



23rd ANNUAL WORKSHOP

on

**APPLICATIONS AND GENERALIZATIONS
OF COMPLEX ANALYSIS**

Booklet of Abstracts

AVEIRO

March 27-28, 2026

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GENERAL INFORMATIONS

We welcome you all to the 23rd Annual Workshop in Aveiro. The workshop will take place in a hybrid form, with the in-presence events being held at room **Sala Sousa Pinto** (second floor).

ZOOM links:

March, 25-28:

<https://us06web.zoom.us/j/87222263198?pwd=VJrDon5WKknOZ8ipwA7QcbGwqYwLj2.1>

Meeting ID: 872 2226 3198

Passcode: 651930

INTERNET ACCESS

Rooms are available for checking your e-mail through a computer terminal.

Alternatively, if you possess a personal Laptop with WLAN you can use either the above login or your personal EDUROAM access at your home university.

WHERE TO EAT?

Around the campus there exist several coffee bars where you can have also small meals such as sandwiches, snacks, fruits, ice creams, etc.

For lunch or dinner, there exist several possibilities, with prices ranging from 6,10 euros to 9,00 euros:

- **(1) Cantina de Santiago** Monday to Friday, lunch 11h45 to 14h30 / dinner 18h30 to 20h30, Saturday and Sunday, dinner from 19h to 20h30.
- **(2) Cantina do Crasto**, Monday to Friday, lunch 11h45 to 14h30.
- **(3) Restaurante Vegetariano**, Monday to Friday, lunch 12h30 to 14h30 (on-line booking).
- **(4) Edifício do Snack-bar and Self-Service (ground floor)**, Monday to Friday, lunch 12h to 14h30.
- **(5) Restaurante Universitário (1st floor)**, Monday to Friday, lunch 12h to 14h30.

In addition, several restaurants can be found all around the campus or at the town center (at walking distance).



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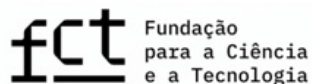
We wish you all a happy stay and a good and fruitful workshop.

Aveiro, March 19, 2026

The Organizers

Paula Cerejeiras
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ABSTRACTS - 27th March

14:30 *Opening Session*

14:45-15:30 What is non-commutative phase space and why you should care about it

Jens Wirth

Universität Stuttgart, Germany

After recalling some classical results related to phase space analysis the talk will provide a short introduction to non-commutative harmonic analysis and phase space transforms related to it. Particular emphasis will be given to homogeneous spaces of some interesting groups.

15:35-15:55 Stein-Weiss type inequality in L^1 norm for vector fields and applications

Tiago Henrique Picon

Universidade de São Paulo, Brasil

In this talk, we investigate the limit case $p = 1$ of the Stein–Weiss inequality for the Riesz potential.

Our main result is a characterization of this inequality for a special class of complex vector fields associated to cocanceling operators. As application, we recovered some classical div-curl inequalities and obtained new solvability results for equations associated to canceling and elliptic differential operators on measures.

This is a collection of joint works with Jorge Hounie (UFSCar - Brazil), Pablo De Nápoli (Universidad de Buenos Aires - Argentina), Victor Biliatto (USP - Brazil) and Joel Coacalle (USP - Brazil).

16:00-16:30 *Coffee-break*

16:35-16:55 The right eigenvalue problem in Clifford Algebras

João Costa

Politecnico di Milano, Italy

We present a description of the right spectrum of Clifford algebra-valued matrices with respect to the invertibility of so-called characteristic operators. We further prove that the characteristic operators are complex monic polynomials uniquely determined by the signature of the underlying Clifford algebra. In particular, we show that the right spectrum of a matrix can be partitioned into a finite number of classes. We provide explicit examples for several algebras and compare the resulting resolvent operators with the pseudo-resolvent operator associated with the S -spectrum.

17:00-17:20 On a paired singular integral operator with a non-Carleman shift

Rui Marreiros

Universidade do Algarve, Portugal

Let \mathbb{T} denote the unit circle. We consider a paired singular integral operator defined by the complementary Cauchy projectors, with a non-Carleman shift and continuous coefficients, acting in the Lebesgue space $L_p^n(\mathbb{T})$, $p \in (1, \infty)$. We obtain some estimates for the dimension of the kernel of this operator.

17:25 -17:45 The H^∞ -functional calculus for right slice hyperholomorphic functions in the Clifford setting

Francesco Mantovani

Politecnico di Milano, Italy

In 2016, the spectral theory on the S -spectrum was used to establish the H^∞ -functional calculus for quaternionic or Clifford operators. This calculus applies for example to sectorial or bisectorial right-linear operators T and left slice hyperholomorphic functions f that can grow as polynomials. It relies on the product of the two operators $e(T)^{-1}$ and $(ef)(T)$, both defined via some underlying S -functional calculus (also called ω -functional calculus). For left slice hyperholomorphic functions f this definition does not depend on the choice of the regularizer function e . However, due to the non-commutative multiplication of Clifford numbers, it was unclear how to extend this definition to right slice hyperholomorphic functions.

In this talk we introduce the H^∞ -functional calculus for right slice hyperholomorphic functions: we will see that, in order to ensure that the regularization procedure is independent of the choice of the regularizer, the functional calculus $f(T)$ must be understood in the sense of right-linear

ABSTRACTS - 28th March**10:00-10:45** Hyperpositive functions, sector bounded functions, and a trace formula

Daniel Alpay

Chapman University, Orange CA, USA

We present an indexed family of functions closely related to functions analytic and with a real positive part in the right open half plane (the so-called positive functions) and to the functions analytic in the right open half-plane and bounded in modulus by one there (the so-called bounded functions). These two families are related by the Cayley transform. We introduce an affine linear relationship between a subclass of positive functions and the family of bounded functions, and study the corresponding connections with passivity of linear systems, interpolation, operator models and inverse scattering. This is therefore a multidisciplinary talk, drawing from engineering, linear system theory complex analysis and operator theory.

Reproducing kernel Hilbert spaces of analytic functions are a key tool in the arguments. A special role is played by the de Branges-Rovnyak spaces associated to bounded functions, and we present a related trace formula connecting an underlying pair of operators. Extension to the case of negative squares and Pontryagin spaces is also considered. A quaternionic version of this work is currently in progress with Fabrizio Colombo and Irene Sabadini (Polimi Milano).

Joint work with Izchak Lewkowicz (Ben-Gurion University of the Negev, Beer-Sheva, Israel)

10:50-11:20 *Coffee-break***11:25-11:45** Global existence of small data Sobolev solutions to generalized de Sitter models of cosmology - Dissipation dominant semi-linear models

Jorge Marques

Universidade de Coimbra, Portugal

We study the Cauchy problem for hyperbolic models generalizing semi-linear de Sitter models of cosmology. The model of interest is

$$\phi_{tt} - a(t)^2 \Delta \phi + m_1 \frac{a(t)}{A(t)} \phi_t + m_2 \left(\frac{a(t)}{A(t)} \right)^2 \phi = |\phi|^p, \quad (\phi(0, x), \phi_t(0, x)) = (f(x), g(x)),$$

where $m_1 > 0$, $m_2 > 0$ are constants, $a(t)$ is positive, decreasing and integrable over $(0, \infty)$ and $A(t) = \int_t^\infty a(s) ds$. Our main goal is to study the interplay of m_1 and m_2 in order that the power non-linearities $|\phi|^p$, $p > 1$, lead to global (in time) existence of small data Sobolev solutions. At first we propose a classification of mass dominant models and a subclassification of dissipation dominant models. Then our considerations are given to dissipation dominant models, which are focused to energy estimates by developing a suitable WKB analysis. We also provide applications for given speed of propagation $a(t) = e^{-\alpha t}$ with $\alpha > 0$ and $a(t) = (1+t)^{-\ell}$ with $\ell > 1$.

My talk is based on joint work with Michael Reissig (TU Bergakademie Freiberg, Germany).

11:50-12:10 Some properties of the null-solutions to the complexified octonionic Cauchy-Riemann operator

Sören Kraußhar

Universität Erfurt, Germany

In this talk we present some rudiments of a function theory in the 16-dimensional complexified octonions. More precisely we look at a complexification of the octonionic Cauchy-Riemann operator which factorizes the ultrahyperbolic operator

$$\mathcal{L} = D\bar{D} = \bar{D}D = \sum_{j=0}^7 \partial_{z_j}^2,$$

where $z_j = x_j + iy_j$ are complex variables.

In real coordinates we obtain a Lichnerowicz-Weitzenböck type formula of the form

$$\mathcal{L} = \Delta_x - \Delta_y + 2i\langle \partial_x, \partial_y \rangle$$

First we investigate the fundamental solution. Then we discuss the polynomial solutions of the operator \mathcal{L} . The set of polynomial solutions can be described completely explicitly. We present explicit basis constructions together with dimension formulae. We also carefully explain the substantial differences to the usual octonionic analysis that here arise from the particular ultrahyperbolic nature of the operator.

This is joint work with Heikki Orelma.

12:15-12:35 Non-homogeneous q -deformed heat equation

Irfan Ali

Ghent University, Belgium

In 1997, Rubin introduced the q^2 -Fourier transform by using the q -Rubin derivative. By using this, we study the q -deformed heat equation. We have used the q^2 -Fourier transform and q -convolution techniques to find our solution. Specifically, we have constructed our q^2 -heat equation with the combination of q -Jackson's and q -Rubin's derivative operators. Moreover, we compare our result with classical case when q goes to 1

12:40-14:55 *Lunch-break***15:00-15:20** Approximation of Fractals via Superoscillations

Fabrizio Colombo

Politecnico di Milano, Italy

The Weierstrass function is a fractal made of high-frequency waves. Normally, these require infinite energy, but "superoscillations" allow us to recreate these shapes using only low-frequency, band-limited waves. This talk describes how accurately these approximations work. We define the so called Divergence Wall that is a breaking point where the approximations via superoscillations turns into explosive numerical error. By calculating specific growth rules, we prove how to stay stable, solving M.V. Berrys challenge of perfectly mimicking fractals without hitting exponential instability.

15:25-15:45 On Fractional Fock Spaces, Fractional Supershifts and Applications

Natanael Alpay

University of California Irvine, CA Irvine, USA

In this presentation, we introduce a fractional Fock space related to derivatives of Gelfond-Leontiev type, a class of derivatives that includes many classic examples like fractional derivatives or Dunkl operators. We then extend the notion of supershifts and superoscillation sequence to this fractional Fock space. Afterwards, we discuss some applications such as the associated evolution Cauchy problem with the fractional supershifts as initial condition.

15:50-16:10 Multiple orthogonality and applications

Juan Díaz

University of Aveiro, Portugal

Multiple orthogonal polynomials are a generalization of the standard orthogonal polynomials that satisfy orthogonality conditions with respect to several weight functions, rather than just one. This leads, on one hand, to the multiple type II polynomials, which have been widely studied and many families are already known. On the other hand, the so-called multiple type I polynomials have not been studied as extensively, constituting an open problem in the field. Recently, an important step in this direction was made with the finding of explicit expressions for the multiple type I polynomials corresponding to some classical families. These are expressed through special functions like the generalized hypergeometric series or the multiple Kampé de Fériet series.

Multiple orthogonality has applications in various fields of mathematics, such as random matrix theory, approximation theory, number theory, integrable systems or probability theory. Here, we will focus on this last one, particularly on their use in the construction and study of Markov chains. This can be done through the matrix that describes the multiple polynomials' recurrence relation. Under certain conditions, this matrix can be turned into a stochastic matrix, thus describing a Markov chain. Then, it is possible to obtain a representation formula for the transition probabilities of this chain, that allows to derive properties about it.

16:20 *Closing Session*