Contributed Talks

Weighted hyperbolic composition groups on the disc and subordinated integral operators

Luciano Abadias, Universidad de Zaragoza, Spain

Abstract: We provide the spectral picture of groups of weighted composition operators, induced by the hyperbolic group of automorphisms of the unit disc, acting on holomorphic functions. Some questions about the spectrum of single weighted hyperbolic composition operators are discussed, and results related with them in the literature are completed or partly extended. Also, our results on the weighted hyperbolic group are applied to the spectral study of multiparameter weighted averaging operators, which generalize Siskakis' operator, and of generalized reduced Hilbert matrix operator. Joint work with J. E. Galé, P. J. Miana and J. Oliva-Maza.

Carleson measure type problem for the tent spaces and integration operators

Tanausú Aguilar-Hernández, University of Seville and University of Malaga, Spain

Abstract: In this talk, we deal with a Carleson measure type problem for the tent spaces AT_p^q in the unit disc $\mathbb{D}$. They consist of the analytic functions of the tent spaces T_p^q introduced by Coifman, Meyer, and Stein.

Let $s, t, p, q \in (0, \infty)$. We will show necessary and sufficient conditions on a positive Borel measure μ on the unit disc in order to exist a constant $C > 0$ such that

$$\int_{\mathbb{T}} \left(\int_{\Gamma(\xi)} |f(z)|^t \, d\mu(z) \right)^{s/t} |d\xi| \leq C \|f\|_{T_p^q}^s, \quad f \in AT_p^q,$$

where $\Gamma(\xi) = \Gamma_M(\xi) = \{z \in \mathbb{D} : |1 - \overline{\xi} z| < M(1 - |z|^2)\}$, $M > 1/2$ and ξ is the boundary point of the unit disc. This problem was posed originally by Luecking.

As a consequence, we apply our result to characterize the boundedness of the integration operator

$$T_g(f)(z) = \int_0^z f(w)g'(w)\ dw,$$

also known as Pommerenke operator, when acting on the spaces of average radial integrability $RM(p,q)$, for $p,q \in [1,\infty)$. These spaces were introduced for the first time in the literature by T. Aguilar-Hernandez, M. Contreras and L. Rodriguez-Piazza. We also consider the action form an $RM(p,q)$ to a Hardy space $H^s = RM(\infty, s)$, where $p,q,s \in [1,\infty)$. This is a joint work with P. Galanopoulos.

Cyclic Vectors in de Branges-Rovnyak Spaces

Alex Bergman, Lund University, Sweden

Abstract: In this talk we consider the problem of characterizing the cyclic vectors in de Branges-Rovnyak spaces, $\mathscr{H}(b)$. We show that the difficulty lies entirely in understanding the subspace $(aH^2)^\perp$ and give a complete function theoretic description in the case $\dim(aH^2)^\perp < \infty$. This generalizes the case of rational b often discussed in the literature. Most of our attention will be given to the case $\dim(aH^2)^\perp = \infty$, where the problem seems drastically more difficult. We will give sufficient results for cyclicity in the general case and discuss examples. Our methods are based on a decomposition of $\mathscr{H}(b)$ analogous to a decomposition often seen in the case of rational b.

Hankel operators of minimal and maximal norm

Ole Fredrik Brevig, University of Oslo, Norway

Abstract: A Hankel operator $\mathbf{H}_\varphi$ on the Hardy space H^2 of the unit circle with analytic symbol φ satisfies the basic norm estimates

$$\|\varphi\|_2 \leq \|\mathbf{H}_\varphi\| \leq \|\varphi\|_\infty.$$

I will discuss the twin problems of characterizing the cases of equality in terms of the function-theoretic properties of the symbol φ.

Based on joint work with Kristian Seip (NTNU).

Fractals and common hypercyclicity

Fernando Costa Jr., Université d'Avignon, France

Abstract: In this talk, we present a new approach to the problem of finding common hypercyclicity vectors for families of operators in several dimensions. We obtain a generalization of the Costakis-Sambarino criterion with optimal applications on families parameterized by many self-similar and uniformly contracting fractals or any Holder curve.

The hyperbolic step of holomorphic self-maps in terms of a representing measure

Francisco J. Cruz-Zamorano, Universidad de Sevilla, Spain

Abstract. Let f be a holomorphic self-map of the upper halfplane of the complex plane. The Herglot'z Representation Formula for positive harmonic functions can be used to relate f with three variables: two real numbers, one of them being non-negative, and a positive finite measure μ on $\mathbb{R}$. In this talk we will try to examine the behaviour of the iterates of f in terms of these quantities. In particular, some conditions that assure that f is parabolic will be revisited. Under that setting, the hyperbolic step of f will be characterized on three different scenarios: using some integrability conditions of the identity function with respect to μ, supposing μ has a property of symmetry and also considering that μ is supported on a half-line. Some of these results are advances on a previous work by Jon Aaronson, who studied the case when μ has compact support. This is a joint work with Manuel D. Contreras and Luis Rodriguez- Piazza.

Generalizations of de Branges-Rovnyak spaces

Frej Dahlin, University of Lund, Sweden

Abstract: Some natural generalizations of sub-Hardy (de Branges-Rovnyak) spaces are Hilbert spaces of analytic functions in the disc, where the backward shift acts as a contraction. The sub-Bergman spaces introduced by K. Zhou are a different generalization which is interesting in its own right. These are essentially a particular case of Hilbert spaces of analytic functions in the disc, where the forward shift satisfies a famous hereditary inequality of S. Shimorin. The basic observation used in the talk is that such spaces are reproducing kernel Hilbert spaces whose kernel is obtained by dividing a given

kernel (like the Szegö or Bergman kernel) by a normalized complete Nevanlinna-Pick kernel. The aim is to deduce some general properties of these objects. We derive a useful formula for the norm and discuss some approximation results as well as some embedding theorems. Joint work with A. Aleman.

On the essential numerical range of generalized Volterra operators on Hardy and Bergman spaces

Vassilis Daskalogiannis, Aristotle University of Thessaloniki, Greece

Abstract: In this talk we discuss the essential numerical range of generalized Volterra operators on an attempt to locate their spectrum on weighted Bergman and Hardy spaces of the unit disc. Having in mind that the spectrum encodes information related to a number of problems in function theory we attempt to confine the spectrum of T_g for different classes of symbols g, thus improving related results. This talk is based on joint work in progress, with N. Chalmoukis and G. Stylogiannis.

Interpolating Sequences for Complete Pick Spaces

Alberto Dayan, Saarland University, Germany

Let $\mathscr{H}_k$ be a reproducing kernel Hilbert space on a set X, $\Lambda := (\lambda_n)_{n\in\mathbb{N}}$ be a sequence in X and $(k_{\lambda_n})_{n\in\mathbb{N}}$ be the associated sequence of kernels functions in $\mathscr{H}_k$. For any f in $\mathscr{H}_k$,

$$|f(\lambda_n)| \leq ||f||\ ||k_{\lambda_n}|| \qquad n \in \mathbb{N},$$

and since any multiplier φ in $\mathscr{M}_k$ is bounded, one has that $(\varphi(\lambda_n))_{n\in\mathbb{N}}$ is in l^∞. Motivated by these two elementary observations, one can define Λ to be

- interpolating for $\mathscr{H}_k$ (or **simply interpolating**) if for all $(w_n)_{n\in\mathbb{N}}$ such that

$$\sum_{n\in\mathbb{N}} |w_n|^2 ||k_{\lambda_n}||^{-2} < \infty$$

  there exists a function f in $\mathscr{H}_k$ such that $f(\lambda_n) = w_n$, for all n;

- interpolating for $\mathscr{M}_k$ (or just **interpolating**) if given any bounded $(w_n)_{n\in\mathbb{N}}$ there exists a function φ in $\mathscr{M}_k$ such that $\varphi(\lambda_n) = w_n$.

If $\mathscr{H}_k$ enjoys the complete Pick property, then separation of points via multipliers is equivalent to separation of the respective kernels in $\mathscr{H}_k$. In particular, two separation conditions that are of general interest when studying interpolating sequences are the following:

- Λ is **strongly separated** if there exists a $\varepsilon > 0$ and a sequence $(\varphi_n)_{n\in\mathbb{N}}$ in the unit ball of $\mathscr{M}_k$ such that $\varphi_n(\lambda_j) = \varepsilon\ \delta_{n,j}$;
- Λ is **uniformly separated** if

$$\inf_{n\in\mathbb{N}} \prod_{j\neq n} \rho_k(\lambda_n, \lambda_j) > 0,$$

where $\rho_k(x,y) := \max\left\{|\varphi(x)| \,\middle|\, ||\varphi||_{\mathscr{M}_k} \leq 1, \varphi(y) = 0\right\}$.

The work of Carleson and Shapiro & Shields shows that in the Hardy space the four conditions above describe the same class of sequences. In a general complete Pick space, every interpolating sequence is uniformly separated, and every simply interpolating sequence is strongly separated. Marshall & Sundberg constructed a sequence in the unit disc that is uniformly separated but not interpolating for the multiplier algebra of the Dirichlet space $\mathscr{D}$, and Bishop showed that any strongly separated sequence is simply interpolating for $\mathscr{D}$.

In this talk, we show that actually strongly separated sequences are simply interpolating in any complete Pick space $\mathscr{H}_k$, and we construct a sequence in the two dimensional unit ball $\mathbb{B}_2$ that is uniformly separated but not interpolating for the Drury-Arveson space H^2_2. Thanks to a result of Berndtsson, this gives sequences that are interpolating for $\mathrm{H}^\infty(\mathbb{B}_2)$ but not for the multiplier algebra of H^2_2.
This is a joint work with Nikolaos Chalmoukis and Michael Hartz.

The Hardy space of univalent functions with prescribed second coefficient

Iason Efraimidis, Universidad Autónoma de Madrid, Spain

Abstract: We study the influence of the second coefficient of convex, starlike and close-to-convex functions to the optimal Hardy space where these functions belong. Moreover, we show that they satisfy an integral Lipschitz condition on the boundary and give a new uniform bound for their coefficients. This is joint work with Martin Chuaqui and Rodrigo Hernández.

Metaplectic Gabor frames and Symplectic Analysis of Time-Frequency spaces

Gianluca Giacchi, University of Bologna, Italy

Abstract: The inversion formula of the Fourier transform highlights that this operator only encodes information about the global frequency content of signals. Indeed, to recover a signal at any time instant, the knowledge of its Fourier transform almost everywhere is necessary. Time-frequency representations overcome this issue and allow to define the *local frequency content* of signals, with (weighted) *modulation spaces* measuring their local frequency concentration and decay in terms of weighted mixed Lebesgue quasi-norms.

Metaplectic Wigner distributions provide a generalization of all the most important time-frequency representations through metaplectic operators. Among others, they include the short-time Fourier transform (STFT), the τ-Wigner distributions and the ambiguity function. *Shift-invertibility* is the key property of those metaplectic Wigner distributions that can be used to define modulation spaces, i.e. that can be used to measure the local time-frequency content of signals.

In this work, we characterize shift-invertible metaplectic Wigner distributions as rescaled STFTs, and generalize Gabor frames to the metaplectic framework. As a byproduct, we obtain new *time-frequency atoms* to represent and model signals. This is a joint work with Prof. Elena Cordero.

Projective Limits of Dirichlet Type Spaces

Nihat Gökhan Göğüş, Sabanci University, Turkey

Abstract: We prove that the projective limit of a certain class of Dirichlet type spaces is isomorphic to the Bloch-type spaces $\mathscr{B}^\alpha$. We provide a complete characterization of bounded or compact embeddings of $\mathscr{B}^\alpha$ into a family of Lebesgue spaces by the derivative operator.

Semigroups of composition operators on some Banach spaces of Dirichlet series

Carlos Gomez - Cabello, Universidad de Sevilla, Spain

Abstract: In this talk, we shall consider continuous semigroups of analytic functions $\{\Phi_t\}_{t\geq 0}$ in the so-called Gordon-Hedenmalm class $\mathscr{G}$, that is, the family of analytic functions $\Phi : \mathbb{C}_+ \to \mathbb{C}_+$ giving rise to bounded composition operators in the Hardy space

of Dirichlet series $\mathscr{H}^2$. We will show the existence of a one-to-one correspondence between continuous semigroups $\{\Phi_t\}_{t\geq 0}$ in the class $\mathscr{G}$ and strongly continuous semigroups of composition operators $\{T_t\}_{t\geq 0}$, where $T_t f = f \circ \Phi_t$, $f \in \mathscr{H}^2$. Then, we will characterise the infinitesimal generators of continuous semigroups in the class $\mathscr{G}$ as the Dirichlet series sending $\mathbb{C}_+$ into its closure. For the case $p = \infty$, we shall prove that there are no non-trivial strongly continuous semigroups of composition operators in $\mathscr{H}^\infty$. If time permits, a brief comment will be made regarding the symbols of the bounded composition operators in the algebra $\mathscr{A}(\mathbb{C}_+)$ of Dirichlet series as well as the interplay between the corresponding semigroups of these symbols and the associated semigroups of composition operators.

Finite rank perturbations of normal operators: invariant subspaces and decomposability

F. Javier González-Doña, ICMAT, Spain

Abstract: The Invariant Subspace Problem is, probably, one of the most studied open problems in Operator Theory in Hilbert spaces. In this talk, we will study the problem for finite rank perturbations of diagonalizable normal operators.

In particular, we will study how Local Spectral Theory provides very powerful tools to produce invariant subspaces for such operators, allowing us to extend previous results of Foiaş, Jung, Ko and Pearcy, and Fang and Xia. In fact, such techniques allow us to construct a large family of invariant subspaces, which will be related to certain spectral decompositions of the operator. In this sense, we will introduce the concept of spectral decomposability of an operator in the sense of Foiaş, and will relate it with some notions arising from Local Spectral Theory and Spectral Theorem for normal operators.

Finally, we will show that a subclass of finite rank perturbations of diagonalizable normal operators are decomposable. This is based on joint works with Eva A. Gallardo-Gutiérrez.

Geometric characterizations for conformal maps in Hardy and Bergman spaces

Christina Karafyllia, Stony Brook University, U.S.A. and University of Thessaly, Greece

Abstract: This talk is about a classical problem in complex analysis and geometric function theory: finding geometric conditions for a conformal mapping of the unit disk to belong to some Hardy space or weighted Bergman space. We give such necessary and

sufficient conditions by studying the harmonic measure and the hyperbolic distance in the image region of the mapping. Moreover, we describe the Hardy number of a simply connected domain in terms of these conformal invariants and give some applications in comb domains.

Orthogonal exponential bases and geometric properties of domains

Kolountzakis Mihalis, University of Crete, Greece

Abstract: Let $\Omega \subseteq \mathbb{R}^d$ be a measurable set. We call it *spectral* if there exists a set $\Lambda \subseteq \mathbb{R}^d$ (the *spectrum*) such that the characters

$$e_\lambda(x) := e^{2\pi\lambda\cdot x}, \quad \lambda \in \Lambda,$$

form an orthogonal basis for $L^2(\Omega)$. As an example, a Euclidean ball in $\mathbb{R}^d$ is not spectral while a cube is spectral ($\Lambda = \mathbb{Z}^d$ is a spectrum for $[0,1]^d$ – this is the usual Fourier series). The main question that interests us is which domains Ω are spectral. The Fuglede conjecture from the 1970s stated that Ω is spectral if and only if Ω can tile space by translations, that is, when there exists $T \subseteq \mathbb{R}^d$ with

$$\sum_{t\in T} \mathbf{1}_\Omega(x-t) = 1, \quad \text{for almost every } x \in \mathbb{R}^d.$$

Since 2004 this is known to be false in both directions for $d \geq 3$. Still, the connections between spectrality and tiling have continued to be studied intensively for special classes of Ω as well as for abelian groups other than Euclidean space, where both spectrality and tiling can be defined analogously. A major development in recent years was the proof by M. Matolcsi and N. Lev that any spectral set Ω can *weak-tile* its complement Ω^c (weak-tiling is tiling with weighted copies of the set, with nonnegative weights). This led to the proof of the Fuglede Conjecture for the class of convex bodies in any dimension, a result that attracted researchers over at least two decades, work that had led to many partial results.

In this talk we will describe some of the background and show even more applications of the weak-tiling idea to spectrality (e.g. of Cantor-type sets). We will also point out some open problems. This is mostly joint work with M. Matolcsi and N. Lev.

The angular derivative problem for petals of one-parameter semigroups in the unit disk

Maria Kourou, Julius-Maximilians University of Wuerzburg, Germany

Abstract: We discuss the angular derivative problem for petals of one-parameter semigroups of holomorphic self-maps of the unit disk. For hyperbolic petals we prove a necessary and sufficient condition for the conformality of the petal in terms of the intrinsic hyperbolic geometry of the petal and the backward dynamics of the semigroup. For parabolic petals conformality is characterized in terms of the asymptotic behaviour of the Koenigs function at the Denjoy – Wolff point. This is a joint work with Pavel Gumenyuk and Oliver Roth.

Schatten class composition operators on the Hardy space of Dirichlet series

Athanasios Kouroupis, NTNU, Norway

Abstract: The Hardy space $\mathscr{H}^2$ of Dirichlet series with square summable coefficients, defined as

$$\mathscr{H}^2 = \left\{ f(s) = \sum_{n \geq 1} \frac{a_n}{n^s} : \|f\|^2 = \sum_{n \geq 1} |a_n|^2 < \infty \right\},$$

was first systematically studied in an influential article of Hedenmalm, Lindqvist, and Seip.

Gordon and Hedenmalm determined the class $\mathfrak{G}$ of analytic functions (symbols) $\psi : \{\Re s > \frac{1}{2}\} \mapsto \{\Re s > \frac{1}{2}\}$ that induce bounded composition operators $C_\psi(f) = f \circ \psi$ on $\mathscr{H}^2$.

The compact operators $C_\varphi \colon \mathscr{H}^2 \to \mathscr{H}^2$ with Dirichlet series symbols, φ, were characterized recently by Brevig and Perfekt, in terms of the mean counting function:

$$M_\varphi(w) = \lim_{\sigma \to 0^+} \lim_{T \to \infty} \frac{\pi}{T} \sum_{s \in \varphi^{-1}(\{w\}),\, |\Im s| < T,\, \sigma < \Re s < \infty} \Re s, \qquad w \neq \varphi(+\infty),$$

C_φ is compact if and only if

$$\lim_{\Re w \to \frac{1}{2}^+} \frac{M_\varphi(w)}{\Re w - \frac{1}{2}} = 0.$$

In the disk setting D. H. Luecking and K. Zhu proved that a composition operator C_ϕ on the Hardy space $H^2(\mathbb{D})$ belongs to the Schatten class S_p, $p > 0$ if and only if

$$\int_{\mathbb{D}} \frac{(N_\phi(z))^{\frac{p}{2}}}{(1 - |z|^2)^{\frac{p}{2} + 2}} \, dA(z) < +\infty,$$

where ϕ is a holomorphic self-map of the unit disk and N_ϕ is the associated Nevanlinna counting function.

Our aim is to study when the analogue condition

$$\int_{\mathbb{C}_{\frac{1}{2}}} \frac{(M_\varphi(w))^{\frac{p}{2}}}{\left(\Re w - \frac{1}{2}\right)^{\frac{p}{2}+2}} \, dA(w) < +\infty,$$

is necessary or sufficient for the composition operator C_φ to exists in the Schatten class S_p. This is joint work with Frédéric Bayart.

Interpolating sequences in the Nevanlinna class

Giuseppe Lamberti, Université de Bordeaux, France

Abstract: The study of interpolating sequences for analytic functions in one or more complex variables is one of the main research areas in complex analysis. It has plenty of applications in fields such as signal theory, control theory, operator theory, etc. For many spaces, like Hardy spaces, these sequences are well understood while for others, like Dirichlet spaces, there exists a characterization which is not very easy to verify. In other circumstances, a characterisation does even not exist. In this scenario it is useful to consider a random setting, which can help us to understand when interpolation is generic. In particular in this talk we are going to introduce deterministic interpolation in the Nevanlinna class, to then consider a random setting, more specifically a radial model where points' radii are fixed, while the arguments are uniformly distributed.

Hardy–Littlewood fractional maximal operators on homogeneous trees

Matteo Levi, Universitat Autonoma de Barcelona, Spain

Let X be a homogeneous tree equipped with the standard graph distance and the counting measure, and denote by $\mathscr{M}^\gamma$, $\gamma \in (0,1]$, the Hardy-Littlewood fractional maximal operator on this space. We discuss for which couples (p,q) the operator $\mathscr{M}^\gamma$ maps continuously $L^p(X)$ to $L^q(X)$, and for which it does not. To obtain the positive results, we prove some endpoint estimates extending the weak $(1,1)$ boundedness of $\mathscr{M}^1$ (proved by Cowling, Meda, and Setti and, independently, by Naor and Tao), and the restricted weak type $(2,2)$ boundedness of $\mathscr{M}^{1/2}$ (proved by Veca) to values of γ different from 1 and $1/2$. We will discuss the optimality of the results and highlight which problems remain open and comment on them. The talk is based on a joint work with Federico Santagati.

Regular functions in model spaces and shift invariant subspaces

Adem Limani, Universitat Autonoma de Barcelona, Spain

Abstract: The famous theorem by A. Beurling in 1949 provides a complete function theoretical description of all closed subspaces of the classical Hardy spaces on the unit disc, which are invariant under the shift operator. It turns that any proper shift invariant subspace contains an inner function which is a common divisor of all elements of the subspace. Much later, the study was carried over the larger setting of Bergman spaces, where H. Shapiro in 1964 announced that not all Hardy space inner functions generate proper shift invariant subspaces on the Bergman spaces, in other words, there exists singular inner functions which are cyclic wrt the shift operator on the Bergman spaces. Roughly around the 1980's a complete description of the shift invariant subspaces generated by inner functions on the Bergman spaces was obtained by B. Korenblum and independently by J. Roberts, which involved the notion of sets with finite entropy, a concept that previously appeared in the work of A. Beurling and L. Carleson on boundary zero sets of analytic functions with certain smooth extensions to the boundary. More recently, it was discovered that shift invariant subspaces generated by inner functions have natural interpretations in terms of the containment of functions with certain smooth extensions to the boundary in the model spaces. In this talk, we intend to investigate shift invariant subspaces generated by inner functions for a broad range of spaces of analytic functions and demonstrate connections to the existence of analytic functions with certain regular extensions to the boundary in the associated model spaces, and to boundary zero sets of such functions. This talk will to a large extent be based on a series of collaborative work together with Bartosz Malman, affiliated with the Royal Institute of Technology, Stockholm, Sweden.

Contractive inequalities between Dirichlet and Hardy spaces

Adrián Llinares, NTNU, Norway and Umea University, Sweden

Abstract: We say that the inclusion between two Banach (or quasi Banach) spaces of analytic functions is contractive if the norm of the corresponding inclusion operator is less than or equal to 1. Although these inclusions are interesting in themselves, they have also attracted the attention of the experts because of their multiple applications. In this talk, we will show some of these contractive inequalities and discuss their most immediate consequences.

An interplay between lineability of operators and the structure of a Banach space

Nisar A. Lone, JK Institute of Mathematical Sciences, Srinagar, India

Abstract: We derive a relationship between lineability and spaceability of norm attaining functionals and norm attaining operators($NA(X,Y)$). We also give an equivalent condition for reflexivity of a Banach space through lineability of $NA(X,Y)$.

Simultaneous approximation by analytic polynomials in two norms

Bartosz Malman, Malardalen University, Sweden

Abstract: Let $\|\cdot\|_{\mathbb{D}}$ be some norm. Say, computed from the values of a function inside the unit disk $\mathbb{D}$ of the complex plane $\mathbb{C}$. Let $\|\cdot\|_{\mathbb{T}}$ be another norm, which instead lives on the unit circle $\mathbb{T}$. An interesting situation occurs if a sequence of analytic polynomials $\{p_n\}_{n\geq 1}$ converges simultaneously in the two norms to the two functions $f_{\mathbb{D}}$ and $f_{\mathbb{T}}$. Experience might suggest that $f_{\mathbb{T}}$ is, in some sense, the boundary trace of the function $f_{\mathbb{D}}$. This is sometimes true and sometimes not, and of course depends on the particular choices of the norms and their interaction.

A particular instance of this problem arose, unexpectedly, in my joint work with Adem Limani. For our applications, we need very precise results on such simultaneous approximations. These are related to a few conjectures of Thomas Kriete and Barbara MacCluer. In the talk, I want to discuss the type of simultaneous approximation problem that we encountered with Adem, the Kriete-MacCluer conjectures, and their connections to other parts of operator theory.

Properties of Abel universal functions

Konstantinos Maronikolakis, University College Dublin, Ireland

Abstract: In general, an object is called universal, if it can approximate through some specific process, every element of a given space. In this talk, I will focus on the class of Abel universal functions which are holomorphic functions on the unit disk whose radial limits uniformly approximate all possible continuous functions on compact subsets of the unit circle. More precisely, given an increasing sequence $\rho = (r_n)$ in $[0,1)$ tending to 1, a holomorphic function f on the open unit disk is an Abel universal function (with

respect to ρ) if for any compact set K on the unit circle, different from the unit circle, the set of functions $\{f(r_n\cdot)|_K : n \in \mathbb{N}\}$ is dense in the space of continuous functions on K. I will discuss properties of Abel universal functions and in particular their similarities and differences with the universal Taylor series, which are well studied in the field of universality. Joint work with Stéphane Charpentier and Myrto Manolaki.

Exponential Riesz bases in L^2 on two intervals

Mikhail Mironov, Technion, Israel

Abstract: The talk is devoted to the study of exponential Riesz bases in $L^2(E)$, where E is the union of two intervals. This problem is equivalent to describing complete interpolating sequences for the Paley-Wiener space PW_E. We obtain sufficient conditions and close necessary conditions for a sequence to be complete and interpolating. In particular, our results allow us to demonstrate the effect of an extra point in comparison with one interval of length $|E|$. The talk is based on a joint work with Yu. Belov.

On the speed of convergence in the ergodic theorem for irrational rotations

Alessandro Monguzzi, University of Bergamo, Italy

Abstract: A classical result obtained independently by P. Bohl, W. Sierpinski and H. Weyl states that whenever $\alpha = (\alpha_1, \ldots, \alpha_d) \in \mathbb{R}^d$ is an irrational vector, then the sequence $\{n\alpha\}_{n\in\mathbb{N}}$ is uniformly distributed in the torus $\mathbb{T}^d = \mathbb{R}^d/\mathbb{Z}^d$. In particular, for every nonconstant continuous function $f(x)$, it holds $\lim_{N\to+\infty} N^{-1} \sum_{n=0}^{N-1} f(x + n\alpha) = \int_{\mathbb{T}^d} f$ for every x. Such a fact actually is also an instance of the classical Birkhoff ergodic theorem since $x \mapsto x + \alpha$ is a measure preserving ergodic transformation. It is known that no general statements can be made about the rate of convergence in the ergodic theorem. In this talk I will consider weighted sums of the form $\sum_n \Phi(N, n) f(x + n\alpha)$ and discuss their speed of convergence as $N \to \infty$ to the mean value $\int_{\mathbb{T}^d} f$. I will provide estimates for such speed of convergence in terms of the Diophantine properties of the vectors α, properties of the weight function Φ and the smoothness of the function f.

This talk is based on a joint work with L. Colzani and B. Gariboldi.

Spectral synthesis for the generalized Laplacian

Annika Moucha, University of Wuerzburg, Germany

Define the domain $\Omega := \{(z,w) \in \hat{\mathbb{C}}^2 \;:\; z \cdot w \neq 1\}$. The set of complex-valued functions that are holomorphic on Ω, denoted by $\mathscr{H}(\Omega)$, plays a significant role in the study of the generalized Laplacian by which we mean the operator

$$\Delta_{zw} : \mathscr{H}(\Omega) \to \mathscr{H}(\Omega), \quad \Delta_{zw} f(z,w) = (1-zw)^2 \partial_z \partial_w f(z,w)$$

where $(z,w) \in \Omega$. The name "generalized Laplacian" is chosen because Δ_{zw} encodes both the hyperbolic and spherical Laplacian on the unit disk resp. the Riemann sphere. The goal of this talk is to establish a special class of eigenfunctions of Δ_{zw} as a Schauder basis of $\mathscr{H}(\Omega)$. In other words, it is possible to find an eigenfunction representation of every function $f \in \mathscr{H}(\Omega)$. This work is part of a joint project with Michael Heins and Oliver Roth.

Universal Taylor Series in one variable, an open question and approximation in several variables

Vassili Nestoridis, University of Athens, Greece

Abstract: The existence of universal Taylor series implies that, if a power series f overconverges towards g, the function g is not necessarily a continuation of f. It is also open if g can also be defined on an open set in the domain of holomorphy of f. Extensions to the case of several variables are also possible.

De Branges-Rovnyak spaces and Dirichlet spaces

Maria Nowak, Maria Curie-Sklodowska University, Lublin, Poland

Abstract: We discuss de Branges-Rovnyak spaces $\mathscr{H}(b)$ generated by non-extreme and rational functions b from the unit ball of H^∞ and their connection with harmonically weighted Dirichlet spaces and local Dirichlet spaces of finite order. Let $Y = S|_{\mathscr{H}(b)}$ denote the restriction of the shift operator S on H^2 to $\mathscr{H}(b)$. Recently S. Luo, C. Gu and S. Richter characterized nonextreme b for which the operator Y is a $2m$-isometry and proved that such spaces $\mathscr{H}(b)$ are equal to local Dirichlet spaces of order m. We find explicite formulas for b in the case when these spaces coincide with equality of norms. We also prove a property of wandering vectors of Y analogues to the property of wandering

vectors of the restriction of S to harmonically weighted Dirichlet spaces obtained by D Sarason in 1998.

The talk is based on joint work with Bartosz Lanucha, Malgorzata Michalska and Andrzej Soltysiak.

Optimal bounds for the Beurling-Ahlfors extension operator

Dimitrios Ntalampekos, Stony Brook University, U.S.A.

Abstract: Beurling and Ahlfors constructed an operator that extends a quasisymmetric homeomorphism of the real line to a quasiconformal homeomorphism of the upper half-plane. We prove an optimal bound for the quasiconformal dilatation of this extension in terms of the symmetric distortion function of the boundary mapping. As a consequence, we obtain extension results for mappings of exponentially integrable distortion and for other types of mappings of finite distortion. This talk is based on joint work with Christina Karafyllia.

Spectrum of composition operators on the unit ball of $\mathbb{C}^N$

Lucas OGER, Université Gustave Eiffel, Labex Bézout, LAMA, France

Abstract: We study the spectrum $\sigma(C_\varphi)$ and point spectrum $\sigma_p(C_\varphi)$ of a composition operator C_φ induced by a holomorphic self-map of the unit ball $\mathbb{B}_N$ of $\mathbb{C}^N$, and acting on the Fréchet space $\mathrm{Hol}(\mathbb{B}_N)$ of complex-valued holomorphic functions. We give a complete description of these sets when φ is hyperbolic, positive-step parabolic, non-automorphic elliptic attractive fixing $\alpha \in \mathbb{B}_N$ with $\varphi'(\alpha)$ invertible, and when φ is a periodic elliptic attractive automorphism. We provide inclusions when $\varphi'(\alpha)$ is not invertible, or when φ is a non-periodic elliptic attractive automorphism.

Symmetric Tensor Products: An Operator Theory Approach

Ryan O'Loughlin, University of Leeds, U.K.

Abstract: Although tensor products and their symmetrisation have appeared in mathematical literature since at least the mid nineteenth century, they rarely appear in the function-theoretic operator theory literature. In this talk I will introduce the symmetric and antisymmetric tensor products from an operator theoretic point of view. I will

present results concerning some of the most fundamental operator-theoretic questions in this area, such as finding the norm and spectrum of the symmetric tensor products of operators. I will then work through some examples of symmetric tensor products of familiar operators, such as the unilateral shift, the adjoint of the shift and diagonal operators.

The norm of the Hilbert matrix acting on K^p.

M. Papadimitrakis, University of Crete, Greece.

Abstract: We consider the Hilbert matrix $\left(\frac{1}{n+m+1}\right)_{n\geq 0,\, m\geq 0}$ which defines an operator $\mathscr{H}$ acting on analytic functions $f(z)=\sum_{n=0}^{\infty} a_n z^n$ on the unit disc as follows:

$$\mathscr{H}(f)(z)=\sum_{m=0}^{\infty}\Big(\sum_{n=0}^{\infty}\frac{a_n}{n+m+1}\Big)z^m.$$

In particular, we consider the space K^p of such functions with norm defined by $\|f\|_{K^p}^p=\sum_{n=0}^{\infty}(n+1)^{p-2}|a_n|^p<+\infty$, and we prove, in a nontrivial way, that $\mathscr{H}$ is bounded on K^p and that its norm is equal to the number $\frac{\pi}{\sin\frac{\pi}{p}}$.

This is joint work with V. Daskalogiannis and P. Galanopoulos, University of Thessaloniki.

Chaotic weighted shifts on directed trees

Dimitris Papathanasiou, Université de Mons, France

Abstract: The problem of characterizing when a unilateral or a bilateral weighted backward shift is chaotic has been completely solved by Grosse-Erdmann. We will discuss the generalization of this problem for weighted backward shifts on directed trees. Specifically, we will characterize when such operators are chaotic when acting on general Fréchet sequence spaces defined on either a rooted or unrooted directed tree. When the underlying space is of type ℓ^p, $1\leq p<\infty$ or c_0, the characterizations can be expressed via generalized continued fractions which depend on the weight family and the geometry of the tree.

Words of analytic paraproducts on Hardy and weighted Bergman spaces

José Ángel Peláez. University of Málaga, Spain

Abstract: Let $\mathscr{H}(\mathbb{D})$ denote the space of analytic functions on the unit disc $\mathbb{D}$ of the complex plane. An N-letter g-word is the composition $L = L_1 \cdots L_N$ of N operators L_j, where each L_j is either of the analytic paraproducts $T_g f(z) = \int_0^z (fg')(\zeta)\, d\zeta$, $S_g f(z) = \int_0^z (f'g)(\zeta)\, d\zeta$ and $M_g f(z) = (fg)(z)$, $f, g \in \mathscr{H}(\mathbb{D})$. The boundedness of a single paraproduct on a classical Hardy spaces and weighted Bergman spaces A^p_α, $0 < p < \infty$ and $\alpha \geq -1$, is well understood and the bounded 2-letter g-words on these spaces have been recently described. We shall present new results for $N \geq 3$, and in particular we shall show the boundedness of a N-letter g-word on A^p_α only depends on the symbol g, N and the total number of T_g's that it contains.

This is a joint work with A. Aleman, C. Cascante, J. Fàbrega and D. Pascuas.

Rhaly Operators on l^2

Gabriel T Prăjitură, SUNY Brockport, U.S.A.

Abstract: Rhaly operators are one of the possible generalizations of the Cesàro operator. We will discuss some of their properties like: boundedness, compactness, spectrum and normality related notions. This is joint work with George Popescu from Technical University of Craiova, Romania.

Conjugations preserving Toeplitz kernels

Marek Ptak, University of Agriculture in Krakow, Poland

Abstract: We study conjugations in $L^2(\mathbb{T})$ and their relation with kernels of Toeplitz operators on $H^2(\mathbb{T})$ space. Such kernels are a generalization of model spaces. We investigate properties of an inequality relation between two unimodular functions defined on the unit circle. This allows us to significantly strengthen previous theorems characterizing all M_z –commuting and M_z–conjugations leaving invariant model spaces to the Toeplitz kernels setting. Joint work with P. Dymek, A. Płaneta.

Uniform convergence of semigroups of analytic functions

Luis Rodriguez-Piazza, Universidad de Sevilla, Spain

Abstract: Let Ω be a region in the complex plane $\mathbb{C}$ and let $\{\phi_t\}_{t\geq 0}$ be a continuous semigroup of functions on Ω; that is, $\phi_t\colon \Omega \to \Omega$ is holomorphic for every $t \geq 0$, $\phi_0(z) = z$, for every $z \in \Omega$, $\phi_t \circ \phi_s = \phi_{s+t}$, for every $s,\, t \geq 0$, and

$$\phi_t(z) \to z\,, \qquad \text{as } t \text{ goes to } 0^+, \tag{0.0.1}$$

uniformly on compact subsets of Ω. Despite the definition of continuous semigroup only requires in (0.0.1) the uniform convergence on compact subsets, P. Gumenyuk has proved, using the No Koebe Arcs Theorem, that, in the case of the unit disc ($\Omega = \mathbb{D}$), the convergence in (0.0.1) is uniform on the whole $\mathbb{D}$. In the case where Ω is a half-plane it is easy to give examples of semigroups where the convergence in (0.0.1) is not uniform on Ω.

The aim of this talk is to present some recent results obtained in collaboration with M. D. Contreras and C. Gomez-Cabello about uniform convergence for the disc and the half-plane. We provide an improvement of Gumenyuk's result proving that for every semigroup $\{\phi_t\}_{t\geq 0}$ on $\mathbb{D}$ we have

$$\sup_{z\in\mathbb{D}} |\phi_t(z) - z| = O(\sqrt{t}), \quad t \to 0^+.$$

Examples show that $O(\sqrt{t})$ is the best possible ratio of uniform convergence valid for all semigroups on $\mathbb{D}$.

In the case Ω is a the half-plane we prove that there is uniform convergence in (0.0.1) under certain boundedness conditions on the infinitesimal generator of the semi group. These boundedness conditions are fulfilled when the semigroup $\{\phi_t\}_{t\geq 0}$ is included in the Gordon-Hedenmalm class (the one which produces bounded composition operators on the Hardy space of Dirichlet series). An important ingredient in the proofs of these results is the use of harmonic measures, which we have done through a classic result of M. Lavrentiev.

Rearrangement invariant hulls of weighted Lebesgue spaces

Javier Soria, Universidad Complutense de Madrid, Spain

Abstract: We characterize the rearrangement invariant hull of weighted Lebesgue spaces. The solution is given in terms of boundedness of Hardy operators and embeddings for weighted Lorentz spaces. Joint work with Martin Křepela and Zdeněk Mihula, both from Czech Technical University in Prague.

The Moment Problem in the Complex Plane: Potential Theory and Operator Theory

Nikos Stylianopoulos, University of Cyprus, Cyprus

Abstract: Let μ be a finite positive measure having compact and infinite support K, in the complex plane $\mathbb{C}$. The measure μ yields the Lebesgue spaces $L^2(\mu)$, with inner product

$$\langle f, g\rangle_\mu = \int f(z)\overline{g(z)}d\mu(z).$$

The (inverse) moment problem for μ is that of the recovery of K from the infinite sequence of its complex moments,

$$\int z^m \overline{z}^n d\mu(z), \quad m, n = 0, 1, 2, \ldots.$$

The truncated version of the moment problem, that is, the computation of an approximation to K from a finite set of moments, has many important applications today. For example, in Geometric Tomography and in the Detection of Outliers in Big Data.

The tools in our approach are based on the use of the orthonormal polynomials $\{p_n(\mu, z)\}_{n=0}^{\infty}$, defined by the measure μ. This is the unique sequence of polynomials,

$$p_n(\mu, z) = \kappa_n(\mu)z^n + \cdots, \quad \kappa_n(\mu) > 0, \quad n = 0, 1, 2, \ldots,$$

satisfying $\langle p_m(\mu, \cdot), p_n(\mu, \cdot)\rangle_\mu = \delta_{m,n}$.

The connection with the trace comes through the subnormal operator

$$S_\mu : \mathscr{P}^2(\mu) \to \mathscr{P}^2(\mu), \quad \text{with} \quad S_\mu f = zf,$$

where $\mathscr{P}^2(\mu)$ denotes the closure of the polynomials in $L^2(\mu)$.

The purpose of the talk is to review some available techniques for the solution of the truncated moment problem, and to present some new results based on the use of trace formulas. This will be a first step in our program of connecting Potential Theory in the Complex Plane with Operator Theory.

Hausdorff operators on Fock Spaces and a coefficient multiplier problem

George Stylogiannis, University of Thessaloniki, Greece

Abstract: Let μ be a positive Borel measure on the positive real axis. We study the integral operator

$$\mathscr{H}_\mu(f)(z) = \int_{(0,\infty)} \frac{1}{t} f\left(\frac{z}{t}\right) d\mu(t), \quad z \in \mathbb{C},$$

acting on the Fock spaces F^p_α, $p \in [1,\infty]$, $\alpha > 0$. Its action is easily seen to be a coefficient multiplication operator by the moment sequence

$$\mu_n = \int_{[1,\infty)} \frac{1}{t^{n+1}}\, d\mu(t).$$

We prove that

$$||\mathscr{H}_\mu||_{F^p_\alpha \to F^p_\alpha} = \int_{[1,\infty)} \frac{1}{t}\, d\mu(t), \quad 1 \leq p \leq \infty \ .$$

It turns out that $\mathscr{H}_\mu$ is compact on F^p_α, $p \in (1,\infty)$ if and only if $\mu(\{1\}) = 0$. In addition, we completely characterize the Schatten class membership of $\mathscr{H}_\mu$. This is joint work with Petros Galanopoulos.

Interpolating sequences for pairs of spaces

Georgios Tsikalas, Washington University in St. Louis, U.S.A.

Abstract: In 2019, Aleman, Hartz, McCarthy and Richter characterized interpolating sequences for multiplier algebras of Hilbert function spaces with a complete Pick kernel. We discuss an extension of their result to pairs of spaces $(\mathscr{H}_s, \mathscr{H}_\ell)$, where s, ℓ are reproducing kernels on a set X and s is a complete Pick factor of ℓ. Specifically, it turns out that a sequence is interpolating for

$$\text{Mult}(\mathscr{H}_s, \mathscr{H}_\ell) = \{\phi : X \to \mathbb{C} \mid \phi \cdot f \in \mathscr{H}_\ell,\ \forall f \in \mathscr{H}_s\}$$

if and only if it generates a Carleson measure for $\mathscr{H}_s$ and is n-weakly separated by ℓ for every $n \geq 2$, the latter condition lying in-between weak separation and strong separation by ℓ. We also exhibit examples to show that, unlike the case of a single complete Pick kernel $s = \ell$, n-weak separation cannot, in general, be replaced by weak separation by ℓ.

On the Essential Spectrum of a Toeplitz Operator on the Bergman Space of a bi-disc

Uğur Gül, Hacettepe University, Ankara, Türkiye

Abstract: In this talk we deal with the problem of determining the essential spectrum of a Toeplitz operator $T_f : A^2(\mathbb{D}^2) \to A^2(\mathbb{D}^2)$ acting on the Bergman space $A^2(\mathbb{D}^2)$ of the bi-disc whose symbol $f \in C(\overline{\mathbb{D}^2})$ lies in the space of continuous functions on the closure $\overline{\mathbb{D}^2}$ of the bi-disc. Our method relies on the tensor product formulation of the Toeplitz

C*-algebra on the Bergman space of the bi-disc. As a result we relate the essential spectrum of T_f to the spectra of the family of Toeplitz operators $T_{f_{\theta_1}}$ and $T_{f_{\theta_1}}$ acting on the Bergman space of the unit disc where $f_{\theta_1}(w) := f(e^{i\theta_1}, w)$ and $f_{\theta_2}(z) := f(z, e^{i\theta_2})$.

Embeddings of Growth Spaces on Circular Domains

Umutcan Erdur, Sabanci University, Turkey

Abstract: We will demonstrate that certain weighted Bergman spaces $A^{p,\kappa}(\Omega)$ of holomorphic functions on a circular domain $\Omega \subset \mathbb{C}^d$ induces a projective limit topology on growth space $A^{\kappa}(\Omega)$. Then, we will characterize Carleson measures for growth spaces, and present continuity and compactness criteria for such embedings. This is a joint work with Nihat Gökhan Göğüş, Sabanci University.

A note on cyclic vectors in Dirichlet-type spaces in the unit ball of $\mathbb{C}^n$

Dimitrios Vavitsas, Jagiellonian University, Poland

Abstract: The three classical Hilbert spaces of holomorphic functions in the unit ball or in the unit polydisk of $\mathbb{C}^n$ are the Hardy, Bergman and Dirichlet spaces. All of them are special cases of a space family consisting of Hilbert spaces and depending on a real parameter, called Dirichlet-type spaces. Our aim is to characterize as far as possible the vectors that are cyclic among Dirichlet-type spaces with respect to the so called shift operators. In particular, one of the goal is to give a full characterization of cyclicity of polynomials, which involves identifying whether a polynomial is cyclic or non-cyclic at a fixed parameter. Researchers concerning Dirichlet-type spaces managed to solve the cyclicity problem of polynomials in the settings of the unit ball and the unit polydisk of $\mathbb{C}^2$. The study of the model polynomials $\pi_1(z_1, z_2) = 1 - z_1$ and $\pi_2(z_1, z_2) = 1 - 2z_1z_2$, $(z_1, z_2) \in \mathbb{C}^2$, was crucial to the cyclicity problem of polynomials in the two dimensional ball settings. We go further giving a full characterization of cyclicity of the model polynomials $\pi_m(z_1, ..., z_n) = 1 - m^{m/2} z_1 \cdots z_m$, $1 \leq m \leq n$, $(z_1, ..., z_n) \in \mathbb{C}^n$, in Dirichlet-type spaces in the unit ball of $\mathbb{C}^n$. A number of lemmas and mathematical tools such as other characterizations of Dirichlet-type spaces and relations among them, equivalent integral norms, the behaviour of the boundary zeros of polynomials non-vanishing in the ball and capacity conditions of identifying non-cyclic vectors coming up in discussion help us to work out how to solve the cyclicity problem of polynomials in arbitrary dimension.

Explicit Koppelman integral formulas on smooth compact varieties.

A.Vidras, Univ. of Cyprus, Cyprus

Abstract: In this talk we derive an explicit Koppelman integral representation formula in terms of the combinatorial data on smooth compact toric varieties for $(0, q)$ smooth forms taking values in specific line bundles. The n-dimensional toric varieties are such that their Newton polyhedron contains the origin and the standard base $\{e_1, \ldots, e_n\}$ of $\mathbb{R}^n$. The results are illustrated in the case of product of projective lines $\mathbb{P}^1 \times \mathbb{P}^1$ and Hirzebruch surfaces. Applying the above formula one obtains an alternative proof about vanishing of the Dolbeault cohomology groups of $(0, q)$ forms over such smooth compact toric varieties with values in various lines bundles. Joint work with C.Tryfonos.

A New Formalization of Dirichlet Type Spaces

Zhijian Wu, University of Nevada, Las Vegas, U.S.A.

Abstract: Applications and findings involving the norm of the weighted Dirichlet space D_α are steadily being discovered. There are notable characterizations of D_α through estimations of its norm. In this talk, we present an improvement of the norm estimation by extending the domain of relevant parameters, and establishing the asymptotic formula with precise constants.

Berezin type operators and Toeplitz operators on Bergman Spaces

Ruhan Zhao, SUNY Brockport, USA

Abstract: We introduce a class of integral operators called Berezin type operators. It is a generalization of the Berezin transform, and has close relation to the Bergman-Carleson measures. We mainly study the boundedness and the compactness of Berezin type operators from a weighted Bergman space to a weighted Lebesgue space on the unit ball of $\mathbb{C}^n$. We also show that Berezin type operators are closely related to Toeplitz operators. This is a joint work with Gabriel Prajitura and Lifang Zhou.