Orthogonal Polynomials and Special Functions

SIAM Activity Group on Orthogonal Polynomials and Special Functions

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The News

L hanks mainly to the contributors of this issue, who thoughtfully followed the new procedures for submitting material, it is being produced on time. We will therefore continue with incremental improvements and suggestions are welcome.

Students can now apply for travel awards to SIAM meetings. During 1995, SIAM will make several such awards of \$300 from the Student Travel Fund. Of course top priority will be given to students presenting papers. For details contact Donna DiLisi at SIAM (ddilisi@siam.org).

A new book by A.M. Mathai is available, dealing with applications of generalized special functions and focussing particularly on Meijer's G-function. The title of the book is *Handbook of Generalized Special Functions for Statistical and Physical Sciences.* The publisher is Oxford, Clarendon Press (1993, 235 pages).

Activity Group Membership Directories will be mailed out during May, according to Vickie Kearn at SIAM (kearn@siam.org). Also, any updates received *as of March 15* will be included.

We have learned from SIAM that there are 2659 regular members who now belong to at least one activity group, and there are 1106 such student members. This adds up to 3765, or nearly half of SIAM (which currently has 8744 members).

If you happen to be at a meeting somewhere, or even if you don't, you might carry your photo apparatus and take a few pictures. We will select a few suitable prints for the Newsletter, so then your friends can see you have actually been there, or somewhere. See the last section of the Newsletter, page 10, for photo technical requirements. _____ SIAM Activity Group ____

Orthogonal Polynomials and Special Functions

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Elected Officers CHARLES DUNKL, Chair GEORGE GASPER, Vice Chair MARTIN E. MULDOON, Program Director TOM H. KOORNWINDER, Secretary

Appointed Officer EUGENE TOMER, Editor of the Newsletter

\Diamond

THE PURPOSE of the Activity Group is

-to promote basic research in orthogonal polynomials and special functions; to further the application of this subject in other parts of mathematics, and in science and industry; and to encourage and support the exchange of information, ideas, and techniques between workers in this field, and other mathematicians and scientists.

Actually, we have been working on improving the quality of photographs but problems with copying still remain. The laser-printed version, prepared by the editor, reflects traditional film processing, good definition and a rather careful reproduction of printed grey scale. The version reproduced by SIAM, however, does not maintain photographic integrity. Members who would like to see reasonably good photographs for their \$10 may wish to support our efforts by contacting SIAM and asking for quality reproduction.

The editor will be travelling from the end of November until January 2. He will not be able to check e-mail during that time, unfortunately. The deadline for the next edition of the Newsletter is February 10, however, so you are requested to send material after January 2.

Finally, all five officers of this Activity Group would like to wish each and every member a Happy and Prosperous New Year!

Addresses, Phone Numbers, e-mails

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 170 members scattered about in more than 20 countries. Whatever your specialty might be, we welcome your participation in this classical, and yet modern, topic.

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The Newsletter is a quarterly publication of the SIAM Activity Group on Orthogonal Polynomials and Special Functions. To receive the Newsletter, you must first be a member of SIAM so that you can join the Activity Group. The annual dues are \$89 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 Tel: (215) 382-9800 service@siam.org

Address corrections: Please note that current Group members should send their address corrections to Marta Lafferty: lafferty@siam.org.

ICIAM '95—Hamburg

Martin Muldoon heard from SIAM that the organizers of ICIAM '95 approved our proposal for a minisymposium, with the title "Orthogonal Polynomials and Spectral Methods". This will take place in Hamburg, Germany during July 3-7, 1995. The organizers of our minisymposium are Francisco Marcellan and Andre Ronveaux. Here are some preliminary details from Martin:

There has been much recent research on orthogonality with respect to Sobolev inner products. The analysis of spectral problems for ordinary differential operators, the asymptotic estimates for the corresponding eigenfunctions as well as the location and properties of their zeros, constitute some new directions in this research. These methods can be used in the design of pseudospectral methods for the discretization of parabolic partial differential equations as well as for the design of efficient algorithms for approximation by polynomials in the underlying Sobolev space.

The confirmed speakers, as of October 1994, are:

- Marcel de Bruin, Delft University of Technology "Sobolev-orthogonal polynomials and their zeros"
- Arieh Iserles, Cambridge University "Sobolev-orthogonal polynomials and pseudospectral methods for parabolic PDE's" (tentative title)
- Yvon Maday, Université Paris VI "Spectral methods for solving axisymmetric partial differential equations"
- Walter van Assche, Katholieke Universiteit Leuven "Direct and inverse problems for Sobolev orthogonal polynomials"

In Memoriam P.J. de Doelder

Pieter J. de Doelder, who was retired from Eindhoven University of Technology, died on October 16, 1994 at the age of 75. From 1957 until 1982 De Doelder was a faculty member of the Department of Mathematics of EUT, where he was primarily involved in teaching. In addition, De Doelder was a prolific problem solver, particularly in the field of special functions. Up till the end of his life he made numerous contributions to the Problem Sections of the Nieuw Archief voor Wiskunde, the SIAM Review, and to the OP-SF Newsletter.

Johannes Boersma

Report from Belgium

The Belgian contact group Special Functions & Applications

by Walter Van Assche

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The Belgian National Fund for Scientific Research has, for years, encouraged the creation of contact groups in various scientific areas. In 1990 we created a contact group Special Functions & Applications. Usually such contact groups meet once or twice every year, during which some invited speakers give one hour talks and there is also time for anyone who wants to communicate his recent results. The Belgian National Fund for Scientific Research pays the travel expenses and lodging for the invited speakers (up to 40,000 Bfr. each year, i.e., approximately \$ 1250) and also offers a lunch to all participants. So far our contact group has met five times at different universities in Belgium. André Ronveaux of the Facultés Universitaires Notre Dame de la Paix in Namur is the president of our contact group and I act as the secretary.

The aim of our contact group was to bring together scientists from different areas where the theory and applications of special functions play a crucial role. We wanted to focus attention to three aspects of special functions:

- 1. Theoretical aspects: spherical harmonics, representations of groups, Lie algebras and quantum groups, root systems, number theory, approximation theory, orthogonal systems in Hilbert space;
- 2. Computational aspects: computation of special functions, algorithms and software, asymptotic expansions, calculus for special functions, product and linearization formulas;
- 3. Applications: differential equations, difference equations, quadrature, signal processing, probability theory and stochastic processes, exact models in statistical physics, dynamical systems.

Apart from Belgian participants, there was also interest from abroad, in particular we had regular participants from the Netherlands, Germany, France and Spain.

The first meeting was on September 28, 1990 at the Facultés Universitaires Notre Dame de la Paix in Namur. The invited speakers were Jesús Sanchez-Dehesa (Universidad de Granada, Spain): Many body problems and Lauricella functions; Henk G. Meijer (Delft Technical University, The Netherlands): Generalizations of Laguerre polynomials; Clemens Markett (Technische Hochschule Aachen, Germany): Product formulas for eigenfunctions of Sturm-Liouville equations: new methods and results; René F. Swarttouw (Delft Technical University, The Netherlands, now at Vrije Universiteit Amsterdam): g-extensions of Bessel functions and integral transforms; and then Lance L. Littlejohn (Utah State University, U.S.A.): Orthogonality of polynomials in Sobolev spaces. At this meeting we did not organize communications since it was our first meeting. There were 26 participants.

The next meeting was at the State University of Gent on September 5, 1991. This meeting was dedicated to Prof. C.C. Grosjean, on the occasion of his 65th birthday, and we therefore invited speakers who knew him. The meeting opened with a talk by Grosjean, titled On a formula proposed by S. Ramanujan. Other invited speakers were Per W, Karlsson (Technical University of Denmark): Inductance and hypergeometric functions; Christian Radoux (Université de l'état à Mons, Belgium): Polynômes de Gauss et algèbre non commutative; W. N. (Norrie) Everitt (The University of Birmingham, U.K.): Bessel type functions satisfying a fourth order differential equation. There were also short communications given by Joris Van der Jeugd (Gent), Charles Kalisa (Louvain-la-Neuve), Arnold Debosscher (Leuven), and Jan Cnops (Gent). This was our most successful meeting, with 44 participants.

Our third meeting was held on April 29, 1992 at the Katholieke Universiteit Leuven. The invited speakers were Philippe Flajolet (INRIA, France): Continued fractions and combinatorical enumerations and Alexander I. Aptekarev (Keldysh Institute, Moscow): The Mehler-Heine asymptotics for general orthogonal polynomials. There were also short communications by A. Di Bucchianico (Groningen, now at Eindhoven), Charles Kalisa (Louvainla-Neuve), Joris Van der Jeugd (Gent), Paco Marcellán (Madrid), and Walter Van Assche (Leuven, that's me). There were 23 participants.

Meeting four was held at the Université Catholique de Louvain, in Louvain-la-Neuve on November 20, 1992. For those of you who are not aware of it: the Katholieke Universiteit Leuven and the Université Catholique de Louvain are two different universities (that's why we don't translate the name of our universities into English). Leuven and Louvain-la-Neuve are two different cities. Leuven is in the Flemish part of Belgium (in the north where the language is Dutch) and Louvain-la-Neuve, Belgium's youngest city, is in the Walloon part of Belgium (in the south where the language is French). The invited speakers were Guillermo López Lagomasino (Universidad de la Habana, Cuba): Convergence of Hermite-Padé approximants for Nikishin

systems of functions and Adhemar Bultheel (Katholieke Universiteit Leuven, Belgium): Rational interpolation and orthogonal matrix polynomials. There were communications by Charles Kalisa (Louvain-la-Neuve), C.C. Grosjean (Gent), Jaap Korevaar (Amsterdam), and Jan L.H. Meyers (Amsterdam). Again, there were 23 participants.

Our latest meeting was held on October 22, 1993 and this time we went back to the Katholieke Universiteit Leuven, with a full program and three invited speakers. The invited talks were Gérard Letac (Université Paul Sabatier, Toulouse, France): The 2d + 4 types of Meixner polynomials in \mathbf{R}^d ; Christian Berg (Københavns Universitet, Denmark): The Nevanlinna parametrization for some indeterminate Stieltjes moment problems associated with birth and death processes; Mourad E.H. Ismail (University of South Florida, Tampa, U.S.A.): g-beta integrals and biorthogonal rational functions. Five communications were given by Wilfried Philips (Gent), Amilcar Branquinho (Coimbra, Portugal), Erik Koelink (Leuven), Arno Kuijlaars (Amsterdam), and Wolfgang Gawronski (Trier, Germany). There were 26 participants.

Unfortunately, the political situation has changed in Belgium. By a change in the constitution we are now a federation, with a central government but also with two regions (Flanders and Wallonia), each with their own government. In particular, the Belgian National Science Foundation has been separated into Nationaal Fonds voor Wetenschappelijk Onderzoek (NFWO) for Flanders, and Fonds National de la Recherche Scientifique (FNRS) for Wallonia. Our contact group was a joint effort of both NFWO and FNRS, but last year NFWO decided to cancel all its existing contact groups. This probably means the end of our Belgian contact group, but we still hope to continue, if needed only with FNRS support (which means that a new secretary needs to be approached).

Nevertheless we were successful in getting full support for a new meeting in 1994. This meeting will be held on Thursday, December 8 at the Facultés Universitaires Notre Dame de la Paix in Namur. Invited speakers will be Rupert Lasser (Medizinische Universität zu Lübeck, Germany): Orthogonal polynomials and hypergroups; Kacha Dzhaparidze and René Janssen (CWI, Amsterdam): Constructing orthonormal polynomials associated with spectral distribution functions; and Eric Opdam (Rijksuniversiteit Leiden, The Netherlands): Special functions and graded Hecke algebras. We hope to attract many participants.

Two More Talks from San Diego

The 1994 Annual Meeting of SIAM took place during July 25-29 at the Sheraton Harbor Island East Hotel in San Diego. The meeting was dedicated to I. Edward Block on the occasion of his retirement as the managing director of SIAM.

Our Activity Group organized a successful Minisymposium "Special Functions and Asymptotics", with twelve talks. In the last issue we printed summaries of eight talks. Here we offer two more summaries and in the next issue we will present one more.

> Approximations and Asymptotic Expansions in the Unorganized Pages of Ramanujan's Second and Third Notebooks

> > by Bruce C. Berndt

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One of the primary areas to which Ramanujan made fundamental contributions, but for which he received no recognition until recent times, is asymptotic analysis. Asymptotic formulas, both general and specific, can be found in several places in his second notebook, in particular, in Chapter 13. However, the 100 pages of unorganized work in the second notebook and the 33 unorganized pages comprising the third notebook contain many beautiful claims in approximations and asymptotic analysis. We give a brief summary here of some of these wonderful theorems.

On pages 270-273 of the second notebook, Ramanujan examines some related functions that can be considered as hybrids of the Riemann zeta-function and hypergeometric functions. Some of these results were established in a paper with R.J. Evans. We quote one of these entries below.

Theorem [formula (5), pp. 272–273]. Let a, p > 0. As p tends to ∞ ,

$$\begin{split} S(a,p) &:= \sum_{n=0}^{\infty} \frac{(a+n)^{n-1}}{(2p+a+n)^{n+1}} \\ &\sim \frac{1}{2ap} - e^{-2p} \sum_{n=0}^{\infty} \frac{(-1)^n P_{2n}}{(a+p)^{2n+1}}, \end{split}$$

where $P_{2n} := P_{2n}(p), n \ge 1$, is a certain polynomial in p of degree n-1.

In another entry, Ramanujan derives the asymptotic expansion of

$$2\sum_{n=0}^{\infty} (-1)^n \left(\frac{1-t}{1+t}\right)^{n(n+1)}$$

as t tends to 0+. A complete description of the asymptotic expansion of this cousin of the theta-functions involves Euler numbers. Curiously, all of the coefficients that we have calculated are integers, but we do not know how to prove this in general.

Toward the end of the second notebook Ramanujan discusses approximations to certain finite sums and certain infinite series. These approximations arise from the orthogonality, respectively, of the discrete Hahn and discrete Charlier polynomials. The results are quite remarkable, for no one had previously realized that Ramanujan must have, in essence, discovered these orthogonal polynomials.

On pages 334, 335, 340, and 341, Ramanujan offers four related claims about products of certain alternating series. In particular, on page 335, he asserts that

"
$$a_1^2 - 2a_1a_2 + (2a_1a_3 + a_2^2) - (2a_1a_4 + 2a_2a_3) + \cdots$$

oscillates between

$$(a_1 - a_2 + a_3 - \cdots)^2 \pm \frac{\pi}{2} \lim_{n \to \infty} n a_n^2$$
."

For example,

$$1 - \frac{2}{\sqrt{2}} + \left(\frac{2}{\sqrt{3}} + \frac{1}{2}\right) - \left(\frac{2}{\sqrt{4}} + \frac{2}{\sqrt{6}}\right) + \left(\frac{2}{\sqrt{5}} + \frac{2}{\sqrt{8}} + \frac{1}{3}\right) - \dots$$

oscillates between

$$\left(\frac{1}{\sqrt{1}} - \frac{1}{\sqrt{2}} + \frac{1}{\sqrt{3}} - \cdots\right)^2 + \frac{\pi}{2}$$

and

$$\left(\frac{1}{\sqrt{1}} - \frac{1}{\sqrt{2}} + \frac{1}{\sqrt{3}} - \cdots\right)^2 - \frac{\pi}{2}$$

In a paper with J.L. Hafner, precise formulations and proofs of this and more general statements are given.

We have given samples of only a few of the many theorems on approximations and asymptotic expansions in the unorganized pages of the second and third notebooks. Other entries give the asymptotic expansions of functions that are hybrids of theta-functions and hypergeometric functions, certain Lambert series as x tends to 0, and multivariable exponential series in the spirit of several theorems that can be found in Chapter 15.

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MAIN MEETING THEME

Computational Science and Engineering

PRELIMINARY TOPICS

Education — CSE Degree Programs Multi-Disciplinary Design Optimization Computational Biology Control of Large Systems Numerical Algorithms Numerical Software

DEADLINE FOR SUBMISSION OF ABSTRACTS: April 24, 1995

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Photo courtesy of Charlotte Convention & Visitors Bureau.





Society for Industrial and Applied Mathematics

Polynomials Orthogonal on The Unit Circle with Random Reflection Coefficients

by JEFFREY S. GERONIMO

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We consider operators H associated with polynomials orthogonal on the unit circle and their doubly infinite analogs. It was shown by Szego that these polynomials satisfy a set of recurrence relations. The coefficients in the recurrence formula have a number of different names such as reflection coefficients, and Schur parameters since they arise in a number of different problems in approximation theory and signal processing.

Here we assume that the recurrence coefficients form a stationary stochastic ergodic process. Thus in general we deal with orthogonality measures that are not in the Szego class and the operators arising from these reflection coefficients form a family of random unitary operators $\{H_{\omega}\}$. Using the theory developed by Kotani, Simon, Craig, Johnson, and others in the study of random Schrodinger operators we investigate the spectral properties of these operators and the growth rate of the polynomials. In particular we show that there is a non-random subset of the unit circle that is the spectrum of H_{ω} for almost all ω .

Next under slightly stronger constraints on the recurrence coefficients we introduce the Lyapunov exponents which are closely related to the growth rate of the polynomials. In the case when the coefficients are periodic one of the Lyapunov exponents is the Green's function. In this case it is known that the vanishing of the Green's function indicates essential spectrum. This is also true in the more general case considered here.

References

J.S. GERONIMO, "Polynomials orthogonal on the unit circle with random recurrence coefficients". Lecture Notes in Math. Vol. 1550, pp.43-61.

J.S. GERONIMO and A. TEPLYAEV, "A difference equation arising from the trigonometric moment problem having random reflection coefficients-An operator theoretic approach". J Funct. Anal. 123 1994, p.12-45.

Meetings and Conferences

The following announcement was taken from our OP-SF Net, Volume 1, Number 8.

1. During the first half of 1995 the Isaac Newton Institute for Mathematical Sciences, at Cambridge, England, will host a program on "Exponential Asymptotics". This is being organized by M.V. Berry, C.J. Howls, M. Kruskal and F.W.J. Olver. Each of the following speakes will be giving several lectures.

M.V. Berry (Bristol) o "Interpreting infinity: Stokes phenomena and resurgence"

N. Joshi (New South Wales) • "Asymptotics and the Painleve property"

M. Kruskal (Rutgers) o "Surreal numbers with applications to exponential asymptotics"

F.W.J. Olver (Maryland)

"Introductory lectures on asymptotics"

A. Olde Daalhuis (Maryland) o "Introductory lectures on asymptotics"

N.M. Temme (CWI)

o "Introductory lectures on asymptotics"

D. Lutz (San Diego) o "Borel associated functions and their application to differential equations"

R. O'Malley (Washington) o "Exponentially long time evolution of shock layers"

B. Salvy (INRIA) o "Computer algebra and asymptotics"

For information please contact

Florence Leroy Isaac Newton Institute for Mathematical Sciences 20 Clarkson Road Cambridge, CB3 0EH England Tel: +44-1223-335 984 Fax: +44-1223-330 508 f.leroy@newton.cam.ac.uk

She will also supply the application forms.

2. A Special Session on "Approximation Theory and Special Functions" is being arranged for the AMS southeastern meeting, to be held at The University of Central Florida, in Orlando, March 17-18, 1995. The organizers are Ram N. Mohapatra and Xin Li. Anyone interested in giving a 20 minute talk should contact them at

Department of Mathematics University of Central Florida Orlando, FL 32816 fdli@ucflvm.cc.ucf.edu or fdli@ucflvm.bitnet

Here is a partial list of the people who have agreed to give a talk at this Special Session: A. Govil, Matthew He, Mourad E. H. Ismail, T. Kilgore, F. Marcellan, D. Masson, K. Pan, Q. I. Rahman, E. B. Saff, D. Stanton, and A. K. Varma.

3. The Stieltjes Colloquium, which has been planned for Toulouse during March 20–22, 1995, is one of the events commemorating Thomas J. Stieltjes, who died in Toulouse one hundred years ago, on the 31st of December, 1894.

The Colloquium will highlight the later development of topics on which Stieltjes worked: specifically, continued fractions and orthogonal polynomials; measures on the real line, moment problems; Laplace, Fourier and Stieltjes transforms; approximation and quadratures. Six plenary talks will be delivered:

- C. Berg
- o "Moment problems and polynomial density"
- J. Dhombres and J.-B. Pecot
- o "Les relations d'orthogonalité depuis 1750"
- J.-P. Kahane
- "La multiplication des series de Dirichlet, depuis Stieltjes"
- T.W. Korner
- o "Via measures to universal Fourier series"
- J. Korevaar
- "Electrostatic fields due to distribution of electrons"
- H. Stahl
- o "Padé approximants to algebraic functions"

There will also be contributed lectures but the deadline for submitting abstracts has already passed.

Registration forms can be obtained from

Madame M. Foerster, Comité local d'organisation du Colloque Stieltjes 1995 U.F.R. Mathématiques, Informatique, Gestion 118, route de Narbonne, 31062 Toulouse, France Tel: (33) 61 55 67 87 Fax: (33) 61 55 61 83

and the fees are 550 FF, taxes included. Completed registration forms are due January 31.

4. Martin Muldoon recently forwarded this announcement of a conference in Canada.

A conference on "Special Functions and Related Topics in Analysis" will be held at York University, North York (Metropolitan Toronto), Ontario, Canada on Friday and Saturday, June 9–10, 1995. It will be dedicated to Lee Lorch, in honour of his forthcoming 80th birthday.

This meeting will follow the 50th Anniversary Meeting of the Canadian Mathematical Society to be held at the University of Toronto during June 4–8, and it will precede the Workshop on q-Series and Special Functions to be held at the Fields Institute, Toronto during June 12–23.

The Lorch Conference will be devoted to those topics in analysis, such as Fourier Analysis, Summability Theory, Special Functions, Ordinary Differential Equations and so on, to which Lee Lorch has made particular contributions.

Here is a tentative and incomplete list of speakers:

Waleed Al-Salam, University of Alberta Mark Ashbaugh, University of Missouri Richard Askey, University of Wisconsin Chandler Davis, University of Toronto James A. Donaldson, Howard University Árpád Elbert, Hungarian Academy of Sciences Mary Gray, American University Mourad Ismail, University of South Florida Jean-Pierre Kahane, Paris-Orsay Lance Littlejohn, Utah State University Amram Meir, York University A. McD. Mercer, University of Guelph Angelo Mingarelli, Carleton University Martin Muldoon, York University Donald J. Newman, Temple University Cora Sadowsky, Howard University Walter Van Assche, Katholieke Universiteit Leuven Roderick Wong, City Polytechnic of Hong Kong and University of Manitoba

The organizing committee consists of

Mourad Ismail, University of South Florida David Masson, University of Toronto Martin Muldoon, York University Roderick Wong, City Polytechnic of Hong Kong and University of Manitoba Asia Ivic Weiss, York University

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5. The following preliminary announcement has been copied from the OP-SF Net Vol.1, #7:

In the summer of 1995 here will be a two week program on "Special Functions, q-Series and Related Topics" at the Fields Institute, University of Toronto, Canada. During the first week, June 12-16, there will be five Minicourses. In the second week, June 19–23, there will be a Workshop on various research topics related to special functions and q-series, with a different emphasis for each day.

The members of the Conference Advisory Committee are G.E. Andrews, R. Askey, C.F. Dunkl, M.E.H. Ismail, T.H. Koornwinder, D.R. Masson, M. Rahman, S.K. Suslov, and D. Zeilberger.

Minicourses, June 12-16, 1995

- Orthogonal Polynomials Walter Van Assche, Katholieke Universiteit Leuven
- Asymptotics of Orthogonal Polynomials Paul Nevai, Ohio State University
- \circ q-series George Gasper, Northwestern University
- Quantum Groups and q-special Functions Tom Koornwinder, University of Amsterdam
- Computer Algebra and Special Functions Doron Zeilberger, Temple University

The Workshop, June 19-23, 1995

Orthogonal Polynomials and Special Functions Multivariable Theory Number Theory and Combinatorics Computer Algebra Quantum Groups and Representation Theory

For each Workshop topic there are three invited speakers as well as a selection of contributed papers. The invited speakers are:

Krishnaswami Alladi, University of Florida Bruce C. Berndt, University of Illinois Peter Borwein, Simon Fraser University David and Gregory Chudnovsky, Columbia University Pavel I. Etingof, Harvard University I. M. Gelfand, Rutgers University R. Wm. Gosper, Symbolics, Inc. Robert A. Gustafson, Texas A & M University D. M. Jackson, University of Waterloo A. Klimyk, Academy of Sciences of the Ukraine Hendrik T. Koelink, Katholieke Universiteit, Belgium Christian Krattenthaler, University of Vienna

M. Noumi, University of Tokyo E. Opdam, University of Leiden, The Netherlands Peter Paule, Johannes Kepler University, Austria

For information and registration material, contact:

Sheri Albers, The Fields Institute 185 Columbia Street West Waterloo, Ontario N2L 5Z5 Canada Tel: (519) 725-0096 Fax: (519) 725-0704 spfunct@fields.uwaterloo.ca

This will be a busy period in Canada. To sum up:

June 4-8, The Canadian Mathematical Society's 50th Anniversary Meeting, University of Toronto.

June 9-10, Conference on "Special Functions and Related Topics in Analysis" at York University, dedicated to Lee Lorch.

June 12-23, The Fields Institute Program.

Call for Papers

The Applied Computational Electromagnetics Society, known to electrical engineers as ACES, wishes to announce a Special Issue of the ACES Journal, which will be called "Applied Mathematics: meeting the challenges presented by Computational Electromagnetics". Among the many topics suggested are integral equations and integrodifferential equations, eigenfunction expansions (both interior and exterior), selfadjoint as well as non-selfadjoint operator approximation, singularity expansion method, scattering poles, natural modes, diffraction and asymptotics, and the application of special functions.

The interior and exterior are defined with respect to the boundary of the scattering object. It is well known that special functions and asymptotics have historically played an important and pervasive role in radiation, diffraction and scattering. For one view of the situation as of 1969, see the compendium Electromagnetic and Acoustic Scattering by Simple Shapes, edited by J.J. Bowman, T.B.A. Senior and P.L.E. Uslenghi. A revised and corrected printing has been available since 1987 from the Hemisphere Publishing Corporation. For quite a different view see Acoustic and Electromagnetic Waves, by D.S. Jones, Oxford, 1986.

The objectives of this special issue are a) to illuminate some current mathematical techniques in computational electromagnetics, by a series of review or survey articles, and b) to initiate and encourage interaction between the applied mathematics community on the one hand, and the electrical engineers and physicists on the other. Papers submitted must address the mathematical problems arising in computational electromagnetics, and the conclusions must have, moreover, some practical value.

ACES, which has about 500 members, emerged officially from an electromagnetics code user's group about ten years ago, but the nucleus of the group had already been formed at the Livermore National Laboratory some years before that. ACES holds their annual meeting every March in Monterey, California. Participants, numbering about 250, include engineers, physicists and applied mathematicians.

The deadline for papers for this special issue is June 30, 1995. For details contact the Guest Editors. One of them is Eugene Tomer, editor of this Newsletter, whose address is on page 2, here. The other is Andrew F. Peterson, School of Electrical Engineering, Georgia Institute of Technology, Atlanta, GA 30332, email: ap16@prism.gatech.edu.

Mathematicians are hereby challenged to get involved with one the many open and difficult applied problems to be found in computational electromagnetics.

Perhaps the most outstanding problem is the question of error estimates. Today, all engineers compute radiation, diffraction and scattering solutions without paying attention to error estimates. As a substitue, they compare with measurement, or with electromagnetic theory, or with still another code which itself lacks error estimates. Consequently they never know whether the printout is accurate.

This is not only a difficult and annoying mathematical issue (see, for example, S.G. Mikhlin, *Error Analysis in Numerical Processes*, Wiley, 1991), it is absolutely vital for all engineering considerations, and it is still largely unresolved in computational electromagnetics. Indeed modern numerical analysis seems not to have lived up to its basic promise, because we do not yet possess useful error estimates, i.e., estimates which are computable at the same time as the solution and which give a close bound.

Problems

Thus far eight problems have been submitted while three have been solved (#1, 4, 6). A printout of all the problems and the solutions is available from the Editor.

2. Is it true that

$$x^{2}t^{x} {}_{2}F_{1}(x+1, x+1; 2; 1-t)$$

is a convex function of x whenever $-\infty < x < \infty$ and 0 < t < 1?

Submitted by George Gasper, August 19, 1992. (g-gasper@nwu.edu) **3.** The following Toeplitz matrix arises in several applications. Define for $i \neq j$

$$A_{ij}(lpha) = rac{\sinlpha\pi(i-j)}{\pi(i-j)},$$

and set $A_{ii} = \alpha$. Conjecture: the matrix

$$M = (I - A)^{-}$$

has positive entries. A proof is known for $1/2 \le \alpha < 1$. Can one extend this to $0 < \alpha < 1$?

Submitted by Alberto Grünbaum, November 3, 1992. (grunbaum@math.berkeley.edu)

5. The result of Problem #4 can be generalized to

$$S_m = \sum_{n=0}^{\infty} \frac{(-1)^n (mn+1/2)!}{\sqrt{\pi} (mn+1)!}$$
$$= \frac{1}{m} \sum_{k=0}^{m-1} \frac{\sin(5(2k+1)\pi/(4m) + \pi/4)}{[2\sin((2k+1)\pi/(2m))]^{1/2}}$$

valid for integral $m \geq 2$.

July 12, 1993.

Submitted by J. Boersma and P.J. de Doelder,

(wstanal@win.tue.nl)

7. The incomplete Airy integral given by 1

$$I_0(\sigma,\gamma;k) = \int_{\gamma}^{\infty} e^{jk(\sigma z + z^3/3)} dz$$
 (1)

serves as a canonical integral for some sparsely explored diffraction phenomena involving the evaluation of high frequency EM fields ² near terminated caustics and composite shadow boundaries. In equation (1), k is the wavenumber of the propagation medium and is assumed to be the large parameter. Both the parameters σ and γ are real.

The desired task is to derive a complete asymptotic expansion for I_0 in inverse powers of $k \to \infty$ for the case when the saddle points of the integrand satisfying

$$z^2 + \sigma = 0 \tag{2}$$

$$z_{1,2} = \pm (-\sigma)^{1/2} \tag{3}$$

are real and widely separated ($\sigma \ll -1$). The asymptotic expansion should be of the form

$$I_0(\sigma,\gamma;k) \sim \sum_{n=0}^{\infty} k^{-n} f(\sigma,\gamma,n)$$
(4)

¹ Electrical engineers use j for $\sqrt{-1}$, reserving i = v/r for current.

 $^{^2}$ See their brief article on electromagnetic (EM) diffraction in the Fall, 1993 issue of the Newsletter.

in which $f(\sigma, \gamma, n)$ is expressed in terms of known and easily computed functions. The asymptotic expansion in (4) should also hold uniformly as the endpoint γ approaches, or coincides with, one of the saddle points.

Submitted by E.D. Constantinides and R.J. Marhefka, August 11, 1993.

(rjm@tiger.eng.ohio-state.edu)

8. Can the real and imaginary parts of a hypergeometric series of type ${}_{p}F_{q}$ with one complex parameter (either in the numerator or the denominator) be expressed by means of multiple hypergeometric series?

Submitted by Ernst D. Krupnikov, July 25, 1993. (ernst@net.neic.nsk.su)



Gone fishing-maybe for that asymptotic expansion

How to Contribute to the Newsletter

Send your Newsletter contributions directly to the Editor:

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The publication schedule is approximately:

Edition	Draft #1	Mailing \approx
Fall	August 10	September 1
Winter	November 10	December 1
Spring	February 10	March 1
Summer	May 10	June 1

Items without mathematical symbols can be submitted in any convenient form, for example as a textfile or as a typewritten manuscript. Items *containing substantial mathematical symbols* must be submitted as a *standard* IAT_EX file by e-mail or by disc. There is only one exception: *plain* T_EX files can be accepted by making special arrangements with the Editor. AMS-TEX and AMS-LATEX files cannot be accepted. You must translate them into standard LATEX.

Whatever the content of your IAT_EX article, you must use the *preamble* below. You can obtain this preamble by e-mail from the Editor. Other preambles, macros, and style files obtained from archives are not allowed.

\documentstyle[twocolumn]{article} \topmargin -0.5in \oddsidemargin -0.375in \evensidemargin -0.375in \textheight 9.2in \textwidth 7.25in \columnsep 0.25in \parskip 0.02in \begin{document} \title{Draft} \author{Name of Author(s)} \date{\today} \maketitle \renewcommand1.051.05 % Text Input. Do not use macros. \vfill \end{document}

To accommodate special situations, a very limited use of \newcommand, \renewcommand, and \newenvironment is allowed provided sufficient explanatory comments appear in the file.

Newsletter material can also include photos and drawings but they must be submitted as *hard copy*. Photos must have good definition and contrast, black and white preferred, minimum size 10 by 15 cm.

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.

The Net is organized by Tom Koornwinder (thk@fwi.uva.nl).