW sites I discovered that our Newsletter seems to be carefully read

and not only by our members. At the address http://www.cecm.sfu.ca/News/Orthogonal2.html my introduction to CECM's *Inverse Symbolic Calculator* in issue 6.3 of the Newsletter (June 1996) is acknowledged.

I hope that besides getting valuable information, you enjoy reading the current issue of the Newsletter!

January 31, 1997 Wolfram Koepf

Memorial Note about Felix Arscott

Felix Arscott, Professor Emeritus in the Department of Applied Mathematics at the University of Manitoba, died suddenly on July 5, 1996 while on holiday in England.

Professor Arscott was a leading expert in the "higher special functions" and associated differential equations (a paper of his from 1980 is picturesquely titled "The Land beyond Bessel") and is one of the authors of the recent monograph "Heun's Differential Equations", Oxford University Press, 1995 (see the announcement in Newsletter 6-1, p. 10).

Born in the London suburb of Greenwich in 1922, Professor Arscott spent most of the Second World War in the Royal Air Force, leaving the service as a commissioned officer and having gained an honours degree in Mathematics from the University of London by private study. After a few years of teaching, he completed an M.Sc. in Mathematics in 1951, and went to teach mathematics at Makerere College, then the leading educational institution in eastern Africa. During this period, he wrote a thesis on special functions and received the Ph.D. of the University of London in 1956. There followed positions at Aberdeen, Battersea College of Technology (later the University of Surrey) and the University of Reading. During this period he coauthored with I. M. Khabaza the book "Tables of Lamé polynomials", Pergamon Press (1962), wrote "Periodic Differential Equations: An Introduction to Mathieu, Lamé, and Allied Functions", Pergamon (1964) and translated O. Borůvka's "Linear differential transformations of the second order", English Universities Press (1971). Along the way, he had been a visiting professor at the Universities of Wisconsin and Calgary, had supervised six Ph.D. theses, had written 21 papers and was a founding Fellow of the Institute of Mathematics and its Applications.

In 1974, Arscott became Head of the fledgling Department of Applied Mathematics at the University of Manitoba, a position he was to hold for eleven years. Apart from administrative leaves at Oxford and Dundee, he was associated with the University of Manitoba for the rest of his life. He accomplished much at Manitoba, building a Department which did all of the Engineers' service teaching and set up Science programmes in Applied Mathematics.

Apart from the work mentioned above, Felix Arscott worked on multiparameter eigenvalue problems, difference equations, orthogonal bipolynomials and (in collaboration) on elasticity and nu-

merical construction of special functions. There can be few members of the group whose work has touched so many facets of our subject.

(I am indebted to Professor Robert Thomas for much of the information in this notice.)

Martin Muldoon
(muldoon@yorku.ca)

Reports from Meetings and Conferences

1. Workshop on Special Functions & Differential Equations: Madras, India, January 13-24, 1997

A workshop on special functions and differential equations was held at the *Institute of Mathematical Sciences* in Chennai (formerly known as Madras) in India, from January 13 to January 24, 1997. The main organizer was K. Srinivasa Rao, who succeeded to get about 75 participants in this workshop, with approximately two thirds of them from India. The other participants were from Belgium (7), The Netherlands (3), Australia (2), New Zealand, Finland, Canada, Poland, Germany, Austria, France, and Italy (each 1), and some people from India working temporarily abroad.

The background of speakers and participants was partly from pure and applied mathematics and partly from mathematical and theoretical physics. At least half of the lectures dealt with the first conference theme, special functions. The other theme of differential equations was approached both from the analytic side and from the numerical side. A few lectures merged both themes. All lectures were plenary and invited and had a standard length of 45 minutes. There were quite a few minicourses consisting of two or three lectures. The topics of these minicourses ranged over: Ramanujan's mock theta functions; connection and linearization coefficients for orthogonal polynomials; generalizations of Laguerre polynomials by adding (a derivative of) $\delta(x)$ to the weight function; applications of $3j$, $6j$ and $9j$ coefficients to special function theory; irrationality and trancendence proofs of some famous numbers by approximation theory; special functions associated with root systems; creation operators for Jack and Macdonald polynomials; numerical methods for solving o.d.e.'s; parallel algorithms for solving o.d.e.'s; non-linear quantum mechanics; the uncertainty principle; nonlinear evolution equations. D.-N. Verma (of Verma module fame) gave some informal seminars on Lie theory, Clebsch-Gordan coefficients and related matters, and Tom Koornwinder filled a gap in the program by giving a seminar lecture on Zeilberger's algorithm.

The workshop even made the local newspaper and television due to a special lecture *A nuclear-weapon free world: desirable? possible? probable?* by F. Calogero, secretary general of the Pugwash conferences on science and world affairs, which was attended by his excellency R. Venkataraman, former president of India.

During the opening ceremony of the workshop, R.P. Agarwal gave a survey on special functions in India during the last century. Among others, the theory of q-special functions, the (Miller type) Lie theoretic approach to special functions, and applications to theoretical physics and probability theory are well represented nowadays in India. Professor Agarwal concluded his survey with a call to avoid superficial work and to look always for deep results. Tom Koornwinder, as vice-chair of our SIAM Activity Group, was asked to make some remarks in reply. He indicated some further active research areas in our field, such as special functions of several variables, their relation with certain algebraic structures (Lie groups and algebras, root systems, quantum groups, Hecke algebras), the general theory of orthogonal polynomials (including the Sobolev inner products), computer algebra methods for finding hypergeometric identities, and the application of special functions in real life situations (engineering). Some of these aspects indeed were the subject of subsequent lectures.

During the workshop there was an informal meeting for founding a Society for Special Functions & Applications in India. Its aim will be to promote research in this area, to inform people of what is going on, and possibly to create a new India-based forum for bringing out research publications of international standard on special functions. Application forms for life-long membership are already available. Interaction with our SIAM activity group looked desirable to all present at the discussions, certainly concerning the Newsletter.

A very extensive cultural program was prepared by the organizers. Among the events were a dance performance, a concert of traditional Indian music, a trip to a drive-in movie to see a Tamil version of Mrs. Doubtfire, and on Sunday a visit to the temple cities Kancheepuram and Mahabalipuram for visiting the temples (barefoot of course) and to do business with the local sandal makers and sculpturers (bargaining skill is desirable).

Ramanujan is of course very closely connected with Chennai and a visit to the Ramanujan museum and the Ramanujan Institute for Mathemical Sciences of the University of Madras was therefore a natural part of the program. The Ramanujan museum is a rather recent realisation located in a mathematics education center. Srinivasa Rao gave a lecture on the life and work of Ramanujan and afterwards we were able to see the displays in the museum. Some of Ramanujan's work is very suitable for use in mathematics courses at all levels and the Ramanujan

museum wants to advertize this idea. Our visit to the museum ended with a delicious high tea organized with great care and effort by the mathematics education center.

All western participants were impressed by the quality of the hosting Institute of Mathematical Sciences, the great hospitality, and (for newcomers) the fascinating intricasies of Indian culture and society. The efforts of prof. K. Srinivasa Rao to make this workshop into a success are really beyond praise.

Tom H. Koornwinder
(thk@wins.uva.nl)
Walter Van Assche
(walter@wis.kuleuven.ac.be)

Forthcoming Meetings and Conferences

1. Bourbaki Lecture: Paris, March 1, 1997

On March 1, 1997, 16:00 hours, Gert Heckman speaks in Séminaire Nicolas Bourbaki, *Institut Henri Poincaré*, Paris, on *Dunkl Operators*. For details see http://www.ens.fr/dmi/bourbaki/

Abstract: Elementary spherical functions on semisimple Lie groups suggest by "variation of structural parameters" the concept of hypergeometric functions associated with root systems. Such a theory was developped several years ago by Opdam and the lecturer. Dunkl operators are a mixture of differential and divided difference operators, and they form a basic tool in the differential algebra of this hypergeometric theory. It is remarkable to see the ubiquitous role played by the representation theory of affine Hecke algebras and their degenerations.

Tom H. Koornwinder
(thk@wins.uva.nl)

2. Workshop on Calogero-Moser-Sutherland Systems: Montréal, March 10-15, 1997

During the period March 10–15, 1997, the CRM organizes a *Workshop on Calogero-Moser-Sutherland Systems* in Montréal.

Keynote Speakers:

F. Calogero	(Università di Roma)
J.K. Moser *	(E.T.H.)
B. Sutherland	(University of Utah)

Invited Speakers:

B.L. Altshuler	(NEC Research Institute)
T. Baker	(Melbourne University)
D. Bernard	(Saclay)
R.K. Bhaduri	(McMaster University)
H.W. Braden	(University of Edinburgh)
P. Di Francesco	(University of North Carolina at Chapel Hill)
T. Eguchi	(University of Tokyo)
B. Enriquez	(École Polytechnique de Palaiseau)
F.D.M. Haldane	(Princeton)
V.I. Inozemtsev	(Joint Institute for Nuclear Research)
I. Krichever *	(Columbia University)
P. Mathieu	(Université Laval)
N. Nekrasov	(Harvard)
M.A. Olshanetsky	(Inst. of Theoretical and Exp. Physics)
V. Pasquier	(Princeton)
A.P. Polychronakos	(University of Ioannina)
V. Rubtsov *	(Inst. of Theoretical and Exp. Physics)
S.N.M. Ruijsenaars	(CWI)
H. Saleur	(University of Southern California)
D. Senechal *	(Université de Sherbrooke)
T. Shiota	(Kyoto University)
E.K. Sklyanin	(University of Tokyo)
A. Varchenko	(University of North Carolina at Chapel Hill)
A. Veselov	(Loughborough University)
M. Wadati	(University of Tokyo)
G. Wilson	(Imperial College)

(* to be confirmed)

Organizers: Jan Felipe van Diejen and Luc Vinet

Information and Registration:

Louis Pelletier
Centre de Recherches Mathématiques
Université de Montréal
C.P. 6128, succ. Centre-ville
Montréal (Québec) H3C 3J7
Canada

or electronically: http://www.CRM.UMontreal.CA

Jan Felipe van Diejen
(ACTIVITES@CRM.UMontreal.CA)

3. MSRI Program on Combinatorics: Berkeley Symmetric Functions and Representation Theory: March 17-May 30, 1997

The *MSRI*, Berkeley organizes during 1996–97 a full-year program on Combinatorics. The program focuses on four main areas of approximately half a semester each. During each of these four periods there will be a one-week workshop. See WWW:

http://www.msri.org/application/comb.html

Between March 17 and May 30, 1997, the topic is *Symmetric functions and representation theory*, and a workshop will be held on April 14–18, 1997.

Subtopics: Macdonald's two-parameter symmetric functions and the corresponding two variable Kostka polynomial; immanent conjectures of Lieb, Goulden-Jackson, Stembridge, et al.; constant term identities and their connection with nilpotent Lie algebras and cyclic homology; random walks on groups and shuffling problems; internal products of symmetric functions; invariant theory.

The workshop is being organized by Curtis Greene (Chair), Sergey Fomin, Phil Hanlon, and Sheila Sundaram. Scope: In recent years there have been many exciting developments in areas that link combinatorics (especially the theory of symmetric functions) with representation theory and algebraic geometry. This workshop will focus on current problems in these areas, emphasizing the interplay between algebraic and combinatorial methods. The program will include the following topics, as well as others:

- Schur functions and their generalizations
- Combinatorics and representations of finite Coxeter groups
- Quantum groups and Hecke algebras
- Centralizer algebras
- Homology representations

For more information:
WWW: http://www.msri.org/sched/CombSymfns.html
e-mail: symfns@msri.org

Tom H. Koornwinder
(thk@wins.uva.nl)

4. Centenary Conference, including Minisymposium on Special Functions: Madison, Wisconsin, May 22-24, 1997

On May 22–24, 1997 the Department of Mathematics of the University of Wisconsin, Madison will celebrate the 100th anniversary of the awarding of the first Ph.D. in Mathematics by the University of Wisconsin in 1897.

Invited speakers, who are being asked to discuss early work at Wisconsin and more recent work of former and current Wisconsin students and faculty, include: Richard Arratia, Richard Askey, Carl de Boor, Robert Brown, Joshua Chover, Michael Crandall, George Glauberman, William Jaco, Yiannis Moschavakis, John Nohel, Louis Solomon, and Walter Rudin. There will also be opportunities for contributed papers.

Charles Dunkl will be organizing a minisymposium there on special functions. Participants will have to pay their own transportation, lodging and meals, but there will be no registration fees.

All current and former Wisconsin faculty, students, visitors, fellows, and other 'Wisconsin friends' are cordially invited to participate in the conference. Rooms for the nights of May 21, 22, 23, and 24 (1997) have been reserved in the name of "UW-Math PhD. Centennial Conference" at three nearby hotels and will be kept open until two weeks before the conference begins.

A banquet/celebration evening is being planned for Friday, May 23, 1997 in Great Hall of the Memorial Union. Mary Ellen Rudin will be the banquet speaker. Other participants will offer reminiscences.

Further information can be obtained on WWW at http://math.wisc.edu/events/cent.html.

Charles F. Dunkl
(cfd5z@virginia.edu)

5. First ISAAC Conference: University of Delaware, Newark, Delaware, June 3-7, 1997

As already announced in the last issue, Wolfram Koepf is organizing Session 13 on *Orthogonal Polynomials* at the First ISAAC Conference, University of Delaware, Newark, Delaware, June 3–7, 1997. Note that the conference is scheduled one day later than originally stated to enable the participants to get cheap flights. The emphasis of this session will be on the use of symbolic computation in connection with orthogonal polynomials and special functions. It is the purpose of the proposed section to bring together developers of symbolic algorithms and implementations which are connected with orthogonal polynomials and special functions with users of computer algebra systems who need this type of software.

The Conference Secretary of the First ISAAC Conference is

Pam Irwin
Department of Mathematics
University of Delaware
e-mail: irwin@math.udel.edu

If you have any questions about the conference, please contact her.

The conference has its WWW page at the address http://www.math.udel.edu/isaac/conferen/congr97.htm, where also travel and hotel information is available, and at http://www.math.udel.edu/isaac/cong.html there is an online registration form available. The conference fee is $ 100 if registered before May 1, 1997.

Note that Wolfram Koepf will present a plenary lecture at the Conference on *Orthogonal Polynomials and Computer Algebra*.

The WWW page http://www.zib.de/koepf/isaac.html contains updated informations about the program of Session 13 on *Orthogonal Polynomials*. Up to now the program is as follows:

- **Victor Adamchik:** *On Series Involving the Riemann Zeta Function*
- **Renato Álvarez-Nodarse:** *Differential and Difference Equations for Orthogonal Polynomials: A Computer Algebra Approach*
- **Tewodros Amdeberhan:** *Computer Aided Proofs of a Determinant Identity*
- **Ivan Area**, E. Godoy, A. Ronveaux and A. Zarzo: *Inversion Problems for Classical Orthogonal Polynomials and their q-analogues*
- **Richard A. Askey:** *Some Problems on Orthogonal Polynomials*
- **Natig M. Atakishiyev:** *On the Fourier-Gauss Transforms of some q-exponential and q-trigonometric Functions*
- **Yang Chen**, Mourad Ismail: *Asymptotics of the Largest Zeros of Some Orthogonal Polynomials*
- **Charles F. Dunkl:** *Using Maple to Explore Special Functions of Several Variables*
- **Tom H. Koornwinder**, René Swarttouw: *rec2ortho: An Algorithm for Identifying Orthogonal Polynomials Given by Their Three-Term Recurrence Relation as Special Functions*
- **John Majewicz:** *On a Positivity Conjecture of Richard Askey*
- **Kelly Roach:** *Maple and Orthogonal Polynomials*
- **André Ronveaux:** *Recurrence Relations for Connecting Coefficients Between Some Orthogonal Polynomials Families–A Simple Algorithm (Mathematica)*
- **Walter Van Assche:** *Some Examples of Computer Experiments in Research on Orthogonal Systems*
- **Alan Schwartz:** *Polynomials of Several Variables and Harmonic Analysis*
- **Rafael J. Yañez**, A. Zarzo and J. Ruano: *Computer Algebra Handling of Hypergeometric-type Functions*
- **A. Zarzo:** *Spectral Properties of Orthogonal Polynomials: A Computer Algebra Approach*
- **Doron Zeilberger:** *The Super-Holonomic Hierarchy*

Obviously, I am also delighted to have people participate in our session without giving a talk. Looking at the list of speakers, I am sure that this session will be a great success.

Wolfram Koepf
(koepf@zib.de)

6. CRM Workshop on Algebraic Combinatorics: Montréal, June 9-20, 1997

The *Centre de Recherches Mathématiques* (Montréal, Canada) is hosting a year-long program in combinatorics and group theory in 1996-1997. The year will be organized around a certain number of workshops spread throughout the year.

A Workshop on Algebraic Combinatorics will take place during June 9–20, 1997. The purpose of the workshop is to study interactions between Algebraic Combinatorics and Symmetric Functions, with a special emphasis on Descent Algebras of Coxeter groups in relation to quasi-symmetric functions and non-commutative symmetric functions, and on doubly parameterized (Macdonald) (q,t)-symmetric functions, in relation to harmonics of reflection groups.

Organizers: F. Bergeron (UQAM), N. Bergeron (York), C. Reutenauer(UQAM)

Invited Speakers: P. Diaconis (to be confirmed), A. Garsia, I. Gessel, I. Goulden (to be confirmed), M. Haiman, I.G. Macdonald, C. Procesi, L. Solomon, R.P. Stanley, J.Y. Thibon.

Those wishing to participate in the above activities are invited to write to:

Louis Pelletier
CRM, Université de Montréal
C.P. 6128, Succ. centre-ville
Montreal (Quebec) Canada H3C 3J7

Further information on WWW:
http://www.crm.umontreal.ca/Activites/Thematique_96-97_Eng.html
or
http://www.crm.umontreal.ca/Activites/Thematique_96-97_Frn.html

Louis Pelletier
(activites@crm.umontreal.ca)

7. Continued Fractions and Geometric Function Theory: Trondheim, Norway, June 24-28, 1997

Haakon Waadeland celebrates his 70th birthday on 20 May 1997. He is responsible for a long list of valuable contributions to the two fields of continued fractions and geometric function theory, and he is still very active. In recognition of his work we have decided to organize a conference in his honour. The conference will be held in Trondheim, Norway from 24 to 28 June 1997 under the title *Continued Fractions and Geometric Function Theory*. We hope to get together a group of people representing both fields, and we would very much appreciate if you would participate. We plan to publish proceedings from the conference.

The conference has its own world wide web page on http://www.matstat.unit.no/CFGT, where we will put new information when it is available. From this page you can also link to pages about Trondheim and about the university, NTNU.

If you want to receive the second announcement, please contact the conference address: confun@imf.unit.no.

Lisa Lorentzen
(lisa@imf.unit.no)

8. SIAM Annual Meeting: Stanford, July 14-18, 1997

Minisymposium: Handbooks for Special Functions and the World Wide Web

The minisymposium will be held at the July 14–18 1997 SIAM Annual Meeting in Stanford as an initiative of the *SIAM Activity Group on Orthogonal Polynomials and Special Functions*. Dick Askey and Willard Miller are co-organizers. The principal handbooks on special functions, the *Bateman Project* and the NIST *Handbook of Mathematical Functions* are among the most useful, widely consulted technical volumes ever published, but they are now out of date, due to rapid research progress and to revolutionary changes in technology. The Minisymposium will feature talks by representatives of the groups that are proposing to update the Bateman Project and Abramowitz & Stegun, respectively, and talks with critiques of those CD-Rom and WWW handbook projects that are already available. The Minisymposium will conclude with a general discussion concerning the appropriate format and structure for handbook projects, and funding possibilities. Confirmed talks to date are the following.

Daniel W. Lozier
Mathematical and Computational Sciences Division
National Institute of Standards and Technology
Gaithersburg, MD 20899

Toward a Revised NBS Handbook of Mathematical Functions

Abstract: A modernized and updated revision of Abramowitz and Stegun, Handbook of Mathematical Functions, first published in 1964 by the National Bureau of Standards, is being planned for publication on the World Wide Web. The authoritative status of the original will be preserved by enlisting the aid of qualified mathematicians and scientists. The practical emphasis on formulas, graphs, and numerical evaluation will be extended by providing an interactive capability to permit generation of tables and graphs on demand.

Mourad E. H. Ismail
Department of Mathematics
University of South Florida
Tampa, Florida, 33620

The Askey-Bateman Project

Abstract: We hope to update the Bateman Project to reflect the developments in the subject over the last fifty years and cover topics of importance that were not covered in the initial project. A presentation will be made as to the current state of this project, the need for it, and a sketch of the contents and the personnel to be involved. Suggestions, recommendations, criticisms and any useful input will be welcome and greatly appreciated.

Richard Askey
Department of Mathematics
University of Wisconsin
480 Lincoln Drive
Madison, WI 53706

Handbooks of Special Functions Through the Decades

Abstract: Handbooks of special functions have been some of the most widely used mathematics books. Features of some of the better ones will be described and some uses will be illustrated.

Willard Miller, Jr.
(miller@ima.umn.edu)

9. VIII Simposium Sobre Polinomios Ortogonales y Aplicaciones, Sevilla, September 22-26, 1997

You are cordially invited to attend the *VIII Simposium sobre polinomios ortogonales y aplicaciones* (8SPOA, in short) which will be held from September 22–26, 1997 at the Facultad de Matemáticas of the Universidad de Sevilla.

The scientific program is currently being elaborated by the scientific committee C. Berg (Copenhagen), A.J. Durán (Sevilla), J.J. Guadalupe (La Rioja), G. López Lagomasino (La Habana), F. Marcellán (Madrid), J. Sánchez Dehesa (Granada) and W. van Assche (Leuven). It consists of some plenary lectures and short communications (20 min). The invited speakers are Alexander I. Aptekarevi, Richard Askey, Christian Berg, Doron Lubinsky, Andrei Martinez, Paul Nevai, Evgeni Rakhmanov, Edward B. Saff, Herbert Stahl, and Vilmos Totik.

The cost of attendance is expected to be very reasonable. The following estimates are subject to change but it is anticipated that the registration fee will be around 20.000 pesetas (1$ =120 pesetas, approx.), which includes the admission to the Symposium, a copy of the book of abstracts, a copy of the Proceedings, reception and participation in some social events. The price for lodging and meals will total about 6.000 pesetas per person and day.

In order to keep discussions informal, the size of the Symposium must be limited to about 100 invited participants. Owing to space limitations, it may happen that we will not be able to accomodate all those interested in attending it. To be on the safe side with the accomodation of the participants of our Symposium, we have already reserved a number of rooms in the comfortable University Residence “Hernando Colón”.

The Symposium will be held at the building of the Facultad de Matemáticas of the Universidad de Sevilla. Both the Faculty and the residence are in “Reina Mercedes Campus”, 30 minutes on foot from the old center of the city

(the biggest in Europe, with the cathedral, Giralda tower, Reales Alcázares, etc.) and 15 minutes from María Luisa Park (España and América Squares, etc.).

Access to Sevilla is easy; it lies along the high speed railroad southwards from Madrid (2 hours and a half). There exist highways from Madrid and Barcelona connecting to Europe, and there is an international airport with several daily flights to Madrid or Barcelona.

A registration form can be obtained via e-mail, fax: (+34 5 4557972), or from the following address

VIII Simposium Sobre Pol. Orto. y Aplicaciones
Dpto. Análisis Matemático
Facultad de Matemáticas
Universidad de Sevilla
Aptdo. 1160
41080 Sevilla, Spain

The WWW page http://www.wis.kuleuven.ac.be/wis/applied/walter/sevilla.html shows more details about the conference.

Antonio J. Duran
(8spoa@obelix.cica.es)

Books and Journals

1. Symmetries and Integrability of Difference Equations
Ed.: Decio Levi, Luc Vinet and Pavel Winternitz
CRM Proceedings & Lecture Notes, Vol. 9, Amer. Math. Soc., 1996, ISBN 0-8218-0601-7.

This book is devoted to symmetries and integrability of difference equations and q-difference equations and the theory of special functions that occur as solutions of such equations. Techniques that have been traditionally applied to solve linear and nonlinear differential equations are now being adapted and applied to discrete equations.

This volume is based on contributions during the *Workshop on Symmetries and Integrability of Difference Equations* held in Esterel, Quebec, in May 1994.

The book treats these specific topics:
- Lie group and quantum group symmetries of difference and q-difference equations
- integrable and nonintegrable discretizations of continuous integrable systems
- integrability of difference equations
- discrete Painlevé property and singularity confinement
- integrable mappings
- applications in statistical mechanics and field theories
- Yang-Baxter equations
- q-special functions and discrete polynomials
- q-difference integrable systems

Contents:

- F. W. Nijhoff and G. D. Pang – Discrete-time Calogero-Moser model and lattice KP equations
- Y. Ohta, K. Kajiwara, and J. Satsuma – Bilinear structure and exact solutions of the discrete Painlevé I equation
- V. Papageorgiou, B. Grammaticos, and A. Ramani – Integrable difference equations and numerical analysis algorithms
- M. Rahman – An integral representation of the very-well-poised ${}_8\psi_8$ series
- M. Rahman and S. K. Suslov – Singular analogue of the Fourier transformation for the Askey-Wilson polynomials
- A. Ramani, B. Grammaticos, and V. Papageorgiou – Singularity confinement
- A. Ronveaux, S. Belmehdi, E. Godoy, and A. Zarzo – Recurrence relation approach for connection coefficients. Applications to classical discrete orthogonal polynomials
- R. Sahadevan, G. B. Byrnes, and G. R. W. Quispel – Linearisation of difference equations using factorisable Lie symmetries
- A. B. Shabat – First integrals of the infinite Toda lattice
- E. Sorace – Non semisimple quantum groups and "Exponential Mappings"
- V. Spiridonov, L. Vinet, and A. Zhedanov – Discrete Schrödinger equation, Darboux transformations, and orthogonal polynomials
- L. A. Takhtajan – Integrable cellular automata and AKNS hierarchy
- C. M. Viallet – On some rational Coxeter groups

Tom H. Koornwinder
(thk@wins.uva.nl)

2. Mathai Festschrift
International Journal of Mathematical and Statistical Sciences, June 1995, Vol. 4, No. 1, 1-130.

This issue contains *A Festschrift in Celebration of Professor A.M. Mathai's Sixtieth Birthday*.

Contents:

- Foreword by S.B. Provost
- Publications of A.M. Mathai
- S. Cakmak, D.A.S. Fraser, P. McDunnogh, and N. Reid: Likelihood centered asymptotic model exponential and location model versions.
- H.J. Haubold: An analytic solar model—Physical principles and mathematical structures.
- S. Kounias: Poisson approximation and Bonferroni bounds for the probability of the union events.
- I.B. MacNeill, Y. Mao, L. Xie, and S.M. Tang: Segmented models for age-period-cohort cancer data.
- A.M. Mathai and P.G. Moschopoulos: The distribution of the standard F-ratio in one-way ANOVA with multinomially distributed cell sizes.
- G. Pederzoli: Integral and series representations of a G-function through statistical techniques.
- S.B. Provost and E.M. Rudiuk: Moments and densities of test statistics for covariance structures.
- W.Y. Tan and M.L. Tiku: On a sampling distribution of the F-ratio in random effect models.
- D.S. Tracy and N.S.Mangat: Respondent's privacy hazards in Moors' randomized response model—A remedial strategy.

Hans J. Haubold
(haubold@ekpvs2.dnet.tuwien.ac.at)

3. Bilinear Forms and Zonal Polynomials
By A.M. Mathai, S.B. Provost and T. Hayakawa
Lecture Notes in Statistics Vol. 102, Springer-Verlag, Berlin and New York, 1995, 376 pp.

The book covers bilinear forms in real random vectors and their generalizations as well as zonal polynomials and their applications with respect to generalized quadratic and bilinear forms. The book begins with the basic principles of the two fields and develops their mathematics and statistics up to recent research results from the point of view of theory. Detailed proofs may satisfy the mathematician while detailed examples may inspire the physicist, particularly those working in the field of quantum theory. Applications of the results are emphasized in extensive numbers of exercises and references. The book is a rich source of material not yet brought to the attention of physicists.

Hans J. Haubold
(haubold@ekpvs2.dnet.tuwien.ac.at)

4. The Collected Works of Lars Onsager
Ed.: P.C. Hemmer, H. Holden and S. Kjelstrup Ratkje
World Scientific, Singapore, New Jersey, London and Hong Kong, 1996.

Onsager's unpublished Ph.D. thesis is printed here. The title is *Solutions of the Mathieu Equation of Period* 4π *and Certain Related Functions*.

The biographical memoir on Onsager by C. Longuet-Higgins and M. Fisher is fascinating. Before he started, at 17, to study chemical engineering at *Norges Tekniske Hoiskole* in Trondheim, Onsager had bought a copy of Whittaker and Watson's "Modern Analysis" and worked through most of the problems. It remained a favorite of his, and the elliptic functions he learned there were used in his solution of the two dimensional Ising model.

Further information on Onsager and many very interesting stories were also given in J. Statistical Physics **78**, 1995, no. 1–2.

Richard Askey
(askey@math.wisc.edu)

5. Quantum Theory of Angular Momentum: Selected Topics
By K. Srinivasa Rao and V. Rajeswari
Springer-Verlag and Narosa Publishing House, 1993, 315 pp.

The topics selected for study in this research monograph are:

- Connection between the angular momentum coupling (3-j) and recoupling (6-j and 9-j) coefficients and generalized hypergeometric functions of unit argument.
- Transformation theory of generalized hypergeometric functions and the relation of the different 3-j coefficient forms – due to Van der Waerden, Wigner, Racah, Majumdar, Raynal.
- Relation between the 3-j coefficient and the Hahn polynomial, the 6-j coefficient and the Racah polynomial and their consequences for recurrence relations.
- Polynomial (or *non-trivial*) zeros of angular momentum coefficients:
  - closed form, *formal* binomial expansions for the 3-j, 6-j and 9-j coefficients.
  - Degree 1 zeros and multiplicative Diophantine equations.
  - Polynomial zeros of higher degrees.
  - Polynomial zeros and exceptional Lie algebras.
  - Numerical algorithms for the generation of polynomial zeros.
- q-3-j and q-6-j coefficients and their relation to sets of basic hypergeometric series.
- Numerical computation of angular momentum coefficients:
  - The 3-j coefficient, using the set of six ${}_3F_2(1)s$.
  - The 6-j coefficient, using two sets of three and four ${}_4F_3(1)s$.
  - The 9-j coefficient, using the triple sum series.
  - Parallel computation of the 9-j coefficient, using the hierarchic formulae.

This research monograph builds on the standard text book material contained in, for example: A.R. Edmonds (1957) *Angular Momentum in Quantum Physics* (Princeton Univ. Press, Princeton) and leads the reader to the recent developments in the selected topics. The contents of this book supplement the results in the Encyclopaedia of Mathematics and its Applications, Vols. 8 and 9 of L.C. Biedenharn and J.D. Louck entitled: *Angular Momentum in Quantum Physics* and *Racah-Wigner Algebra in Quantum Physics*; and the compilation of all the known formulae in this field contained in the book: *Quantum Theory of Angular Momentum* by D.A. Varshalovich, A.N. Moskalev and V.K. Khersonskii, World Scientific (1988), English edition of the original Russian publication (Leningrad: Nauka 1975).

Fortran programs for the computation of the 3-j, 6-j and 9-j coefficients are included for use by atomic, molecular and nuclear Physicists/Chemists.

K. Srinivasa Rao
(wssf97@imsc.ernet.in)

6. Annales de la Faculté des Sciences de Toulouse
Volume Editor: J.-B. Hiriart-Urruty
Université Paul Sabatier, Toulouse, November 1996, 175 FF.

A special issue of the *Annales de la Faculté des Sciences de Toulouse* titled *100 ans après Th.-J. Stieltjes* (100 years after Th.-J. Stieltjes) has just been published by the *Université Paul Sabatier*. Guest editor is J.-B. Hiriart-Urruty. This special issue contains the texts of the plenary talks of a Colloquium at the Université Paul Sabatier (Toulouse) held in March 1995. The talks are

- Christian Berg: *Moment problems and polynomial approximation* (pp. 9-32)
- Jean-Pierre Kahane: *Sur trois notes de Stieltjes relatives aux séries de Dirichlet* (pp. 33-56)
- Jacob Korevaar: *Electrostatic fields due to distributions of electrons* (pp. 57-76)
- Thomas William Körner: *On the representation of functions by trigonometric series* (pp. 77-119)
- Herbert Stahl: *Diagonal Padé approximants to hyperelliptic functions* (pp. 121-193)
- Walter Van Assche: *Compact Jacobi matrices: from Stieltjes to Krein and $M(a, b)$* (pp. 194-215)

This special issue can be ordered at the price of 175 FF (French Francs) plus shipping. Send your order to:

Prof. J.-B. Hiriart-Urruty
Université Paul Sabatier
118, route de Narbonne
F-31062 Toulouse Cedex
France

Walter Van Assche
(walter@wis.kuleuven.ac.be)

7. Special Functions, q-Series and Related Topics
Ed.: Mourad E. H. Ismail, David R. Masson, Mizan Rahman
Fields Institute Communications, Vol. 14, Amer. Math. Soc., 1997, hardcover, 277 pp., $ 82, ISBN 0-8218-0524-X.

This book contains contributions from the proceedings at *The Fields Institute Workshop on Special Functions, q-Series and Related Topics* that was held in Toronto in June

1995. See Newsletter 6-1, October 1995, pp. 4–6. The articles cover areas from quantum groups and their representations, multivariate special functions, q-series, and symbolic algebra techniques as well as the traditional areas of single-variable special functions. The book contains both pure and applied topics and reflects recent trends of research in the various areas of special functions.

Contents:

- K. Alladi – Refinements of Rogers-Ramanujan type identities
- B. C. Berndt, H. H. Chan, and L.-C. Zhang – Ramanujan's class invariants with applications to the values of q-continued fractions and theta functions
- G. Gasper – Elementary derivations of summation and transformation formulas for q-series
- R. W. Gosper, Jr. – $\int_{n/4}^{m/6} \ln \Gamma(z) dz$
- F. A. Grünbaum and L. Haine – On a q-analogue of Gauss equation and some q-Riccati equations
- R. A. Gustafson and C. Krattenthaler – Determinant evaluations and $U(n)$ extensions of Heine's ${}_2\phi_1$-transformations
- M. E. H. Ismail, D. R. Masson, and S. K. Suslov – Some generating functions for q-polynomials
- E. Koelink – Addition formulas for q-special functions
- T. H. Koornwinder – Special functions and q-commuting variables
- M. Noumi, M. S. Dijkhuizen, and T. Sugitani – Multivariable Askey-Wilson polynomials and quantum complex Grassmannians
- P. Paule and A. Riese – A Mathematica q-analogue of Zeilberger's algorithm based on an algebraically motivated approach to q-hypergeometric telescoping
- W. Van Assche – Orthogonal polynomials in the complex plane and on the real line
- Y. Xu – On orthogonal polynomials in several variables
- Appendix I: Program list of speakers and topics
- Appendix II: List of participants

Martin Muldoon
(muldoon@yorku.ca)

Software Announcements

1. CPC Program Library

The following information was taken from WWW http://www.cpc.cs.qub.ac.uk/cpc/

Computer Physics Communications (CPC) is an international interdisciplinary journal published by Elsevier Science BV. It is aimed at the computing needs of the computational physics and physical chemistry communities. A unique feature of the CPC journal is its publication of refereed computer programs in physics and physical chemistry. The principal aim of the *CPC Program Library* is the storage and dissemination of those computer programs whose descriptions have been published in the CPC journal.

In January 1996 the CPC Program Library became an integral part of CPC. Under this arrangement a subscription to the CPC journal will include a subscription to the Program Library and each member of a subscribing institute will be permitted to have electronic access to the entire contents of the Program Library; see the library index http://www.cpc.cs.qub.ac.uk/cpc/contents.html

The following sections are of interest for OP & SF:

4.1 angular momentum

4.7 other functions

5. computer algebra

The index and abstracts can be browsed freely. The programs themselves can only be retrieved freely if your institute subscribes to the corresponding printed journal. Otherwise you are charged Dfl 140 per retrieved program.

Tom H. Koornwinder
(thk@wins.uva.nl)

Problems and Solutions

Thus far 17 problems have been submitted six of which have been solved (#**1**, **4**, **6**, **7**, **10**, **14**), and two of which are new (#**16**, **17**). Still unsolved are Problems #**2**, **3**, **5**, **8**, **9**, **11**, **12**, and **13**. Please send in your solutions!

13. Product of Chebyshev Polynomials. For any pair of positive even $n, m \in \mathbb{N}$ let

$$F^{(n,m)}(x) = 2^n \prod_{k=0}^{n-1} \cosh\left(\frac{m}{2} \operatorname{arccosh}\left(x - \cos\frac{(2k+1)\pi}{n}\right)\right)$$
$$= 2^n \prod_{k=0}^{n-1} T_{m/2}\left(x - \cos\left(\frac{(2k+1)\pi}{n}\right)\right) ,$$

where $T_m(x)$ denotes the Chebyshev polynomials of the first kind. These functions occur in statistical physics. They constitute polynomials in x

$$F^{(n,m)}(x) = \sum_{j=0}^{nm/4} A_j(n,m)\, x^{2j}$$

whose coefficients $A_j(n,m)$ are integers. Show the symmetry

$$F^{(n,m)}(x) = F^{(m,n)}(x) ,$$

and give a representation of the coefficients $A_j(n,m)$.
(Submitted on January 16, 1996)

Christian Hege
(hege@zib.de)

15. Critical Values of Orthogonal Polynomials. Let P_n be an OP system on $[-1,1]$ with respect to a weight function $w(x)$. Denote $-1 < y_{n,1} < \ldots < y_{n,n-1} < 1$ the set of all critical points, i.e. the set of all zeros of the derivative P_n'. The values $P_n(y_{n,k})$, $k = 1, 2, \ldots n-1$ are known as critical values of P_n. Let $N(P_n)$ be the number of all *different* critical values of P_n.

Problem 15.1. Describe the set of OP systems with the property $N(P_n) = O(1)$, $n \to \infty$.

It is clear that for the first kind Chebyshev polynomials T_n one has $N(T_n) = 2$ for all n.

Problem 15.2. Given $w(x)$, find the value

$$a(w) := \limsup_{n\to\infty} \frac{N(P_n)}{n} \; .$$

(Submitted on August 16, 1996)

Leonid B. Golinskii
(golinskii@ilt.kharkov.ua)

16. A Definite Integral. Prove that

$$\int_0^1 \frac{\log(\pi^2 + (\log x)^2)}{1+x^2}\, dx = \pi \log \frac{\sqrt{\pi/2}\,\Gamma(1/4)}{2\,\Gamma(3/4)} \; .$$

Remark: The integral is related to the Dirichlet L-function. The right side of this identity can be rewritten as

$$\frac{\pi\,(\gamma + 2\,\log(\pi/2))}{2} - 2\,L'(1)$$

where $L(s)$ is the Dirichlet L-function

$$L(s) = \sum_{k=0}^{\infty} \frac{(-1)^k}{(2k+1)^s} \; .$$

(Submitted on October 10, 1996)

Victor Adamchik
(victor@wolfram.com)

17. Canonical Leibniz' Formula for Difference Operators.

Let Δ and ∇ be the usual forward and backward operators. The action on a product $f(x)g(x)$ is usually written in a nonsymmetrical (and nonunique) form, for instance:

$$\begin{aligned} \Delta[f(x)g(x)] &= f(x)\Delta g(x) + g(x+1)\Delta f(x) \\ &= g(x)\Delta f(x) + f(x+1)\Delta g(x) \; . \end{aligned}$$

A (unique) canonical form, without any shift on argument x, is sometime preferable to the nonsymmetrical formula, like

$$\Delta[f(x)g(x)] = f(x)\Delta g(x) + g(x)\Delta f(x) + \Delta f(x)\Delta g(x) \; ,$$

or

$$\nabla[f(x)g(x)] = f(x)\nabla g(x) + g(x)\nabla f(x) - \nabla f(x)\nabla g(x) \; .$$

Iteration of Δ or ∇ acting on a product of r functions $f_i(x)$ can obviously be written in the canonical form

$$\Delta^n \left[\prod_{i=1}^{r} f_i(x)\right] = \sum_{j_1\cdots j_r=0}^{n} R_n(j_1\cdots j_r) \prod_{i=1}^{r} \Delta^{j_i} f_i(x) \; ,$$

where the coefficients $R_n(j_1\cdots j_n)$ are nonnegative integers, invariant under the group of permutation P_r; ($S_n(j_1\cdots j_r)$ appears when using the operator ∇^n). Using two times the link with the shift operator E ($\Delta^n = (E-1)^n, E^k = (\Delta+1)^k$), the Δ^n canonical formula can be written:

$$\Delta^n\left[\prod_{i=1}^{r} f_i(x)\right] = \sum_{k=0}^{n} (-1)^k \binom{n}{k} \prod_{i=1}^{r} \left[\sum_{j=0}^{n-k} \binom{n-k}{j} \Delta^j[f_i(x)]\right] .$$

Is it possible, using this representation, to obtain coefficients R_n (and S_n) in a closed form?

It is obvious that $R_n(0,\cdots,0) = R_n(s,0,\cdots,0) = R_n(0,s,0,\cdots,0) = \cdots = R_n(0,\cdots,0,s) = 0$, ($s = 1,\cdots,r-1$).
(Submitted on January 7, 1997)

André Ronveaux
(Andre.Ronveaux@fundp.ac.be)

Compiled Booklist and Electronic Services

1. Compiled Booklist

Here I give the announced list of books and survey papers that should give a basis to understand the current trends and needs in OP-SF. Let me repeat that the given list can be neither complete nor perfect. If somebody feels that an important item is missing, please let me know. The following list should rather be understood as under construction. We will try to put this list on OP-SF Web, where it can easily be updated. Electronically, the material could also be easier organized in various ways.

[1] Artin, E.: *The Gamma Function*. Holt, Rinehart and Winston, New York, 1964.

[2] Askey, R. A. (Ed.): *Theory and Application of Special Functions*. Proceedings of an advanced seminar sponsored by the Mathematics Research Center, University of Wisconsin-Madison, March 21–April 2, 1975. Academic Press, New York, 1975.

[3] Askey, R. A. (Ed.): *Orthogonal Polynomials and Special Functions.* Regional Conference Series in Applied Mathematics 21, SIAM, Philadelphia, 1975.

[4] Askey, R. A., Koornwinder, T. H. and Schempp, W. (Eds.): *Special Functions: Group Theoretical Aspects and Applications.* Mathematics and Its Applications, Vol. 18. Reidel, Dordrecht–Boston–Lancaster, 1984.

[5] Askey, R. A. and Wilson, J.: Some basic hypergeometric orthogonal polynomials that generalize Jacobi polynomials. Memoirs Amer. Math. Soc. 319, Providence, Rhode Island, 1985.

[6] Bailey, W. N.: *Generalized Hypergeometric Series.* Cambridge University Press, England, 1935; reprinted 1964 by Stechert-Hafner Service Agency, New York–London.

[7] Chihara, T. S.: *An Introduction to Orthogonal Polynomials.* Gordon and Breach Publ., New York, 1978.

[8] Freud, G.: *Orthogonale Polynome.* Birkhäuser, Basel, 1969; English translation, Pergamon Press, Oxford, 1971.

[9] Gasper, G. and Rahman, M.: *Basic Hypergeometric Series.* Encyclopedia of Mathematics and Its Applications, Vol. 34. Cambridge University Press, 1990.

[10] Geronimus, Ya. L.: *Polynomials Orthogonal on a Circle and Interval.* International Series of Monographs on Pure and Applied Mathematics, Vol. 18. Pergamon Press, Oxford–London–New York–Paris, 1961.

[11] Geronimus, Ya. L.: Appendix to the Russian translation of Szegő's book *Orthogonal Polynomials.* Staatsverlag für physikalisch-mathematische Literatur, Moskau, 1962.

[12] Henrici, P.: *Applied and Computational Complex Analysis, Vol. 1: Power Series, Integration, Conformal Mapping, Location of Zeros.* John Wiley & Sons, New York, 1974.

[13] Henrici, P.: *Applied and Computational Complex Analysis, Vol. 2: Special Functions, Integral Transforms, Asymptotics, Continued Fractions.* John Wiley & Sons, New York, 1977.

[14] Hua, L.K.: *Harmonic Analysis of Functions of Several Complex Variables in the Classical Domains.* Translations of Mathematical Monographs, Vol. 6, Amer. Math. Soc., Providence, Rhode Island, 1963.

[15] Lebedev, N. N.: *Special Functions and Their Applications.* Translated and edited by Richard A. Silverman. Dover Publications, New York, 1972.

[16] Lorentzen, L. and Waadeland, H.: *Continued Fractions with Applications.* Studies in Computational Mathematics, Vol. 3. North-Holland, Amsterdam, 1992.

[17] Miller, W., Jr.: *Lie Theory and Special Functions.* Academic Press, New York, 1968.

[18] Miller, W., Jr.: *Symmetry and Separation of Variables.* Encyclopedia of Mathematics and Its Applications, Vol. 4. Addison-Wesley, Reading, Massachussets, 1977.

[19] Nevai, P. G.: *Orthogonal Polynomials.* Memoirs Amer. Math. Soc., Vol. 213, Providence, Rhode Island, 1979.

[20] Nevai, P. (Ed.): *Orthogonal Polynomials: Theory and Practice.* Proceedings of the NATO Advanced Study Institute on Orthogonal Polynomials and Their Applications, Colombus, Ohio, U.S.A., May 22–June 3, 1989, Kluwer Academic Publ., Dordrecht–Boston–London, 1990.

[21] Nikiforov, A. F. and Uvarov, V. B.: *Special Functions of Mathematical Physics.* Translated from the Russian by R. P. Boas, Birkhäuser, Basel, 1988.

[22] Nikiforov, A. F., Suslov, S. K. and Uvarov, V. B.: *Classical Orthogonal Polynomials of a Discrete Variable.* Springer-Verlag, Berlin–Heidelberg–New York, 1991.

[23] Nikishin, E. M. and Sorokin, V. N.: *Rational Approximations and Orthogonality.* Translations of Mathematical Monographs 92, Amer. Math. Soc., Providence, Rhode Island, 1991.

[24] Olver, F. W. J.: *Asymptotics and Special Functions.* Academic Press, New York, 1974.

[25] Perron, O.: *Die Lehre von den Kettenbrüchen.* Teubner, Leipzig, 1913; second edition, Chelsea, New York, 1950.

[26] Petkovšek, M., Wilf, H. S. and Zeilberger, D.: $A = B$. A. K. Peters, Wellesley, 1996.

[27] Rainville, E. D.: *Special Functions.* The MacMillan Co., New York, 1960.

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[29] Shohat, J. A. and Tamarkin, J. D. : *The Problem of Moments.* Amer. Math. Soc., Providence, Rhode Island, 1963.

[30] Szegő, G.: *Orthogonal Polynomials*. Amer. Math. Soc. Coll. Publ., Vol. 23, New York, 1939; 4th Edition, 1975.

[31] Stahl, H. and Totik, V.: *General Orthogonal Polynomials*. Encyclopedia of Mathematics and Its Applications. Cambridge University Press, Cambridge, 1992.

[32] Talman, J.: *Special Functions: a Group Theoretic Approach*. W. A. Benjamin, New York, 1968.

[33] Temme, N. M.: *Special Functions. An Introduction to the Classical Functions of Mathematical Physics*. John Wiley & Sons Inc., New York, 1996.

[34] Tricomi, F. G.: *Vorlesungen über Orthogonalreihen*. Grundlehren der Mathematischen Wissenschaften 76, Springer-Verlag, Berlin–Göttingen–Heidelberg, 1955.

[35] Van Assche, W.: *Asymptotics for Orthogonal Polynomials*. Lecture Notes Math. 1265, Springer, Berlin–Heidelberg–New York, 1987.

[36] Vilenkin, N. Ya.: *Special Functions and the Theory of Group Representations*. Translations of Mathematical Monographs 22, Amer. Math. Soc., Providence, Rhode Island, 1968.

[37] Vilenkin, N. Ya., and Klimyk, A. U.: *Representation of Lie Groups and Special Functions, Vols. 1–3*, and *Recent Advances*, Kluwer Academic Publ., Dordrecht–Boston–London, 1992–1995.

[38] Wall, H. S.: *Analytic Theory of Continued Fractions*. Chelsea, Bronx, NY, 1973.

The following are handbooks and other reference manuals for orthogonal polynomials and special functions.

[1] Abramowitz, M. and Stegun, I. A.: *Handbook of Mathematical Functions*. Dover Publ., New York, 1964.

[2] Erdélyi, A., Magnus, W., Oberhettinger, F. and Tricomi, F. G.: *Higher Transcendental Functions, Vols. 1–3*, McGraw-Hill, New York, 1953–1955.

[3] Erdélyi, A., Magnus, W., Oberhettinger, F. and Tricomi, F. G.: *Tables of Intragral Transforms, Vols. 1–2*. McGraw-Hill, New York, 1954.

[4] Gradshteyn, I. S. and Ryzhik, I. M.: *Table of Integrals, Series, and Products*. Printed and CD-ROM Version. Academic Press, San Diego, California, 1996.

[5] Hansen, E. R.: *A Table of Series and Products*. Prentice-Hall, Englewood Cliffs, NJ, 1975.

[6] Koekoek, R. und Swarttouw, R. F.: The Askey-scheme of hypergeometric orthogonal polynomials and its q analogue. Report 94–05, Technische Universiteit Delft, Faculty of Technical Mathematics and Informatics, Delft, 1994. Electronic version: http://www.can.nl/~renes/index.html

[7] Magnus, W., Oberhettinger, F. and Soni, R. P.: *Formulas and Theorems for the Special Functions of Mathematical Physics*. Springer, Berlin–Heidelberg–New York, 1966.

[8] Prudnikov, A.P., Brychkov, Yu.A. and Marichev, O.I.: *Integrals and Series, Vols. 1–3*. Gordon and Breach Publ., New York, 1989–1990.

2. Electronic Services

Here is a list of electronic services and WWW sites which are of interest to the members of our Activity Group.

[1] http://www.math.yorku.ca/Who/Faculty/Muldoon/siamopsf
SIAM Activity Group on Orthogonal Polynomials and Special Functions.

[2] http://www.math.yorku.ca/Who/Faculty/Muldoon/siamopsf/WWWaddresses.html
Martin Muldoon and Tom H. Koornwinder: A collection of electronic services relevant for OPSF

[3] ftp://unvie6.un.or.at/siam/
Hans Haubold: OPSF ftp site

[4] http://www.ams.org/msnhtml/about_mathsci.html
or
http://ams.mathematik.uni-bielefeld.de/about_mathsci.html
Mathematical Reviews: about MathSciNet

[5] http://www.ams.org/msnhtml/mathscinet
or
http://ams.mathematik.uni-bielefeld.de/mathscinet
Mathematical Reviews: MathSciNet

[6] http://www.ams.org/committee/publications/author-lookup.html
Mathematical Reviews: Author Lookup

[7] http://www.emis.de/cgi-bin/MATH
Zentralblatt für Mathematik: MATH Database 1931–1996 on-line

[8] http://www.ams.org/preprints
AMS: Preprint Server

[9] http://www.netlib.org
Netlib: collection of mathematical software, papers, and databases

[10] http://www.cpc.cs.qub.ac.uk/cpc
Elsevier: The CPC International Program Library

[11] http://www.can.nl/~renes/index.html
René Swarttouw: Electronic version of the Askey-Wilson scheme report.

[12] http://www.can.nl/~demo/CAOP/CAOP.html
René Swarttouw: An interactive on-line version of the Askey-Wilson scheme, using Koepf's Maple implementations of Zeilberger's algorithm

[13] http://www.integrals.com
Wolfram Research: On-line Mathematica Integrator

[14] http://www.cecm.sfu.ca/projects/ISC
CECM: Inverse Symbolic Calculator

[15] http://netlib.att.com/math/sloane/doc/eistop.html
N. J. A. Sloane: Integer Sequences

[16] http://http.cs.berkeley.edu/~fateman/htest.html
Richard Fateman: Table of Integrals Look Up

[17] http://www.mathsoft.com/cgi-shl/constant.bat
Steven Finch: Favorite Mathematical Constants

[18] http://www.cecm.sfu.ca/organics/papers/bailey
David H. Bailey and Simon Plouffe: Recognizing Numerical Constants

[19] http://archives.math.utk.edu/subjects/numbers.html
Mathematics Archives: Numbers

[20] http://math.nist.gov/nesf
Daniel Lozier: Numerical Evaluation of Special Functions

Wolfram Koepf
(koepf@zib.de)

3. Bibliography on Orthogonal Polynomials

Information about the book:

> A bibliography on orthogonal polynomials, Bulletin of the National Research Council, Number 103, National Academy of Sciences, Washington D.C., 1940.

During the depression of the 1930s, there were various projects funded by different governments. One of those in the United States was a bibliography on orthogonal polynomials. The nominal authors were listed as Shohat, Hille and Walsh, and they did much of the background work, preparing the outline format, and in Shohat's case knowing much of the early Russian literature. Much of the actual work was done by H.N. Laden as you can read in two sentences which hint at this in the introduction. The book is titled "A Bibliography on Orthogonal Polynomials", it was published by the National Research Council of the National Academy of Sciences, Washington, D.C., in 1940 as Number 103 of the Bulletin of the National Research Council.

It is a 204 page book which starts with a list of 303 periodicals which are referenced. Then there is a seven page outline of information about orthogonal polynomials. This starts with special polynomials (Classical OP) and includes three in two variables as well as the usual ones of Jacobi, Laguerre and Hermite and special cases of them. Each of these is denoted by a letter which will be used later. Then the area of general orthogonal polynomials is broken down into many different types of polynomials; finite interval of real axis, two finite intervals of real axis, more than two, ..., Jordan arc or closed curve in plane, etc., and then a section on types of weight functions. That is the first $1\frac{1}{3}$ pages. The rest of the seven pages break up properties of OP into different groups, listed by letters, Greek for such things as general properties, expansions of functions, moment problem, application to mathematical physics, etc. Under each of these heading there are further details. For example, under *Moment Problem* there is:

a. Criteria for the character, determined or indeterminate, of the problem

b. Solution

   1. Infinitely many data
   2. Finitely many data

Then the real information is given by an alphabetical list of authors of papers first, and then books and theses. Here is one listing:

Adams, J.C. 1. On the expression of the product of any two Legendre's coefficients by means of a series of Legendre's coefficients. [8]27(1878)63-71.

Here [8] is *Abstracts of the Papers Communicated to the Royal Society of London: vol. 6.* The last refers to the last volume consulted.

Furthermore the information `P: `α`b4-f, `μ is included. `P` means Legendre polynomials, α `b 4` refers to general properties for α, various representations for `b` and n-th derivative for `4`. The `f` is recurrence relation. μ is evaluation of sums and definite integrals involving OP (especially products of two or more OP).

In this case the title of the paper tells what is there. In most cases this is not true, and the outline if it were more easily searched could be useful. The attempt to make it searchable in the book is at the end, where there are 7 pages under the title *Abbreviated Topical Index*. The first is *Hermite Polynomials*. There are 34 lines of which the following is the first:

Adamoff 2; Agronomoff 1; Aitken 1; Aitken and Oppenheim 1; Angelesco 7,

and this is followed by 13,15,17; etc on the next line.

I have known of this book for over 40 years and have owned a copy for more than 20. I have successfully used it

for finding something to use in research once or twice, and for historical purposes a few more than that.

Richard Askey
(askey@math.wisc.edu)

(Editor's Remark: The officers of the Activity Group are currently discussing the possibility to implement an on-line version of this book with Keith Dennis from Math. Reviews.)

Miscellaneous

1. Editorship, SIAM J. Math. Anal.

I want to inform the OP & SF community that I have accepted an invitation from Managing Editor DiBenedetto to join the editorial board of SIAM J. Math. Analysis.

I have pointed out that my main activities are in asymptotics (also related with special functions) and that I expect that more theoretical papers on special functions and orthogonal polynomials will be handled by a different editor.

Nico M. Temme
(nicot@cwi.nl)

(Editor's Remark: Charles Dunkl has resigned from the editorial board of SIAM J. Math. Anal. on August 29, 1996.)

2. History of OP & SF on OP-SF WEB

On OP-SF WEB we have started a page about the history of OP & SF; see
http://www.math.yorku.ca/Who/Faculty/Muldoon/siamopsf/

This section of OP-SF WEB is intended to provide on-line information on significant contributors to Orthogonal Polynomials and Special Functions, who are no longer alive. A rich source of initial information can be found in the History of Mathematics archive at St. Andrews University, see http://www-groups.dcs.st-and.ac.uk/~history/

In particular, consult their full alphabetical index and their search form. A quick scan revealed the names of Airy, Akhiezer, Appell, Bateman, Bell, Bessel, Catalan, Chebyshev, Chandrasekhar, Coulomb, Dixon, Erdélyi, Euler, Fibonacci, Gauß, Gegenbauer, Henrici, Jacobi, Kummer, Laguerre, Legendre, Lerch, Mascheroni, Padé, Pfaff, Ramanujan, Stieltjes, Sturm, Szegő, Ulam, Vandermonde, Whittaker. Probably, many further names relevant for our field can be found there.

On our Web page we will provide specific links to places elsewhere on the Web which provide historical information about persons significant for our field. Until now we only know about a few such places. We invite our readers to inform us about other relevant places. We also want to ask you to write a page about your favourite mathematician from history if you think that this person is not yet sufficiently covered on the Web.

Note that the existing WWW pages are not always as accurate as one should hope. The interesting article *History of mathematics on the World Wide Web* by John Fauvel, Bull. Can. Soc. Hist. Phil. Math., Nov. 1995, addresses this question nicely. If you find any misleading information, please let us know.

Tom H. Koornwinder
(thk@wins.uva.nl)

3. Revising the 1991 Mathematics Subject Classification

In the Newsletter 6-3, June 1996, topic 2 on p. 18, the revision of the 1991 AMS Mathematics Subject Classification was announced. We called then for suggestions for revision concerning the sections on Orthogonal Polynomials and Special Functions. Up to now we have received the following comments:

Charles Dunkl (cfd5z@virginia.edu):

- Should wavelets get more attention in 42C?
- A finer classification of Askey-Wilson types?
- A cross-reference to quantum groups?

Per W. Karlsson (karlsson@mat.dtu.dk):

- In my opinion, 40A05 is too broad; there should be a separate box for multiple series. This, I think, goes for integrals too (40A10).

Wolfram Koepf (koepf@zib.de):

- In one way or the other the Askey-Wilson scheme should appear here. One could mention these in 33C45 and 33D45. A distinction between these "classical" systems and other systems could also be helpful.
- Algorithmic methods, and/or the use of symbolic computation could be mentioned explicitly.

Tom Koornwinder (thk@wins.uva.nl):

- 33C45, change into: Orthogonal polynomials and functions of hypergeometric type (Jacobi, Laguerre, Hermite, Askey scheme, etc.; see 42C05 for general orthogonal polynomials and functions)
- add: 33C47 Other special orthogonal polynomials and functions
- 33C50: change into: Orthogonal polynomials and functions in several variables expressible in terms of special functions in one variable
- add: 33C52 Special functions associated with root systems
- 33C55, change into: Spherical harmonics Motivation: ultraspherical polynomials unrelated to spherical harmonics are covered by 33C45; spherical functions (on Gelfand pairs) are covered by 33C80
- 33C80, change into: Connections with groups, algebras and related topics
- 33D10: What is the difference between theta functions and basic theta functions?
- 33D15 and 33D20: What is the distinction between basic hypergeometric functions and generalized basic hypergeometric functions? For instance: the first category is ${}_r\phi_s$ with $r \leq 2$ and $s \leq 1$ and the second category is general ${}_r\phi_s$?

- 33D45, change into: Orthogonal polynomials and functions of q-hypergeometric type (Askey-Wilson polynomials, etc.)
- add: 33D50 Orthogonal polynomials and functions in several variables expressible in terms of q-special functions in one variable
- add: 33D52 q-Special functions associated with root systems
- 33D55: skip this item, it is not clear what is meant.
- 33C80, change into: Connections with quantum groups, Chevalley groups, p-adic groups, Hecke algebras and related topics
- 42C05. change into: Orthogonal functions and polynomials in one variable, general theory [See also ...]
- add: 42C07: Orthogonal functions and polynomials in several variables, general theory [See also ...]

Walter Van Assche (walter@wis.kuleuven.ac.be) suggests to add the following:

- 42C07: Orthogonal polynomials of several variables
- 42C35: Moment problems (See also 30E05)
- 42C40: Wavelets
- 42C45: Biorthogonal families of functions

Several people pointed out that in a list distributed some years ago by Zentralblatt, items 33C25–33C55 and 33D25–33D45 are at variance with the AMS list. This seems to have been corrected later. For your convenience we have included parts 33 and 42C of the 1991 Math. Subject Classification on p. 18.

Readers of the Newsletter are invited to send their comments for inclusion in the next issue. All comments will be eventually bundled and passed to the Executive Editor of Mathematical Reviews.

Tom H. Koornwinder
(thk@wins.uva.nl)

4. SIAM Student Paper Prizes

The annual SIAM Student Paper Prizes will be awarded during the 1997 SIAM Annual Meeting.

If you are a student or know of a student who would like to take part in the competition, here are the details:

The authors of the three best papers in applied and computational mathematics written by students and submitted to SIAM will be invited to attend the 1997 annual meeting in Stanford, California, July 14–18. Each winner must present his/her paper at the meeting and will receive a $750 cash award as well as gratis registration for the meeting. Winners will be awarded calligraphed certificates at a special prize ceremony at the meeting. Papers must be singly authored and not previously published or submitted for publication to be eligible for consideration. To qualify, authors must be students in good standing who have not received their PhDs at the time of submission.

In submitting their work for publication, authors are asked to consider SIAM journals. However, student paper prize winners are not guaranteed publication in any SIAM journal; all papers submitted to SIAM journals are subject to the same refereeing process and standards.

Submissions must be received by SIAM on or before March 15, 1997.

Submissions, which must be in English, can be sent by regular mail or fax. Each submission must include

1. an extended abstract **not longer than 5 pages** (including bibliography);
2. the complete paper, which will be used solely for clarification of any questions;
3. a statement by the student's faculty advisor that the paper has been prepared by the author indicated and that the author is a student in good standing;
4. a letter by the student's faculty advisor describing and evaluating the paper's contribution; and
5. a short biography of the student.

Submissions will be judged on originality, significance, and quality of exposition.

The winners will be notified by June 1, 1997.

If you have any questions, please contact A. Bogardo at SIAM, 3600 University City Science Center, Philadelphia, PA 19104-2688; phone: (215) 382-9800; e-mail to bogardo@siam.org; fax to (215) 386-7999.

Allison Bogardo
(bogardo@siam.org)

5. SCAGOP: Spanish Computer Algebra Group on Orthogonal Polynomials

The main aim of our group is the study of Special Functions with particular emphasis on Orthogonal Polynomials by using computer algebra systems. Topics of our research interest can be summarized in the following points:

- Algorithmic construction of sum rules of zeros of polynomials (Newton sum rules, Moments of the distribution of zeros, ...)
- Analytical approximation to the density of the zero distribution of second order differential equation solutions.
- Algorithms for finding second (or higher) order differential and difference equations of non-classical orthogonal polynomials (Krall-type, Sobolev-type (discrete case), Modifications of the classical discrete polynomials, quasi-orthogonal polynomials, associated and correcursive of classical polynomials, ...)
- Solution of connection and linearization problems between polynomials.

The members of the group are:

- Renato Álvarez-Nodarse, Universidad Carlos III de Madrid, (renato@dulcinea.uc3m.es)
- Ivan Area, Universidad de Vigo, (area@dma.uvigo.es)
- Jorge Arvesz Carballo, Universidad Carlos III de Madrid, (arvesu@dulcinea.uc3m.es)
- Eduardo Godoy, Universidad de Vigo, (egodoy@dma.uvigo.es)
- Rafael J. Yañez, Universidad de Granada, (ryanez@goliat.ugr.es)

- Alejandro Zarzo, Universidad Politicnica de Madrid, (azarzo@etsii.upm.es)

The Group has a website at the URL:
http://dulcinea.uc3m.es/users/renato/scagop.html

R. Álvarez-Nodarse
(renato@dulcinea.uc3m.es)

6. Steele Prize for Bruce Berndt

According to the Notices of the American Mathematical Society, November 1996, pp. 1340-1341, Bruce C. Berndt has received one of the three 1996 Steele Prizes. Citation:

> The prize was awarded to Bruce Berndt for his four volumes "Ramanujan's Notebooks", Parts I, II, II, and IV, Springer, 1985, 1989, 1991, and 1994. In recognition of Berndt's heroic and extraordinary achievement in exposing to the general mathematical researcher a trove of results that were utterly inaccessible before, the AMS decided this year, exceptionally, to broaden the standard interpretation of "exposition". In an impressive scholarly accomplishment, spread out over 20 years, Berndt has provided a readable and complete account of the Notebooks, making them accessible to other mathematicians. Ramanujan's enigmatic, unproved formulas are now readily available, together with context and explication, often after the most intense and clever research efforts on Berndt's part.

See also Berndt's Response in the Notices, or at http://www.ams.org/publications/notices/199611/comm-steele.html

Tom H. Koornwinder
(thk@wins.uva.nl)

7. Joaquin Bustoz receives Presidential Mentoring Award

Joaquin Bustoz, Arizona State University, was one of 16 recipients of the first Presidential Awards for Excellence in Science, Mathematics and Engineering Mentoring named by U.S. President Clinton on September 25, 1996. The award recognizes their work in "encouraging minorities, women and persons with disabilities to earn degrees in science, mathematics and engineering"

The following information is taken from the December 1996 issue of FOCUS, the Newsletter of the Mathematical Association of America: "Bustoz has received numerous teaching awards, and his research has been in analysis, focusing most recently on orthogonal polynomials and special functions. Since 1985 Bustoz has been involved in enhancing the number and quality of minority students entering the university and intending to study mathematics and science. He initiated and directs a Math-Science Honors Program at ASU, which provides an intense introduction to university mathematics to two hundred high school students each summer. As a direct result of the program, nearly one-third of ASU's mathematics majors are from underrepresented minorities."

Martin Muldoon
(muldoon@yorku.ca)

8. Question about Heine Polynomials

Dear Colleagues,

I'm currently working on the polynomials that are treated on pages 151-155 of Szegő's book on orthogonal polynomials. I call them Heine polynomials because they were first studied by Heine. They are called Stieltjes polynomials in Morris Marden's book *Geometry of Polynomials*. The treatment in Szegő's book seems to be rather incomplete. Is there literature on the Heine polynomials in the last decades?

Your help would be very appreciated.

Hans Volkmer
Dept. of Math. Sciences
University of Wisconsin-Milwaukee
U.S.A.

Hans Volkmer
(volkmer@csd.uwm.edu)

9. Question on Infinite Sum

I would like to know whether it is possible to compute the following series

$$\sum_{i=0}^{\infty} \frac{q\delta_1^i}{q\delta_1^i + (1-q)\delta_2^i}$$

where $q, \delta_1, \delta_2 \in (0,1)$ and $\delta_1 < \delta_2$. My interest in the problem is not purely speculative, indeed the series can be interpreted as the sum of successive posteriors obtained through Bayes' theorem starting from a prior q over an unknown parameter θ, that can take two values say θ_1 and θ_2, and interpreting δ_1 and δ_2 as the conditional probabilities that given a sampling result, the value the parameter takes are, respectively, δ_1 and δ_2.

Giovanni Cespa
(gcespa@idea.uab.es)

1991 Mathematics Subject Classification Parts 33 and 42C

(This item is included in connection with the item *Revising the 1991 Mathematics Subject Classification* on p. 16.)

Classification: 33-XX Special functions, 33-XX deals with the properties of functions as functions. For orthogonal functions, See also 42Cxx; for aspects of combinatorics, See 05Axx; for number-theoretic aspects, See 11-XX; for representation theory, See 22Exx

33-00	General reference works (handbooks, dictionaries, bibliographies, etc.)
33-01	Instructional exposition (textbooks, tutorial papers, etc.)
33-02	Research exposition (monographs, survey articles)
33-03	Historical (must be assigned at least one classification number from Section 01)
33-04	Explicit machine computation and programs (not the theory of computation or programming)
33-06	Proceedings, conferences, collections, etc.

33Bxx Elementary classical functions
33B10 Exponential and trigonometric functions
33B15 Gamma, beta and polygamma functions
33B20 Incomplete beta and gamma functions (error functions, probability integral, Fresnel integrals)
33B99 None of the above but in this section
33Cxx Hypergeometric functions
33C05 Classical hypergeometric functions, ${}_2F_1$
33C10 Bessel and Airy functions, cylinder functions, ${}_0F_1$
33C15 Confluent hypergeometric functions, Whittaker functions, ${}_1F_1$
33C20 Generalized hypergeometric series, ${}_pF_q$
33C45 Orthogonal polynomials and functions (Chebyshev, Legendre, Gegenbauer, Jacobi, Laguerre, Hermite, Hahn, etc.)
33C50 Orthogonal polynomials and functions in several variables
33C55 Spherical functions, spherical harmonics, ultraspherical polynomials
33C60 Hypergeometric integrals and functions defined by them (E, G and H functions)
33C65 Appell, Horn and Lauricella functions
33C70 Other hypergeometric functions and integrals in several variables
33C75 Elliptic integrals as hypergeometric functions
33C80 Connections with groups, algebras, root systems and related topics
33C90 Applications
33C99 None of the above but in this section
33Dxx Basic hypergeometric functions
33D05 q-gamma functions, q-beta functions and integrals
33D10 Basic theta functions
33D15 Basic hypergeometric functions in one variable
33D20 Generalized basic hypergeometric series
33D45 Basic orthogonal polynomials and functions in one and several variables
33D55 Basic spherical functions, spherical harmonics (continuous and discrete)
33D60 Basic hypergeometric integrals and functions defined by them
33D65 Bibasic functions and multiple bases
33D70 Other basic hypergeometric functions and integrals in several variables
33D80 Connections with groups, algebras, and related topics
33D90 Applications
33D99 None of the above but in this section
33Exx Other special functions
33E05 Elliptic functions and integrals
33E10 Lame, Mathieu, and spheroidal wave functions
33E15 Other wave functions
33E20 Other functions defined by series and integrals
33E30 Other functions coming from differential, difference and integral equations
33E99 None of the above but in this section

42Cxx Non-trigonometric Fourier Analysis
42C05 Orthogonal functions and polynomials, general theory
42C10 Fourier series in special orthogonal functions (Legendre polynomials, Walsh functions, etc)
42C15 Series of general orthogonal functions, generalized Fourier expansions, nonorthogonal expansions
42C20 Rearrangements and other transformations of Fourier and other orthogonal series
42C25 Uniqueness and localization for orthogonal series
42C30 Completeness of sets of functions
42C99 None of the above, but in this section

How to Contribute to the Newsletter

Send your Newsletter contributions directly to the *Editor:*

Wolfram Koepf
Konrad-Zuse-Zentrum für Informationstechnik (ZIB)
Takustr. 7
D-14195 Berlin, Germany
phone: +49-30-841 85-348/347
fax: +49-30-841 85-269/125
e-mail: koepf@zib.de

preferably by e-mail, and in LaTeX format. Other formats are also acceptable and can be submitted by e-mail, regular mail or fax.

Deadline for submissions to be included in the June issue 1997 is May 15, 1997.

The Activity Group also sponsors an electronic news net, called the **OP-SF Net**, which is transmitted periodically by SIAM. The Net provides a rather fast turnaround compared to the Newsletter. To *receive* transmissions, just send your name and e-mail address to poly-request@siam.org (as with other nets, nonmembers can also receive the transmissions). Your OP-SF Net *contributions* should be sent to poly@siam.org. Please note that submissions to OP-SF Net are automatically considered for publication in the Newsletter, and vice versa, unless the writer requests otherwise.

The Net is organized by Tom Koornwinder (thk@wins.uva.nl) and Martin Muldoon (muldoon@yorku.ca). Back issues of OP-SF Net can be obtained by anonymous ftp from `ftp.fwi.uva.nl`, in the directory

pub/mathematics/reports/Analysis/koornwinder/opsfnet.dir

or by WWW at the addresses

ftp://ftp.fwi.uva.nl/pub/mathematics/reports/Analysis/koornwinder/opsfnet.dir

http://www.math.ohio-state.edu/JAT

Martin Muldoon, moreover, manages our home page

http://www.math.yorku.ca/Who/Faculty/Muldoon/siamopsf/

on World Wide Web. Here you will find also a WWW version of the OP-SF Net. It currently covers the topics

- Conference Calendar
- Books, Conference Proceedings, etc.
- Compendia, tools, etc.
- Meeting Reports
- Projects
- Problems
- Personal, Obituaries, etc.
- History
- Positions available
- Miscellaneous

The **Newsletter** is a publication of the *SIAM Activity Group on Orthogonal Polynomials and Special Functions*, published three times a year. To receive the Newsletter, you must first be a member of SIAM so that you can join the Activity Group. The annual dues are $93 for SIAM plus $10 for the Group. To join, contact:

Society for Industrial and Applied Mathematics
3600 University City Science Center
Philadelphia, PA 19104-2688
phone: +1-215-382-9800 service@siam.org

Address corrections: Current Group members should send their address corrections to Marta Lafferty (lafferty@siam.org). Please feel free to contact any of the Activity Group Officers. Their addresses are:

Charles Dunkl — *Chair of the Activity Group*
Department of Mathematics
University of Virginia, Charlottesville, VA 22903
phone: +1-804-924-4939 fax: +1-804-982-3084
e-mail: cfd5z@virginia.edu
WWW: "http://www.math.virginia.edu/~cfd5z/home.html"

Tom H. Koornwinder — *Vice Chair*
Department of Mathematics
University of Amsterdam, Plantage Muidergracht 24
NL-1018 TV Amsterdam, The Netherlands
phone: +31-20-525 5297 fax: +31-20-525 5101
e-mail: thk@wins.uva.nl
WWW: "http://turing.wins.uva.nl/~thk/"

Willard Miller — *Program Director*
Institute of Technology
University of Minnesota
105 Walter Library, 117 Pleasant Street S.E.
Minneapolis, Minnesota 55455
phone: +1-612-624 2006 fax: +1-612-624 2841
e-mail: miller@ima.umn.edu

Nico M. Temme — *Secretary*
CWI (Centrum voor Wiskunde en Informatica)
Kruislaan 413
NL-1098 SJ Amsterdam, The Netherlands
phone: +31-20-592 4240 fax: +31-20-592 4199
e-mail: nicot@cwi.nl
WWW: "http://www.cwi.nl/~nicot"

Wolfram Koepf — *Editor of the Newsletter*
Konrad-Zuse-Zentrum für Informationstechnik (ZIB)
Takustr. 7
14195 Berlin, Germany
phone: +49-30-841 85-348 fax: +49-30-841 85-269
e-mail: koepf@zib.de
WWW: "http://www.zib.de/koepf"

Martin E. Muldoon — *Webmaster*
Department of Mathematics & Statistics
York University
North York, Ontario M3J 1P3, Canada
phone: +1-416-736-5250 fax: +1-416-736-5757
e-mail: muldoon@yorku.ca
WWW: "http://www.math.yorku.ca/Who/Faculty/Muldoon/"

Activity Group: Addresses

The *SIAM Activity Group on Orthogonal Polynomials and Special Functions* consists of a broad set of mathematicians, both pure and applied. The Group also includes engineers and scientists, students as well as experts. We now have around 150 members scattered about in more than 20 countries. Whatever your specialty might be, we welcome your participation in this classical, and yet modern, topic. Our WWW home page http://www.math.yorku.ca/Who/Faculty/Muldoon/siamopsf/ is managed by Martin Muldoon (muldoon@yorku.ca).