WHO 19
International Workshop on Harmonic Analysis and Operator Theory

26–29 August 2019

İstanbul University
Fuat Sezgin Congress and Cultural Center
İstanbul, Turkey

Information, Schedule, and Abstracts

Welcome

Dear Colleagues and Friends,

It is our pleasure to welcome you to İstanbul for a union at the International Workshop on Harmonic Analysis and Operator Theory. We are proud to host one of the first meetings bringing together these two areas of mathematics.

Harmonic analysis and operator theory are modern and active domains of research in mathematics whose roots are firmly embedded in classical theories. More recently, both fields have seen rapid growth by expanding into wider areas both in the abstract, such as operator spaces and algebras, and in the applied, such as time-frequency analysis and wavelets, and interconnections between them have developed. The results and methods obtained are used in everyday life by many people working in applied fields of mathematics, engineering, medicine, and physics.

This meeting is also an occasion to make and renew contacts among mathematicians from different backgrounds and cultures. There are 16 plenary talks and more over 60 contributed talks on a wide range of topics. Our aim is to create a friendly and supportive atmosphere for the participants. We hope that this first meeting will be a source of inspiration for further cooperation in research and many more joint meetings.

We wish you fruitful and enjoyable days in the historical city of İstanbul.

On behalf of the Organizing Committee,

Serap Öztop Kaptanoğlu

Scientific Committee

Serap Öztop Kaptanoğlu (*İstanbul University, İstanbul*)
Aurelian Gheondea (*Bilkent University, Ankara, and IMAR, Bucharest*)
H. Turgay Kaptanoğlu (*Bilkent University, Ankara*)
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Volker Runde (*University of Alberta, Edmonton, AB*)
Ebrahim Samei (*University of Saskatchewan, Saskatoon, SK*)
Nicolaas Spronk (*University of Waterloo, Waterloo, ON*)

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ISAAC, International Society for Analysis, its Applications and Computation
İstanbul University
TÜBİTAK, Scientific and Technological Research Council of Turkey
TMD, Turkish Mathematical Society
H. T. Kaptanoğlu, for the web site and this booklet
And volunteer work of colleagues and students.

Useful Information

Registration Desk

The registration desk will be at the foyer on the ground floor of the Fuat Sezgin Congress and Cultural Center of İstanbul University. It will open at 8:00 on Monday, 26 August, and stay open throughout the workshop. Please feel free to ask the help of the students working there when needed.

Coffee, tea, and cookies in breaks will be served also in this area.

Welcome dinner on Monday, August 26, will also take place in this area at 19:30.

Lecture Halls

The opening ceremony on Monday and the plenary lectures in the mornings will take place in room "Salon 2" located on the second floor of the congress center.

Sessions 1 and 2 in the afternoons will take place in the rooms "Salon 3" and "Salon 1A", respectively, located on the first floor of the center.

Every lecture hall is equipped with a computer, a data projector, and a white board.

Internet

Wireless internet service is available.
SSID: IU_MEETING (TOPLANTI)
Password: istn1453

Also İstanbul University is a part of the "eduroam" system.

Wednesday Cruise with Dinner

If you are interested in joining the cruise with dinner on the Bosphorus on Wednesday, 28 August, please buy your tickets on Monday from the registration desk. We need the total number attending as early as possible.

The boat will depart from Karaköy at 19:00 and come back to the same pier at 23:00. To get to Karaköy, you can take the tram T1 in Kabataş direction, and right after it crosses the Galata bridge, get off it at Karaköy station. Please be there, say, at 18:45.

Please indicate any dietary restrictions, such as vegetarian, red or white meat.

Money

The unit of currency in Turkey is the Turkish Lira (TL). Recent rates are that 1 euro is worth about 6.40 lira, and 1 US dollar about 5.75 lira. İstanbul University is at a busy section of the city, and one can exchange money at banks or exchange offices nearby, or at the airports. Many places will accept euros or dollars for shopping, but possibly at a not-so-favorable rate.

Transportation

To travel with public transportation, one must have the İstanbulKart, which works on buses, trams, subway, and boats. You can buy one at most stops and stations, and even at newspaper stands and kiosks. Initially it is loaded with a small amount, and you can load more later.

General Program

Monday, 26 August 2019

8:00– 9:00	Registration (Foyer)
9:00– 9:30	Opening Ceremony (Salon 2)
	Plenary Talks
Room	Salon 2
Chair	*V. Runde*
9:30–10:10	A. Ülger, *Existence of accumulation points in* $(\Phi_A, weak)$ *and applications*
10:15–10:55	N. Spronk, *On operator amenability of Fourier-Stieltjes algebras*
11:00–11:30	Break
11:30–12:10	H. Feichtinger, *A study of the multiplier problem using the Banach-Gelfand triple*
12:15–12:55	M. Daws, *Fields of algebras*
13:00–14:30	Lunch
14:30–16:30	**Sessions**
16:30–17:00	Break
17:00–17:30	**Sessions**
19:30–21:30	Welcome Dinner (Foyer)

Tuesday, 27 August 2019

	Plenary Talks
Room	Salon 2
Chair	*N. Spronk*
9:00– 9:40	L. Molnár, *Preservers on positive definite cones in operator algebras*
9:45–10:25	E. Samei, *Exotic* C^**-algebras of geometric groups*
10:30–11:00	Break
11:00–11:40	C. Muscalu, *The helicoidal model*
11:45–12:25	V. Lie, *A unified approach to three themes in harmonic analysis*
12:30–14:00	Lunch
14:00–16:00	**Sessions**
16:00–16:30	Break
16:30–18:30	**Sessions**

Wednesday, 28 August 2019

	Plenary Talks
Room	Salon 2
Chair	*E. Samei*
9:00– 9:40	Y. Choi, *Alternating cocycles on Fourier algebras of Lie groups*
9:45–10:25	L. Turowska, *Completely bounded maps and invariance properties*
10:30–11:00	Break
11:00–11:40	V. Runde, *Amenable subalgebras of Connes-amenable dual Banach algebras*
11:45–12:25	J. Wright, *From Fourier restriction to Diophantine equations (and back)*
12:30–14:00	Lunch
14:00–19:00	Free Time for Touristic Activities
19:00–23:00	Cruise and Dinner

Thursday, 29 August 2019

	Plenary Talks
Room	Salon 2
Chair	*Y. Choi*
9:00– 9:40	J. Toft, *Analytic pseudodifferential calculus via Bargmann transform*
9:45–10:25	C. Trapani, *Frames and bases beyond Hilbert space: Results and perspectives*
10:30–11:00	Break
11:00–11:40	L. Marcoux, *Hilbert space operators with compatible off-diagonal corners*
11:45–12:25	M. Pap, *Properties of voice transform on weighted Bergman spaces related to Toeplitz operators*
12:30–14:00	Lunch
14:00–16:00	**Sessions**
16:00–16:30	Break
16:30–18:00	**Sessions**
18:00	Closing Remarks

Schedule of Sessions

Monday, 26 August 2019

	Session 1	**Session 2**
Room	Salon 3	Salon 1A
Chair	*A. Ülger*	*V. Lie*
14:30–14:55	O. Blasco	K. Dziedziul
15:00–15:25	Ö. F. Doğan	
15:30–15:55	E. M. Semenov	D. Tiwari
16:00–16:25		M. Gandehari
16:30–17:00	Break	
Chair	*L. Molnár*	
17:00–17:25	A. Lahssaini	

O. Blasco	*On the Taylor coefficients of functions in the Hardy Space over the bidisc*
K. Dziedziul	*Smooth orthogonal decomposition of identity and Parseval frames on Riemannian manifolds*
Ö. F. Doğan	*Harmonic Besov spaces with small exponents on the ball*
E. M. Semenov	*Banach limits and applications*
D. Tiwari	*Haar vs Hermite wavelets on a class of BVPs arising in exothermic reactions*
M. Gandehari	*Characterization of wavefront sets via continuous wavelet transforms*
A. Lahssaini	*On the pseudospectrum preservers*

Tuesday, 27 August 2019

	Session 1	**Session 2**
Room	Salon 3	Salon 1A
Chair	*H. Feichtinger*	*M. Daws*
14:00–14:25	V. Marraffa	F. Yılmaz
14:30–14:55	M. Joiţa	N. G. Göğüş
15:00–15:25	T. L. Costache	F. Bouchelaghem
15:30–15:55	S. Ivković	
16:00–16:30	Break	
Chair	*G. Kohr*	*O. Blasco*
16:30–16:55	Z. Moayyerizadeh	S. Tabatabaie
17:00–17:25		S. Menkad
17:30–17:55		E. Feizi
18:00–18:25		Z. A. Abdelali

V. Marraffa	*Integral problems driven by regulated functions and closure properties*
F. Yılmaz	*On generators of invariant subspaces of the Dirichlet space*
M. Joiţa	*Ternary domains on Hilbert C^*-modules for completely positive linear maps*
N. G. Göğüş	*The closure of Dirichlet spaces in the Bloch space*
T. L. Costache	*Projective u-covariant (α)-completely positive linear maps and their associated projective J-representations*
F. Bouchelaghem	*On the factorization of monic quadratic operator pencils with accretive coefficients*
S. Ivković	*Semi-Fredholm theory on Hilbert C^*-modules*
Z. Moayyerizadeh	*Compactness of substitution vector-valued integral operators on Orlicz spaces*
S. Tabatabaie	*Spaceability on some function spaces*
S. Menkad	*On a new generalized projection in Hilbert spaces*
E. Feizi	*Cohomology of Banach algebras with coefficients in character modules and point derivation*
Z. A. Abdelali	*Preservers of the local spectrum of some products of operators*

Thursday, 29 August 2019

	Session 1	**Session 2**
Room	Salon 3	Salon 1A
Chair	*L. Turowska*	*J. Toft*
14:00–14:25	S. Öztop	G. Kohr
14:30–14:55	C.-C. Chen	M. Kohr
15:00–15:25	R. Üster	K. Smaoui
15:30–15:55	A. Osançlıol	H. T. Kaptanoğlu
16:00–16:30	Break	
Chair	*S. Öztop*	
16:30–16:55	E. Elgün Kırımlı	
17:00–17:25	M. Guesba	
17:30–17:55	F. Temur	

S. Öztop	*A survey of Orlicz algebras on locally compact groups*
G. Kohr	*Loewner chains and approximation properties associated with biholomorphic mappings in several complex variables*
C.-C. Chen	*Chaotic translations on weighted Orlicz spaces*
M. Kohr	*Layer potentials and boundary value problems for the Stokes system with L^∞ coefficients*
R. Üster	*Compact multipliers on Orlicz spaces*
K. Smaoui	*Heisenberg-Pauli-Weyl inequality for connected nilpotent Lie groups*
A. Osançlıol	*Notes on bilinear multipliers on Orlicz spaces*
H. T. Kaptanoğlu	*Shift operators on harmonic Hilbert function spaces*
E. Elgün Kırımlı	*Gabor frames on Heisenberg-type group extensions*
M. Guesba	*Some inequalities for d-tuples of operators in Hilbert spaces*
F. Temur	*Discrete fractional integral operators with quadratic bivariate phase polynomials*

Abstracts

Preservers of the local spectrum of some products of operators

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Let $B(X)$ be the algebra of all bounded linear operators on a Banach space X. We characterize the forms of surjective mappings on $B(X)$ that preserve the local spectrum of the Lie product of operators. When X is finite-dimensional, we characterize the forms of mappings on $B(X)$ that preserve the local spectrum of the skew Lie product and quadratic products of matrices.

References

[1] Z. Abdelali and A. Bourhim, Maps preserving the local spectrum of quadratic products of matrices, *Acta Sci. Math. (Szeged)* **84** (2018), 49–64.

[2] Z. Abdelali, A. Bourhim and M. Mabrouk, Lie product and local spectrum preservers, *Linear Algebra Appl.* **553** (2018), 328–361.

On the Taylor coefficients of functions in the Hardy space over the bidisc

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Joint work with Ismael Garcia-Bayona.
Research supported by MTM2014-53009-P (MINECO Spain).

In this paper we analyze the Taylor coefficients of functions in Hardy spaces on the bidisc. We present the two-dimensional versions of some classical Hardy and Paley inequalities and we find certain conditions on the Taylor coefficients for the converse of these inequalities to hold.

References

[1] M. Pavlovic, Analytic functions with decresing coefficients and Hardy and Bloch spaces, *Proc. Edinburgh Math. Soc.* **56** (2013), 623–625.

[2] W. Rudin, *Function Theory in Polydiscs*, W. A. Benjamin, New York, 1969.

On the factorization of monic quadratic operator pencils with accretive coefficients

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Joint work with Mohammed Benharrat.

We give a canonical factorization of monic quadratic operator pencils with accretive coefficient operators acting on Hilbert space. Under some conditions this factor generates s holomorphic C_0-semigroup of contraction operators. The results carry over to the case of pencils of unbounded operators and are used to prove the existence and uniqueness of solutions of an abstract second order differential equation. We also investigate some necessary and sufficient conditions to ensure the separation of spectral values between the spectra of this factors, in the case of bounded Hilbert space operators. As an application a finite-dimensional case is also discussed.

References

[1] T. Kato, *Perturbation Theory for Linear Operators*, Springer, New York, 1995.

[2] N. J. Higham, H.-M. Kim, *Numerical analysis of a quadratic matrix equation*, IMA J. Numer. Anal. **20** (2000), 499–519.

[3] K. Gustafson, D. Rao, *Numerical range and accretivity of operator products*, J. Math. Anal. Appl. **60** (1977), 693–702.

Chaotic translations on weighted Orlicz spaces

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Joint work with K.-Y. Chen, S. Öztop and S. M. Tabatabaie.

Let G be a locally compact group, and let w be a weight on G. Let Φ be a Young function. We give some characterizations for translation operators to be topologically transitive and chaotic on the weighted Orlicz space $L^\Phi_w(G)$. In particular, transitivity is equivalent to the blow-up/collapse property in our case. Moreover, the dense set of periodic elements implies transitivity automatically.

Alternating cocycles on Fourier algebras of Lie groups

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Consider the algebra A of all C^1 functions on $\mathbb{T}^2$, and the bilinear map $\Psi : A \times A \to A^*$:

$$\Psi(F_1, F_2)(F_0) = \int_{\mathbb{T}^2} \left(\frac{\partial F_1}{\partial \theta_1} \frac{\partial F_2}{\partial \theta_2} - \frac{\partial F_2}{\partial \theta_1} \frac{\partial F_1}{\partial \theta_2} \right) F_0 \, d\theta_1 \, d\theta_2$$

Ψ is an example of an *alternating* 2*-cocycle* on A; and for each $k > 2$, the only alternating k-cocycle on A is zero.

The systematic study of alternating cocycles on commutative Banach algebras was first initiated by B. E. Johnson [2] but since then seems to have gone largely unexplored. In view of recent advances in understanding derivations on Fourier algebras of connected Lie groups [1, 3], the time seems ripe to revisit the problem of constructing higher-degree cocycles on such algebras. This is not as straightforward as one might first think.

In this talk I will start with some motivation and a brief overview of the background context from Banach algebras and harmonic analysis. I will then report on work that provides the first examples (and many of them) of groups whose Fourier algebras support non-zero alternating 2-cocycles. Although we do not require our cocycles to be completely bounded, it turns out that operator space techniques play a crucial role in our construction.

References

[1] Y. Choi and M. Ghandehari, Weak and cyclic amenability for Fourier algebras of connected Lie groups, *J. Funct. Anal.* **266** (2014), 6501–6530.

[2] B. E. Johnson, Higher-dimensional weak amenability, *Studia Math.* **123** (1997), 117–134.

[3] H. H. Lee, J. Ludwig, E. Samei and N. Spronk, Weak amenability of Fourier algebras and local synthesis of the anti-diagonal, *Adv. Math.* **292** (2016), 11–41.

Projective u-covariant (α)-completely positive linear maps and their associated projective J-representations

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We construct a Krein space, a J-representation and a projective J-unitary representation associated with a unital projective J-covariant completely positive linear map. We find a Krein space representation for a unital projective (θ, u)-covariant α-completely positive linear map. For a given projective unital (θ, u)-covariant α-completely positive linear map ρ and a projective (τ, σ, u)-covariant ρ-map we construct a projective covariant J-representation of a C^*-dynamical system. We form projective J-unitary representations associated to a projective (u, u')-covariant completely positive ρ-maps. We prove that there is a projective covariant representation associated with a projective covariant α-completely positive linear map on an S-module.

References

[1] *T.-L. Costache*, KSGNS type representations on Krein C^*-modules associated with projective J-covariant (α)-completely positive maps, UPB Sci. Bull., Series A, **77** (2015), 67–78.

[2] *J. Heo, J. P. Hong, U. C. Ji*, On KSGNS Representations on Krein C^*-modules, J. Math. Phys. **51** (2010), 1–17.

[3] *J. Heo*, Covariant representations on Krein C^*-modules associated to pairs of two maps, J. Math. Anal. Appl. 398 (2013), 35–45.

Fields of algebras

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Joint work with Adam Skalski and Sam Evington.

We will discuss bundles, or fields, of algebras over a space X, formalised as being $C_0(X)$-algebras, as well as associated ideas, such as Hilbert $C_0(X)$-modules, and Banach $C_0(X)$-modules. Our primary interest comes from the operator algebra approach to quantum groups. Here the pioneering work is by Blanchard, who defined and studied fields of compact quantum groups and multiplicative unitaries. Such a formalism can give meaning to the notion of quantum groups "converging"; a recent example in this direction,due to De Commer and Flore, shows that the (discrete) duals of $SU_q(2)$ converge to a certain quantum group of "upper triangular matrices", as q tends to 1. (Notice that we do not obtain the dual of $SU(2)$). The ideas have also been applied to study the Connes-Baum conjecture for (certain) quantum groups, this time the idea being that the limit point is a classical group, from which we can "borrow" the representation theory we need. Recently the idea of looking at $C(X)$-algebras which are closed in a weak*-topology (in some sense), thus giving a field of von Neumann algebras, has arisen in the Classification programme for C^*-algebras. We will discuss to what extent we can talk of fields of quantum groups at the von Neumann algebra level, or, passing to the predual, fields of Banach convolution algebras, for quantum groups. We will also discuss some of the background theory, which in our opinion is attractive.

Harmonic Besov spaces with small exponents on the ball

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We study harmonic Besov spaces b^p_α on the unit ball of $\mathbb{R}^n$, where $0 < p < 1$ and $\alpha \in \mathbb{R}$. We provide characterizations in terms of partial and radial derivatives and certain radial differential operators that are more compatible with reproducing kernels of harmonic Bergman-Besov spaces. Thus we complete the picture about the interchangeability of various kinds of derivatives in defining the two-parameter harmonic Besov space family for the full range of parameters. We show that the dual of harmonic Besov space b^p_α is weighted Bloch space b^∞_β under certain volume integral pairing for $0 < p < 1$ and $\alpha, \beta \in \mathbb{R}$. Our other results are about growth at the boundary and atomic decomposition.

References

[1] S. Axler, P. Bourdon and W. Ramey, *Harmonic Function Theory*, 2nd ed., Springer, New York, 2001.

[2] S. Gergün, H. T. Kaptanoğlu and A. E. Üreyen, Harmonic Besov spaces on the ball, *Internat. J. Math.*, **27** (2016), #1650070.

[3] G. Ren, Harmonic Bergman spaces with small exponents in the unit ball, *Collect. Math.* **53** (2003), 83–98.

Smooth orthogonal decomposition of identity and Parseval frames on Riemannian manifolds

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Joint work with Marcin Bownik and Anna Kamont.

I will present a concept of smooth orthogonal decomposition of identity in $L^2(M)$ subordinate to an open cover $\mathcal{U}$ of a connected Riemannian manifold M introduced in [1]. Next I show how to construct Parseval frame on a smooth connected Riemannian manifold (without boundary). On compact manifolds such frames characterize Besov and Triebel-Lizorkin spaces. Other systems that characterize Besov and Triebel-Lizorkin spaces on compact manifolds are u-wavelet basis of Triebel, spline basis [2] and space-frequency concentrated frames [3] (also for noncompact manifolds).

References

[1] M. Bownik, K. Dziedziul and A. Kamont, Smooth orthogonal projections on Riemannian manifold, (2018), arXiv:1803.03634.

[2] Z. Ciesielski, T. Figiel, *Spline approximation and Besov spaces on compact manifolds*, Studia Math. **75** (1982), 13–36.

[3] H. Feichtinger, H. Führ, I. Pesenson, Geometric space-frequency analysis on manifolds. *J. Fourier Anal. Appl.* **2** (2016), 1294–1355

Gabor frames on Heisenberg-type group extensions

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Joint work with Serap Öztop.
Research supported by TÜBİTAK 2232 Program.

Given a locally compact group G, a locally compact Abelian group A, and a continuous mapping $w : G \times G \to A$ satisfying cocycle conditions, we construct a locally compact group $G_w = G \times_w A$ which is equipped by a Heisenberg type multiplication and contains A as an Abelian normal subgroup. In this talk our goal is to investigate Gabor frames on non-Abelian locally compact groups of the form G_w. First we will construct a continuous Gabor transform on G_w, extending the one on A. We will observe that orthogonality and inversion properties also carry to G_w, suggesting that Heisenberg type non-Abelian locally compact groups not only play an important role in time frequency analysis of Abelian groups, but also provide a suitable setting on their own.

A study of the multiplier problem using the Banach-Gelfand triple

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It is the purpose of this talk to present an interpretation concerning results on multipliers between L^p-spaces (in the spirit of the book of R. Larsen: bounded linear operators commuting with translations) making use of the so-called Banach-Gelfand Triple $(S0, L2, SO')$. Although these results are valid in the context of general LCA groups, we will illustrate the results for the Euclidean setting $G = R^d$. That there is a kernel theorem for this setting which allows to characterize bounded linear operators from SO to SO' via their distributional kernels in SO' (of two variables) is one of the key ingredients, together with the Fourier invariance of the spaces involved: not just $L2$, but also SO and SO'.

We will also discuss the role of the Herz algebra $A_p(G)$ which is usually considered a very complicated but important object for the representation of L^p-multipliers. In fact, they can be characterized as convolution operators with elements from the dual space (which is also a subspace of SO'). Their Fourier transforms (in the distributional resp. SO'-sense) are just the p-Fourier multipliers. The approach also suggests some open problems concerning these spaces.

Cohomology of Banach algebras with coefficients in character modules and point derivation

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Research supported by Bu-Ali Sina University

Let $\mathcal{A}$ be a Banach algebra and $\Delta(\mathcal{A})$ be a space of all characters (nonzero, complex, multiplicative linear functionals). For a character $\varphi \in \Delta(\mathcal{A})$, a Banach space $\mathcal{X}$ is called Banach $(\mathcal{A}, \varphi)$-module and denoted by $\mathcal{X}_\varphi$ whenever the module actions are defined by $a \cdot x = x \cdot a = \varphi(a)x$ for $a \in \mathcal{A}$ and $x \in \mathcal{X}$. We are interested in studying the first and second cohomology groups of $\mathcal{A}$ with coefficients in $\mathcal{X}_\varphi$. We show that $H^1(\mathcal{A}, \mathcal{X}_\varphi) = 0$ and $H^2(\mathcal{A}, \mathcal{X}_\varphi)$ is a Hausdorff space (Banach space) for all $\varphi \in \Delta(\mathcal{A})$. We apply our results to some Banach algebras related to locally compact groups. In a special case we conclude that there is no nonzero point derivations on this class of Banach algebras.

Theorem. *Let $\mathcal{A}$ be a Banach algebra and φ be a character on $\mathcal{A}$. If the absolute convex hull $abco(I_1 \cap S_1)$ is dense in S_1, then $\mathcal{H}^1(\mathcal{A}, \mathcal{X}) = \{0\}$ and hence $\mathcal{H}^2(\mathcal{A}, \mathcal{X})$ is Hausdorff, for all Banach $(\mathcal{A}, \varphi)$-module $\mathcal{X}$.*

Corollary. *Let G be a locally compact group and let φ be the augmentation character on $M(G)$. Then the bounded cohomology group $\mathcal{H}^1(M(G), \mathcal{X}_\varphi) = 0$ and $\mathcal{H}^2(M(G), \mathcal{X}_\varphi)$ is Hausdorff.*

Corollary. *Let G be a locally compact group and let $\psi(u) = u(e)$ be the dual augmentation character on Fourier-Stieltjes algebra $B(G)$. Then the bounded cohomology group $\mathcal{H}^1(B(G), \mathcal{X}_\psi) = \{0\}$ and $\mathcal{H}^2(B(G), \mathcal{X}_\psi)$ is Hausdorff.*

References

[1] E. Feizi and A. Pourabbas, *Second Hochschild cohomology group of convolution algebras*, Bull. Iran. Math. Soc. **36** (2010), 167–173.

[2] B. E. Johnson, *Cohomology in Banach algebras*, Mem. Amer. Math. Soc. **127** (1972), 96 pp.

[3] H. Kamowitz, *Cohomology groups of commutative Banach algebras*, Trans. Amer. Math. Soc. **102** (1962), 352–372.

Characterization of wavefront sets via continuous wavelet transforms

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Joint work with Hartmut Führ.

In recent years, certain wavelet-type transformations such as the curvelet or shearlet transformation have gained considerable attention, due to their potential for efficiently handle data with features along edges. This property was confirmed for the continuous curvelet transform by Candes and Donoho, and for the shearlet transform by Kutyniok and Labate. In both cases, it was shown that the decay rate of the corresponding transformation coefficients of a tempered distribution can resolve the wavefront set of the distribution. Roughly speaking, the wavefront set of a tempered distribution f is the set of points $t \in \mathbb{R}^n$ and directions $\xi \in S^{n-1}$ along which f is not smooth at t.

Recently, many efforts have been made aiming to generalize the above characterization, i.e., characterization of the wavefront set of a tempered distribution in terms of its continuous wavelet transform, for higher dimensional continuous wavelet transforms constructed using square-integrable representations of $\mathbb{R}^n \rtimes H$, where H can be any suitably chosen dilation group. In this talk, we consider the problem of characterizing the Sobolev wavefront set of a distribution for a higher-dimensional wavelet transform in two important cases where 1) the mother wavelet is compactly supported, and 2) the mother wavelet has compactly supported Fourier transform.

The closure of Dirichlet spaces in the Bloch space

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Joint work with Guanlong Bao.
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The aim of this talk is to give a characterization of the closure of Dirichlet type spaces on the unit disk in the Bloch space. Our characterizations involve high order derivatives and embedding derivatives of Bloch type functions into Lebesgue spaces. As an application of this characterization we provide further information on the interpolating Blaschke products in the closure of Dirichlet type spaces in the Bloch space. The results presented in the talk are published recently in [2] and followed up and generalized by the work in [1].

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Some inequalities for d-tuples of operators in Hilbert spaces

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Our aim is to give new inequalities of the d-tuples of operators on a complex Hilbert space H. An extension of the generalized some Dragomir inequality is proved for multivarible operators on a complex Hilbert space. Based on that some numerical radius inequalities are proved for a single operator. We first prove the inequality

$$\omega^2(\mathbf{T}) \leq \frac{1}{2}\left(\|\mathbf{T}\|\,\|\mathbf{T}^*\| + \omega\left(\mathbf{T}^2\right)\right),$$

where $\mathbf{T} = (T_1, ..., T_d) \in B(H)^d$ for each positive integer $d \geq 1$. We then show the inequality

$$\omega^2(\mathbf{T}) \leq \frac{1}{2}\left(\|\mathbf{T}\| \|\mathbf{T}^*\| + \|\mathbf{T}^2\|\right),$$

for any d-tuples of operators $\mathbf{T} = (T_1, ..., T_d) \in B(H)^d := B(H) \times ... \times B(H)$, where $\omega(\mathbf{T})$ and $\|\mathbf{T}\|$ are respectively the joint numerical raduis and the joint operator norm of $\mathbf{T}$. Lastly we prove that

$$\omega(\mathbf{T}) \leq \frac{1}{2}\||\mathbf{T}| + |\mathbf{T}^*|\|,$$

where $|\mathbf{T}| := (|T_1|, ..., |T_d|)$ with $|T_j| := \left(T_j^* T_j\right)^{\frac{1}{2}}$. We have further such inequalities.

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Semi-Fredholm theory on Hilbert C^*-modules

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In this paper we establish the semi-Fredholm theory on Hilbert C^*-modules as a continuation of Fredholm theory on Hilbert C^*-modules established by Mishchenko and Fomenko. We give a definition of a semi-Fredholm operator on Hilbert C^*-module and prove that these semi-Fredholm operators are those that are one-sided invertible modulo compact operators, that the set of proper semi-Fredholm operators is open. We prove a generalization in this setting of Schechter's characterization of Φ_+ operators and we define new classes of operators on $H_{\mathcal{A}}$ as various generalizations of Φ_+^- and Φ_-^+ operators. Then we show, form instance, that these new classes are open semigroups and invariant under compact perturbations. In addition, we show many other results concerning semi-Fredholm operators on Hilbert C^*-modules that generalize their classical counterparts.

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Ternary domains on Hilbert C^*-modules for completely positive linear maps

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Joint work with M. B. Asadi and R. Behmani.
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We associate to an operator valued completely positive map φ on a C^*-algebra A and a Hilbert C^*-module X over A a subset X_φ of X, called '*ternary domain*' of φ on X, and we show that X_φ is a Hilbert C^*-module over the multiplicative domain of φ and every φ-map (i.e., associated quaternary map with φ) acts on it as a ternary map. We introduce the notion of ternary domain for an operator valued completely positive map on a C^*-algebra and show that T_φ, the ternary domain of φ, is a closed two-sided $*$-ideal of the multiplicative domain of φ. Also, we show that $XT_\varphi = X_\varphi$ and we give several characterizations of X_φ. Furthermore, we establish some relationships between X_φ and minimal Stinespring dilation triples associate to φ. Finally, we show that every operator valued completely positive linear map φ on a C^*-algebra A induces a unique (in a some sense) completely positive linear map on the linking algebra of X and we determine its multiplicative domain in terms of the multiplicative domain of φ and the ternary domain of φ on X.

Shift operators on Hilbert harmonic function spaces

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Joint work with Daniel Alpay of Chapman University.

In an attempt to identify the harmonic Drury-Arveson space, we introduce and investigate large families of reproducing kernel Hilbert spaces of harmonic functions the unit ball of $\mathbb{R}^n$. Using zonal harmonics, we define and develop basic properties of shift operators and their adjoints in the harmonic setting. We prove a dilation result for the shift operators on harmonic spaces that are row contractions. As a consequence, we show that the norm of one of our spaces $\breve{\mathcal{G}}$ is maximal among those spaces on which the shift operator is a row contraction. We then describe the progress towards a von Neumann inequality for harmonic polynomials and a tuple of commuting operators on harmonic spaces that are row contractions and belong to a certain class showing the maximality of the operator norm of the shift on $\breve{\mathcal{G}}$.

Loewner chains and approximation properties associated with biholomorphic mappings in several complex variables

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Joint work with Ian Graham (Toronto), Hidetaka Hamada (Fukuoka), Mirela Kohr (Cluj-Napoca), and Mihai Iancu (Cluj-Napoca).

In the first part of this talk we survey various results related to Loewner chains, the generalized Loewner differential equation, and Herglotz vector fields on the Euclidean unit ball $\mathbb{B}^n$ in

$\mathbb{C}^n$. Extremal problems and related results for the family $S_A^0(\mathbb{B}^n)$ of univalent mappings with A-parametric representation on $\mathbb{B}^n$ will be also discussed, where $A \in L(\mathbb{C}^n)$ with $k_+(A) < 2m(A)$. Next, we present recent results on approximation properties of various families of normalized univalent mappings f on $\mathbb{B}^n$, with Runge image, by automorphisms of $\mathbb{C}^n$ whose restrictions to $\mathbb{B}^n$ have the same geometric property as the initial mappings f. Open problems and questions will be also considered.

Layer potentials and boundary value problems for the Stokes system with L^∞ coefficients

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Joint work with Sergey E. Mikhailov (Brunel University, London) and Wolfgang L. Wendland (Stuttgart University).

We obtain well-posedness results in L^p-based weighted Sobolev spaces for transmission and exterior boundary problems for the Stokes system with L^∞ strongly elliptic coefficient tensor in bounded and exterior Lipschitz domains of $\mathbb{R}^n$, $n \geq 3$. We explore a variational approach that reduces two linear transmission problems for the Stokes system to equivalent mixed variational formulations with data in L^p-based weighted Sobolev and Besov spaces. We show that such a mixed variational formulation is well-posed in the space $\mathcal{H}^{1,p}(\mathbb{R}^n)^n \times L^p(\mathbb{R}^n)$, $n \geq 3$, for any p in an open interval containing 2. These results are used to define the Newtonian and layer potential operators for the considered Stokes system. Various mapping properties of these operators are also obtained. Well-posedness and regularity results of the exterior Dirichlet and mixed problems for the Stokes system with L^∞ elliptic coefficient tensor in an exterior Lipschitz domain Ω_- of $\mathbb{R}^n$, $n \geq 3$, and in L^p-based weighted Sobolev spaces $\mathcal{H}^{1,p}(\Omega_-)^n \times L^p(\Omega_-)$. For $p = 2$, the solution is obtained in terms of Newtonian and layer potentials.

On the pseudospectrum preservers

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Joint work with Mustapha Ech-Cherif El Kettani.

Let $\mathcal{B}(X)$ be the algebra of all bounded linear operators on a complex Banach space X. We characterize additive maps from $\mathcal{B}(X)$ onto $\mathcal{B}(Y)$ compressing the pseudospectrum subsets $\Delta_\epsilon(.)$, where $\Delta_\epsilon(.)$ stands for any one of the spectral functions σ_ϵ, σ_ϵ^l and σ_ϵ^r for some $\epsilon > 0$. We also characterize the additive (resp. nonlinear) maps from $\mathcal{B}(X)$ onto $\mathcal{B}(Y)$ preserving the pseudospectrum $\sigma_\epsilon(.)$ of generalized products of operators for some $\epsilon > 0$ (resp. for every $\epsilon > 0$). We will say that ϕ satisfies the condition (P) if the the range of ϕ contain all operators of rank at most two if, $T_1 \circ T_2 \circ ... \circ T_k = T_{i_1}...T_{i_m}$, or the range contain all operators of rank at most three if $T_1 \circ T_2 \circ ... \circ T_k = T_{i_1}...T_{i_m} + T_{i_m}...T_{i_1}$.

Theorem. *Let $\epsilon > 0$. Suppose $\phi : \mathcal{B}(X) \longrightarrow \mathcal{B}(Y)$ is an additive map satisfying the condition (P), and $\sigma_\epsilon(\phi(T_1) \circ \phi(T_2) \circ ... \circ \phi(T_k)) = \sigma_\epsilon(T_1 \circ T_2 \circ ... \circ T_k)$. Then one of the following conditions holds.*

1. *There are λ with $\lambda^m = 1$ and an isometry $A : X \to Y$ such that $\phi(T) = \lambda ATA^{-1}$ for all $T \in \mathcal{B}(X)$.*
2. *Both X and Y are reflexive, and there exist a scalar λ with $\lambda^m = 1$ and an isometry $A : X^* \to Y$ such that $\phi(T) = \lambda AT^*A^{-1}$ for all $T \in \mathcal{B}(X)$.*

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A unified approach to three themes in harmonic analysis

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This talk discusses a new and unified approach to three main distinct themes in harmonic analysis.

Main Problem. (Informal) *For each point $x \in \mathbb{R}$ we associate a curve $\Gamma_x = (t, -\gamma(x,t))$ in the plane, where $t \in \mathbb{R}$ and*

$$\gamma_x(\cdot) := \gamma(x, \cdot) : \mathbb{R} \to \mathbb{R},$$

is a real function obeying some "suitable" smoothness and nonzero curvature conditions in the t-parameter. Define now the variable family of curves in the plane $\Gamma \equiv \{\Gamma_x\}_{\{x \in \mathbb{R}\}}$.

Task: *Under minimal conditions on the curve Γ (e.g. only measurability in the x-variable), study the L^p-boundedness, $1 \le p \le \infty$, of the following operators:*

(I) **Linear Hilbert transform and (sub)linear maximal operator along** Γ:

$$H_\Gamma(f)(x,y) := \text{p.v.} \int_{\mathbb{R}} f(x-t,\, y+\gamma(x,t))\, \frac{dt}{t},$$

$$M_\Gamma(f)(x,y) := \sup_{h>0} \frac{1}{2h} \int_{-h}^{h} |f(x-t,\, y+\gamma(x,t))|\, dt\,;$$

(II) γ **- Carleson operator**:

$$C_\gamma f(x) := \text{p.v.} \int_{\mathbb{R}} f(x-t)\, e^{i\,\gamma(x,t)}\, \frac{dt}{t}\,;$$

(III) **Bilinear Hilbert transform and (sub)bilinear maximal operator along** Γ:

$$H_\Gamma^{\mathcal{B}}(f,g)(x) := \text{p.v.} \int_{\mathbb{R}} f(x-t)\, g(x+\gamma(x,t))\, \frac{dt}{t}, \tag{1}$$

$$M_\Gamma^{\mathcal{B}}(f,g)(x) := \sup_{h>0} \frac{1}{2h} \int_{-h}^{h} |f(x-t)\, g(x+\gamma(x,t))|\, dt\,;$$

The above three themes have a very deep and inter-related history:

(I) originates in the area of PDE through the study of the constant coefficient parabolic operators initiated by F. Jones, E. Fabes and M. Riviere. Departing from this, E. Stein and S. Wainger, followed later by several others high profile harmonic analysts, developed a systematic study of this theme relying gradually on Van der Corput estimates, orthogonality methods, Fourier methods, Littlewood-Paley square function techniques etc. In a different context, theme (I) can be related - as a suitable model case - with the celebrated Zygmund's differentiation conjecture along vector fields.

(II) can be traced back to the seminal 1910's conjecture of Luzin regarding the almost everywhere convergence of the Fourier series associated to functions in $L^2(\Pi)$. This conjecture was positively solved by L. Carleson half a century later by developing fundamental new tools that are now part of the area of time-frequency analysis. Closely related with the development of (I) and (II) is the work of E. Stein and S. Wainger on the singular and maximal oscillatory integral operators on Heisenberg groups that eventually led Stein to conjecture the L^p boundedness of the so-called Polynomial Carleson Operator, conjecture whose main (one dimensional) case was positively solved by the author.

(III) originally initiated by A. Calderon, this theme derives from the study of Cauchy transform along Lipschitz curves. Indeed, in this setting Calderon was naturally led to conjecture the boundedness (for Hölder exponents within the "Banach triangle") of the bilinear Hilbert transform - which is the object defined in (1) for the *zero-curvature case* $\gamma(x,t) = t$. This conjecture of Calderon was proved affirmatively by M. Lacey and C. Thiele in the nineties. The *non-zero curvature case* $\gamma(x,t) = t^d$, $d \in \mathbb{N}$, $d \geq 2$, was firstly approached by X. Li and later - via different methods - extended by the author to more general curves $\gamma(x,t) = \gamma(t)$.

Our talk will focus on the following two aspects:

1. A presentation of the historical evolution of our three themes and inter-connections among them;

2. A description of the main ideas and methods that we use in order to obtain our most recent results that, under suitable non-zero curvature and non-degeneracy conditions on $\gamma(x,t)$, provide a unitary treatment of all of the above three themes.

Hilbert space operators with compatible off-diagonal corners

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Given a complex, separable Hilbert space $\mathcal{H}$, we characterize those operators for which $\|PT(I-P)\| = \|(I-P)TP\|$ for all orthogonal projections P on $\mathcal{H}$. When $\mathcal{H}$ is finite-dimensional, we also obtain a complete characterization of those operators for which $\operatorname{rank}(I-P)TP = \operatorname{rank} PT(I-P)$ for all orthogonal projections P. When $\mathcal{H}$ is infinite-dimensional, we show that any operator with the latter property is normal, and its spectrum is contained in either a line or a circle in the complex plane.

Integral problems driven by regulated functions and closure properties

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Joint work with Luisa Di Piazza and Bianca Satco.
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The role of convergence results for integrals in the theory of differential and integral equations is well-known. Indeed, studying a large number of problems one can notice the appearance of discontinuities in the behavior of the functions, so we are lead to the idea of working with measure driven problems, i.e.,

$$x(t) = x_0 + \int_0^t f(s, x(s))dg(s),$$

where X is a Banach space, g is a real bounded variation function, $x_0 \in X$ and $f : [0,1]\times X \to X$. It is of interest to develop an existence theory for this kind of problems when the function g is regulated. It is not an easy task since the properties of primitives with respect to such functions are very weak. It is also important to have closure results for this problem, namely to check if when considering a sequence $(g_n)_n$ of functions converging to a function g the solutions of the equation governed by g_n is "close" to solutions of the equation governed by g.

To this purpose, it is necessary to have a convergence result for Stieltjes integrals and since when working with regulated functions the most appropriate integration theory is the Kurzweil-Stieltjes one, we consider a convergence theorem for the Kurzweil-Stieltjes integral.

This convergence result is used to get the existence of regulated solutions for integral equations and inclusions driven by regulated functions in general Banach spaces. Moreover, we focus on the closure properties of the solutions set for such problems; namely, to study if, when taking a sequence of regulated functions $(g_n)_n$ converging to a regulated function g, the solution set of the problem governed by g_n is close to the solution set of the problem governed by g.

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On a new generalized projection in Hilbert spaces

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Let H be a complex Hilbert space and let $B(H)$ be a space of all bounded linear operators on H. The group inverse of $A \in B(H)$ is the unique operator $A^{\#} \in B(H)$ such that

$$AA^{\#}A = A, \qquad A^{\#}AA^{\#} = A^{\#}, \qquad AA^{\#} = A^{\#}A.$$

In recent years, the notation of projections and orthogonal projections have been generalized in variant directions. In 1997, Gross and Trenkler have introduced two generalizations of projections called generalized projections and hypergeneralized projections (i.e., bounded linear operators which satisfy conditions $A^2 = A^*$ or $A^2 = A^+$, respectively). We give a new generalization of projection which is defined by the class of operators A satisfying $A^n = A^\#$, where $n \geq 2$ is a integer. We also give characterizations of this class of operators by using the spectral theorem for normal operators on Hilbert spaces.

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Compactness of substitution vector-valued integral operators on Orlicz spaces

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Joint work with Hamed Bazgir of Lorestan University.

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We consider some fundamental properties of a substitution vector-valued integral operator T^u_φ from an Orlicz space $L^\theta(\mu)$ to a Hilbert space $\mathcal{H}$ by the language of conditional expectation operators. We present necessary and sufficient conditions for boundedness and compactness T^u_φ from $L^\theta(\mu)$ to $\mathcal{H}$.

Let $X = (X, \Sigma, \mu)$ be a σ-finite complete measure space. If θ is a Young function, then the set of Σ-measurable functions $L^\theta(\mu) = \{f : X \to \mathbb{C} : \exists\alpha > 0, \int_X \theta(\alpha|f|)d\mu < \infty\}$ is a Banach space, with respect with the Luxemburg norm defined by $\|f\|_\theta = \inf\{\delta > 0 : \int_X \theta(\frac{|f|}{\delta})d\mu \leq 1\}$. Then $(L^\theta(\mu), \|.\|_\theta)$ is called an Orlicz space.

Definition. Let $\varphi : X \to X$ be a nonsingular measurable transformation, $\mathcal{C}_\varphi$ a composition operator on $L^\theta(X)$, and $u : X \to \mathcal{H}$ a weakly measurable function. The pair (u, φ) induces a substitution vector-valued integral operator $T^\varphi_u : L^\theta(\mu) \to \mathcal{H}$ defined by $\langle T^\varphi_u f, g\rangle = \int_X \langle u, g\rangle f \circ \varphi d\mu$ for $f \in L^\theta(\mu)$.

Theorem. *Let $u : X \to \mathcal{H}$ be a weakly measurable function. If u is a semi-weakly bounded function and $h \in L^\infty(\Sigma)$, then $T^\varphi_u : L^\theta(\mu) \to \mathcal{H}$ is bounded.*

Theorem. *The substitution vector-valued integral operator T^φ_u is a compact operator on $L^\theta(\mu)$ if and only if for any $\epsilon > 0$ the set $\{x \in X : \sup_{\lambda\in\mathcal{H}_1} hE|\langle u, \lambda\rangle| \circ \varphi^{-1} \geq \epsilon\}$ consists of finitely many atoms.*

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Preservers on positive definite cones in operator algebras

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The positive definite cone of a C^*-algebra is an important and rich structure both from the algebraic and the geometrical points of view. In this talk we present an overview of results describing the related symmetries which are different sorts of isomorphisms or isometries or, even more generally, preservers of generalized distance measures on positive definite cones in operator algebras. Open problems will also be discussed.

The helicoidal model

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The goal of the talk is to describe some of the aspects of the "helicoidal method" that we developed with Cristina Benea over the last few years. One particular more recent consequence of it, that we could discuss more in detail, is the natural extension of the classical Coifman-Meyer theorem, to the setting of multiple vector valued and mixed norm estimates, that play an important role in non-linear PDE.

Notes on bilinear multipliers on Orlicz spaces

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Let Φ_1, Φ_2 and Φ_3 be Young functions and let $L^{\Phi_1}(\mathbb{R})$, $L^{\Phi_2}(\mathbb{R})$ and $L^{\Phi_3}(\mathbb{R})$ be the corresponding Orlicz spaces. We say that a function $m(\xi,\eta)$ defined on $\mathbb{R}\times\mathbb{R}$ is a bilinear multiplier of type (Φ_1,Φ_2,Φ_3) if

$$B_m(f,g)(x) = \int_{\mathbb{R}}\int_{\mathbb{R}} \hat{f}(\xi)\hat{g}(\eta)m(\xi,\eta)e^{2\pi i(\xi+\eta)x}d\xi d\eta$$

defines a bounded bilinear operator from $L^{\Phi_1}(\mathbb{R})\times L^{\Phi_2}(\mathbb{R})$ to $L^{\Phi_3}(\mathbb{R})$. We denote by $\mathcal{BM}_{(\Phi_1,\Phi_2,\Phi_3)}(\mathbb{R})$ the space of all bilinear multipliers of type (Φ_1, Φ_2, Φ_3) and investigate properties of such a class. Under some conditions on the triple (Φ_1, Φ_2, Φ_3) we give examples of bilinear multipliers of type (Φ_1, Φ_2, Φ_3). We focus on the case $m(\xi, \eta) = M(\xi - \eta)$ and obtain necessary conditions on (Φ_1, Φ_2, Φ_3) to find non-trivial multipliers in this class. In particular we recover some of the known results for Lebesgue spaces.

A survey of Orlicz algebras on locally compact groups

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Let G be a locally compact group, Φ be a Young function, and denote by $L^{\Phi}(G)$ the associated Orlicz space. This talk is a survey of results on Banach algebra and Banach module structures of Orlicz spaces on G that we have obtained recently in collaboration with our colleagues. We present conditions for an Orlicz algebra to be Arens regular. We investigate their cohomological properties such as amenability. We determine when an Orlicz algebra is an operator algebra. Our approach can be applied to a vast variety of cases and extend the results in the classical situation.

This presentation draws from joint works with Ebrahim Samei and Varvara Shepelska of the University of Saskatchewan, Canada.

Properties of voice transform on weighted Bergman spaces related to Toeplitz operators

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Let us denote by $\mathbb{D}$ the unit disc and $\mathcal{A}$ the set of functions $f : \mathbb{D} \to \mathbb{C}$ which are analytic in $\mathbb{D}$. Denote by

$$dA_\lambda(z) := \frac{\lambda+1}{\pi}(1-|z|^2)^\lambda \, dxdy\,, \quad z = x+iy$$

the weighted area measure on $\mathbb{D}$. Denote by $dA(z) := dA_0(z) := \frac{1}{\pi}\, dxdy$. For all $\gamma > -1$, let us consider the weighted Bergman space as a subset of analytic functions defined in the following way

$$A^p_\lambda := \{f \in \mathcal{A} : \int_{\mathbb{D}} |f(z)|^p dA_\lambda(z) < \infty\}.$$

The set $\mathcal{H} = A^2_\lambda$ is a Hilbert space with the scalar product $\langle f, g\rangle_\lambda := \int_{\mathbb{D}} f(z)\overline{g(z)}dA_\lambda(z)$.

For $-1 < \lambda < +\infty$, the weighted Bergman projection $P_\lambda : L^2(\mathbb{D}, dA_\lambda) \to A^2_\lambda$ is defined by

$$P_\lambda f(z) = \int_{\mathbb{D}} f(\xi)\frac{1}{(1-\bar{\xi}z)^{\lambda+2}}dA_\lambda(\xi).$$

This is an orthogonal projection operator that satisfies $P_\lambda f = f$ for $f \in A^2_\lambda$, and is a pointwise formula. The P_λ can be extended to $L^1(\mathbb{D}, dA_\lambda)$. The property $P_\lambda f = f$ is valid also for $f \in A^1_\lambda$

and the extension. Let us denote by

$$B_a(z) := \epsilon \frac{z-b}{1-\bar{b}z} \qquad (z \in \mathbb{C},\ a=(b,\epsilon) \in \mathbb{B} := \mathbb{D} \times \mathbb{T},\ \bar{b}z \neq 1),$$

the so called *Blaschke functions*, where $\mathbb{T} := \{z \in \mathbb{C} : |z| = 1\}$. If $a \in \mathbb{D}$, then B_a is an one-to-one map on both $\mathbb{T}$ and $\mathbb{D}$. The restrictions of the Blaschke functions on $\mathbb{D}$ or $\mathbb{T}$ with the operation $(B_{a_1} \circ B_{a_2})(z) := B_{a_1}(B_{a_2}(z))$ form a group. The set of the parameters $\mathbb{B} := \mathbb{D} \times \mathbb{T}$ with the operation induced by the function composition $B_{a_1} \circ B_{a_2} = B_{a_1 \circ a_2}$ is the Blaschke group.

The representations of the Blaschke group on the weighted Bergman space A^2_λ is defined by

$$\pi^\lambda(a^{-1})f(z) := e^{i\frac{\lambda+2}{2}\psi} \frac{(1-|b|^2)^{\frac{\lambda+2}{2}}}{(1-\bar{b}z)^{\lambda+2}} f\left(e^{i\psi}\frac{z-b}{1-\bar{b}z}\right) \qquad (a=(b,e^{i\psi}) \in \mathbb{B}).$$

For all $\lambda \geq 0$, the representation π^λ is a unitary, irreducible, square integrable representation of the group $\mathbb{B}$ on the Hilbert space A^2_λ.

The voice transform V_g of the Blaschke group on weighted Bergman space is defined in the following way: for $a^{-1} \in \mathbb{B}$, $(a=(b,e^{i\psi}) \in \mathbb{B}$, and $f, g \in A^2_\lambda)$,

$$(V_g f)(a^{-1}) = (V_g f)(-b\epsilon, \bar{\epsilon}) := \langle f, \pi^\lambda(a^{-1})g\rangle_\lambda.$$

In [1], the properties of this voice transform were studied. In [2] using the coorbit theory, new atomic decomposition results were derived in weighted Bergman spaces. In [3], multiresolution analyses were constructed in these spaces.

Connection with Toeplitz operators

The Toeplitz operator with symbol $a_1 \in L^\infty(\mathbb{D})$ can be expressed by the Bergman projection in the following way: $T_{a_1} : A^2_\lambda \to A^2_\lambda,\ T_{a_1}(f) = P_\lambda(a_1 f)$. Our purpose is to study how the voice transform V_g on the weighted Bergman spaces is related to the Toeplitz operators.

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Wittstock moduli and their application to generalized notions of amenability

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Let H be a Hilbert space, and let $T : B(H) \to B(H)$ be a completely bounded map. As a consequence of Wittstock's operator-valued Hahn-Banach theorem, there is a (not necessarily unique) completely positive operator $|T| : B(H) \to B(H)$ with $\| \, |T| \, \|_{\mathrm{cb}} \leq \|T\|$ such that $|T| \pm \operatorname{Re} T$ and $|T| \pm \operatorname{Im} T$ are completely positive. We explicitly describe $|T|$ in the case where T is an elementary operator with coefficients in a C^*-algebra acting on H and use these moduli to shed light on the question whether or not an approximately (or, equivalently, pseudo-) amenable C^*-algebra is nuclear.

Exotic C^*-algebras of geometric groups

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Joint work with M. Wiersma.

We study a new class of potentially exotic group C^*-algebras $C^*(\mathrm{PF}^*_p(G))$ for a locally compact group G, and its connection with the class of potentially exotic group C^*-algebras $C^*_{L^p}(G)$ introduced by Brown and Guentner. Surprisingly, these two classes of C^*-algebras are intimately related. By exploiting this connection, we show that $C^*_{L^p}(G) = C^*(\mathrm{PF}^*_p(G))$ for $p \in (2, \infty)$, and the C^*-algebras $C^*_{L^p}(G)$ are pairwise distinct for $p \in (2, \infty)$ when G belongs to a large class of nonamenable groups possessing the Haagerup property and either the rapid decay property or Kunze-Stein phenomenon by characterizing the positive definite functions that extend to positive linear functionals of $C^*_{L^p}(G)$ and $C^*(\mathrm{PF}^*_p(G))$. This greatly generalizes earlier results of Okayasu and Wiersma on the pairwise distinctness of $C^*_{L^p}(G)$ for $2 < p < \infty$ when G is either a noncommutative free group or the group $\mathrm{SL}(2, \mathbb{R})$, respectively.

As a byproduct of our techniques, we present two applications to the theory of unitary representations of a locally compact group G. Firstly, we give a short proof of the well-known Cowling-Haagerup-Howe theorem which presents a sufficient condition implying the weak containment of a cyclic unitary representation of G in the left regular representation of G. Also we give a near solution to a 1978 conjecture of Cowling stating that if G is a Kunze-Stein group and π is a unitary representation of G with cyclic vector ξ such that the map $G \ni s \mapsto \langle \pi(s)\xi, \xi \rangle$ belongs to $L^p(G)$ for some $2 < p < \infty$, then $A_\pi \subseteq L^p(G)$. We show that $B_\pi \subseteq L^{p+\epsilon}(G)$ for every $\epsilon > 0$ (recall that $A_\pi \subseteq B_\pi$). Here A_π and B_π are the closed span of coefficients of π in the norm and w^*-topology of the Fourier-Stieljes algebra $B(G) = C^*(G)^*$, respectively. In particular, we have $A_\pi \subseteq B_\pi$.

Banach limits and applications

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Let l_∞ be the space of all bounded sequence $x = (x_1, x_2, \ldots)$ with the usual partial order and the norm $\|x\|_{l_\infty} = \sup_{n\in\mathbb{N}} |x_n|$, where $\mathbb{N}$ is the set of natural numbers. A linear functional $B \in l_\infty^*$ is said to be a Banach limit if

1) $B \geq 0$, i.e. $Bx \geq 0$ for all $x \geq 0$, $x \in l_\infty$,

2) $B(1, 1, \ldots) = 1$,

3) $BTx = Bx$ for all $x \in l_\infty$, where T is the shift operator defined by $T(x_1, x_2, \ldots) = (x_2, x_3, \ldots)$.

The set of all Banach limits is denoted by $\mathfrak{B}$. It follows directly from the definition that $\liminf_{n\to\infty} x_n \leq Bx \leq \limsup_{n\to\infty} x_n$ for all $x \in l_\infty$ and $B \in \mathfrak{B}$. In particular, $Bx = \lim_{n\to\infty} x_n$ for every convergent sequence x and $\mathfrak{B}$ is a closed convex subset of the unit sphere of l_∞^*. By Krein-Milman Theorem, $B = \overline{\operatorname{conv}}\operatorname{ext}\mathfrak{B}$, where $\operatorname{ext}\mathfrak{B}$ is the set of extreme points of $\mathfrak{B}$ and the closure is taken in weak-* topology of the space l_∞^*.

We shall present some new results about $\operatorname{ext}\mathfrak{B}$ and Banach limits with additional properties.

Heisenberg-Pauli-Weyl inequality for connected nilpotent Lie groups

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The purpose of this talk is to give an analogue of the classical Heisenberg-Pauli-Weyl uncertainty inequality for connected nilpotent Lie groups with non-compact center (see [2]), extending then the results obtained in [1, 2] for connected, simply connected nilpotent Lie groups. Representation theory and a localized Plancherel formula play an important role in the proof.

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On operator amenability of Fourier-Stieltjes algebras

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I wish to apply topological techniques to form certain decompositions of a Fourier-Stieltjes algebra $B(G)$ of a locally compact group. As a consequence, $B(G)$ is operator amenable only if the Eberlein compactification admits only finitely many idempotents. As a corollary, I can show for a connected group that $B(G)$ is operator amenable exactly when G is compact.

Spaceability on some function spaces

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A subset S of a (quasi-)Banach space E is called *spaceable* if $S \cup \{0\}$ contains an infinite-dimensional closed subspace of E. In this talk, we recall main theorems about this concept and give some related results for the spaceability in the context of locally compact hypergroups. In sequel, we give some sufficient conditions for a subset of a Lebesgue space in the context of a double coset space to be spaceable. Finally, we extend our results on some famous generalizations of Lebesgue spaces.

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Discrete fractional integral operators with quadratic bivariate phase polynomials

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Joint work with Ezgi Sert.

Let $f : \mathbb{Z}^l \to \mathbb{C}$ be a function and $P : \mathbb{Z}^{k+l} \to \mathbb{Z}^l$ be a polynomial with integer coefficients. A discrete fractional integral is an operator of the form

$$\mathcal{I}_\lambda f(n) = \sum_{m \in \mathbb{Z}^k_*} \frac{f(P(m,n))}{|m|^{\lambda k}} \tag{2}$$

where $\mathbb{Z}_*^k = \mathbb{Z}^k - \{0\}$ and $\lambda > 0$. When $P(m,n) = n - m$ these operators enjoy the same boundedness properties as their continuous counterparts, but when $P(m,n)$ contains a nonlinear term the range is more extensive, and deeply related to number theory. Owing to these they have been intensely studied for over 30 years starting with the work [2]. Studies mainly concentrated on the case where $P(m,n)$ is linear in n, as this allows use of the Fourier transform and the Hardy-Littlewood circle method, see [3]. In this talk we summarize our results in [1], where we use the classical theory of binary quadratic forms to prove boundedness results for $P(m,n)$ a quadratic bivariate polynomial of elliptic or hyperbolic type.

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Haar vs Hermite wavelets on a class of BVPs arising in exothermic reactions

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Joint work with Amit K. Verma.
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We will discuss about modified Arrhenius equation which can express the temperature dependence of the rate constant and propose a model governing exothermic reactions in parallel plate vessel, cylindrical vessel and spherical vessel. The proposed model is governed by nonlinear singular BVPs. We also propose computational methods based on Haar wavelet and Hermite wavelet coupled with quasilinearization or Newton-Raphson. The accuracy of these methods are verified by solving the new model and some existing test problems. We will also discuss convergence analysis of the method.

Let us consider 2nd order ordinary differential equation in general form $G(t,u,u',u'') = 0$. We consider the Hermite Wavelet Newton Approach (HeWNA) method. Let $f(t) = u''(t) = \sum\limits_{n=1}^{\infty}\sum\limits_{m=0}^{\infty} c_{nm}\psi_{nm}(t)$. Integrating this equation two times we have $u(t) = \sum\limits_{n=1}^{\infty}\sum\limits_{m=0}^{\infty} c_{nm}J^2\psi_{nm}(t) + B_T(t)$, where $B_T(t)$ stands for the boundary term.

Theorem. *Let us assume that $f(t) = d^2u/dt^2 \in L^2[R]$ is a continuous function defined on [0,1]. Let us assume also $f(t)$ is bounded, i.e., $\forall t \in [0,1]$, $\exists \eta$ such that $\left|d^2u/dt^2\right| \le \eta$. Then method based on HeWNA converges.*

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Analytic pseudodifferential calculus via Bargmann transform

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Joint work with Nenad Teofanov of the University of Novi Sad.

The Bargmann transform is a transform that maps Fourier-invariant function spaces and their duals to certain spaces of formal power series expansions, which sometimes are convenient classes of analytic functions.

In the 70s, Berezin used the Bargmann transform to translate problems in operator theory into a pseudo-differential calculus, where the involved symbols are analytic functions, and the corresponding operators map suitable classes of entire functions into other classes of entire functions.

Recently, some investigations on certain Fourier invariant subspaces of the Schwartz space and their dual (distribution) spaces have been performed by the author. These spaces are called Pilipović spaces, and are defined by imposing suitable boundaries on the Hermite coefficients of the involved functions or distributions. The family of Pilipović spaces contains all Fourier-invariant Gelfand-Shilov spaces as well as other spaces which are strictly smaller than any Fourier-invariant non-trivial Gelfand-Shilov space. In the same way, the family of Pilipović distribution spaces contains spaces that are strictly larger than any Fourier invariant Gelfand-Shilov distribution space.

In the talk we show that the Bargmann images of Pilipović spaces and their distribution spaces are convenient classes of analytic functions or power series expansions which are suitable when investigating analytic pseudo-differential operators.

We also deduce continuity properties for such pseudo-differential operators when the symbols and target functions possess certain (weighted) Lebesgue estimates. We also show that the counter image with respect to the Bargmann transform of these results generalise some continuity results for (real) pseudo-differential operators with symbols in modulation spaces, when acting on other modulation space.

Frames and bases beyond Hilbert space: Results and perspectives

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The Gel'fand-Maurin theorem states that if $\mathcal{D}$ is a domain in a Hilbert space $\mathcal{H}$ which is a nuclear space under a certain topology τ and A is an essentially self-adjoint operator in $\mathcal{D}$ which maps $\mathcal{D}[\tau]$ into $\mathcal{D}[\tau]$ continuously, then A admits a *complete set of generalized eigenvectors*. In this case in fact A has a continuous extension $\hat{A}$ given by the conjugate duality (the adjoint, in other words; i.e., $\hat{A} = A^\dagger$) from the conjugate dual space $\mathcal{D}^\times$ into itself. A *generalized eigenvector* of A, with eigenvalue $\lambda \in \mathbb{C}$, is then an eigenvector of $\hat{A}$; that is, a conjugate linear functional $\Phi_\lambda \in \mathcal{D}^\times$ such that

$$\langle \Phi_\lambda | Af \rangle = \lambda \langle \Phi_\lambda | f \rangle, \quad \forall f \in \mathcal{D}.$$

The above equality can be read as $\hat{A}\Phi_\lambda = A^\dagger \Phi_\lambda = \lambda \Phi_\lambda$. The completeness of the set $\{\Phi_\lambda; \lambda \in$

$\sigma(\overline{A})\}$ is understood in the sense that the Parseval identity holds, that is,

$$\|f\| = \left(\int_{\sigma(\overline{A})} |\langle f|\Phi_\lambda\rangle|^2\, d\lambda\right)^{1/2}, \quad \forall f \in \mathcal{D},$$

which gives also account of a kind of *orthogonality* of the Φ_λ's (a family $\{\Phi_\lambda\}$ with this property will be called here a *Parseval frame* and, if every $f \in \mathcal{D}$ can be expanded in terms of the Φ_λ's, a *Gel'fand distribution basis*).

Starting from these observations, we discuss distribution-valued functions which constitute a "continuous basis" or a "continuous frame" for the smallest space $\mathcal{D}$ of the triplet $\mathcal{D} \subset \mathcal{H} \subset \mathcal{D}^\times$. As we shall see, many notions of the ordinary theory in Hilbert spaces can be generalized to this framework and produce extensions of some known results. The main difference with the usual theory is that the elements of the basis may live *beyond the Hilbert space $\mathcal{H}$*.

Completely bounded maps and invariance properties

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Joint work with Mahmood Alaghmandan and Ivan Todorov.

Herz-Schur multipliers of the Fourier algebra $A(G)$ of a locally compact group G are intimately related to Schur multipliers, which are elements of $L^\infty(G) \otimes_{\mathrm{eh}} L^\infty(G)$, and to completely bounded weak*-continuous $L^\infty(G)$-bimodule maps leaving the von Neumann algebra $VN(G)$ of G invariant, due to a result of Bożejko and Fendler. Exchanging the role of $L^\infty(G)$ and $VN(G)$ one may consider the space of completely bounded weak* continuous $VN(G)'$-bimodule maps and elements of $VN(G) \otimes_{\mathrm{eh}} VN(G)$. The maps that leave $L^\infty(G)$ invariant were characterised by Neufang as arising from bounded complex measures on G. In this talk we show how these results can be unified and give an intrinsic characterisation of the invariance of more general completely bounded maps in terms of their symbols. To do so we need, in particular, certain spectral properties of the algebra $A(G) \otimes_{\mathrm{h}} A(G)$, the Haagerup tensor product of $A(G)$.

Existence of accumulation points in $(\Phi_A, weak)$ and applications

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Let A be a commutative semisimple Banach algebra and Φ_A its structure space. The set Φ_A, equipped with the topology induced by $\sigma(A^*, A^{**})$, will be denoted by $(\Phi_A, weak)$. This talk is centred around the following question and some applications of it:

Question. When does the topological space $(\Phi_a, weak)$ have accumulation points?

We recall that if the algebra A is amenable (or operator amenable in the case where A is an operator algebra), the space $(\Phi_A, weak)$ is discrete, whence the interest in this question, which is also important in the study of some other problems.

Compact multipliers on Orlicz spaces

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Let G be a locally compact group with left Haar measure μ and Φ be a Young function. We will consider the Orlicz space $L^{\Phi}(G)$ as an $L^1(G)$-module. If we take $\Phi(x) = x^p/p, 1 \leq p < \infty$, $L^{\Phi}(G)$ becomes the classical Lebesgue space $L^p(G)$.

We study the problem of compact multipliers for Orlicz spaces. For this purpose, first we study the closed, convex, left invariant subsets of $L^{\Phi}(G)$ and characterize affine mappings for Orlicz spaces. Then we apply our results to the study of the compact multipliers of $L^{\Phi}(G)$. These results generalize the classical results on L^p spaces.

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From Fourier restriction to Diophantine equations (and back)

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Recently Bourgain, Demeter and Guth resolved the Vinogradov Mean Value Theorem (a central problem in number theory which counts precisely the number of integer solutions to a classical system of Diophantine equations) as a direct consequence of a basic result in euclidean harmonic analysis (a decoupling theorem). Decoupling theorems underpin many of the central problems in euclidean harmonic analysis such as the Fourier restriction problem. In this talk we will examine the interplay between these two areas at a much more elementary level which will allow us to make connections more seamlessly. The interplay and interactions go in both directions.

On generators of invariant subspaces of the Dirichlet space

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Joint work with Stefan Richter.

The Dirichlet space $\mathcal{D}$ consists of analytic functions on the open unit disc whose derivative is square integrable with respect to area measure. Unlike the Hardy space, the question concerning the characterization of the invariant subspaces of the Dirichlet space remains open. For a subset E of the unit circle $\mathbb{T}$, it is known that

$$D_E = \{f \in \mathcal{D} : lim_{r\to 1^-} f(re^{it}) = 0 \; q.e. \; on \; E\}$$

is a closed subspace of the Dirichlet space. Here, q.e. stands for quasi-everywhere which means everywhere except possibly in a set of zero logarithmic capacity. We show that if E is a Carleson set, then there is a function $f \in D_E \cap A(\mathbb{D})$, where $A(\mathbb{D})$ denotes the disc algebra, that generates D_E in the sense that $D_E = \text{closure}\{pf : p \text{ polynomial}\}$. Also we show that if $\varphi \in \mathcal{D}$ is an extremal function, then the limit of $|\varphi(z)|$ exists for every $e^{it} \in \mathbb{T}$ as z approaches e^{it} in any polynomially tangential approach region.

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