

SIAM Activity Group Orthogonal Polynomials and Special Functions Charter Renewal Application

This CHARTER RENEWAL APPLICATION applies to the SIAM Activity Group on Orthogonal Polynomials and Special Functions (SIAG - OPSF). The SIAM Activity Group (SIAG - OPSF) to which this renewal applies was originally formed under the aegis of SIAM on July 15, 1990 by the SIAM Council and July 19, 1990 by the SIAM Board of Trustees with its initial operating period beginning January 1, 1990 and ending December 31, 1992. Its charter has been renewed by the Council and Board nine times thereafter.

This SIAG has 148 members, including 42 student members, as of December 31, 2018.

According to its Rules of Procedure, the objective(s) of the SIAG are:

- The purpose of the SIAG 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.
- The activity group is concerned with the following topics and their applications: orthogonal polynomials (general systems, Askey scheme, asymptotic analysis, recurrence relations, numerical quadrature), harmonic analysis, approximation theory, representations of compact groups, quantum mechanics, combinatorics, coding and design theory, orthogonal polynomials in several variables, hypergeometric functions and their q-analogues and elliptic analogues, special functions in connection with Lie groups, tomography, optics, wave functions in crystals, classical special functions (for example, Bessel, gamma, beta, theta, spheroidal wave, etc.), non-linear special functions (Painlevé equations), random matrices, solutions of ordinary and partial differential equations, statistical mechanics, integral transforms, number theory. Within the framework of SIAM, the SIAG will conduct activities that implement its purposes.

Its purposed functions were:

The SIAG on Orthogonal Polynomials and Special Functions will organize activities in orthogonal polynomials. The SIAG is expected to:

- 1) Organize mini symposia at the SIAM Annual Meeting on years where there is no SIAG conference.
- 2) Organize a track of at least six mini symposia at the SIAM Annual Meeting at least once every five years. The VP for Programs and the VP at Large will coordinate the scheduling with the SIAG Chairs.

And others may include:

- 3) Dissemination of information about upcoming conferences and sponsoring special sessions at SIAM meetings. Also, the group will assist researchers in the use of symbolic computer calculations by publicizing available software for special functions. Another goal is to establish some working relationships with the various SIAM journals, especially the one on mathematical analysis, with the view of sporadically sponsoring some invited or contributed Articles.
- 4) With the approval of the SIAM Program Committee, the SIAG may organize special sessions at SIAM meetings, and conduct special one- or two-day meetings immediately before or after a regular SIAM meeting. Other SIAG meetings may be organized only with the approval of the SIAM President and Vice President for Programs.
- 5) Award the SIAG-OPSF Gábor Szegő prize every two years to an early-career researcher for outstanding research contributions, as determined by the prize committee, in the area of orthogonal polynomials and special functions.

SIAG meetings, workshops, and conferences may be organized only with the approval of the SIAM President and the SIAM Vice President for Programs.

The SIAG has complemented SIAM's activities and supported its proposed functions. The answers to the questions below indicate how this was accomplished and what the officers propose as the future directions for the SIAG.

1. List all current officers of the activity group (including advisory board, if relevant).

Elected

- Chair: [Walter Van Assche](#) (KU Leuven, Belgium)
- Vice chair: [Andrei Martínez Finkelshtein](#) (Baylor University, Texas)
- Program director: [Sarah Post](#) (University of Hawaii at Mānoa)
- Secretary: [Yuan Xu](#) (University of Oregon)

Appointed

- OP-SF Talk moderators: Diego Dominici, Bonita V. Saunders
 - OP-SF NET Co-editor: Howard Cohl
 - OP-SF NET Co-editor: Sarah Post
 - OP-SF Webmaster: Bonita V. Saunders
2. How is the field covered by the activity group doing? Is it growing, is the focus shifting? What have been the significant advances over the last three years?

The field of orthogonal polynomials and special functions continues to have a lot of ongoing activities in mathematics, physics and engineering, where special functions, and in particular orthogonal polynomials, are still needed for various models and applications. Researchers in the fields of random matrices and integrable systems have also realized that special functions are very useful there. The Riemann-Hilbert approach to orthogonal polynomials and the steepest descent analysis of oscillatory Riemann-Hilbert problems have been used and extended by various members of the SIAG-OPSF. Multiple orthogonal polynomials have become an important new focus, with applications in (simultaneous) rational approximation, number theory, random matrix theory, and non-intersection random paths. The latter two are examples of determinantal point processes and various important cases turn out to be using (multiple) orthogonal polynomials and various special functions. Matrix-valued orthogonal polynomials and their use in representations of Lie groups is receiving renewed attention. The non-linear special functions arising as solution of the Painlevé equations turn out to play a remarkable role in the asymptotics of orthogonal polynomials and determinantal point processes. Another important development are the elliptic hypergeometric functions, which are under investigation by several members of SIAG-OPSF.

The NIST Handbook of Mathematical Functions (edited by F.W.J. Olver, D.W. Lozier, R.F. Boisvert, C.W. Clark), with an online companion: The Digital Library of Mathematical Functions (<http://dlmf.nist.gov>) are an important source of information for our activity group. Several members of the SIAG-OPSF were involved in the handbook and the digital library. The most recent update is from March 15, 2019. Interest in the field of “Orthogonal Polynomials and Special Functions” is high: the book “Special Functions” by G.E. Andrews, R. Askey and R. Roy (Cambridge University Press, 1999) already has more than 1903 citations according to MathSciNet and the NIST Handbook of Mathematical Functions (together with the Digital Library of Mathematical

Functions) has 4858 citations according to Google Scholar, of which 826 in 2018. The Digital Library of Mathematical Functions website had 415286 user sessions in 2018 (which is more than 1100 per day) by approximately 22000 unique visitors.

3. How is the activity group doing? Is it remaining vibrant? Is the size of the SIAG stable or increasing? How is the SIAG keeping up with the changes in the field? How are the broader interests of SIAM reflected in the activities of the SIAG?

Membership of the activity group has decreased 23% from December 2015 to December 2018. The high number of members in 2015 is most likely the result of the fact that the international conference OPSFA-13 in 2015 was organized by SIAM. We are now at a membership level that we had before 2015. The SIAG-OPSF Gábor Szegő Prize attracted a number of early career researchers. The list of people receiving our electronic newsletter OPSF-NET is much larger than the membership. The main reason that many people are not a member seems to be the high membership fee for SIAM.

4. Please list conferences/workshops the activity group has sponsored or co-sponsored over the past three years, and give a brief (one sentence or phrase) indication of the success or problems with each.
 - 4.1. Our SIAG-OPSF is strongly involved in the biennial meetings on *Orthogonal Polynomials, Special Functions and Applications* (OPSFA). The last meeting (OPSFA-14) was July 3-7, 2017 at the University of Kent in Canterbury, UK. There were 156 registered participants.
 - 4.2. There is a steering committee for the OPSFA meetings which consists of three local organizers of the last five meetings and a representative of the SIAG-OPSF (not necessarily the chair). This committee makes the selection where the next OPSFA meeting will be. The upcoming OPSFA-15 meeting will be held in Hagenberg, Austria on July 22-26, 2019.
 - 4.3. The steering committee for the OPSFA also coordinates summer schools in *Orthogonal Polynomials and Special Functions*. There was a summer school (OPSF-7) at the University of Kent, Canterbury UK, June 26-30, 2017, just before the OPSFA-14 conference. There were three lecture courses and three guest lectures. 46 participants attended this summer school, mostly PhD students and early career researchers (postdocs).
 - 4.4. There was another summer school (OPSF-8) in Sousse, Tunisia, June 25-29 2018. There were five lecture series and one guest lecture. This attracted mostly participants from Northern Africa: there were 68 participants, mostly from Tunisia and Algeria, but also a few from Europe.
 - 4.5. A mini symposium on *Special Functions and Orthogonal Polynomials* was organized during the Foundations of Computational Mathematics (FoCM 2017) meeting in Barcelona, Spain (July 10-19, 2017) by members of our SIAG-OPSF. A special session will be organized by people of our SIAG at the FoCM 2020 meeting in Vancouver, Canada.

4.6. A special session *Orthogonal Polynomials and Approximation Theory* was organized during the joint meeting of the Royal Spanish Mathematical Society and the Brazilian Mathematical Society, December 11-14, 2018, in Cadíz, Spain.

4.7. Several members of SIAG-OPSF have organized special sessions at the American Mathematical Society meetings:

- Orthogonal polynomials and Applications (Jan. 10-13, 2018; San Diego, CA)
- Orthogonal polynomials, quantum probability and stochastic analysis (Jan. 10-13, 2018; San Diego, CA)
- Special functions and combinatorics (Jan. 10-13, 2018; San Diego, CA)
- Algebraic, analytic and geometric aspects of integrable systems, Painlevé equations and random matrices (Jan. 10-13, 2018; San Diego, CA)
- Mathematical information in the digital age of science (Jan. 10-13, 2018; San Diego, CA)
- Orthogonal polynomials, quantum probability, harmonic and stochastic analysis (Jan. 16-19, 2019; Baltimore, MD)
- Continued fractions (Jan. 16-19, 2019; Baltimore, MD)

4.8. Several members of the SIAG-OPSF were in the organizing committees of international conferences

- International conference on *Special Functions: Theory, computation and Applications*, June 5-9, 2017, Hong Kong.
- International conference: *Approximation and Computation* (in honor of Walter Gautschi), November 30-December 2, 2017, Belgrade, Serbia.
- International conference on *Orthogonal Polynomials and Holomorphic Dynamics*, August 14-17, 2018, Copenhagen, Denmark.

4.9. Several workshops were organized by members of the SIAG-OPSF

- Workshop on *Painlevé Equations and Applications* (in memory of A. Kapaev), August 25-29, 2017, Ann Arbor, MI.
- Workshop: An Introduction to Orthogonal Polynomials and Applications, October 5-12, 2018, Douala, Cameroon.
- Two days on Orthogonal Polynomials, December 3-4, 2018, Granada, Spain.

4.10. There was a thematic program *Orthogonal Polynomials and Special Functions in Approximation Theory and Mathematical Physics* at ICMAT (Instituto de Ciencias Matemáticas) in Madrid, Spain, which ran from September to November 2017, with many people from our SIAG/OPSF involved. This program included

- A school (October 23-27) with four advanced courses
- A conference: *Integrable Systems, Symmetries and Orthogonal Polynomials* (September 18-22, 2017)
- A workshop in El Escorial (near Madrid), November 17-19.

5. Please indicate the number of mini symposia directly organized by the activity group at the last two SIAM annual meetings. When did the SIAG last organize a track at an annual meeting or meet jointly with the SIAM Annual Meeting?

At the SIAM Annual Meeting in Boston (2016) we organized a mini-symposium on *Computational Aspects of Special Functions*.

We regret to say that we did not organize any mini-symposia at the SIAM Annual meetings of 2017 and 2018. For 2017 this is because we had our meeting OPSFA-14 at about the same time.

At the ICIAM meeting in Valencia, Spain (July 2019) there will be three mini-symposia organized by member of our SIAG:

- *Integrable systems and discrete dynamics*
- *Orthogonal polynomials and quadrature: Theory, computation, and applications.*
- *Multivariate orthogonal polynomials*

At the SIAM Annual meeting of 2020 in Vancouver, we will organize a track. The coordinator is Diego Dominici and we already proposed Andrei Martínez Finkelshtein as our topical speaker.

6. Please indicate other activities sponsored by the activity group, to include newsletters, prizes and web sites. Have each of these been active and successful?

6.1. The most visible activity of our SIAG is the electronic newsletter OPSF-Net. There are six issues every year, containing information about conferences, workshops, symposia in field of Orthogonal Polynomials and Special Functions. The newsletter also has reports of recent meetings, obituaries, new books and book reviews. There is also a list of papers on OPSF which appeared on arXiv.org during the last two months. The mailing list of OPSF-Net is much larger than the membership, but this is partly caused by multiple entries and entries of people no longer active.

6.2. The activity group has a website which is hosted at NIST (<https://math.nist.gov/opsf/>). The website contains a calendar, an archive of all the newsletters since 1990, a list of useful books, tools, obituaries, history, available positions, and links to useful places on the internet. Many of the links redirect to the SIAM webpage <https://www.siam.org/membership/Activity-Groups/detail/orthogonal-polynomials-and-special-functions>

6.3. The SIAG-OPSF awards the **Gábor Szegő Prize** every two years to an early-career researcher for outstanding research contributions, as determined by the prize committee, in the area of orthogonal polynomials and special functions. The first prize was awarded in 2011, the second prize in 2013, the third prize in 2015 and the latest in 2017. The next prize will be awarded in 2019 at the OPSFA-15 meeting in Hagenberg, Austria.

6.4. Our activity group has strong connections with the *Society for Special Functions & Their Applications* in India, and in particular we are consulted for their annual international conferences (ICSFA).

6.5. Some members of SIAG-OPSF are involved in the Iberoamerican Workshops on Orthogonal Polynomials and Applications (EIBPOA). The latest was at the Universidad

Carlos III de Madrid in Spain (July 3-6, 2018). The participants are mostly early career researchers, interested in topics covered by our SIAG.

7. What activities are planned and proposed for the next period of the charter? Please describe scheduled and suggested future activities in detail.

7.1. The SIAG-OPSF will continue to support the organization of the OPSFA conferences. One of the elected officers will be part of the steering committee of the OPSFA meetings. These meetings are an important tradition in our community and we try to organize them in various locations around the world, with a list of plenary speakers containing specialists in the field, early career researchers and with a diversity in geography and gender. The award ceremony for the Gábor Szegő Prize includes an invited lecture by the award winner.

7.2. The SIAG-OPSF will also support the OPSF summer schools, which were organized annually from 2000 to 2004 and which were revived recently with summer schools in 2016 (College Park, Maryland), 2017 (University of Kent, Canterbury, UK) and 2018 (Sousse, Tunisia). The next summer school is planned for August 10-14 at the Radboud University, Nijmegen, Netherlands.

7.3. We will get more involved with the organization of mini symposia at the annual SIAM meetings. In particular we will organize a track at the annual meeting in 2020 in Vancouver.

8. How can SIAM help the activity group achieve its goals?

The SIAM journal which is closest to our activity group is SIAM J. Math. Anal. (SIMA). We regret that special functions do not appear in the journal description and that there is a lot of emphasis that every paper should relate to a model for natural phenomena in such areas as fluid mechanics, materials science, quantum mechanics, biomathematics, mathematical physics, or to the computational analysis of such phenomena. This makes the distinction with SIAM J. Appl. Math. (SIAP) very small. We would like to see the topic Special Functions in the journal description and to have more members of the SIAG-OPSF on the editorial board of SIMA.

One of the main obstacles for people to attend the SIAM annual meetings is the high registration fee, even as a speaker in a mini symposium. To support young researchers interested in our field, it would help to have a reduced registration, in particular for early career researchers who give a talk in a mini symposium.

What we found very useful in the past is that SIAM offers travel grants to early career researchers enabling them to attend our workshops and conferences. We would very much like SIAM to continue this.

9. How can the activity group help SIAM in its general role of promoting Orthogonal Polynomials and Special Functions?

Our activity group should get more involved in contributing news items for the monthly SIAM News. We will more actively look for news items related to OPSF and encourage SIAG-OPSF members to write a text for a general audience (SIAM News readership).

In our own newsletter (OPSF-Net) we should emphasize the links between our SIAG and other SIAG's that have some intersection with our research field, e.g. discrete mathematics (SIAG-DM), dynamical systems (SIAG-DS), linear algebra (SIAG-LA).

This SIAG requests that the SIAM Council and Board of Trustees renew its charter for a three operating period beginning January 1, 2020.

Signed

A handwritten signature in black ink, appearing to read 'Walter Van Assche', with a large, sweeping flourish extending from the bottom of the signature.

Walter Van Assche, SIAG-OPSF chair
May 6, 2019