

ISAAC - Newsletter December

Dear Members,

First of all let me wish you a Merry Christmas and a Happy New Year. 2019 was a successful year for ISAAC. We have a large number of new members and you can find the latest ones in this newsletter. We can be sure that their participation in ISAAC will enrich our community.

Instead of presenting only new special interest groups (SIG) the current newsletter will start with a new column where long established special interest groups will present themselves and their fields. The first SIG will be one of the largest SIGs, the one on quaternionic and Clifford analysis. You will also find the list of all international conferences/intensive courses which are related to ISAAC. All of them are of a high quality and several of them are also being supported by us. Take a look and if you find it interesting not only consider participation, but also encourage your younger colleagues and students to participate.

Furthermore, the elections for the ISAAC board just started. In the newsletter we present the nominated candidates and provide details on how to proceed with the voting.

Best regards and enjoy the holiday season

Uwe Kähler

(Vice-president of ISAAC)

Special Interest Group in Clifford and Quaternionic Analysis

Short remarks on the history of the field

Since the discovery of quaternions by R. Hamilton whose result can still be seen at Broom Bridge in Dublin today the quest for a higher-dimensional analogue to complex analysis has been irresistible. This quest became even more interesting after W.K. Clifford introduced his algebras by combining Grassmann's exterior algebra with the quaternions in 1878 and allowed to overcome the limitation to four dimensions.

Interestingly, the basic idea behind it is nowadays still used in Linear Algebra in a disguised form. When we multiply two vectors we get a scalar (inner product) and a bi-vector/ an oriented plane (which in 3D can be identified with its normal vector and provides the cross-product).

But Clifford's idea goes beyond this because his works in an algebra which consists of scalars, vectors, oriented planes, oriented volumes, etc. and allows their additive and multiplicative manipulation.

Since then many milestones appeared such as Vahlen's representation of higher-dimensional Möbius transformations as fractional linear transformations in 1901 which were rediscovered by Ahlfors in 1982, or Atiyah-Singer index theorem in 1963.

The last one also shows the close relation between Clifford-valued functions and the Dirac operator which provides the basis for modern hypercomplex function theory. There are many ways to introduce holomorphic functions, we mention three principal approaches: via the limit of a difference quotient, as power series of a complex variable, or as functions satisfying the Cauchy-Riemann equation. In higher

dimensions the first approach is too restrictive. As Mehlikzon proved in 1948 the only quaternionic-valued functions for which such a limit exist are linear functions. In alternative one can use suitable difference quotients, thus obtaining functions of the third type below. The second approach was initially thought to be to general allowing for all real-analytic functions, but nowadays this class of quaternionic-valued functions together with the Hadamard product represents the class of slice hyperholomorphic functions, i.e. functions which are holomorphic on each complex plane.

The third option had a natural generalization in quaternionic or Clifford-algebra-valued functions which are annihilated by the Dirac operator. This leads to the class of monogenic functions which together with the class of slice hyperholomorphic functions represent the principal objects under study in modern times.

Starting from the late twenties various mathematicians among which G. Moisil, N. Teodorescu, R. Fueter, M. Sce, G. Scorza laid the groundwork for the theory of monogenic functions and Fueter and his school extensively developed the quaternionic case. However, these works were relatively fast forgotten. This was in large part due to the fast development of the alternative theory of several complex variables as well as the continuous algebraization of Mathematics which put less emphasis on its combination with geometric reasoning.

The modern theory of monogenic functions started in earnest only at the end of the 1970s and is closely linked to mathematicians like R. Delanghe, J. Ryan, V. Soucek, and W. Sprößig. But the largest influence on the field was provided by F. Sommen who's ideas drove the field of hypercomplex analysis for decades. The book of R. Delanghe, F. Sommen, and V. Soucek „Clifford algebra and spinor-valued functions“ published in 1993 continues to be the fundamental book in the area. During the 1990s hypercomplex analysis received a boost from the establishment of the Seiberg-Witten theory in 1994 and Sijue Wu's study of the Well-posedness in Sobolev spaces of the full water wave problem in 3-D in 1998. Even T. Tao worked on the L_2 -boundedness of convolution operators on Lipschitz graphs with harmonic kernels using Clifford analysis in 1996.

Quaternionic operator theory was stimulated by a paper of G. Birkhoff and J. von Neumann, in 1936 on the logic of quantum mechanics, where they proved that quantum mechanic can be formulated also on quaternionic numbers, but the notion of spectrum of quaternionic linear operators was not made clear until the introduction of the S-spectrum, 70 years later.

Some attempts to obtain the quaternionic spectral theorem were made by O. Teichmüller in 1936 and K. Viswanath in 1971 without a precise notion of quaternionic spectrum of a linear operator.

New developments and current research directions

The members of the SIG are very active on various topics in hypercomplex analysis which cover several different aspects. We mention some of them below with no pretense of completeness.

Monogenic or Fueter regular functions generate the spectral theory on the monogenic spectrum introduced and studied by A. McIntosh, T. Qian, B. Jefferies and their collaborators. This theory has deep implications in Harmonic analysis in higher dimensions and, moreover, the monogenic functional calculus is related to the Weyl functional calculus.

Similar to the complex case boundary value problems can be treated with quaternionic techniques using monogenic functions or its variations, as shown by K. Gürlebeck, W. Sprössig, M. Shapiro, V. Kravchenko, and many others.

F. Colombo, I. Sabadini and co-authors started a systematic development of a spectral theory based on the S-spectrum motivated by the problem of quaternionic spectra in quantum mechanics. This spectrum

was deduced using only techniques based on slice hyperholomorphic functions. Since then since the literature in quaternionic spectral theory has grown rapidly, although for the quaternionic spectral theorem for normal operators based on the S-spectrum we had to wait until the recent work of D. Alpay, F. Colombo, and D. P. Kimsey. The spectral theory on the S-spectrum opened also the way to new classes of fractional diffusion problems that are based on the definition of fractional powers of vector linear operators, the characteristic operator functions with applications to linear system theory by D. Alpay and collaborators, and to the theory of quaternionic spectral operators introduced by J. Gantner.

Schur analysis is a collection of problems of great importance in operator theory and has many applications in science and technology. Using the theory of monogenic functions and of slice hyperholomorphic functions D. Alpay and his co-authors developed extended Schur analysis in the hyperholomorphic setting.

The theory of several quaternionic variables started with the work of D. Pertici using analytic tools, but it turned out that algebraic analysis is a very powerful tool for the treatment of differential operators with constant coefficients arising in the quaternionic and Clifford setting. This treatment started with the work of C. A. Berenstein, I. Sabadini, D. C. Struppa and their co-authors and culminated in a monograph. Moreover, for a complete description of complexes of Fueter and Dirac operators a second fundamental tool is the representation theory as shown by the works of V. Soucek and his collaborators.

The study of the Dirac operator on manifolds is a topic of great importance and a systematic treatment of the Dirac operator in Riemann geometry can be found in the book of T. Friedrich, but also in the works of M. Atiyah, R. Penrose, V. Guillemin, J. J. Duistermaat, C. Bär, and many others. Although this is mainly focused on elliptic and hyperbolic Dirac operators (over Lorentzian manifolds) also parabolic Dirac operators have been studied (P. Cerejeiras, U. Kähler, F. Sommen).

Another interesting development consists in discrete versions of hypercomplex function theory. Two major lines appeared. One which studies discrete Dirac operators over lattices which was developed mainly by the groups in Aveiro, Ghent, and Weimar. The other is to use discrete versions of Hilbert complexes and is closely linked to so-called Script geometry.

From the practical applications the concept of the monogenic signal as a spatial generalization of the classic analytic signal of Gabor has been introduced by M. Felsberg and is widely used in image and video processing as well as in mathematical optics (G. Sommer, S. Held, S. Bernstein, P. Cerejeiras, U. Kähler, B. Forster-Heinlein, M. Storath, T. Fink).

Another field of applications is in the study of Radon transforms linked to integrations over groups and homogeneous spaces, such as the crystallographic Radon transform used in diffraction tomography.

Among the recent studies in hypercomplex analysis we also mention generalizations to the octonionic case with the work of G. Ren and coauthors, fractional Dirac operators, and Dirac operators for Coxeter groups.

If the above sounds interesting you can check out the activities of the special interest group at

<http://isaac-clifford.web.ua.pt/>

Elections of ISAAC board

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From December 20, 2020, until January 30, 2021 voting for the ISAAC board is open. Please, do not forget to vote.

The voting website is

<http://isaacmath.org/voting/9/>

In case you are missing your credentials, please contact Alfred Budziak [<fb@ux.up.krakow.pl>](mailto:fb@ux.up.krakow.pl)

The nominated candidates are

Fabrizio Colombo (Italy)

I am life member since 2010 and I have been participating to all the Conferences since 2005. If elected, I am willing to cooperate more actively to promote and support the ISAAC activities among young researchers. I am convinced that bridges between various disciplines are very fruitful, so I will work to enlarge the interactions of ISAAC with groups working in mathematical physics, spectral theory, operator theory.

Marcelo Rempel Ebert (Brazil)

I am a Life member since 2014 and I have been one of the organizers of the session "Recent Progress in Evolution Equations" in the last two congresses, in Vaxjo and in Aveiro.

The reason to propose my name to become a member of the ISAAC Board is in order to officially represent and spread the ISAAC society with its activities in South America, in particular in Brazil.

Narciso Gomes (Cabo Verde)

As a professor at the University of Cabo Verde I have a lot of experience with the situation of Mathematicians in developing countries in general and in Africa in particular. ISAAC has a lot to offer to mathematicians in developing countries for which it is much more difficult to get into contact with top-level Mathematics and mathematicians. If elected I would be the first elected board member from an African country and I will do my best to both promote ISAAC in these countries as well as using ISAAC to promote young and promising mathematicians from those countries.

Massimo Lanza de Cristoforis (Italy)

I believe Isaac should keep standards of excellence in Mathematics and be an equal opportunity.

In particular, I believe all activities including the ISAAC congress should be organized so that scientists can participate regardless of the economical status of their country of origin.

Vladimir Mityushev (Poland)

In 2020, I plan to work with the ISAAC webpage <http://isaacmath.org/home/> to update some technical procedures not visible for users but important for modern webpages. In particular, I plan to create mirrors of the ISAAC webpage to make it more stable.

Michael Oberguggenberger (Austria)

ISAAC plays a very important and indispensable role in fostering the subjects it represents, notably through its international congresses and publications, its website and its Interest Groups. Thanks to the efforts of its main representatives, ISAAC is also flourishing. As a board member, I will strive for making good decisions about ISAAC's future activities and personell in order to keep ISAAC on the good route it is currently taking.

Michael Ruzhansky (Belgium)

I have been working for the benefit of ISAAC over the years, as the main organiser of the 7th ISAAC Congress at Imperial College London in 2009, then as the ISAAC President during 2009-2013. I will be happy to continue this work, in particular in helping the organisation of the next ISAAC Congress at the Ghent University in Belgium in 2021, where I am working since last year.

Durvudkhan Suragan (Kazakhstan)

ISAAC has already become one of the largest international mathematical societies. It is also growing. One of the important roles of ISAAC is to boost the image of mathematics and its applications in the collective imagination at an international level. I think I can wholeheartedly help the ISAAC board try to make decisions a success on its way of flourishing.

Joachim Toft (Sweden)

As a board member of ISAAC I will try to be the support for the organisation as it is requested, from the ISAAC members and from the officers. There are issues which become easier to perform as board member. One such issue concerns attracting scientists to become new members of ISAAC. An other issue concerns update some details in the ISAAC constitution. Some of this is connected. ISAAC is today stronger compared to the situation some years ago. We have several new members and a lot of them are younger. In my opinion we shall try to continue (however not in the same speed) to attract new members, especially young ones. In my opinion, the ISAAC constitution needs to be changed at this part, where more considerations are taken with respect to the scientists situation (non-permanent positions, young, retired, from less wealthy countries etc.).

Ville Turunen (Finland)

In order to develop steadily, ISAAC needs to attract and connect especially the younger generations of mathematicians worldwide, and make their research more visible.

Baoxiang Wang (China)

If I can be elected as a board member of ISAAC, I will do my best to develop the relationship between Chinese analysis groups and ISAAC, and invite more Chinese mathematicians to join the membership of ISAAC, take part in the Congress of ISAAC.

Jens Wirth (Germany)

In recent years, ISAAC has seen an increased interest in its international congresses with quite large audiences, huge varieties in topics and above all a growing number of young researchers participating at its events. This is great for the future of our society and as a board member, I want to advance this development even more. It is important to make sensible decisions for the future, to enhance the visibility of ISAAC and to increase the scientific impact of our society. As subjects develop, new sessions at our conferences will appear and in particular new interest groups will have to be formed. As board member I will continue to support ISAAC members interested in organising such groups und give help in establishing them.

Conferences and Intensive Courses associated to ISAAC

Conference "Dispersive and subelliptic PDEs", Centro De Giorgi in Pisa, February 10-12, 2020, Pisa, Italy

<http://www.crm.sns.it/event/464/>

International conference on Hypercomplex Analysis in Mathematics and in the Applied Sciences, February 19-21, 2020, Weimar, Germany,

<https://www.uni-weimar.de/de/bauingenieurwesen/professuren/angewandte-mathematik/>

[tagungen/hams2020/](https://www.uni-weimar.de/de/bauingenieurwesen/professuren/angewandte-mathematik/tagungen/hams2020/)

24th European Intensive Course on Complex Analysis, its Generalizations and Applications, March 16-19, 2020, Universidade de Aveiro, Portugal

<http://sweet.ua.pt/pceres/complex2020/>

20th Annual Workshop on Applications and Generalizations of Complex Analysis, March 20-21, 2020, Universidade de Aveiro, Portugal

<http://sweet.ua.pt/pceres/complex2020/Webpage/Workshop.html>

Modern Methods, Problems and Applications of Operator Theory and Harmonic Analysis - OTHA-2020, April 26 - May 01, 2020, Rostov-on-Don, Russia

<http://otha.sfedu.ru/conf2020/>

Harmonic Analysis and related topics - celebrating Michael Lacey's birthday, May 25-29, 2020, Centre de Recerca Matemàtica, Barcelona, Catalunya, Spain,

<http://people.math.gatech.edu/~glivshyts6/Lacey-conference.html>

Applied Harmonic Analysis and Friends, Strobl, Austria, June 1st - 5th 2020

<https://www.univie.ac.at/projektservice-mathematik/e/?event=strobl20>

44th Summer Symposium in Real Analysis, Paris & Orsay, France, June 22-26 2020,

<https://ssra44.sciencesconf.org/>

12th International Conference on Clifford Algebras and Their Applications in Mathematical Physics (ICCA12), August 3 - 7, 2020, University of Science and Technology of China (USTC)

<http://www.smartchair.org/hp/ICCA2020/>

International Conference on Generalized Functions GF2020, August 31 - September 4, 2020, Ghent University, Belgium

<http://cage.ugent.be/gf2020>



Our president at the INDAM Workshop "Anomalies in Partial Differential Equations", Rome, September 12, 2019

New members

Daniel Alpay

Daniel Alpay is Foster G. and Mary McGaw Professor at Chapman University and was previously professor at Ben Gurion University in Beer Sheva. He is a well-known expert in Schur analysis in the complex and hypercomplex setting as well as in infinite dimensional analysis in the white noise space setting and in free analysis. He is also Editor in Chief of the journal Complex Analysis and Operator Theory.



Afonso S. Bandeira

Afonso S. Bandeira is a Full Professor at Department of Mathematics at ETH Zurich. Previously he was an Associate Professor (with tenure) at the Courant Institute and Center for Data Science at NYU. He received his PhD in Applied and Computational Mathematics from Princeton University, and completed his undergraduate and masters education at University of Coimbra. Afonso is one of the two recipients of the 2019 ISAAC Award for Young Scientists and was awarded a Sloan Fellowship in 2018.



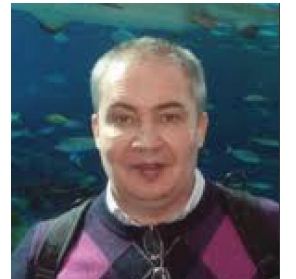
Cinzia Bisi

Doctoral Degree at Firenze University (Italy) in 2001. Post-doc positions at Jussieu University, Paris. Researcher positions first at Calabria University and then at Ferrara University (Italy) from 2005 to 2015. Associate Professor at Ferrara University from April 2016. Seminars in many prestigious Universities: Ecole Normale Supérieure, Lyon, Jussieu and Orsay University, Paris, UCLA; Purdue and Notre Dame University (USA), Imperial College London, Oslo University, Sissa Trieste, Politecnico di Milano. Research Interests: Quaternionic and Clifford Analysis and Geometry.



Nikolai Vasilievich Chemetov

He holds a doctorate in Applied Mathematics from Novosibirsk State University (1989). He worked at the scientific institutes of the Russian Academy of Science (1983-1989). In the years 1991-1992 held research internship at the University of Lisbon, Portugal. From 1992 until 2018 he was a professor at Portuguese universities. He is currently a Full Professor at the Department of Mathematics at the Federal University of Amazonas (UFAM), where he serves as deputy head of the department. He was Editor of the Portuguese Society of Mathematics Bulletin and Honorary Editor of Fluid Mechanics Research International Journal. His research focuses on the modeling and mathematical study of the motion of complex fluids: (in) compressible, newtonian, non-newtonian, biphasic and porous media fluids.



João Marques da Costa

He was born in 26/05/2000 in Portugal. In 2018 he entered the Department of Mathematics at University of Aveiro. He is doing research in Mathematical Analysis and Operator Theory under the tutorship of Paula Cerejeiras and Uwe Kähler.



Hennie de Schepper

She got her Ph.D. in Mathematics from Ghent University in 1998. She is a full professor at Ghent University. Her main interests are in Clifford and Harmonic Analysis.



Kamal Diki

He is Marie Skłodowska-Curie fellow of the *Istituto Nazionale di Alta Matematica* and PhD student at Politecnico di Milano under the supervision of Irene Sabadini. His research interests are in Complex, Quaternionic and Clifford Analysis.



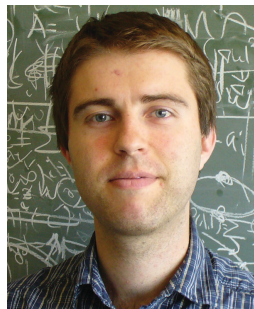
Alí Guzmán Adán

He obtained his Ph.D. in 2018 from Ghent University, Belgium, under the joint supervision of Profs. Hennie De Schepper, Frank Sommen, and Juan Bory-Reyes. His thesis was centered on extensions harmonic and Clifford analysis to the context of superspaces. His main research interests are in distribution and integration theory, harmonic and Clifford analysis, analysis on superspace and differential geometry. He is currently a postdoctoral fellow at Ghent University.



James Kennedy

He obtained his doctorate in 2010 at the University of Sydney, Australia, in the area of spectral theory of partial differential equations. After postdoctoral stays at the Universities of Lisbon, Portugal in 2010--11, Ulm, Germany as a Humboldt postdoctoral fellow in 2012--2013 and Stuttgart, Germany, 2013--2017, he returned to Lisbon as a research fellow in 2017. James' interests lie at the intersection of partial differential equations, spectral theory, and operator theory, in particular the relationship between the geometry of an object and the structure of the spectrum of differential operators defined on it.



Sören Kraußhar

He obtained his PhD in 2000 at Aachen University of Technology on Eisenstein series in Clifford Analysis. He had several positions in Aveiro - Portugal 1998-2000, Gent - Belgium (2000-2006) and Leuven - Belgium (2007-2009), Paderborn - Germany (2010) and Darmstadt - Germany (2011-2012) until he got his tenure position at Erfurt University - Germany (since 2013). His scientific interest lie on the intersection of hypercomplex analysis, analytic number theory, algebraic geometry, partial differential equations and applications to theoretical physics.



Vishvesh Kumar

He was born in India on June 1, 1991. He received his master degree in Mathematics from IIT Bombay, India in 2014. He was a Ph.D. student in the Department of Mathematics, IIT Delhi from July 2014 to April 2019. He is currently working as a Postdoctoral Fellow in the lab of Prof. Micheal Ruzhansky at Ghent University, Belgium. His research interests lie in the area of Pseudo-differential operators and Abstract harmonic analysis.



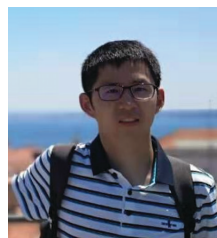
Simão Lucas

He is currently a student in Mathematics at the Mathematics Department of the University of Aveiro. Previously, he attended Geology at the same university, for a year. His main interests are Analysis, Topology, Geometry and Algebra.



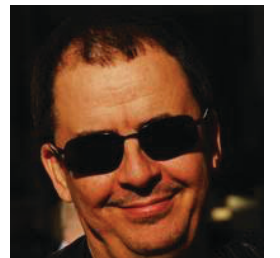
Baoping Liu

He got his B.S. in Mathematics from Peking University in 2006 and his Ph.D. in Mathematics from the University of California in Berkeley. From 2012 until 2015 he was a Dickson Instructor at the University of Chicago and from 2015 onwards he is Assistant Professor at Peking University. His main research interests are in harmonic analysis and nonlinear dispersive equations.



Zouhair Mouayn

He got his Ph.D. in Mathematics from Mohammed V-Agdal University in Rabat (Morocco) in 2004. In the past he had extensive research stays at NuHaG in Vienna and the Universities of Aveiro and Coimbra in Portugal. Currently, he is Full Professor at the Department of Mathematics, Faculty of Sciences and Technics (M Ghila), Sultan Moulay Slimane University. His research interests are in Harmonic Analysis, Partial Differential Equations, Spectral Theory, Group Representations and Function Spaces, Orthogonal Polynomials, Special functions, q-Calculus, and Mathematical Physics. He is also the new representative of the special interest group on reproducing kernels and integral transforms.



Ivan Pombo

Ivan Pombo finished both his Master and Bachelor at the University of Aveiro. He started his Ph.D. studies with a fellowship from FCT for a PhD at the University of Aveiro in partnership with the University of Stuttgart. His current interests are in the area of Inverse Problems and Clifford Analysis, in particular, the Calderón problem for the case of complex conductivities and in three dimensions.



Fabio Pusateri

He got his PhD at New York University in 2011 and completed his master studies in Rome. Currently, Fabio Pusateri is assistant professor at the University of Toronto. He was previously assistant professor at Princeton University.

His research interests are in PDE's precisely: dispersive and wave equations, fluid dynamics but also harmonic analysis. He made major contributions to the study of the water wave problems with and without surface tension and with/without vorticity in 2D and 3D.

Fabio is one of the two recipients of the 2019 ISAAC award for young scientists.



Luís Santos

He is a student of Mathematics at the Mathematics Department of the University of Aveiro.



Final remarks

And to finish, and as a service to our young members, we would like you to consider publication in the distinguished and prestigious journal *Trivia Mathematica*, founded by Norbert Wiener and Aurel Winter in 1939. We join its original description for your enlightenment:

„The first issue will be dedicated to N. Bourbaki, John Rainwater, Adam Riese, O.P. Lossers, A.C. Zitronenbaum, Anon, and to the memory of T. Radó, who was not amused. It is expected to include the following papers:

On the well-ordering of finite sets

A Jordan curve passing through no point of any plane

Fermat’s last theorem I: The case of even primes.

Fermat’s last theorem II: A proof assuming no responsibility

On the topology im Kleinen of the null circle

On prime round numbers

The asymptotic behaviour of the coefficients of a polynomial

The product of large consecutive integers is never a prime

Certain invariant characterisations of the empty set

The random walk on one-sided streets

The statistical independence of the zeros of the exponential function

Fixed points in theorem space

On the tritangent planes of the ternary antiseptic

On the asymptotic distribution of gaps in the proofs of theorems in harmonic analysis

Proof that every inequation has an unrooot

Sur un continu d’hypothèses qui équivalent à l’hypothèse du continu

On unprintable propositions

A momentous problem for monotonous functions

On the kernels of mathematical nuts

The impossibility of the proof of the impossibility of a proof

A sweeping-out process for inexhaustible mathematicians

On transformations without sense

The normal distribution of abnormal mathematicians

The method of steepest descents on weakly bounding bicycles

Elephantine analysis and Giraffical representation

The twice-Born approximation

Pseudoproblems for pseudifferential operators

The Editors are please to announce that because of a timely subvention from the National Silence Foundation, the first issue will not appear.,,

Taken from R. P. Boas, J.R., Lion hunting and other mathematical pursuits, The Mathematical Association of America, 1995.

To all a Merry Christmas
And a Happy New Year!

