

Complex Analysis and Spectral Theory Conference

A conference in celebration of
Thomas J. Ransford's
60th birthday

Université Laval
May 21 - 25
2018

Titles and Abstracts

Wolfgang Arendt
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Title: Composition semigroups: generation and asymptotics

Abstract: In the talk we will establish relations of spectral properties and the asymptotic behaviour of the powers of an operator. For composition operators something remarkable happens: whenever the powers converge strongly, they converge already uniformly. A particular role is played by the poles of the resolvent. We will also consider holomorphic flows and the associated composition semigroups on diverse Banach spaces of holomorphic functions. The results on asymptotics reflect different properties of the spaces. We also characterize those operators which generate a semigroup of composition operators.

References:

- W. Arendt, I. Chalendar, M. Kumar, S. Srivastava: Asymptotic behavior of the powers of composition operators on spaces of holomorphic functions. *Indiana J. Math.* , to appear.
- W. Arendt, I. Chalendar: Generators of semigroups on Banach spaces inducing holomorphic semiflows. *Israel J. Math.* to appear.

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Richard Aron
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Title: Some problems related to algebras of holomorphic functions in finite and infinite dimensions

Abstract: Let X be a complex Banach space with open unit ball B . Let

$\mathcal{H}_b(X)$ denote the algebra of entire (= complex analytic = holomorphic) functions $f : X \rightarrow \mathbb{C}$ such that f is bounded on nB for all $n \in \mathbb{N}$. Using the family of norms $f \in \mathcal{H}_b(X) \rightsquigarrow \|f\|_n = \sup_{x \in nB} |f(x)|$, $\mathcal{H}_b(X)$ is a Fréchet algebra. We will also consider the Banach algebra

$$\mathcal{H}^\infty(B) = \{f : B \rightarrow \mathbb{C} \mid f \text{ is bounded and holomorphic on } B\}$$

and its subalgebra $\mathcal{A}_u(B)$ consisting of those functions in $\mathcal{H}^\infty(B)$ that are uniformly continuous. We will review some old, and perhaps a few new, open problems related to homomorphisms on these algebras.

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Catherine Bénéteau
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Title: Boundary behavior of optimal polynomial approximants

Abstract: In this talk, I will be interested in polynomials that approximate inverses of functions in Dirichlet-type spaces of the disk, in some optimal sense. These polynomials are closely related to classical objects of function theory such as orthogonal polynomials and weighted reproducing kernels. I will discuss the question: what happens to the boundary values of these optimal polynomial approximants, for a given function f ?

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Abdellatif Bourhim
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Title: Nonlinear spectrum preserving maps

Abstract: In this talk, we discuss maps between two C^* -algebras \mathcal{A} and \mathcal{B} preserving certain spectral sets. In particular, we address the problem of describing maps ϕ from \mathcal{A} onto \mathcal{B} satisfying

$$\sigma(\phi(x)\phi(y)) = \sigma(xy)$$

for all $x, y \in \mathcal{A}$. Here, $\sigma(x)$ denotes the spectrum of any $x \in \mathcal{A}$.

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Isabelle Chalendar
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Title : Growth of binomial sums and applications

Abstract: In a joint work with K. Kellay and T. Ransford, we obtained that a sequence of complex numbers $(a_n)_n$ is zero for n large enough, whenever the growth of some binomials sums associated with $(a_n)_n$ is polynomial. We will present some applications and further developments of such results providing in particular approximate versions of Carleman uniqueness of probability measures.

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Joseph Cima
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Title: An integral operator on H^p

Abstract: Hankel matrices give rise to families of integral operators acting on Banach spaces of analytic functions. One such operator acting on functions analytic in the unit disc is given by

$$I_\mu(f)(z) = \int_0^1 \frac{f(t)d\mu(t)}{(1-zt)},$$

where z is in the unit disc, and μ is a finite, positive Borel measure on the interval $[0, 1)$. We will show that if μ is a positive Carleson measure on $[0, 1)$ then I_μ maps H^1 into the space of Cauchy transforms of finite Borel measure on the circle integrated against the Cauchy kernel. Further, we show that the singular part of the associated measures has its support at the number one.

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Constantin Costara
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Title: On local spectra preserver problems

Abstract: In this talk, we shall present some recently obtained results for the theory of linear/nonlinear local spectra preserver problems on matrices/operators.

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Garth Dales
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Title: Factorization in commutative Banach algebras

Abstract: The famous Cohen's factorization theorem asserts that a commutative Banach algebra that has a bounded approximate identity factors. In fact, there are several, considerably stronger versions of this theorem, and we obtain a sequence of implications. We wish to determine, by seeking suitable examples, which implications in this sequence cannot be reversed within various classes of commutative Banach algebras. In particular, in this talk, I shall pay particular attention to the class of maximal ideals of uniform algebras, and so bring in some complex analysis involving uniform algebras of bounded analytic functions.

This is joint work with Joel Feinstein (Nottingham University, UK) and Hung Le Pham (Victoria University, Wellington, New Zealand).

The three authors are a mathematical brother and two mathematical nephews of Thomas J. Ransford.

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Omar El-Fallah
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Title: Asymptotic estimates of the eigenvalues of compact Toeplitz operators on Bergman spaces

Abstract: Let Ω be a domain of \mathbb{C}^d and let $A_\omega^2(\Omega)$ be the Bergman space on Ω defined by

$$A_\omega^2(\Omega) := \{f \in Hol(\Omega) : \int_\Omega |f(z)|^2 \omega(z) dA(z) < \infty\},$$

where ω is a positive continuous weight on Ω . Let μ be a positive Borel measure on Ω . The Toeplitz operator T_μ , acting on $A_\omega^2(\Omega)$, induced by μ is given by

$$T_\mu(f)(z) = \int_\Omega f(\zeta) K(z, \zeta) \omega(\zeta) d\mu(\zeta),$$

where K is the reproducing Kernel of $A_\omega^2(\Omega)$. In this talk we will give some asymptotic estimates of the eigenvalues of T_μ . Hankel and composition operators will also be considered.

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Jean Esterle
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Title: About holomorphic functional calculus on semigroups of bounded operators

Abstract: We will have a fresh look at the holomorphic functional calculus on semigroups in the very general framework of semigroups which are weakly continuous with respect to an "Arveson pair" (X, X^*) . We introduce the Arveson ideal I associated to the semigroup and the algebras $QM(I)$ (resp. $QMr(I)$) of quasimultipliers (resp. regular quasimultipliers) on I . The algebra $QMr(I)$ is an inductive limit of Banach algebras, and the generator A of the semigroup can be interpreted as an element of $Q(I)$. The functional calculus associated to bounded holomorphic functions on a suitable open set U such that $-U$ contains the Arveson spectrum of A takes values in $QMr(I)$, and so may take some values which do not represent bounded operators, but this functional calculus works for bounded operators not necessarily bounded at the origin. This work makes use of the theory of regular quasimultipliers developed by the author in the Proceedings of the Conference on Banach algebras and Applications organized in 1981 at Long Beach. A multivariable version of this approach will be outlined, which is valid for

finite families of semigroups which are strongly continuous on the half-line or holomorphic in sectors.

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Brian Forrest
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Title: Exotic Ideals in the Fourier-Stieltjes Algebra of a Locally Compact group

Abstract: There are two well known C^* -algebras associated with any locally compact group G , the full group C^* -algebra $C^*(G)$ and the reduced C^* -algebra $C_r^*(G)$. It is well known that these two C^* -algebras coincide precisely when the group G is amenable. Recently, there has been considerable interest in identifying natural intermediate C^* -algebras sitting strictly between these two canonical algebras for various non-amenable groups such as the free group on two generators. One way to generate such *exotic* C^* -algebras is to consider various L_p -representations of the underlying group. (A unitary representation π of G is said to be an L_p -representation if there is a dense set of vectors $\xi \in H_\pi$ such that the coefficient function $u(x) = \langle \pi(x)\xi, \xi \rangle \in L^p(G)$). For example, building on work of Brown and Guentner, Okayasu showed that if $2 \leq p < q < \infty$, then the C^* -algebras resulting from the universal L^p and L^q representations are distinct. In this talk, we will focus on the dual version of this problem. In particular, we show that for large classes of locally compact groups, including even abelian groups, that these L^p -representations generate distinct exotic ideals in the Fourier-Stieltjes of G which contain the Fourier algebra. We also look at some basic properties of these exotic ideals that distinguish them from the Fourier algebra itself.

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Maxime Fortier-Bourque
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Title: Local maxima of the systole function

Abstract: The systole of a hyperbolic surface is the length of its shortest closed geodesic(s). I will explain a construction of an infinite family of closed hyperbolic surfaces which are local maxima for the systole function. The simplest of these surfaces is the Bolza surface, which is the surface of genus 2 with the largest number of symmetries. We also obtain $F(n,g)$ distinct local maxima at certain heights $L(n)$ in infinitely many genera g , where $F(n,g)$ grows super-exponentially in g for every n . In particular, level sets of the systole function can have an arbitrarily large number of components.

This is joint work with Kasra Rafi.

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Richard Fournier
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Title: On Jack's Lemma

Abstract: I will state and prove a version of the Clunie-Jack lemma with minimal hypotheses on the boundary smoothness of the functions involved. I will also obtain an improvement of Julia's lemma and various other related results.

This is joint work with Oli Roth from Wuerzburg.

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Emmanuel Fricain
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Title : Multipliers between sub-Hardy Hilbert spaces

Abstract: In this talk, I will discuss multipliers from one Sub-Hardy Hilbert space to another. We first examine the case of model spaces and see that this problem is connected to Carleson measures and Beurling–Malliavin theory. In a second part of the talk, we will discuss the case of the range of co-analytic Toeplitz operators which are connected to de Branges–Rovnyak spaces.

This talk is based on collaborations with Hartmann-Ross and Rupam.

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Jose Gale
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Title: RKH spaces defined by Cesaro operators

Abstract: Certain Hilbert spaces with reproducing kernel are defined via Cesaro operators. Such spaces are related with variations of Brownian motion. Their elements can be represented as holomorphic functions on the half plane.

The content of the talk is part of joint work with P. J. Miana and L. Sanchez-Lajusticia.

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Paul Gauthier
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Title: Mapping a given countable dense set to another given countable dense set. Preliminary report.

Abstract: Barth and Schneider have shown that, given any two countable dense subsets of the complex plane, there exists an entire function mapping one set onto the other. We discuss related results.

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Pam Gorkin
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Title: Numerical ranges of restricted shifts, norms of truncated Toeplitz operators, and the role of Banach algebras

Abstract: We discuss numerical ranges of restricted shift operators and their unitary dilations, focusing first on the history of work in this area. We then turn to methods for calculating the numerical radii of such operators, providing specific examples for low-degree cases. We also consider related results on truncated Toeplitz operators, and discuss the role of Banach algebras in this area.

Joint work with J. R. Partington.

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Dominique Guillot
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Title: Entrywise positivity preservers

Abstract: A classical theorem proved in 1942 by I.J. Schoenberg describes all real-valued functions that preserve positivity when applied entrywise to positive semi-definite (psd) matrices of arbitrary size; such functions are necessarily analytic with non-negative Taylor coefficient. The analogous problem for matrices of a fixed dimension remains elusive to date. In this talk, I will present a recent characterization of polynomials of degree at most N that preserve positivity when applied entrywise to $N \times N$ psd matrices. Central to the proof are novel determinantal identities involving Schur polynomials. I will also discuss related problems involving Hankel matrices and total positivity.

Joint work with Alexander Belton (Lancaster), Apoorva Khare (IISc Bangalore), and Mihai Putinar (UCSB and Newcastle).

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Dima Jakobson
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Title: Remainder in Weyl's law and spectral function: a survey

Abstract: I will survey some old and more recent results about asymptotic behaviour of the remainder in Weyl's law and the spectral function. Those results include upper and lower bounds, almost periodic properties, and connection to asymptotic results in the theory of dynamical systems. I will also discuss some related problems in graph theory and representation theory, as time permits.

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Karim Kellay
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Title: On the reachable space of the heat equation

Abstract: We consider the heat equation some interval with Dirichlet boundary control and we aim describing the space of all possible states which can be attained in some positive time (called reachable space in control theoretic terms). The main results assert that this space is generally sandwiched between two Hilbert spaces of holomorphic functions defined on an appropriately chosen square in the complex plane. More precisely, we prove that the reachable space contains the Hardy-Smirnov space and it is contained in the Bergman space associated to the above mentioned square. This is based on a joint work with Andreas Hartmann and Marius Tucsnak.

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Dmitry Khavinson
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Title: Variations on the (eternal) theme of analytic continuation

Abstract: The shortest and best way between two truths of the real domain often passes through the imaginary one. - P. Painleve - J. Hadamard.

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Damir Kinzebulatov Université Laval
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Title: A new look at the KLMN theorem

Abstract: We use the old ideas of E. Hille and J. Lions (alternatively, E. Hille and H.F. Trotter) to construct an operator realization of the formal differential expression $-\Delta + b \cdot \nabla$ on \mathbb{R}^d , $d \geq 3$, as the generator of a quasi-bounded holomorphic semigroup in L^2 , with the vector field $b : \mathbb{R}^d \rightarrow \mathbb{R}^d$ in the class of weakly form-bounded vector fields (containing e.g. the weak L^d class and the Kato class \mathbf{K}^{d+1} , thus allowing to combine, for the first time, critical-order point and critical-order hypersurface singularities).

This is joint work with Yu.A.Semenov (Toronto).

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Lukasz Kosinski
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Title: Extension Property

Abstract: A subset V of a domain D in \mathbb{C}^n is said to have an extension property if any bounded holomorphic function f on V can be extended to a holomorphic function F on D such that $\|F\|_D = \|f\|_V$. The aim of my talk is to study the problem in the polydisc and the class of strongly convex domains.

It is based on joint papers with J.E. McCarthy.

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Norm Levenberg
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Title: Multivariate approximation and pluripotential theory

Abstract: Given a convex body P in $(\mathbf{R}^+)^d$, one can associate natural subclasses of polynomials in \mathbf{C}^d as well as a natural class of plurisubharmonic functions on \mathbf{C}^d of appropriate growth. Motivated by observations in real

multivariate approximation theory, we give a version of the Bernstein-Walsh theorem on uniform polynomial approximation of holomorphic functions on compact sets in several complex variables in this setting.

This is based on joint work(s) with Turgay Bayraktar, Tom Bloom and Len Bos.

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Laurent Marcoux
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Title: Hilbert space operators with compatible off-diagonal corners

Abstract: 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 $\text{rank}(I - P)TP = \text{rank} PT(I - P)$ 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.

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Javad Mashreghi
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Title: An application of entire functions of exponential type in Banach algebras

Abstract: We illustrate a technique from the theory of entire functions by proving the following variant of a result of Allan about power growth in Banach algebras. Let a be an element of a unital Banach algebra, let $m \geq 0$ and let $\alpha \in (0, 1)$. Then

$$\|a^m((1 + a)^n - (1 - a)^n)\| = O(e^{\epsilon n^\alpha}) \quad (n \rightarrow \infty)$$

for all $\epsilon > 0$ if and only if $\lim_{n \rightarrow \infty} n^{1/\alpha - 1} \|a^n\|^{1/n} = 0$.

Joint work (the first one!) with T. Ransford.

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Mostafa Mbekhta
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Title: Nonlinear maps commuting with the λ -Aluthge Transform under certain products

Abstract: In this talk we give a complete form of the bijective (not necessarily linear) maps $\Phi : B(H) \rightarrow B(K)$, where H, K are Hilbert spaces of dimension greater than 2, that satisfy

$$\Delta_\lambda(\Phi(A) \star \Phi(B)) = \Phi(\Delta_\lambda(A \star B)) \text{ for all } A, B \in B(H),$$

where $\Delta_\lambda(T)$ is the λ -Aluthge transform of T and the operation $A \star B$ means one of the following products:

1. The standard product $A \star B = AB$
2. The jordan product $A \star B = A \circ B = \frac{1}{2}(AB + BA)$.
3. The start Jordan product $A \star B = A \circ B^* = \frac{1}{2}(AB^* + B^*A)$.
4. The (n, m) -Jordan triple product $A \star B = A^n B A^m$ with $n, m \in \mathbb{N}$ such that $n + m \geq 1$.

This is joint work with Fadil Chabbabi (Lille).

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Tony OFarrell
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Title: Boundary values of holomorphic distributions in negative Lipschitz classes

Abstract: We consider the behaviour at a boundary point of an open subset $U \subset \mathbb{C}$ of distributions that are holomorphic on U and belong to what are

called negative Lipschitz classes. The result explains the significance for holomorphic functions of Wiener-type series involving Hausdorff contents of dimension between 0 and 1. We begin with a survey about function spaces and capacities that sets the problem in context and reviews the relevant general theory.

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Stanatis Pouliasis
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Title: Dirichlet spaces with superharmonic weights

Abstract: The topic of this talk will be Dirichlet spaces D with superharmonic weights of holomorphic functions on the unit disc and the Moebius invariant spaces $M(D)$ generated by them. We will give norm estimates depending on the total Riesz mass of the superharmonic weight and characterize the cases where equality occurs. Also, we will discuss the relation of the spaces $M(D)$ with classical Moebius invariant spaces and describe some classes of inner functions contained in them.

This is based on joint works with G. Bao, N. G. Gogus, J. Mashreghi, and H. Wulan.

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Mario Roy
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Title: Conformal Graph Directed Markov Systems

Abstract: Iterated function systems and graph directed Markov systems are often used to determine properties of dynamical systems, including complex ones. I will discuss recent advances in the theory of conformal graph directed Markov systems.

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William Ross
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Title: In the footsteps of Pythagoras

Abstract: Pythagoras of Samos (c. 570 – 495 BCE) was a mathematician, philosopher, and teacher whose influence is still being felt millennia after he lived. He is known to all school children by this Pythagorean theorem which, in modern notation, gives us a notion of orthogonality and parallelogram laws in Hilbert spaces. In this joint work with Raymond Cheng and Javad Mashreghi, we explore some notions of weak parallelogram laws and how far certain Banach spaces deviate from Hilbert spaces. This talk also explores a more general notion of orthogonality that has applications to problems in complex analysis (zero sets of analytic functions) and prediction theory (ARMA).

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Elizabeth Strouse
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Title: A Szego Theorem for truncated Toeplitz operators

Abstract: The Szego theorem can be interpreted as a theorem about 'approximating' Toeplitz operators by Toeplitz matrices. It turns out that this theorem can be generalized to certain types of truncated Toeplitz operators - but is not well adapted for other types.

Joint work with Dan Timotin and Mohamed Zarrabi.

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Michael White
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Title: Differentiating Absolutely Continuous Functions

Abstract: The algebra of absolutely continuous functions consists of contin-

uous functions on $[0, 1]$ with an $L^1([0, 1])$ derivative. It is natural to investigate other notions of derivative for this algebra. Unusually for a Banach Algebra the Kahler module of differentials for this algebra is well-behaved (flat) as a module, and this can be used to show that higher cohomology vanishes for all commutative dual modules.

Work joint with Yemon Choi.

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Malik Younsi
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Title: Conformal rigidity of circle domains

Abstract: A domain in the Riemann sphere is called a circle domain if every connected component of its boundary is either a round circle or a point. The famous Koebe uniformization conjecture states that every planar domain is conformally equivalent to a circle domain. The existence of a Koebe conformal map has been proved only in some special cases, such as domains with at most countably many boundary components, thanks to the major progress of He and Schramm in the 1990's. In this talk, I will discuss uniqueness of the map, which is closely related to the notion of conformal rigidity. More precisely, we say that a circle domain is (conformally) rigid if every conformal map of the domain onto another circle domain is the restriction of a Möbius transformation. It is well-known that some circle domains are rigid and some are not, but both sufficient and necessary conditions are yet to be found. I will survey recent results on the rigidity of circle domains, and we shall see how all of this is related to conformal removability.

This is (partly) joint work with Dimitrios Ntalampekos.

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Nina Zorboska
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Title: Isometric weighted composition operators on weighted Bergman spaces

Abstract: Weighted composition operators play an important role in the determination of isometries on some Banach spaces. In this talk I will present the characterization of isometric weighted composition operators in the case of a Hilbert weighted Bergman space where, in general, there are many other different types of isometries. The characterization uses measure theoretic methods, similarly to the Hardy space case, but there are also several significant differences. I will also mention more concrete descriptions of these type of isometries in some special cases, and talk about some geometric aspects of the isometry criteria.

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Włodzimierz Zwonek
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Title: Geometric function theory on special domains

Abstract: Special domains (like the symmetrized polydisc, tetrablock) have drawn a lot of attention in the last two decades. In the lecture, their importance and possible generalizations will be presented with the stress put on the geometric function theory on the domains involved.