

Complex and Hypercomplex Analysis Group - GACH

Group Coordinator: Uwe Kähler

SHORT DESCRIPTION

GACH was founded in 1999 as a research group of the previous center UIMA and is nowadays one of the leading research centers in the field of Hypercomplex Analysis.

VISIBILITY TO THE EXTERIOR

Belonging to one of the leading research centers in Hypercomplex Analysis also implies to give plenary talks at principal conferences in the field ([International Conference on Clifford Algebras and Applications - ICCA](#), [International conference on Noncommutative Analysis Operator Theory and Applications - Milano 2014](#), [Encuentro Iberoamericano de Polinomios Ortogonales y sus Aplicaciones](#)) as well as participating in invitation-only conferences/workshops (like [Noncommutative Analysis and PDE - Imperial College 2016](#), [INdAM Workshop on Hypercomplex Analysis 2010](#), [MOIMA - Schloss Herrenhausen 2016](#), etc.) where experts in the field exchange their views. Additionally, members also gave plenary talks at large international conferences with a broad scope like [ICNAAM \(International conference on Numerical Analysis and Applied Mathematics\)](#).

- Members of the research group are regularly giving seminar talks and having research stays in all known major research centres in the field of hypercomplex analysis (such as University of Ghent, Charles University Prague, Politecnico di Milano, CECHA - Chapman University, Bergakademie Freiberg, University of Science and Technology of China, University of Macau, and CINVESTAV México)



Figure 1: Photo at USTC, China.

- Members are involved in academic societies with close connection within the field, like the [Society of Analysis, its Application, and Computation \(ISAAC\)](#) where several members of the group are board members as well as in the steering committee for [ICCA-conferences](#). Members of GACH are organising the next ISAAC congress in 2019 as well as the next ICCA conference in 2020 in Hefei (China).

INTERNATIONAL COLLABORATIONS

The group has close collaborations with many well-known researchers in either the field itself or in closely related fields, among them D. Alpay (Bersheeva, CECHA), I. Pesensen (Temple University), M. Ruzhansky (Imperial College/Ghent University), I. Sabadini (Politecnico di Milano), F. Sommen (Ghent University), G. Teschke (Zuse Institute, Neubrandenburg), and J. Wirth (Stuttgart).

Over the past decade the group had as visitors many well-known mathematicians, like H. Feichtinger (University of Vienna), M. Fornasier (TU München), A. Kuijlaars (K.U. Leuven), C. Micchelli (SUNY at Albany), R. Novikov (École Polytechnique), L. Päiväranta (Tallinn University of Technology), I. Pesensen (Temple University), M. Ruzhansky (Imperial College London), S. Siltanen (University of Helsinki), among others, which greatly influenced the research conducted at the center.

In parallel, senior researchers within GACH also supervised / co-supervised PhD-students in universities outside Portugal (Germany / China).

RECOGNITION

- Members published in a variety of mathematical journals, such as **Applied and Computational Harmonic Analysis**, **Transactions/Proceedings of AMS**, **Constructive Approximation**, **Journal of Fourier Analysis and Applications**, and **Journal of Mathematical Analysis and Applications**, to name a few.
- The group has always an eye on possible applications, as can be seen in European projects like MEPROS (CRAFT) and the involvement in the transversal thematic line Inverse Problems in Health Sciences (LtPICS).

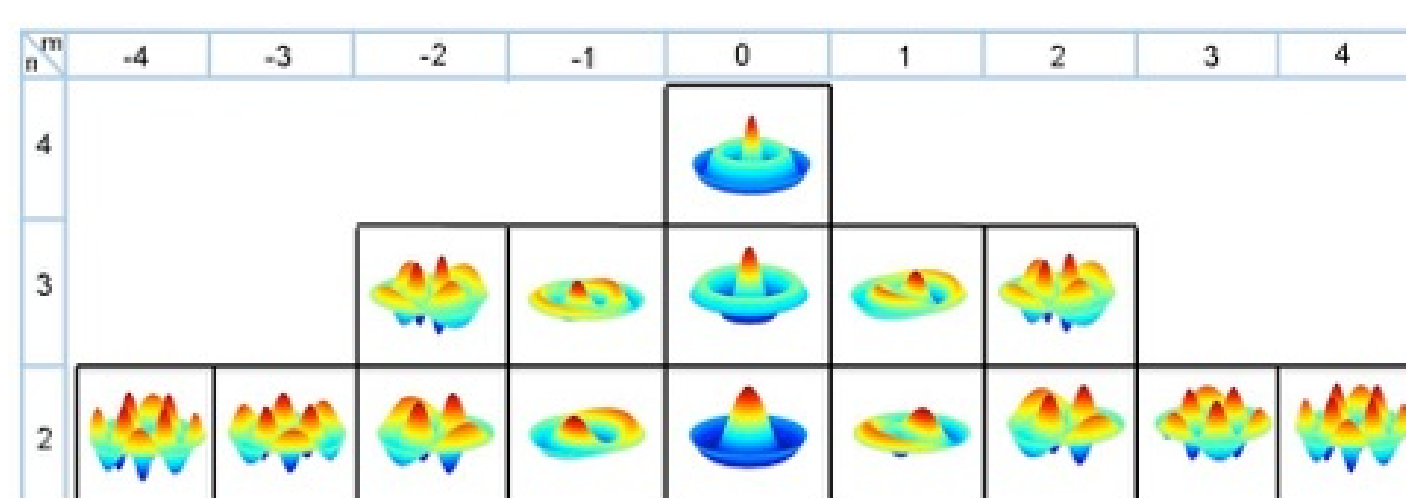


Figure 2: Model of abnormalities of the cornea based on Bessel polynomials.
<http://sweet.ua.pt/pceres/LtPICS/Webpage/Home.html>

- In the past members of GACH have had long term research stays in places like Politécnico di Milano, Imperial College London, University of Ghent, University of Macau, University of Science and Technology of China (Hefei), University of Wuhan, Tampere University of Technology, University of Rome “La Sapienza”, and Bauhaus-Universität Weimar, on a regular basis.
- In the research conducted by the group the [annual workshop](#) and the [annual European intensive course](#) plays an important part. While the former counts with experts from the leading research centers in hypercomplex analysis and allows for the exchange of the newest research the latter provides new influx of ideas by leading mathematicians.



Figure 3: Photo at the 16th Workshop Applications and Generalizations of Complex Analysis.

- Members had visiting professorships at University of Passau (Germany), and at CHECHA, Chapman University (U.S.A.)
- Recognition of the group can also be seen in the fact that GACH is present in the editorial boards of main journals in the field like **Complex Analysis and Operator Theory** (Birkhäuser), **Applied Mathematics and Computation** (Elsevier), **Advances in Applied Clifford Algebras** (Birkhäuser), **OpenMathematics** (de Gruyter), **International Journal for Wavelets, Multiresolution Analysis and Information Processing** (World Scientific) or **Central European Journal of Mathematics** (de Gruyter).

CURRENT RESEARCH TOPICS

(a non-exhaustive list)

- Fractional Clifford analysis and corresponding potential theory
- Study of discrete structures in the context of Clifford algebras (including analytic, geometric, and combinatorial properties)
- Riemann-Hilbert problems for matrix orthogonal polynomials and Painlevé equations and differential properties as well as over non-commutative structures
- Approximation theory (polynomials, splines, wavelets, Gabor systems, curvelets, shearlets) In the context of hypercomplex analysis
- Spectral theory for quaternionic normal operators
- Pseudodifferential calculus for operators defined on the spin group
- Harmonic and Gabor analysis in hyperbolic spaces
- Reproducing kernel Hilbert and Krein modules
- Generalised Clifford algebras and Dirac operators with $SU(n)$ -symmetries

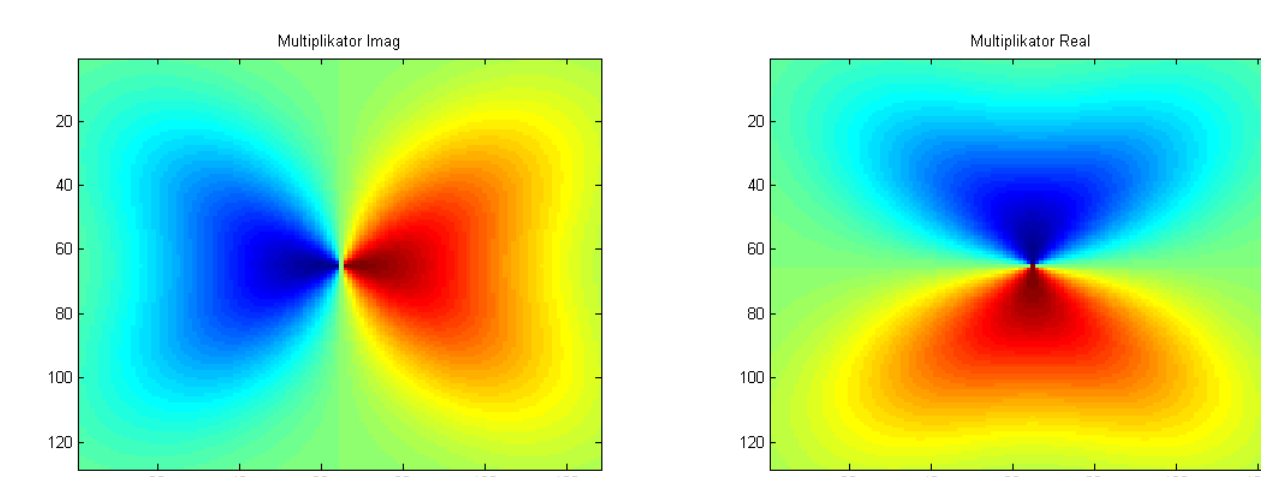


Figure 4: Preliminar results on curvature detection in images.

This poster was supported through CIDMA and the Portuguese Foundation for Science and Technology (FCT-Fundação para a Ciência e a Tecnologia), within project UID/MAT/04106/2019.