国际算子理论及其应用会议 | IWOTA 2018

International Workshop on Operator Theory and its Applications

PROGRAM

2018.7.23-2018.7.27　中国上海

The 29th International Workshop on Operator Theory and its Applications

July 23–27, 2018, Shanghai, China

PROGRAM

Host: Research Center for Operator Algebras of East China Normal University

FUDAN UNIVERSITY 1905 復旦大學 FUDAN UNIVERSITY

EAST CHINA NORMAL UNIVERSITY 華東師範大學 EAST CHINA NORMAL UNIVERSITY

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NATIONAL SCIENCE FOUNDATION


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长风公园
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Hyatt Regency Hotel
in Global Harbor (Shopping mall)
(环球港，凯悦酒店)
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(北门)
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Jinshajiang Rd.
(金沙江路站)
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(河西食堂)
Special sessions at
Tianjabing building
(田家炳教育书院)
Campus dining (E)
(河东食堂)
East Gate
(东门)
Science bldg. A
(理科大楼 A)
RCOA at 5F
Plenary talks at
Science Auditorum
(科学会堂)
Semi-plenary talks at
Yifu building
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To Metro Station (line 2, 3&4)
Zhongshan Park
(至中山公园站)
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Welcome Letter

Dear friends and colleagues,

It is our privilege to welcome you at Shanghai for our union at the *International Workshop on Operator Theory and its Applications.* We are proud to host the 29th edition of this meeting since its initiation in 1981, which provides an outstanding opportunity to showcase mathematical progress in the field.

Born about a century ago, operator theory is one of the determining fields standing behind the progress in science and technology. The methods developed are used everyday by many working in the known applied fields of mathematics, engineering and physics.

Several contributed talks were accepted for presentation. These demonstrate the diversity of operator theory, extending over a wide range of topics. As a first indicator for you, we roughly grouped them into the following categories:

- Function Spaces and Operator Theory
- Free Analysis and Free Real Algebraic Geometry
- Infinite Dimension Systems and Wavelets
- Multivariable Operator Theory
- Non-commutative Geometry
- Operator Spaces and Harmonic Analysis
- Operator Theory and Quantum Information
- Operator Theory on Reproducing Kernel Hilbert Spaces
- Panel Discussion: Women in Mathematics
- Special Week on Operator Algebras
- Spectral Theory and Differential Operators
- Graduate Student Forum

We would like to express our sincerest and warmest welcome to all the scientists who will give talks at the meeting. You embody excellence in your field and your contribution to the development of knowledge is unquestionable. Moreover, we hope that IWOTA will be a source of inspiration for you.

Enjoy the conference in the week from 23rd to 27th of July 2018 and your stay here in Shanghai.

Sincerely,
your local organizers,

Xiaoman Chen, Kunyu Guo,
Huaxin Lin, Qin Wang,
Yijun Yao, Guoliang Yu
July 2018

Organization Committee

- **Xiaoman Chen**, Fudan University
- **Kunyu Guo**, Fudan University
- **Huaxin Lin**, University of Oregon & East China Normal University (**Co-chair**)
- **Qin Wang**, East China Normal University
- **Yijun Yao**, Fudan University & SCMS
- **Guoliang Yu**, Texas A&M University & SCMS (**Co-chair**)

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- **Bill Helton**, University of California San Diego

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Venue:

Plenary talks: **Science Auditorium**

Semi-plenary talks: **Science Auditorium & lecture room on the first floor of Yifu Building**

Special Sessions: **Classrooms on the second floor of Tianjiabing Building**

Plenary/Semi-plenary Talks

Plenary talks will take place at **Science Auditorium**, and live video will be broadcasted at **lecture room on the first floor of Yifu Building**. Two parallel **semi-plenary talks** will take place at Science Auditorium and lecture room on the first floor of Yifu Building simultaneously.

Monday, July 23

8:30-8:40	**OPENING**
8:40-9:30	**Michael R. Douglas (SUNY Stony Brook)**
	Following in the footsteps of Ronald Douglas
9:30-9:50	**GROUP PHOTO**
9:50-10:10	**TEA BREAK**
10:10-11:00	**Guoliang Yu (Texas A&M University & SCMS)**
	The work of Ronald Douglas
11:10-12:00	**Xiaoman Chen (Fudan University)**
	Higher Index at Infinity

Tuesday, July 24

8:00-8:50	**Chunlan Jiang (Hebei Normal University)**
	Classification of C-algebras with the ideal property*
9:00-9:50	**Mikael Rørdam (University of Copenhagen)**
	Groups, C^*-algebras and traces
9:50-10:10	**TEA BREAK**
10:10-11:00	**Arthur Jaffe (Harvard University)**
	The Story Behind the Millennium Prize Problems
11:10-12:00	**David Kerr (Texas A&M University)**
	Venue: Science Auditorium
	Small boundary properties and the classification of crossed products
	Magdalena Musat (University of Copenhagen)
	Venue: Yifu Building
	Von Neumann Algebras meet Quantum Information Theory

Wednesday, July 25

8:00-8:50	**Kunyu Guo (Fudan University)**
	Totally Abelian Toeplitz operators and geometric invariants associated with their symbol curves
9:00-9:50	**Andrew Toms (Purdue University)**
	TBA
9:50-10:10	**TEA BREAK**
10:10-11:00	**John McCarthy (Washington University at St Louis)**
	Operator Norms
11:10-12:00	**Zhuang Niu (University of Wyoming)**
	Venue: Science Auditorium
	The classification of simple separable amenable KK-contractible C^*-algebras
	Hang Wang (East China Normal University)
	Venue: Yifu Building
	Equivariant Index, Traces and Representation Theory

Thursday, July 26

8:00-8:50	**Alexei Poltoratski (Texas A&M University)**
	Completeness of exponentials
9:00-9:50	**Guihua Gong (University of Puerto Rico)**
	On the classification of simple separable C^*algebras of finite nuclear dimension
9:50-10:20	**TEA BREAK**
10:10-11:00	**Yijun Yao (Fudan University)**
	Complex/conformal structures on Noncommutative 2-Tori
11:10-12:00	**Gadadhar Misra (Indian Statistical Institute)**
	Venue: Science Auditorium
	Homogeneous bundles and operators in the Cowen-Douglas class
	Zhizhang Xie (Texas A&M University)
	Venue: Yifu Building
	K-theory of operator algebras and higher index theoretic invariants

Friday, July 27

8:00-8:50	**Roland Speicher (Universität des Saarlandes)**
	Random Matrices and Their Operator Limits
9:00-9:50	**Xiang Tang (Washington University at St Louis)**
	Analytic Grothendieck Riemann Roch Theorem
9:50-10:10	**TEA BREAK**
10:10-11:00	**Hanfeng Li (University of New York at Buffalo)**
	Bivariant Sylvester rank functions
11:10-12:00	**Sanne Ter Horst (North-West University)**
	Venue: Science Auditorium
	Bounded real lemma and the KYP inequality for infinite dimensional discrete-time systems
	Kai Wang (Fudan University)
	Venue: Yifu Building
	Curvature inequalities of higher order for operators of the Cowen–Douglas class

Speaker: Michael R. Douglas (SUNY Stony Brook)
Title: *Following in the footsteps of Ronald Douglas*
Abstract: Many of you knew my father Ronald Douglas as a mentor, a collaborator or a colleague. While I never wrote a paper with him, he was a powerful influence on my own career. Some of my most important works, such as those on Dirichlet branes and noncommutative geometry, turned out to have strong connections with his work. In this talk I will reminisce a bit and describe a few of these works and connections.

Speaker: Kunyu Guo (Fudan University)
Title: *Totally Abelian Toeplitz operators and geometric invariants associated with their symbol curves*
Abstract: This talk mainly focus on geometric analysis of symbol curves of analytic Toeplitz operators. It is found that winding numbers, indices and points of self-intersection of symbol curves of Toeplitz operator altogether play an important role in this topic. Techniques of algebraic topology, complex analysis, geometry, index theory and operator theory are intrinsic in our studies. As a byproduct, under a mild condition we provides an affirmative answer to a problem raised in [BDU,T1], and also construct some examples to show that the answer is negative if the associated conditions are weakened.

This is a joint work with Hui Dan and Hansong Huang.

Speaker: David Kerr (Texas A&M University)
Title: *Small boundary properties and the classification of crossed products*
Abstract: I will discuss how the small boundary property, in both its measure-theoretic and topological versions, relates to finite approximation in topological dynamics and the classification of crossed product C^*-algebras. The talk is based on joint work with Gabor Szabo.

Speaker: Hanfeng Li (University of New York at Buffalo)
Title: *Bivariant Sylvester rank functions*
Abstract: For a unital ring R, a Sylvester rank function assigns a nonnegative real number (the rank) to each rectangular matrix over R, or equivalently, to each finitely presented left R-module. The Sylvester rank functions play a vital role in the proof of Kaplansky's direct finiteness conjecture for sofic groups, L^2-invariants theory, and classification program for C^*-algebras. I will discuss how to extend each Sylvester rank function to a bivariant one for pairs (A, B) with A being a submodule of any left R-module B, and give some applications of this extension.

Speaker: John E. McCarthy (Washington University at St Louis)
Title: *Operator Norms*
Abstract: The reason that Operator Theory is useful when studying classical Function Theory is that holomorphic functions can be evaluated not just on scalars, but also on operators. Let Ω be an open set in $\mathbb{C}^d$, and let $\mathcal{F}$ be a set of d-tuples of commuting operators all of which have

spectrum in Ω. One can define a norm on holomorphic functions on Ω by

$$\|\phi\|_{\mathcal{F}} := \sup_{T \in \mathcal{F}} \|\phi(T)\|.$$

An operator norm is a norm that arises this way. Operator norms arise frequently. Some important theorems, such as von Neumann's inequality and Andô's inequality, assert that certain operator norms agree exactly with norms defined by function theory. Other theorems prove inequalities. For example, let Ω be a convex set in $\mathbb{C}$, and let $\mathcal{F}$ be the set of operators with numerical range in Ω. A theorem of B. and F. Delyon asserts that there is some constant C_Ω so that

$$\|\phi\|_{\mathcal{F}} \leq C_\Omega \sup_{z \in \Omega} |p(z)|.$$

Later, M. Crouzeix proved that there is a universal constant, independent of Ω, making the inequality true, and conjectured that the sharpest such constant is 2. Operator norms that do not have an easy function theoretic definition appear when analyzing, for example, the Oka extension theorem. We shall discuss why operator norms are natural objects to study, how model theory can help to analyze them, and how some operator norms are intimately linked to questions about extensions of functions.

Speaker: Gadadhar Misra (Indian Statistical Institute)
Title: *Homogeneous bundles and operators in the Cowen-Douglas class*
Abstract: It is known that all the homogeneous holomorphic vector bundles can be obtained by holomorphic induction from representations of a certain parabolic Lie algebra on finite dimensional inner product spaces. The representations, and the induced bundles, have composition series with irreducible factors. The existence of an explicit differential operator equivariantly intertwining the bundle with the direct sum of its factors is one of the main results. We use this to get a full description and a similarity theorem for homogeneous Cowen-Douglas n-tuples in the case of the unit ball in $\mathbb{C}^n$. This is joint work with A. Koranyi.

Speaker: Magdalena Musat (University of Copenhagen)
Title: *Von Neumann Algebras meet Quantum Information Theory*
Abstract: The study of quantum correlations arising under two different assumptions of commutativity of observables, initiated by Tsirelson in the 80's, has proven over the last decade to have deep interconnections with important problems in operator algebras theory, including various reformulations of the Connes Embedding Problem. In very recent work with M. Rørdam, we show that in every dimension $n \geq 11$, the set of $n \times n$ correlation matrices arising from unitaries in finite dimensional von Neumann algebras is not closed. As a consequence, in each such dimension there are quantum channels that admit type II_1-von Neumann algebras as ancillas, but not finite dimensional ones.

Speaker: Zhuang Niu (University of Wyoming)
Title: *The classification of simple separable amenable KK-contractible C^*-algebras*
Abstract: A C^*-algebra is KK-contractible if it is KK equivalent to the zero C^*-algebra (or equivalently, if it satisfies the UCT and has trivial K-groups). I will discuss the classification of simple separable amenable KK-contractible C^*-algebras with finite nuclear dimensions. This

is based on a joint work with George Elliott, Guihua Gong, and Huaxin Lin.

Speaker: Alexei Poltoratski (Texas A&M University)
Title: *Completeness of exponentials*
Abstract: I will discuss two classical problems on completeness of exponential functions in L^p-spaces. The first problem, solved by Beurling and Malliavin in 1960s, has multiple applications in spectral theory, complex and harmonic analysis. I will discuss some of such applications along with some of the modern generalizations of the Beurling–Malliavin theory. In the second part of the talk I will discuss the so-called type problem together with its recent solution and applications.

Speaker: Mikael Rørdam (University of Copenhagen)
Title: *Groups, C^*-algebras and traces*
Abstract: I will give an overview of properties of amenable groups, as well as of the less known classes of supramenable groups (introduced by Rosenblatt in 1974), respectively, groups with the fixed point property for cones (introduced by Monod a year ago), with emphasis on how these groups act on C^*-algebras. It is, for example, well-known that any action of an amenable group on a unital C^*-algebra with a tracial state admits at least one invariant trace, while any non-amenable group can act on, say, the Cantor set, such that the crossed product is purely infinite and simple (and hence traceless). We consider similar statements for actions of groups on non-unital C^*-algebras, which are more subtle, and turn out to involve the above classes of supramenable groups and groups with the fixed point property for cones.

Speaker: Roland Speicher (Saarland University)
Title: *Random Matrices and Their Operator Limits*
Abstract: In some sense, tuples of random matrices converge very often, in the limit of large size, to tuples of operators which generate interesting operator algebras. An important aspect in this context is to understand functions in our non-commuting variables (i.e., random matrices or operators) and their regularity properties. Whereas many prior investigations concentrated on polynomials, I started in recent years a program of looking on non-commutative rational functions. I will explain the challenges and some achieved results in this context. In particular, I will address the question, when we can apply a non-commutative rational function to a tuple of "nice" operators. As it turns out, this is always possible if we work in the unbounded operators affiliated to a tracial von Neumann algebra.

This is joint work with Tobias Mai and Sheng Yin.

Speaker: Xiang Tang (Washington University at St Louis)
Title: *Analytic Grothendieck Riemann Roch Theorem*
Abstract: In this talk, we will discuss an index problem inspired by the Arveson-Douglas conjecture. We will present some recent progress in the study of this index problem. This talk is based on joint work with R. Douglas, M. Jabbari, and G. Yu.

Speaker: Sanne Ter Horst (North-West University)
Title: *Bounded real lemma and the KYP inequality for infinite dimensional discrete-time systems*
Abstract: Generally speaking, a bounded real lemma provides a linear matrix inequality characterization, often referred to as Kalman-Yakubovich-Popov (KYP) inequality, for when an input-state-output linear system satisfies a dissipation inequality. While the original work on this topic goes back to the 1960s, there has been a continuous stream of publications since, with a current emphasis on differential-algebraic systems, bicausal systems, infinite dimensional systems and various multidimensional systems. In this talk we will focus on the KYP inequality in the context of infinite dimensional discrete time systems, connections with state-space similarity and the storage function approach of Willems. If time permits, attention will be given to how some of the methods can be extended to noncommutative multidimensional systems.

The talk is based on joint work with J. A. Ball and G. J. Groenewald.

Speaker: Hang Wang (East China Normal University)
Title: *Equivariant Index, Traces and Representation Theory*
Abstract: K-theory of C^*-algebras associated to a semisimple Lie group can be understood both from the geometric point of view via Baum-Connes assembly map and from the representation theoretic point of view via harmonic analysis of Lie groups. A K-theory generator can be viewed as the equivariant index of some Dirac operator, but also interpreted as a (family of) representation(s) parametrised by the torsion free abelian part in the Levi component of a cuspidal parabolic subgroup. Applying orbital traces to the K-theory group, we obtain the equivariant index as a fixed point formula which, when applied to this realisation of discrete series, recovers Harish-Chandra's character formula for the discrete series on the representation theory side. This is a noncompact analogue of Atiyah-Segal-Singer fixed point theorem in relation to the Weyl character formula. This is joint work with Peter Hochs.

Speaker: Zhizhang Xie (Texas A&M University)
Title: *K-theory of operator algebras and higher index theoretic invariants*
Abstract: K-theory of operator algebras has played a fundamental role in the developments of various branches of mathematics during the last thirty years or so. In particular, its applications to geometry and topology have greatly advanced some of the most important problems in those areas of mathematics, such as the Novikov conjecture, the Baum-Connes conjecture and the Gromov-Lawson-Rosenberg conjecture. One of the most fruitful interactions of K-theory of operator algebras with geometry and topology is through higher index theoretic invariants. In this talk, I will give a brief introduction to some of the most recent advances in K-theory of operator algebras and it applications to geometry and topology, such as the positive scalar curvature problem in geometry and the manifold rigidity problem in topology.

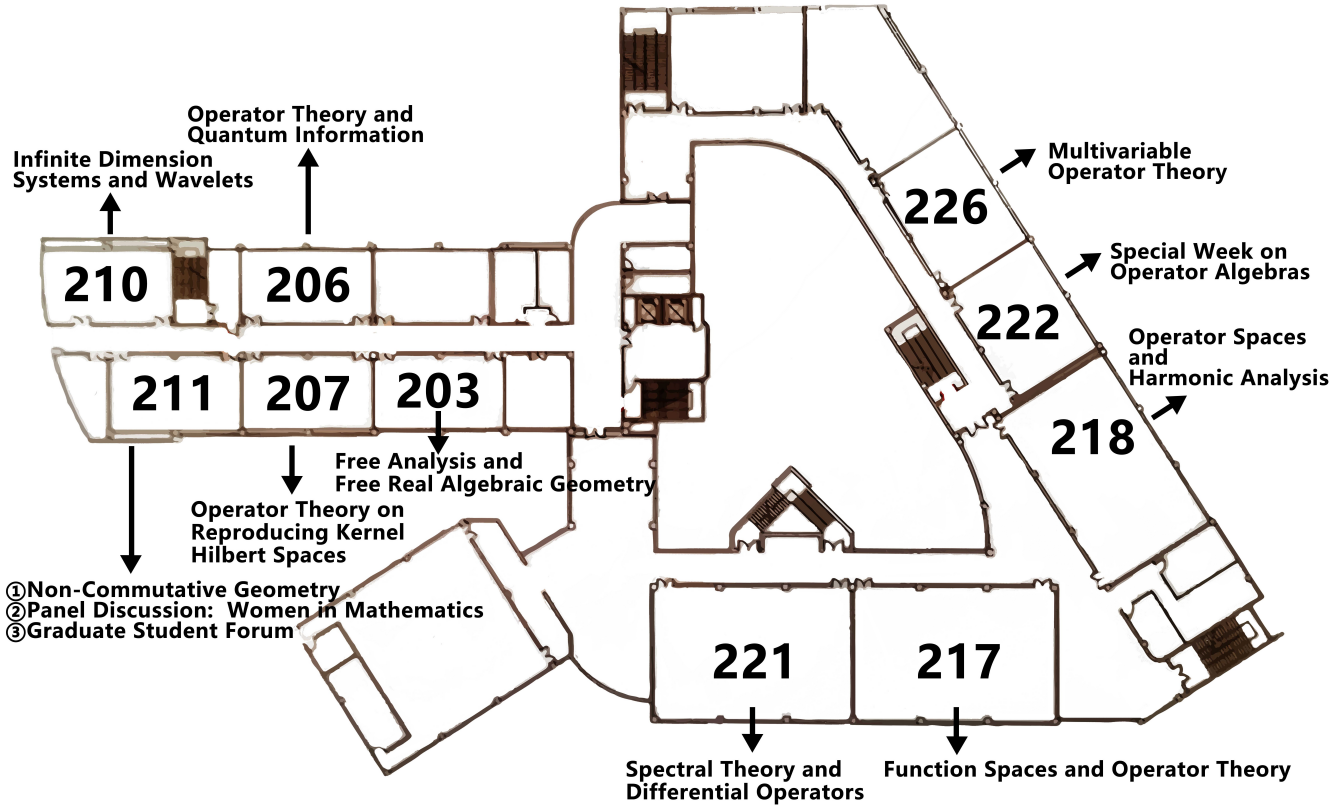
Speaker: Yijun Yao (Fudan University)
Title: *Complex/conformal structures on Noncommutative 2-Tori*
Abstract: We will explain the notion of complex/conformal structures from the noncommutative geometric point of view,which involves the concept of positive cocycles of Connes-Cuntz.

Then we apply this notion to noncommutative 2-tori. Our aim is to classify all the extremal points of the set of positive cocycles that are in the same Hochschild class of the noncommutative fundamental class of noncommutative 2-tori. It is based on an ongoing project with Jiawen Zhang (Southampton).

Special Sessions

Venue: **Tianjiabing Building**

Room Map



Function Spaces and Operator Theory

Organizers: **Kunyu Guo** (Fudan University)
Dechao Zheng (Vanderbilt University)

Venue: **Room 217, Tianjiabing Building**

Monday, July 23

14:20-14:40 **Boo Rim Choe (Korea University)**
Characterizations for compact linear combinations of Bergman-space composition operators

14:45-15:05 **Maofa Wang (Wuhan University)**
Some progresses on composition operators

15:10-15:30 **Caixing Gu (California Polytechnic State University San Luis Obispo)**
Norms of composition operators on the unit ball and the polydisk

15:30-16:00 **TEA BREAK**

16:00-16:20 **Liming Yang (Fudan University)**
The State of subnormal operators II

16:25-16:45 **Hansong Huang (East China University of Science and Technology)**
Cyclic vectors in Fock-type spaces in multi-variable cases

16:50-17:10 **Shengzhao Hou (Soochow University)**
On the zero sets of Bernstein spaces

Tuesday, July 24

14:20-14:40 **Zeljko Cuckovic (University of Toledo)**
The essential norm estimates of Hankel and the $\overline{\partial}$-Neumann operators

14:45-15:05 **Ruhan Zhao (State University of New York at Brockport)**
On Berezin type operators and Toeplitz operators

15:10-15:30 **Xianfeng Zhao (Chongqing University)**
The spectrum of Toeplitz operators on the Bergman space

15:30-16:00 **TEA BREAK**

16:00-16:20 **Zhijian Wu (University of Nevada)**
Weighted composition operators on Bergman spaces

16:25-16:45 **Guangfu Cao (South China Agricultural University)**
The Bargmann transform on $L^p(\mathbb{R})$

16:50-17:10 **Penghui Wang (Shandong University)**
Polydisc version of Arveson's conjecture

17:15-17:35 **Hasi Wulan (Shantou University)**
TBA

Wednesday, July 25

14:20-14:40 **Peng Cao (Beijing Institute of Technology)**
How to characterize the ideals in Banach (Jordan) algebras

14:45-15:05 **Zipeng Wang (Shaanxi Normal University))**
Carleson measures for Dirichlet spaces

15:10-15:30 **Congwen Liu (University of Science and Technology of China)**
Besov spaces on the Siegel upper half-space

15:30-16:00 **TEA BREAK**

16:00-16:20 **Guozheng Cheng (Sun Yat-sen University)**
Random coefficient multipliers

16:25-16:45 **Guoxing Ji (Shaanxi Normal University)**
On some partial orders on $B(\mathcal{H})$

16:50-17:10 **Karel Stroethoff (University of Montana)**
TBA

Speaker: Guangfu Cao (South China Agricultural University)
Title: *The Bargmann transform on $L^p(\mathbb{R})$*
Abstract: We study the mapping properties of the Bargmann transform B on L^p spaces of the real line. It is well known that B maps $L^2(\mathbb{R})$ isometrically onto the Fock space F^2. When $2 < p < \infty$, we show that B maps $L^p(\mathbb{R})$ boundedly into the Fock space F^p and that the mapping is not onto. When $1 \leqslant p < 2$, we show that B maps $L^p(\mathbb{R})$ boundedly into the Fock space F^q, where $1/p+1/q = 1$, and that B does not map $L^p(\mathbb{R})$ into F^p. There is no reasonable way to define the Bargmann transform on $L^p(\mathbb{R})$ when $0 < p < 1$.

Speaker: Peng Cao (Beijing Institute of Technology)
Title: *How to characterize the ideals in Banach (Jordan) algebras*
Abstract: There are some mathematicians working on the characterizations of ideals in Banach (Jordan) algebras from the side of operator theory. In this talk, we will give some characterizations of the ideals from three different ways, that are the perturbation theory, cardinality of the spectrum, and also the root distribution of some special analytic multifuntion. Here the ideals mean Jacobson radical, socle, kh(soc), and scattered radical.

Speaker: Guozheng Cheng (Sun Yat-sen University)
Title: *Random Coefficient Multipliers*
Abstract: Given two analytic functional spaces X, Y, the coefficient multiplier (X, Y) is the collection of complex sequences $\{\lambda_n\}_{n=0}^{\infty}$ such that $\sum\limits_{n=0}^{\infty} a_n\lambda_n z^n \in Y$ if $\sum\limits_{n=0}^{\infty} a_n z^n \in X$. In this talk, the sequence $\{\lambda_n\}_{n=0}^{\infty}$ is randomized by a sequence of i.i.d. random variables. We will introduce related background and some questions being investigated recently.

Speaker: Boo Rim Choe (Korea University)
Title: *Characterizations for compact linear combinations of Bergman-space composition operators*
Abstract: Motivated by the question of Shapiro and Sundberg raised in 1990, study on linear combinations of composition operators has been a topic of growing interest. In this talk, we announce complete characterizations for the compactness of any finite linear combination of composition operators with general symbols on the weighted Bergman spaces in two classical terms: one is a function theoretic characterization of Julia-Carathéodory type and the other is a measure theoretic characterization of Carleson type. Our approach is completely different from what have been known so far. This is a joint work with Hyungwoon Koo and Maofa Wang.

Speaker: Željko Čučković (University of Toledo)
Title: *The essential norm estimates of Hankel and the $\overline{\partial}$-Neumann operators*
Abstract: Compactness of the $\overline{\partial}$-Neumann operator is closely connected to the compactness of Hankel operators on the Bergman space. At first, for convex domains in $\mathbb{C}^n$, we use the $\overline{\partial}$ methods to relate the compactness of a Hankel operator to the boundary behavior of its symbol. In the absence of compactness, we give the essential norm estimates of Hankel operators. This

in turn, led us to obtain the essential norm estimates for the $\overline{\partial}$-Neumann operator on convex domains. (This is joint work with Sonmez Sahutoglu.)

Speaker: Caixing Gu (California Polytechnic State University San Luis Obispo)
Title: *Norms of composition operators on the unit ball and the polydisk*
Abstract: We extend norm estimates of composition operators of Michael Jury in 2007 on weighted Hardy and Bergman spaces of the unit ball to more general reproducing kernel spaces on the unit ball and the polydisk, for example, on the Dirichlet space of the unit ball and the Hardy space of the polydisk. For the composition operators with affine symbols on the unit ball, we find their exact norms which extend the corresponding results of Cowen in 1988 and Hurst in 1997.

Speaker: Shengzhao Hou (Soochow University)
Title: *On the zero sets of Bernstein spaces*
Abstract: In this talk, we will discuss the zero sets of Bernstein spaces. Our main result is the following: $\{\lambda_n\}$ is a zero set for Bernstein space B_p $(1 \leqslant p < +\infty)$ if and only if the following holds
(1) the limit

$$\lim_{R\to\infty} \sum_{0<|\lambda_n|<R} \frac{1}{\lambda_n}$$

exists;
(2) we have

$$0 < \lim_{t\to\infty} \frac{n(0,t)}{t} \leqslant 2;$$

(3) there exists $b \in \mathbb{R} \setminus \{\lambda_n\}$ such that

$$\int_{-\infty}^{+\infty} \exp\left\{p \int_0^{+\infty} \big[n(b,t) - n(x,t)\big] t^{-1} dt\right\} dx < +\infty.$$

Speaker: Hansong Huang (East China University of Science and Technology)
Title: *Cyclic Vectors in Fock-type Spaces in Multi-variable Cases*
Abstract: In this talk we mainly consider cyclic vectors in the Fock-type spaces $L^p_a(\mathbb{C}^d, s, \alpha)$ of multi-variable cases, with positive parameters s, α and $p \geqslant 1$. It is shown that for a positive number $s \notin \mathbb{N}$, a function f in the Fock-type space $L^p_a(\mathbb{C}^d, s, \alpha)$ is cyclic if and only if f is non-vanishing. For each positive integer s, a function f in $L^p_a(\mathbb{C}^d, s, \alpha)$ is cyclic if and only if f is non-vanishing and $f\mathcal{C}$ is contained in the Fock-type space $L^p_a(\mathbb{C}^d, s, \alpha)$, where $\mathcal{C}$ denotes the polynomial ring. Also presented are the exact forms of these cyclic vectors in both cases.

Speaker: Guoxing Ji (Shaanxi Normal University)
Title: *On some partial orders on $B(\mathcal{H})$*
Abstract: In this talk, we discuss the star partial order and the diamond order on a von Neumann algebra on a Hilbert space $\mathcal{H}$. We consider certain properties on these orders. In particular, we give the star partial order-hereditary subspace in a von Neumann algebra. We also give

the automorphism of the unit interval under the diamond order.

Speaker: Congwen Liu (University of Science and Technology of China)
Title: *Besov spaces on the Siegel upper half-space*
Abstract: In this talk, we present the notion of the Besov space on the Siegel upper half-space. We give a few characterizations of this space and find its dual space. This talk is based on recent joint work with Jiajia Si and Kehe Zhu.

Speaker: Maofa Wang (Wuhan University)
Title: *Some progresses on composition operators*
Abstract: In this talk, we will summarize some progresses of composition operators on spaces of analytic functions, which reveals a beautiful interaction between operator theory, classical function theory, non-commutative analytic function theory as well as operator algebra.

Speaker: Penghui Wang (Shandong University)
Title: *Polydisc version of Arveson's conjecture*
Abstract: In this talk, I will give some recent development on the essential normality of quotient modules over the polydiscs. The essentila normality of homogenous(quasi-homogenous) quotient modules will be completely characterized. This can be seen as a polydisc version of Arveson's conjecture. The talk is based on the joint papers with Kunyu Guo and Chong Zhao.

Speaker: Zipeng Wang (Shaanxi Normal University)
Title: *Carleson Measures for Dirichlet Spaces*
Abstract: In this talk we prove that all doubling measures on the unit disk are Carleson measures for the standard Dirichlet space. The proofs are based on (1) a characterization of Carleson measures which holds true for general reproducing kernel Hilbert spaces; (2) a new equivalent condition for Carleson measures, which holds true only for the standard Dirichlet space; (3) an application of dyadic method to our setting.

Speaker: Zhijian Wu (University of Nevada)
Title: *Weighted Composition Operators on Bergman Spaces*
Abstract: The Bergman space A^p_μ is defined as the closure of analytic polynomials in $L^p(\mathbb{D}, d\mu)$. For a measurable function u on $\mathbb{D}$ and an analytic self-map φ of $\mathbb{D}$, the operator $uC_\varphi : f \mapsto uf \circ \varphi$ on A^p_μ is called a weighted composition operator with weight u and symbol φ. We characterize the compactness of the difference of two weighted composition operators in terms of the symbols and weights. We also calculate the Hilbert-Schmidt norm of the difference operators. Some related questions are also discussed.

Speaker: Liming Yang (Fudan University)
Title: *The State of Subnormal Operators II*
Abstract: We discuss the state of research problems in the papers "J. Conway and Liming

Yang, Some Open Problems in the Theory of Subnormal Operators, Holomorphic Spaces, MSRI Publications, Vol 33, 201-209, 1998" and "J. Conway and N. Feldman, The State of Subnormal Operators, Operator Theory: Advances and Applications, Vol. 207, 177-194, 2010". In particular, we will show how Tolsa's breakthrough results on analytic capacity can be applied in studying the theory of subnormal operators. We will also discuss further research problems.

Speaker: Ruhan Zhao (State University of New York at Brockport)
Title: *On Berezin type operators and Toeplitz operators*
Abstract: In this talk we introduce a type of integral operators associated with a positive measure and resembling the Berezin transforms on the unit ball. Boundedness and compactness of these Berezin type operators between weighted Bergman spaces are characterized using Carleson measures. It has been found that the results are closely relative to those of Toeplitz operators between weighted Bergman spaces. This is a joint work with Gabriel Prajitura and Lifang Zhou.

Speaker: Xianfeng Zhao (Chongqing University)
Title: *The spectrum of Toeplitz operators on the Bergman space*
Abstract: In this talk, we discuss the spectrum of Toeplitz operators with harmonic symbols on the Bergman space. We will show that the spectrum of the Toeplitz operator with symbol $\overline{z} + p$ is always connected for every polynomial p with degree less than 3. On the other hand, we will prove that for each integer k greater than 2, there exists an analytic polynomial p with degree k such that the spectrum of the Toeplitz operator with symbol $\overline{z} + p$ has an isolated point. Moreover, we will construct a cubic polynomial p such that the spectrum of the Toeplitz operator with symbol $\overline{z} + p$ has at least one isolated point but has at most finitely many isolated points.

Free Analysis and Free Real Algebraic Geometry

Organizers: **J. William Helton** (University of California San Diego)
Igor Klep (University of Auckland)
Victor Vinnikov (Ben Gurion University of the Negev)

Venue: **Room 203, Tianjiabing Building**

Monday, July 23

14:00-14:30 **Peter Semrl (University of Ljubljana)**
Isometries of Grassmann spaces

14:30-15:00 **James E. Pascoe (Washington University in St. Louis)**
TBA

15:00-15:30 **Marcell Gaal (University of Szeged)**
On a class of determinant preserving maps for finite von Neumann algebras

15:30-16:00 **TEA BREAK**

16:00-16:30 **Raphael Clouatre (University of Manitoba)**
Hyperrigidity via non-commutative function systems on state spaces

16:30-17:00 **Eric Evert (University of California San Diego)**
Absolute Extreme Points of Free Spectrahedra

17:00-17:30 **Baruch Solel (Israel Institute of Technology)**
Minimal and maximal matrix convex sets

Tuesday, July 24

14:30-15:00 **Joe Ball (Virginia Polytechnic Institute and State University)**
TBA

15:00-15:30 **Gregory Marx (Virginia Polytechnic Institute and State University)**
A Positivstellensatz for free noncommutative functions

15:30-16:00 **Guy Salomon (Israel Institute of Technology)**
Algebras of bounded noncommutative functions on noncommutative varieties

16:00-16:30 **TEA BREAK**

16:30-17:00 **Eli Shamovich (University of Waterloo)**
Fixed Points of Free Self-Maps of the Ball

17:00-17:30 **Robert T.W. Martin (University of Cape Town)**
The free Smirnov class

17:30-18:00 **Nicholas Young (Newcastle University & Leeds University)**
The free Riemann surface of the noncommutative square root function

Wednesday, July 25

14:00-14:30 **Victor Vinnikov (Ben-Gurion University of the Negev)**
TBA

14:30-15:00 **Motke Porat (Ben-Gurion University of the Negev)**
TBA

15:00-15:30 **Bill Helton (University of California San Diego)**
TBA

15:30-16:00 **TEA BREAK**

16:00-16:30 **Igor Klep (University of Auckland)**
Free Real and Convex Algebraic Geometry

16:30-17:00 **Jurij Volcic (Ben-Gurion University of the Negev)**
A Nullstellensatz for noncommutative polynomials

Thursday, July 26

14:00-14:30 **Jiawang Nie (University of California San Diego)**
Tight Relaxations for Polynomial Optimization and Lagrange Multiplier Expressions

14:30-15:00 **Maria Infusino (University of Konstanz)**
Projective limit techniques for the infinite dimensional moment problem

15:00-15:30 **Samya Kumar Ray (Indian Institute of Technology Kanpur)**
TBA

15:30-16:00 **TEA BREAK**

16:00-16:30 **Edward Timko (University of Manitoba)**
TBA

16:30-17:00 **Ryan Tully-Doyle (Hampton University)**
TBA

17:00-17:30 **Michael Hartz (Washington University in St. Louis)**
Quotients of multipliers in complete Pick spaces

Speaker: Raphael Clouatre (University of Manitoba)
Title: *Hyperrigidity via non-commutative function systems on state spaces*
Abstract: Arveson's hyperrigidity conjecture puts a non-commutative spin on a classical approximation result of Korovkin and Šaškin from the theory of function systems on compact metric spaces. Underlying this idea is the philosophy that $*$-representations are the non-commutative analogue of points in the space. The conjecture then predicts a certain unique extension property for $*$-representations whenever the non-commutative Choquet boundary of an operator system is as large as possible. In this talk, we will explore an alternative perspective, one which "linearizes" the problem by considering states to be the non-commutative points. States are typically simpler to handle than $*$-representations, but we will see how they can nevertheless be used to characterize hyperrigidity of operator systems through various restriction and extension properties. We will also illustrate how peaking behaviour for states can be leveraged to establish a local version of Arveson's conjecture.

Speaker: Eric Evert (University of California San Diego)
Title: *Absolute Extreme Points of Free Spectrahedra*
Abstract: Let $M_n(\mathbb{S})^g$ denote g-tuples of $n \times n$ real symmetric matrices. Given tuples $X = (X_1, \ldots, X_g) \in M_{n_1}(\mathbb{S})^g$ and $Y = (Y_1, \ldots, Y_g) \in M_{n_2}(\mathbb{S})^g$, a matrix convex combination of X and Y is a sum of the form

$$V_1^T X V_1 + V_2^T Y V_2 \qquad V_1^T V_1 + V_2^T V_2 = I_n$$

where $V_1 : M_n(\mathbb{R}) \to M_{n_1}$ and $V_2 : M_n(\mathbb{R}) \to M_{n_2}$ are contractions. Matrix convex sets are sets which are closed under matrix convex combinations. A key feature of matrix convex combinations is that the g-tuples X, Y, and $V_1^T X V_1 + V_2^T Y V_2$ do not need to have the same size. As a result, matrix convex sets are a dimension free generalization of convex sets.

While in the classical setting there is only one good notion of an extreme point, there are three natural notions of extreme points for matrix convex sets: ordinary, matrix, and absolute extreme points. A central goal in the theory of matrix convex sets is to determine if one of these notions of extreme points for matrix convex sets is minimal with respect to spanning.

Absolute extreme points are the most restricted class of extreme points of matrix convex sets and are closely related to Arveson's boundary and satisfy a strong notion of minimality should they span. While general finite dimensional matrix convex sets may fail to have absolute extreme points, every compact matrix convex set which is defined by a linear matrix inequality, i.e. a free spectrahedron, has absolutes extreme points. This talk will focus on the properties of absolute extreme points of free spectrahedra, some theoretical and some conjectured from experiments.

Speaker: Marcell Gaal (University of Szeged)
Title: *On a class of determinant preserving maps for finite von Neumann algebras*
Abstract: Let $\mathscr{R}$ be a finite von Neumann algebra with a faithful tracial state τ and let Δ denote the associated Fuglede-Kadison determinant. In this paper, we characterize all unital bijective maps ϕ on the set of invertible positive elements in $\mathscr{R}$ which satisfy

$$\Delta(\phi(A) + \phi(B)) = \Delta(A + B).$$

We show that any such map originates from a τ-preserving Jordan $*$-automorphism of $\mathscr{R}$ (either $*$-automorphism or $*$-anti-automorphism in the more restrictive case of finite factors). In

establishing the aforementioned result, we make crucial use of the solutions to the equation $\Delta(A+B) = \Delta(A)+\Delta(B)$ in the set of invertible positive operators in $\mathscr{R}$. To this end, we give a new proof of the inequality

$$\Delta(A+B) \geq \Delta(A) + \Delta(B),$$

using a generalized version of the Hadamard determinant inequality and conclude that equality holds for invertible B if and only if A is a nonnegative scalar multiple of B.

Speaker: Michael Hartz (Washington University in St. Louis)
Title: *Quotients of multipliers in complete Pick spaces*
Abstract: Every function in the Hardy space on the unit disc is a quotient of two bounded analytic functions. I will talk about a generalizations of this result to other function spaces. Moreover, I will explain applications to zero sets and invariant subspaces and connections to non-commutative function theory. This is joint work with Alexandru Aleman, John McCarthy and Stefan Richter.

Speaker: Maria Infusino (University Konstanz)
Title: *Projective limit techniques for the infinite dimensional moment problem*
Abstract: In this talk we deal with the following general version of the classical moment problem: when can a linear functional on a unital commutative real algebra A be represented as an integral w.r.t. a Radon measure on the character space of A equipped with the Borel sigma-algebra generated by the weak topology? In a joint work with Salma Kuhlmann, Tobias Kuna and Patrick Michalski, we approach this problem by constructing the character space $X(A)$ as a projective limit of a certain family of Borel measurable spaces and so by considering on $X(A)$ the associated cylinder sigma-algebra beside the Borel one. This allows us to obtain representations of linear functionals, which are positive on sum of squares in A and fulfill certain quasi-analytic bounds, as integrals w.r.t. measures defined on the cylinder sigma-algebra on $X(A)$. Combining this result with the well-known Prokhorov theorem, we get extensions of such measures to the Borel sigma-algebra and, hence, generalize to infinitely (even uncountably) generated algebras some of the classical theorems for the moment problem such as the ones by Nussbaum and Putinar. Our results apply in particular to the case when A is the polynomial algebra in an arbitrary number of variables or the symmetric algebra of a locally convex real vector space of arbitrary dimension, providing alternative proofs of some recent results for these instances of the moment problem and offering at the same time a unified setting which enables comparisons.

Speaker: Igor Klep (University of Auckland)
Title: *Free Real and Convex Algebraic Geometry*
Abstract: The talk will give background and basics for this burgeoning field and then describe recent results. The talks of Igor Klep and Bill Helton will be coordinated but each will be presented in a self-contained way. Work described will be joint mostly with Scott McCullough, Meric Augat, and Jurij Volčič.

Speaker: Robert T.W. Martin (University of Cape Town)
Title: *The free Smirnov class*
Abstract: We prove that any closed, densely-defined operator is affiliated to the right free shift of the full Fock space over $\mathbb{C}^d$ if and only if it acts as right multiplication by a free holomorphic function in the right free Smirnov class. Here the Fock space is identified with the free Hardy space of bounded free holomorphic functions on the open non-commutative multi-variable unit ball, and the right free Smirnov class is the algebra of ratios of right free multipliers with outer denominator.

Several further characterizations and applications including Lebesgue decomposition of free Aleksan-drov-Clark functionals will be discussed.

Speaker: Gregory Marx (Virginia Polytechnic Institute and State University)
Title: *A Positivstellensatz for free noncommutative functions*
Abstract: A well-known theorem due to J.W. Helton says that a nonnegative free noncommutative polynomial is a sum of squares. This result is an example of a Positivestellensatz, i.e., an algebraic certificate for those functions satisfying an appropriate positivity condition. In this talk, we present a Positivestellensatz for the broader class of free noncommutative functions and discuss connections with other Positivstellensätze in the literature. This talk is based on on-going work with J.A. Ball and V. Vinnikov.

Speaker: Jiawang Nie (University of California San Diego)
Title: *Tight Relaxations for Polynomial Optimization and Lagrange Multiplier Expressions*
Abstract: We propose tight semidefinite relaxations for polynomial optimization. The optimality conditions are investigated. We show that generally Lagrange multipliers can be expressed as polynomial functions in decision variables over the set of critical points. The polynomial expressions can be determined by linear equations. Based on these expressions, new Lasserre type semidefinite relaxations are constructed for solving polynomial optimization. We show that the hierarchy of new relaxations has finite convergence, or equivalently, the new relaxations are tight for a finite relaxation order. James E. Pascoe Washington University in St. Louis

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Speaker: Guy Salomon (Israel Institute of Technology)
Title: *Algebras of bounded noncommutative functions on noncommutative varieties*
Abstract: The algebra of bounded noncommutative (nc) functions over a nc subvariety of the nc ball can be identified as the multiplier algebra of a certain reproducing kernel Hilbert space consisting of nc functions on the subvariety.

In this talk I will try to answer the following question: in terms of the underlying varieties, when are two such algebras isomorphic? (The word "isomorphic" will be considered in at least four different categories.)

Along the way, I will show that while in some aspects the nc and the classical commutative settings share a similar behavior, the first enjoys — and also suffers from — some unique nc phenomenons.

The talk is based on a joint work with Orr Shalit and Eli Shamovich.

Speaker: Peter Semrl (University of Ljubljana)
Title: *Isometries of Grassmann spaces*
Abstract: Let H be a (real or complex) Hilbert space and n a positive integer. We denote by $P_n(H)$ the set of all rank n projections on H. In the case when H is an infinite-dimensional separable Hilbert space, the symbol $P_\infty(H)$ stands for the set of all projections whose images and kernels are both infinite-dimensional. By $\|\cdot\|$ we denote the usual operator norm on $B(H)$, the set of all bounded linear operators on H. The distance on the set of all projections induced by the operator norm is usually called the gap metric. The structural results for surjective isometries of $P_n(H)$, $n = 1, 2, 3, \ldots$, and $P_\infty(H)$ with respect to the gap metric will be presented.

Speaker: Eli Shamovich (University of Waterloo)
Title: *Fixed Points of Free Self-Maps of the Ball*
Abstract: In this talk, I will discuss the free generalization of the classical results of Rudin and Hevre on fixed points of self-maps of the unit ball. Let $f\colon \mathfrak{B}_d \to \mathfrak{B}_d$ be a free noncommutative (nc) map, such that $f(0) = 0$. Here $\mathfrak{B}_d$ stands for the free ball, i.e, the nc-set of all matrix d-row contractions. I will explain how one can apply the Perron-Frobenius theory of completely positive maps on matrix algebras combined with some classical hyperbolic geometry of convex domains to show that the fixed points of f are an intersection of a quantization of a subspace with $\mathfrak{B}_d$. I will show how this result applies to the question of completely isometric isomorphism of certain quotients of the free semigroup algebra generated by the creation operators.

Speaker: Baruch Solel (Israel Institute of Technology)
Title: *Minimal and maximal matrix convex sets*
Abstract: To every convex body $K \subseteq \mathbb{R}^d$, one may associate a minimal matrix convex set $\mathcal{W}^{\min}(K)$, and a maximal matrix convex set $\mathcal{W}^{\max}(K)$, which have K as their ground level. The main question treated in this talk is: under what conditions on a given pair of convex bodies $K, L \subseteq \mathbb{R}^d$ does $\mathcal{W}^{\max}(K) \subseteq \mathcal{W}^{\min}(L)$ hold? For a convex body K, we aim to find the optimal constant $\theta(K)$ such that $\mathcal{W}^{\max}(K) \subseteq \theta(K)\mathcal{W}^{\min}(K)$; we achieve this goal for all the ℓ^p unit balls, as well as for other sets. For example, if $\overline{\mathbb{B}}_{p,d}$ is the closed unit ball in $\mathbb{R}^d$ with the ℓ^p norm, then

$$\theta(\overline{\mathbb{B}}_{p,d}) = d^{1-|1/p-1/2|}.$$

This constant is sharp, and it is new for all $p \neq 2$. Moreover, for some sets K we find a minimal set L for which $\mathcal{W}^{\max}(K) \subseteq \mathcal{W}^{\min}(L)$. In particular, we obtain that a convex body K satisfies $\mathcal{W}^{\max}(K) = \mathcal{W}^{\min}(K)$ if and only if K is a simplex.

These problems relate to dilation theory, convex geometry, operator systems, and completely positive maps. We discuss and exploit these connections as well. For example, our results show that every d-tuple of self-adjoint operators of norm less than or equal to 1, can be dilated to a commuting family of self-adjoints, each of norm at most $\sqrt{d}$. We also introduce new explicit constructions of these (and other) dilations. This is a joint work with Ben Passer and Orr Shalit.
Michael Stessin State University of New York at Albany

Speaker: Jurij Volcic (Ben-Gurion University of the Negev)
Title: *A Nullstellensatz for noncommutative polynomials*
Abstract: The talk concerns (matrices of) noncommutative polynomials $f = f(x)$ from the perspective of free real algebraic geometry. There are several natural notions of a "zero set" of f. The one we study is the free locus of f, $\mathcal{Z}(f)$, which is defined to be the union of hypersurfaces

$$\{X \in \mathbf{M}_n(k)^g : \det f(X) = 0\}$$

over all $n \in \mathbb{N}$. The talk will describe a recent advance on characterizing when $\mathcal{Z}(f_1) \subseteq \mathcal{Z}(f_2)$ holds, and other results concerning geometric properties of free loci.

The talk is be based on joint work with J.W. Helton and I. Klep.

Infinite Dimension Systems and Wavelets

Organizer: **Marcin Bownik** (University of Oregon)
Xingde Dai (University of North Carolina at Charlotte)
Qiyu Sun (University of Central Florida)

Venue: **Room 210, Tianjiabing Building**

Monday, July 23

14:00-14:25 **Marcin Bownik (University of Oregon)**
Open problems in wavelet theory

14:30-14:55 **Eric Weber (Iowa State University)**
The Kaczmarz Algorithm and Harmonic Analysis of Singular Measures

15:00-15:25 **Felix Voigtlaender (Katholische Universität Eichstätt-Ingolstadt Germany)**
Analyzing sparsity properties of frames using decomposition spaces

15:30-16:00 **TEA BREAK**

16:00-16:25 **Hong kun Xu (Hangzhou Dianzhi University)**
Nonconvex Regularization Techniques for Sparse Signal Recovery

16:30-16:55 **Ilya Kristhal (Northern Illinois University)**
Phaseless reconstruction in dynamical sampling

17:00-17:25 **Youfa Li (Guangxi University)**
Phase retrieval for the union of cones

Tuesday, July 24

14:00-14:25 **Ole Christensen (Denmark Technical University)**
Frames and dynamical sampling

14:30-14:55 **Say Song Goh (National University of Singapore)**
Frame constructions on locally compact abelian groups

15:00-15:25 **Jakob Lemvig (Denmark Technical University)**
Criteria for generalized translation-invariant frames and the Walnut operator

15:30-16:00 **TEA BREAK**

16:00-16:25 **Yunzhang Li (Beijing University of Technology)**
The frame theory on the half real line

16:30-16:55 **Zhongyan Li (North China Electric Power University)**
Some results on Frame Wavelets Multipliers

Wednesday, July 25

14:00-14:25 **Alexander Powell (Vanderbilt University)**

Sharp Balian-Low theorems and Fourier multipliers

14:30-14:55 **Serap Öztop Kaptanoğlu (Istanbul University)**

Gabor Analysis on Heisenberg-Type Group Extensions

15:00-15:25 **Jinsong Leng (University of Electronic Science and Technology)**

TBA

15:30-16:00 **TEA BREAK**

16:00-16:25 **Xunxiang Guo (Southwestern University of Finance and Economics)**

Joint Similarities and Parameterizations for Naimark Complementary Frames

16:30-16:55 **Xingde Dai (University of North Carolina at Charlotte)**

Isomorphism in wavelets

Speaker: Ole Christensen (Denmark Technical University)
Title: *Frames and dynamical sampling*
Abstract: The talk will give a short survey on frame theory in Hilbert spaces, followed by a more detailed discussion of the recent recearch topic "dynamical sampling." Formulated in purely mathematical terms, the key question is when and how a frame a frame can be represented via iterations of a certain bounded operator, acting on a fixed vector in the underlying Hilbert space. The talk presents joint work with Marzieh Hasannasab.

Speaker: Xingde Dai (University of North Carolina at Charlotte)
Title: *Isomorphism in wavelets*
Abstract: Two scaling functions φ_A and φ_B for Parseval frame wavelets are algebraically isomorphic, $\varphi_A \simeq \varphi_B$, if they have matching solutions to their (reduced) isomorphic systems of equations. Let A and B be $d \times d$ and $s \times s$ dyadic expansive integral matrices with $d, s \geq 1$ respectively and let φ_A be a scaling function associated with matrix A and generated by a finite solution. Then there always exists a scaling function φ_B associated with matrix B such that φ_B is algebraically isomorphic to φ_A. An example shows that the assumption on the finiteness of the solutions can not be removed.

Speaker: Say Song Goh (National University of Singapore)
Title: *Frame constructions on locally compact abelian groups*
Abstract: Gabor frames and wavelet frames on the real line are two areas of active research with many practical applications. Both of these frames can be unified and generalized under the setting of locally compact abelian groups. This generalization, in the notion of Fourier-type frames, covers both stationary and nonstationary cases, as well as various variants of Gabor frames and wavelet frames in the literature. We focus on establishing general approaches to construct explicitly Fourier-type frames. One approach utilizes the partition of unity condition to satisfy the frame conditions, while another is the unitary extension principle on locally compact abelian groups. The resulting Fourier-type frames, defined on the dual group, are generated by modulates of a collection of functions. As illustrations, weighted B-splines on locally compact abelian groups are used to construct localized Gabor frames on the dual group and localized tight wavelet frames on the group. This is joint work with Ole Christensen.

Speaker: Xunxiang Guo (Southwestern University of Finance and Economics)
Title: *Joint Similarities and Parameterizations for Naimark Complementary Frames*
Abstract: It is known that the Naimark complementary frames for a given frame are not necessarily unique up to the similarity. In this paper we introduce the concept of joint complementary frame pairs for a given dual frame pair, and prove that they are unique up to the joint similarity. As an application, we give a necessary and suffcient condition under which two Naimark complementary frames are similar. For different pairs of dual frames, we present an operator parameterization for their joint complementary frame pairs.

Speaker: Jakob Lemvig (Denmark Technical University)
Title: *Criteria for generalized translation-invariant frames and the Walnut operator*

Abstract: Generalized shift-invariant (GSI) systems in $L^2(\mathbb{R}^n)$ are structured and flexible function systems of the form $(g_j(\cdot - \gamma))_{j\in J,\gamma\in\Gamma_j}$, where $(\Gamma_j)_{j\in J}$ and $(g_j)_{j\in J}$ are countable families of lattices in $\mathbb{R}^n$ and functions in $L^2(\mathbb{R}^n)$, respectively. GSI systems have since the beginning of the millennium been used as a unifying framework for the study of Gabor, wavelet, curvelet, shearlet, etc. systems, but they have only recently been identified as function systems of independent interest offering adaptive time-frequency and time-scale representations. As a consequence, many fundamental questions on GSI systems are still unanswered. In this talk we focus on sufficient and necessary conditions for the frame property of generalized translation-invariant systems, which are a generalization of GSI systems to include continuous transforms. The conditions are formulated in the Fourier domain and consists of estimates involving the upper and lower frame bound. Contrary to known conditions of a similar nature, the estimates take the phase of the generating functions in consideration and not only their modulus. The possibility of phase cancellations makes these estimates optimal for tight frames. We relate these conditions to a Walnut representation of the frame operator. Our results also shed new light on the case of sufficient and necessary conditions for the frame property of wavelet systems in $L^2(\mathbb{R}^n)$, e.g., we obtain Daubechies-Tchamitchian type estimates and a lower bound of the Calderón sum for almost all dilations $A \in \mathrm{GL}_n(\mathbb{R})$. *This talk is based on joint work with Jordy van Velthoven and Hartmut Führ.*

Speaker: Youfa Li (Guangxi University)
Title: *Phase retrieval for the union of cones*
Abstract: The phase retrieval for the union of cones on R^n can be done by two procedures: to identify the source of a target signal, and to recover it. The procedures are all completed by magnitude measurements. For the identification, we give the sufficient and necessary condition on the cones such that each of them can be distinguished from others. Under the condition, we prove that the phase retrieval of every cone can be done by at most n vectors. Therefore $n + L - 1$ vectors are sufficient for the phase retrieval on the union of L cones, where $L <= n$. Moreover, we construct $n+L-1$ special vectors by which the total operations for identification and recovery cost at most FFT time. Numerical experiments are conducted to compare our method with PhaseLift, Wirtinger Flow, BlockPR and Alternating Minimization.

Speaker: Yunzhang Li (Beijing University of Technology)
Title: *The frame theory on the half real line*
Abstract: This talk addresses the frame theory in $L^2(\mathbb{R}_+)$. We will give an overview of its development, and then focus on our some recent results on dilation-and-modulation frames in $L^2(\mathbb{R}_+)$. And we will show that dilation-and-modulation frames have distinct properties from the usual wavelet and Gabor frames.

Speaker: Zhongyan Li (North China Electric Power University)
Title: *Some results on Frame Wavelets Multipliers*
Abstract: In this Talk, we will present some results on wavelet multipliers, frame wavelet multipliers and their applications; Gabor frame wavelet multipliers and multipliers on finite group representation frames.

Speaker: Serap Öztop Kaptanoğlu (Istanbul University)
Title: *Gabor Analysis on Heisenberg-Type Group Extensions*
Abstract: Let A be a locally compact Abelian group and G be a locally compact group. We study a continuous Gabor transform on a non-Abelian central group extension G_A of A by G induced by a 2-cocycle map of the form $\omega : G \times G \to A$, where G_A is equipped with a Heisenberg-type multiplication. Locally compact Abelian groups have been seen as a natural setting for time-frequency analysis. We observe that many basic properties of Gabor transform carry over to the central group extensions G_A. This presentation is based on joint work with Elçim Elgün at İstanbul University.

Speaker: Ilya Kristhal (Northern Illinois University)
Title: *Phaseless reconstruction in dynamical sampling*
Abstract: The talk is about the problem of phaseless reconstruction in the context of dynamical sampling in finite and infinite dimensional spaces. We will discuss a sufficient condition for phaseless reconstruction that involves a possibly new class of matrices. The talk is based on joint research with A. Aldroubi and S. Tang.

Speaker: Alexander M. Powell (Vanderbilt University)
Title: *Sharp Balian-Low theorems and Fourier multipliers*
Abstract: The classical Balian-Low theorem is a strong form of the uncertainty principle that constrains the time-frequency localization of Gabor systems that form orthonormal bases. We discuss a general- ization of the Balian-Low theorem that provides a sharp scale of constraints on the time-frequency localization of Gabor systems under a weaker form of spanning structure associated with so-called Cq systems. Admissibility conditions on Fourier multipliers play an important role in the proofs and, as an additional application, yield sharp Balian-Low type theorems in the setting of shift-invariant spaces.

This is joint work with Shahaf Nitzan and Michael Northington.

Speaker: Felix Voigtlaender (Katholische Universität Eichstätt-Ingolstadt Germany)
Title: *Analyzing sparsity properties of frames using decomposition spaces*
Abstract: We present a systematic approach towards understanding the sparsity properties of different frame constructions like Gabor systems, wavelets, shearlets, and curvelets. Here, analysis sparsity means that the frame coefficients are sparse (in an ℓ^p sense), while synthesis sparsity means that the function can be written as a linear combination of the frame elements using sparse coefficients. We show that both forms of sparsity of a function are equivalent to membership of the function in a certain decomposition space. These decomposition spaces are a common generalization of Besov spaces and modulation spaces. While Besov spaces can be defined using a dyadic partition of unity on the Fourier domain, modulation spaces employ a uniform partition of unity, and general decomposition spaces use an (almost) arbitrary partition of unity on the Fourier domain. To each decomposition space, there is an associated frame construction: Given a generator, the resulting frame consists of certain translated, modulated and dilated versions of the generator. These are chosen so that the frequency concentration of the frame is similar to the frequency partition of the decomposition space. For Besov spaces,

one obtains wavelet systems, while modulation spaces yield Gabor systems. We give conditions on the (possibly compactly supported!) generator of the frame which ensure that analysis sparsity and synthesis sparsity of a function are both equivalent to membership of the function in the decomposition space.

Speaker: Eric Weber (Iowa State University)
Title: *The Kaczmarz Algorithm and Harmonic Analysis of Singular Measures*
Abstract: The Kaczmarz algorithm is an iterative method for solving (finite) systems of linear equations. Kwapien and Mycielski have proven that the algorithm converges to the solution in infinite-dimensional Hilbert spaces under the conditions that the "rows of the matrix" form a stationary sequence, and the spectral measure of this stationary sequence is singular. This remarkable result has provided a new tool for understanding the harmonic analysis of singular measures, including the existence of Fourier series expansions, boundary representations for certain subspaces of the Hardy space, and Paley-Wiener like characterizations of entire functions with singular spectra. We shall present an overview of these results that are consequences of the Kaczmarz algorithm.

Speaker: Hong kun Xu (Hangzhou Dianzi University)
Title: *Nonconvex Regularization Techniques for Sparse Signal Recovery*
Abstract: To recover a sparse signal from the linear system $Ax = b$, a convex l_p regularization method (i.e., $1 \leq p < 2$) is commonly used under certain conditions. Recently, however, more attentions have been paid to use the nonconvex l_p regularization method (i.e., $0 < p < 1$, in particular, $p = 1/2$) to recover a sparse signal. In this talk, we will discuss a nonconvex reweighted l_p regularization method for recovering a sparse signal from the linear system. Our model is the nonconvex version of the model of S. Voronin and I. Daubechies (An iteratively reweighted least squares algorithm for sparse regularization, arXiv:1511.08970v3).

Multivariable Operator Theory

Organizers: **Joseph A. Ball** (Virginia Tech)
Ronald G. Douglas (Texas A&M University)
Rongwei Yang (the State University of New York at Albany)

Venue: **Room 226, Tianjiabing Building**

Monday, July 23

14:00-14:30 **Joseph Ball (Virginia Tech)**
Functional models and invariant subspaces for pairs of commuting contractions

14:30-15:00 **Tirthankar Bhattacharyya (Indian Institute of Science-Bangalore)**
Interpolating Sequences

15:00-15:30 **Zinaida Lykova (University of Newcastle)**
The norm-preserving extension property in the symmetrize bidisc Γ and von Neumann-type inequalities for Γ-contractions

15:30-16:00 **TEA BREAK**

16:00-16:30 **Sourav Pal (Indian Institute of Technology-Bombay)**
Rational dilation on the symmetrized n-disk for any $n \geq 2$: failure, success and unknown

16:30-17:00 A**riel Pinhas (Ben-Gurion University of the Negev)**
Caratheodory functions on compact Riemann surface and the associated reproducing kernel spaces

Tuesday, July 24

14:00-14:30 **Quanlei Fang (City University of New York)**
Hankel operators on weighted Bergman spaces and norm ideals

14:30-15:00 **Yi Wang (Texas A&M University)**
An inequality involving principal submodules on strongly pseudoconvex domains

15:00-15:30 **Jingbo Xia (SUNY at Buffalo)**
Essential normality for quotient modules and complex dimensions

15:30-16:00 **TEA BREAK**

16:00-16:30 **Kehe Zhu (SUNY at Albany)**
Hankel operators between Bergman spaces

16:30-17:00 **Kui Ji (Hebei Normal University)**
Curvature and similarity of Cowen-Douglas operators

Wednesday, July 25

14:00-14:30 **Rostislav Grigorchuk (Texas A&M University)**
Projective joint spectrum: the dynamical approach

14:30-15:00 **Bryan Goldberg (SUNY at Albany)**
Complex dynamics on the projective spectrum of the infinite dihedral group

15:00-15:30 **Wei He (Southeastern University)**
Projective spectrum and Kernel bundle

15:30-16:00 **TEA BREAK**

16:00-16:30 **Rongwei Yang (SUNY at Albany)**
Projective spectrum and weak containment of group representations

16:30-17:00 **Yanqi Qiu (Inst. of Mathematics, Chinese Academy of science)**
Patterson-Sullivan measures for point processes and reconstruction of holomorphic functions

Thursday, July 26

14:00-14:30 **Salma Kuhlmann (Universitat Konstanz)**
The moment problem for infinite dimensional spaces

14:30-15:00 **Raul Curto (University of Iowa)**
Spherically quasinormal pairs of commuting operators

15:00-15:30 **Ji Eun Lee (Sejong University-Seoul)**
Properties of (m, C)-isometric commuting tuples of operators

15:30-16:00 **TEA BREAK**

16:00-16:30 **Constanze D. Liaw (University of Delaware)**
Finite rank d-perturbations

16:30-17:00 **Mai Tran (SUNY at Albany)**
Non-Euclidean metrics on resolvent set

Speaker: Joseph A. Ball (Virginia Tech)
Title: *Functional models and invariant subspaces for pairs of commuting contractions*
Abstract: We present a Sz.-Nagy–Foias-type functional model for a pair of commuting contractions T_1, T_2 with product $T = T_1T_2 = T_2T_1$ equal to a completely non-unitary (cnu) contraction operator. In addition to the Sz.-Nagy–Foias characteristic operator function $(\mathcal{D}, \mathcal{D}_*, \Theta)$ for the cnu contraction operator T, we identify some additional invariants ($\mathbb{G} = (G_1, G_2)$ equal to a pair of contraction operators on $\mathcal{D}_*$ and $\mathbb{W} = (W_1, W_2)$ equal to a pair of unitary operators $\mathbb{W} = (W_1, W_2)$ on the defect space $\overline{\Delta_\Theta L^2_\mathcal{D}}$ (here $\Delta_\Theta(\zeta) = (I - \Theta(\zeta)^*\Theta(\zeta))^{1/2}$ on the unit circle $\mathbb{T}$) subject to some additional conditions) which together serve as a complete unitary invariant for the triple (T_1, T_2, T) (up to a natural notion of coincidence), and which lead to the functional model for the triple (T_1, T_2, T). A key ingredient in the analysis is a concise construction of an Andô isometric lift for the commuting contractive pair (T_1, T_2) with the Sz.-Nagy–Foias functional model for the minimal isometric lift of T as the starting point. We then use this functional model to characterize invariant subspaces for pairs of commuting contractions and illustrate the theory with some simple examples. This is a report on joint work with Haripada Sau currently at Virginia Tech who was originally scheduled to give this talk.

Speaker: Tirthankar Bhattacharyya (Indian Institute of Science-Bangalore)
Title: *Interpolating Sequences*
Abstract: We discuss a brief history of interpolating sequences in the unit disc and the bidisc followed by a characterization of such sequences in the symmetrized bidisc.

Speaker: Raul Curto (University of Iowa)
Title: *Spherically quasinormal pairs of commuting operators*
Abstract: We study spherically quasinormal commuting pairs of Hilbert space operators, which are the fixed points of the spherical Aluthge transform. In the case of commuting 2-variable weighted shifts, we prove that spherically quasinormal pairs are intimately related to spherically isometric pairs. We show that all spherically quasinormal 2-variable weighted shifts arise from a single unilateral weighted shift (either the 0-th row or the 0-th column in the weight diagram).

We then focus our attention on the case when this unilateral weighted shift is recursively generated (which corresponds to a finitely atomic Berger measure). We show that in this case the 2-variable weighted shift is also recursively generated, with a finitely atomic Berger measure that can be computed from its 0-row or 0-column. We do this by invoking the relevant Riesz functionals and the functional calculus for the columns of the associated moment matrix.

The talk is based on joint work with Jasang Yoon.

Speaker: Quanlei Fang (City University of New York)
Title: *Hankel operators on weighted Bergman spaces and norm ideals*
Abstract: In this talk we consider Hankel operators H_f on the weighted Bergman space. We e give a characterization of the membership of $(H_f^*H_f)^{s/2} = |H_f|^s$ in the norm ideal $\mathcal{C}_\Phi$, where $0 < s \leq 1$ and the symmetric gauge function Φ is allowed to be arbitrary. This is a joint work with Jingbo Xia.

Speaker: Bryan Goldberg (the State University of New York at Albany)
Title: *Complex Dynamics on the Projective Spectrum of the Infinite Dihedral Group*
Abstract: Using the self-similarity of the infinite dihedral group (D_∞) in *Joint Spectrum and the Infinite Dihedral Group*, Grigorchuk and Yang defined a mapping $F : \mathbb{C}^3 \to \mathbb{C}^3$ where $F(z) = \big(z_0(z_0^2 - z_1^2 - z_2^2), z_1^2 z_2, z_2(z_0^2 - z_2^2)\big)$. After establishing some background on $F(z)$ we'll use complex dynamics to establish some properties of this mapping. We'll use equivalent projective space and look at $F : \mathbb{P}^2 \to \mathbb{P}^2$ to discuss some results about the extended indeterminacy set, cyclic points, and components of the Fatou and Julia sets. We'll conclude by examing connections between spectral theory and dynamics in this particular situation. This is a joint work with Rongwei Yang.

Speaker: Rostislav Grigorchuk (Texas A&M University)
Title: *Projective joint spectrum: The dynamical approach*
Abstract: I will explain how problems of spectral theory of groups and graphs in some cases naturally lead to the necessity to study a joint projective spectrum of pencils of operators associated with unitary representations of groups. Then I will explain how this problem in some cases can be converted to a problem from the theory of dynamical systems, namely: finding an appropriate invariant set for a multidimensional rational mapping. Several examples will be considered where the invariant set is a Julia set of the corresponding map. Also a certain measure, called the KNS (Kesten-von Neumann-Serre) spectral measure, will be defined and its role and dynamical interpretation will be explained.

Speaker: Wei He (Southeast University)
Title: *Projective spectrum and kernel bundle*
Abstract: For a tuple $A = (A_1, A_2, \ldots, A_n)$ of elements in a unkital Banach algebra $\mathcal{B}$, its associated multiparameter pencil is $A(z) = z_1A_1 + z_2A_2 + \cdots + z_nA_n$ and its normalized multiparameter pencil is $A_*(z) = I + A(z)$. The *projective joint spectrum* $P(A)$ or $P(A_*)$ is the collection of $z \in \mathbb{C}^n$ such that $A(z)$, or respectively $A_*(z)$, is not invertible. In this talk, we will show some topological properties of the projective joint spectrum and projective resolvent set. Firstly, if $\mathcal{B}$ is Banach, then the resolvent set $P^c(A)$ consists of domains of holomoprhy. Secondly, we study tuples of compact operators on an infinite dimensional Banach space. Clearly $P(A) = \mathbb{C}^n$ in this case. But it is known that $P(A_*)$ is a *thin set*. We show that if $P(A_*)$ is *smooth*, then $\vee_{z\in P(A_*)} \ker A_*(z)$ forms a holomorphic line bundle over $P(A_*)$. For linearly indejpendent vectors e_1, e_2, e_3 and $A_i = e_i \otimes e_i$, $i = 1, 2, 3$, the smoothness of $P(A_*)$ depends rather subtly on the relative position of the vectors. As an example, we compute the Chern character of the line bundle in the two vectro case and show that it is nontrivial.

Speaker: Kui Ji (Hebei Normal University)
Title: *Curvature and similarity of Cowen-Douglas operators*
Abstract: Let Ω be a bounded connected open subset of complex plane $\mathbb{C}$ and n be a positive integer. Let H be a complex separable Hilbert space. In this talk, we study a class of bounded linear operators on Hilbert space, $B_n(\Omega)$, which was first introduced by M. J. Cowen and R. G.

Douglas as follows:

$$\begin{aligned}\mathcal{B}_n(\Omega) := \{T \in \mathcal{L}(\mathcal{H}) : \ & (1)\ \Omega \subset \sigma(T) := \{w \in \mathbb{C} : T - wI \text{ is not invertible}\},\\ & (2)\ \bigvee_{w\in\Omega} \text{Ker}(T-w) = \mathcal{H},\\ & (3)\ \text{Ran}(T-w) = \mathcal{H},\\ & (4)\ \dim \text{Ker}(T-w) = n, \forall\ w \in \Omega.\}\end{aligned}$$

It follows that $\pi : E_T \to \Omega$, where

$$E_T = \{\text{Ker}(T-w) : w \in \Omega, \pi(\text{Ker}(T-w)) = w\}$$

defines a Hermitian holomorphic vector bundle on Ω. Let E be a Hermitian holomorphic vector bundle, following M. I. Cowen and R. G. Douglas, the curvature for E can be defined as:

$$K(w) = -\frac{\partial}{\partial \overline{w}}(h^{-1}\frac{\partial h}{\partial w}), \text{for all } w \in \Omega,$$

where the metric h defined as the following:

$$h(w) = (\!(< \gamma_j(w), \gamma_i(w) >)\!)_{n\times n}, \forall w \in \Omega,$$

where $\{\gamma_1, \gamma_2, \cdots, \gamma_n\}$ is a frame of E over Ω.

In this talk, we will discuss the similarity classifcation of opeators in Cowen-Douglas operators by using some geometric invariants involving curvatures.

Speaker: Salma Kuhlmann (Universität Konstanz)
Title: *The moment problem for infinite dimensional spaces*
Abstract: In this talk, we shall present the multivariate moment problem in the general context of the polynomial algebra $\mathbb{R}[x_i \mid i \in \Omega]$ in an arbitrary number of variables x_i, $i \in \Omega$. We shall introduce the class of *constructibly Radon measures* (cf. [1]) on an infinite dimensional real vector space, and explain how they provide solutions to the above moment problem. We shall then recast our results in terms of *cylinder measures*, thus providing a comparison to the results of [2].

References:

[1] M. Ghasemi, S. Kuhlmann, M. Marshall, Moment problem in infinitely many variables, Israel J. Math. **212** (2016), 989-1012.

[2] K. Schmüdgen, On the infinite dimensional moment problem, arxiv: 1712.06360 (2017).

Speaker: Ji Eun Lee (Sejong University-Seoul)
Title: *Properties of (m, C)-isometric commuting tuples of operators*
Abstract: A commuting tuple of operators $\mathbf{T} = (T_1, \ldots, T_d) \in \mathcal{B}^{(d)}$ is said to be (m, C)-isometric tuple if

$$\mathcal{Q}_m(\mathbf{T} := \sum_{0\le k\le m} (-1)^{m-k} \binom{m}{k} \left(\sum_{|\beta|=k} \frac{k!}{\beta!} \mathbf{T}^{*\beta} C \mathbf{T}^{\beta} C \right) = 0$$

for some positive intreger m and some conjugation C. In this paper, we study the class of (m, C)-isometric operators. We focus on a multivariable generalization of these single variable (m, C)-isometric operators and provide some of their basic properties of such operators.

The talk is based on joint work with Ould Ahmed Mahmoud Sid Ahmed and Muneo Chō.

Speaker: Constanze D. Liaw (University of Delaware)
Title: *Finite rank d perturbations*
Abstract: Kato-Rosenblum theorem and Aronszajn-Donoghue theory provide us with reasonably good understanding of the subtle theory of rank one $d = 1$ perturbations. We will briefly discuss these statements. When $d > 1$, the situation is different. While the Kato-Rosenblum theorem still ensures the stability of the absolutely continuous part of the spectrum, the singular parts' behavior may be more complex. Nonetheless, some positive results prevail in the finite rank setting.

Speaker: Zanida Lykova (University of Newcastle)
Title: *The norm-preserving extension property in the symmetrized bidisc Γ and von Neumann-type inequalities for Γ-contractions*
Abstract: A set V in a domain U in $\mathbb{C}^n$ has the norm-preserving extension property if every bounded holomorphic function on V has a holomorphic extension to U with the same supremum norm. We describe all algebraic subsets of the symmetrized bidisc

$$G \stackrel{\text{def}}{=} \{(z+w, zw) : |z| < 1,\ |w| < 1\}$$

which have the norm-preserving extension property. In contrast to the case of the ball or the bidisc, there are sets in G which have the norm-preserving extension property, but are not holomorphic retracts of G. We give applications to von Neumann-type inequalities for Γ-contractions (that is, commuting pairs of operators for which the closure of G is a spectral set) and for symmetric functions of commuting pairs of contractive operators.
The talk is based on joint work with Jim Agler and Nicholas Young.

[1] Jim Agler, Zinaida A. Lykova and N. J. Young, Geodesics, retracts, and the norm-preserving extension property in the symmetrized bidisc, accepted by *Memoirs of the American Mathematical Society*, 2016, 106 pp.

Speaker: Sourav Pal (Indian Institute of Technology-Bombay)
Title: *Rational dilation on the symmetrized n-disk for any $n \geq 2$: failure, success and unknown*
Abstract: A commuting tuple of operators $(S_1, \ldots, S_{n-1}, P)$, defined on a Hilbert space $\mathcal{H}$, for which the closed symmetrized polydisc or symmetrized n-disk

$$\Gamma_n = \left\{ \left(\sum_{1\leq i\leq n} z_i, \sum_{1\leq i<j\leq n} z_i z_j, \ldots, \prod_{i=1}^{n} z_i \right) : |z_i| \leq 1, i = 1, \ldots, n \right\}$$

is a spectral set, is called a Γ_n-contraction. We show that rational dilation succeeds on Γ_n for $n = 2$ and fails for all $n \geq 3$. We characterize major classes of Γ_n-contractions which dilate and also identify different classes where we could not draw any conclusion.

Speaker: Ariel Pinhas (Ben-Gurion University of the Negev)
Title: *Carathéodory functions on compact Riemann surfaces and the associated reproducing*

kernel spaces
Abstract: Carathéodory functions, analytic functions with positive real parts in the open upper half-plane $\mathbb{C}_+$, play important role in the theory of reproducing kernel Hilbert spaces, $1D$ system theory and colligation theory. In this talk, we consider Carathéodory functions in the setting of real compact Riemann surfaces. We study the corresponding reproducing kernel Hilbert space and the counterpart of the Herglotz integral representation will be presented. Furhtermore, we establish the relations of Carathéodory functions to pairs of commuting self-adjoint operators and $2D$ overdetermined-impedance-conservative systems. These results are based on joint work with Daniel Alpay and Victor Vinnikov.

Speaker: Yanqi Qiu (Inst. of Mathematics, AMSS, Chinese Academy of Science, CNRS)
Title: *Patterson-Sullivan measures for point processes and reconstruction of holomorphic functions*
Abstract: I will talk about the Patterson-Sullivan measures in random setting for random subsets in hyperbolic spaces. For concreteness, the main part of the talk will be focused on the random configuration generated by the reproducing kernel of Bergman space on hyperbolic unit disc and a reconstruction problem of holomorphic functions including continuous harmonic functions, Hardy functions, Bergman functions from their restrictions to a random uniqueness set. The talk is based on a joint work with Alexander Bufetov.

Speaker: Mai Tran (the State University of New York at Albany)
Title: *Non-Euclidean Metrics On Resolvent Set*
Abstract: For a bounded linear operator A on a complex Hilbert space $\mathcal{H}$, the functions $g_x(z) = \|(A - z)^{-1}x\|^2$, where $x \in \mathcal{H}$ with $\|x\| = 1$, defines a family of non-Euclidean metrics on the resolvent set $\rho(A)$. Thus the arc length of a fixed circle $C \subset \rho(A)$ with respect to the metric g_x is dependent on the choice of x. There is an integral equation for the extremal values of the arc length, and its solution x has particular properties relating to A. In the case A is the unilateral shift operator on the Hardy space $H^2(\mathbb{D})$, the arc length of C is maximal if and only if x is an inner function. This is joint work with R. Yang.

Speaker: Yi Wang (Texas A&M University)
Title: *An Inequality Involving Principal Submodules on Strongly Pseudoconvex Domains*
Abstract: The Arveson-Douglas Conjecture concerns essential normality of submodule and quotient modules of certain reproducing kernel Hilbert modules. An essentially normal quotient module defines an element in the odd K-homology group on the boundary of the variety. In the special case that the corresponding submodule is principal, we show that the conjecture follows by an inequality involving the generator. We prove the inequality for generators that are holomorphic functions in a neighborhood of the closure of a bounded strongly pseudoconvex domain with smooth boundary and therefore obtain new results on the Arveson-Douglas Conjecture. I will also talk about application of this inequality on submodules that are not principal.

Speaker: Jingbo Xia (the State University of New York at Buffalo)

Title: *Essential normality for quotient modules and complex dimensions*
Abstract: For an analytic set $\widetilde{M}$ in $\mathbb{C}^n$, we have the submodule $\mathcal{R} = \{f \in L^2_a(\mathbb{B}_n) \ominus \mathbb{R}\}$. Under standard conditions on $\widetilde{M}$, we show that the quotient module $\mathcal{Q}$ is p-essentially normal for all $p > \dim_{\mathbb{C}} \widetilde{M}$, which verifies the Geometric Araveson-Douglas Conjecture in this case. This result makes it possible to study the Helton-Howe trace invariants on both the quotient module $\mathcal{Q}$ and the submodule $\mathcal{R}$. This is joint work with Yi Wang.

Speaker: Rongwei Yang (the State University of New York at Albany)
Title: *Projective spectrum and weak containment of group representations*
Abstract: Weak containment is a partial order defined for the set of unitary representations of locally compact groups. It has important connections with the spectral theory of linear operators. Weak containment of the trivial representation 1_G plays a surprisingly important role in classifying locally compact groups G into amenable groups, Haagerup groups and Kazhdan groups. In this talk we will look at this classification from the point of view of projective spectrum for operator tuples. Talk is self-contained.

Speaker: Kehe Zhu (State University of New York at Albany and Shantou University)
Title: *Hankel Operators between Bergman Spaces*
Abstract: For any $p > 0$ and $\alpha > -1$ the Bergman space A^p_α consists of holomorphic functions f such that

$$\|f\|^p_{p,\alpha} = \int_{B_n} |f(z)|^p (1 - |z|^2)^\alpha \, dv(z) < \infty,$$

where B_n is the unit ball in C^n and dv is volume measure on B_n. We will consider the boundedness and compactness of the Hankel operators

$$H_\varphi, H_{\overline{\varphi}} : A^p_\alpha \to A^q_\beta.$$

It turns out that the theory critically depends on whether $0 < p \le q < \infty$ or $p > q$. In both cases the characterizations will be based on the mean oscillation of φ in the Bergman metric. In one case the characterization is in terms of the boundedness of the mean oscillation, while in the other case the characterization is in terms of an integral condition of the mean oscillation.

The talk is based on recent joint work with Zhangjian Hu, Xiaofen Lv, Jordi Pau, and Ruhan Zhao.

Non-Commutative Geometry

Organizers: **Rufus Willett** (University of Hawaii)
Xiang Tang (Washington University in St. Louis)
Zhizhang Xie (Texas A&M University)
Yi-jun Yao (Fudan University)

Venue: **Room 211, Tianjiabing Building**

Tuesday, July 24

14:00-14:30 **Efton Park (Texas Christian University)**
Unitary Equivalence of Normal Matrices over Topological Spaces

14:35-15:05 **Bingbing Liang (Max-Planck Institute)**
Dynamical correspondences of L^2-Betti numbers

15:05-15:25 **TEA BREAK**

15:25-15:55 **Huichi Huang (Chongqing University)**
TBA

16:00-16:30 **Jianchao Wu (Penn State University)**
The Novikov conjecture and groups of diffeomorphisms

16:40-17:10 **Dmitry Zanin (University of New South Wales)**
Connes Character Formula for locally compact spectral triples

17:20-17:35 **Hao Guo (University of Adelaide)**
Index of Equivariant Callias-Type Operators

18:00 Dinner Together

Wednesday, July 25

14:00-14:30 **Ronghui Ji (Indiana University–Purdue University Indianapolis)**
Relative soficity

14:35-15:05 **Kuok-fai Chao (Shanghai University)**
On the local Langlands correspondence and Noncommutative Geometry

15:05-15:25 **TEA BREAK**

15:25-15:55 **Yanli Song (Washington University in St. Louis)**
TBA

16:00-16:30 **Shilin Yu (Texas A&M University)**
Connes-Kasparov isomorphism and representation theory

16:40-17:10 **Benyin Fu (Shanghai Lixin University of Accounting and Finance)**
A Result about the Equivariant Higher Index Map

Thursday, July 26

14:00-14:30 **Herve Oyono-Oyono (Universite de Lorraine)**

TBA

14:35-15:05 **Xianjin Wang (Chongqing University)**

Equivariant coarse Baum-Connes conjecture for metric spaces with proper group actions

15:05-15:25 **TEA BREAK**

15:25-15:55 **Yoshiyasu Fukumoto (East China Normal University)**

G-Homotopy invariance of Analytic signature of proper G-manifolds

16:00-16:30 **Hongzhi Liu (Fudan University)**

Higher and relative higher rho invariant

16:40-17:10 **Qin Wang (East China Normal University)**

Group action on Banach spaces and higher index problems on warped cones

Friday, July 27

14:00-14:30 **Sherry Gong (Massachusetts Institute of Technology)**

TBA

14:35-15:05 **Yang Liu (Max-Planck Institute)**

Modular curvature and Hypergeometric functions

15:05-15:25 **TEA BREAK**

15:25-15:55 **Yu Qiao (Shaanxi Normal University)**

Fredholm Groupoids and Applications to Neumann-Poincaré Operators on Polygons

16:00-16:30 **Safdar Quddus (Indian Institute of Science, Bangalore)**

Noncommutative torus and its derived spaces

16:40-17:10 **Markus Pflaum (University of Colorado)**

On the Hochschild homology of convolution algebras of proper Lie groupoids

Speaker: Kuok-fai Chao (Shanghai University)
Title: *On the local Langlands correspondence and Noncommutative Geometry*
Abstract: In this talk, we would like to introduce how we can connect Langlands programme with Noncommutative geometry. More precisely, we will use the dual space of Lie groups as the main object to construct the link between local Langlands correspondences and the reduced C^*-algebras. This is a joint work with Wang Hang.

Speaker: Benyin Fu (Shanghai Lixin University of Accounting and Finance)
Title: *A Result about the Equivariant Higher Index Map*
Abstract: Let X be a discrete metric space with bounded geometry, Γ a countable discrete group. Assume that Γ acts on X properly and isometrically, in this case we call X a Γ-space. There is an equivariant higher index map

$$\mathrm{ind}^{\Gamma} : \lim_{d\to\infty} K_*^{\Gamma}(P_d(X)) \to K_*(C^*(X)^{\Gamma}),$$

where $K_*^{\Gamma}(P_d(X))$ is the Γ-equivariant K-homology group of the Rips complex $P_d(X)$, and $K_*(C^*(X)^{\Gamma})$ is the K-theory group of the equivariant Roe algebra $C^*(X)^{\Gamma}$ for the Γ-space X. The isomorphism or the injectivity of this map has many applications in geometry and topology.

If X/Γ and Γ can be coarsely embedded into a Hilbert space respectively, then the equivariant higher index map above is injective. This is joint work with Xianjin Wang and Guoliang Yu.

Speaker: Yoshiyasu Fukumoto (East China Normal University)
Title: *G-Homotopy invariance of Analytic signature of proper G-manifolds*
Abstract: In this talk we will discuss on the the Strong Novikov conjecture (SNC), the Novikov conjecture (NC), and its extension to the case of proper action of locally compact groups. More specifically, NC is deduced from SNC by the homotopy invariance of G-index of the signature operator in the K-theory of group C^*-algebra. This homotopy invariance is proved using the Hilsum and Skandalis' deformation argument.

Speaker: Hao Guo (University of Adelaide)
Title: *Index of Equivariant Callias-Type Operators*
Abstract: Suppose M is a smooth Riemannian manifold on which a Lie group G acts properly and isometrically. In this talk I will explore properties of a particular class of G-invariant operators on M, called G-Callias-type operators. These are Dirac operators that have been given an additional $\mathbb{Z}_2$-grading and a perturbation so as to be "invertible outside of a cocompact set in M". It turns out that G-Callias-type operators are equivariantly Fredholm and so have an index in the K-theory of the maximal group C^*-algebra of G. This index can be expressed as a KK-product of a class in K-homology and a class in the K-theory of the Higson G-corona. In fact, one can show that the K-theory of the Higson G-corona is highly non-trivial, and thus the index theory of G-Callias-type operators is not obviously trivial. As an application of the index theory of G-Callias-type operators, I will mention an obstruction to the existence of G-invariant metrics of positive scalar curvature on M.

Speaker: Ronghui Ji (Indiana University–Purdue University Indianapolis)
Title: *Relative soficity*
Abstract: We will define a notion of relative soficity for a countable discrete group with respect to a family of countable discrete groups. This notion extends soficity for discrete groups. We find nontrivial examples of relative soficity and prove that if a group is relative sofic with respect to a family of sofic groups, then the group is sofic. This applies to the case of relatively amenable groups with respect to a family of subgroups.

Speaker: Bingbing Liang (Max-Planck Institute)
Title: *Dynamical correspondences of L^2-Betti numbers*
Abstract: We investigate dynamical analogues of the L^2-Betti numbers for modules over the integral group ring of a discrete sofic group. In particular, we show that the L^2-Betti numbers exactly measure the failure of addition formula for dynamical invariants.

Speaker: Hongzhi Liu (Fudan University)
Title: *Higher and relative higher rho invariant*
Abstract: Higher rho invariant, defined for invertible elliptic differential operator in K-theory of obstruction algebra, is an obstruction for invertibel elliptic differential operaotor to have local defined inverse. It have a lot applications to geometry and topology, by reducing computation in geometry and topology to computation of K-theory. To define it in various setting, one usually need to deal with relative index theory for manifold with boundary. In this talk, we introduce the definitions of higher rho invaraint and several techniques in defining relative index. At last, we introduce relative higher rho invariant.

Speaker: Yang Liu (Max-Planck Institute)
Title: *Modular curvature and Hypergeometric functions*
Abstract: In noncommutative geometry, an essential question is to extend the notion of metric and curvature in Riemannian geometry to noncommutative spaces in a operator theoretical framework. A fundamental feature, in contrast to Riemannian geometry, is the fact that metrics are parametrized by noncommutative coordinates. In the conformal geometry of noncommutative tori, the new structure in the modular analog of the Gaussian curvature consists of two spectral functions, which compress the ansatz caused by the noncommutativity between the metric coordinate and its derivatives. In the first part of the talk, I will explain the higher dimensional generalization of a fantastic functional equation between them due to Connes and Moscovici. In the second part, I will show that hypergeometric functions are the build blocks of those spectral functions. A surprising discovery, obtained by combining the power of hypergeometric functions and computer algebra systems, is that Connes-Moscovici functional relation can be extended to a continuous family with respect to the dimension parameter.

Speaker: Efton Park (Texas Christian University)
Title: *Unitary Equivalence of Normal Matrices over Topological Spaces*
Abstract: One of the most striking theorems in linear algebra is the spectral theorem: every normal matrix with complex entries is diagonalizable. An immediate consequence of the

spectral theorem is that a normal matrix over $\mathbb{C}$ is determined up to unitary equivalence by its eigenvalues, counting multiplicities. Now suppose we have a normal matrix with entries in $C(X)$ for some (reasonable) topological space X. Under what circumstances does the spectral theorem still hold? Given two such matrices, when are they unitarily equivalent? These questions and related ones have interesting and nontrivial answers, and are best answered using ideas from algebraic topology. I will discuss several such results, assuming only the material from a first course in algebraic topology. This is joint work with Greg Friedman.

Speaker: Markus Pflaum, University of Colorado)
Title: *On the Hochschild homology of convolution algebras of proper Lie groupoids*
Abstract: The inertia space of a compact Lie group action or more generally of a proper Lie groupoid has an interesting singularity structure which appears to be important for the understanding of the Hochschild homology theory of the convolution algebra of the underlying groupoid. In the talk we explain this phenomenon. Moreover we show that a de Rham theorem holds for inertia spaces and indicate a connection between the inertia space and the non-commutative geometry of the underlying groupoid in terms of basic relative Grauert-Grothendieck forms on the inertia space.

Speaker: Safdar Quddus (Indian Institute of Science, Bangalore)
Title: *Noncommutative torus and its derived spaces*
Abstract: We talk about various finite discrete groups of $SL(2,\mathbb{Z})$ and their actions on the noncommutative algebraic torus. The resultant space/algebra is then classified based upon the Hochschild, cyclic and periodic homology and cohomology groups. Further their Chern-Connes indices are calculated using the projections. We also note some recent results comparing these properties with those of the analytic/smooth noncommutative torus.

Speaker: Yu Qiao (Shaanxi Normal University)
Title: *Fredholm Groupoids and Applications to Neumann-Poincaré Operators on Polygons*
Abstract: In this talk, I will introduce the concept of a Fredholm groupoid via the representation theory of C^*-algebras, in some sense, which is the largest class of groupoids for which certain Fredholm criteria hold with respect to a natural class of representations, namely the regular representations of a groupoid. Then I use this notion to show the Fredholmness of $I + K$ on certain suitable weighted Sobolev spaces, where I is the identity operator and K is the Neumann-Poincaré operator associated to Laplace operator and a polygon. This is joint work with Catarina Carvalho and Victor Nistor.

Speaker: Xianjin Wang (Chongqing University)
Title: *Equivariant coarse Baum-Connes conjecture for metric spaces with proper group actions*
Abstract: Let G be a countable discrete group, X a bounded geometry metric space with a proper and isometric G-action. The equivariant coarse Baum-Connes conjecture asserts that the equivariant higher index map

$$\mathrm{ind}^G : \lim_{d\to\infty} K_*^G(P_d(X)) \to K_*(C^*(X)^G),$$

is an isomorphism, where $K_*^G(P_d(X))$ is the G-equivariant K-homology of the Rip complex $P_d(X)$, and $K_*(C^*(X)^G)$ is the K-theory of the equivariant Roe algebra $C^*(X)^G$. In this talk, I will introduce our resent works on the equiavariant coarse Baum-Connes conjecture provided that X or X/G and G are coarsely embeddable into Hilbert spaces.

Speaker: Jianchao Wu (Penn State University)
Title: *The Novikov conjecture and groups of diffeomorphisms*
Abstract: The Novikov conjecture is one of the most prominent problems on smooth manifolds. Noncommutative geometry has enjoyed much success in dealing with this classical problem. I will explain my joint work with Guoliang Yu on using the geometry of infinite-dimensional manifolds and their associated C^*-algebras to prove the Novikov conjecture for a certain class of groups of diffeomorphisms.

Speaker: Shilin Yu (Texas A&M University)
Title: *Connes-Kasparov isomorphism and representation theory*
Abstract: I will explain the connection between Connes-Kasparov isomorphism and representation theory of real reductive Lie groups.

Speaker: Dimtry Zanin (University of New South Wales)
Title: *Connes Character Formula for locally compact spectral triples*
Abstract: In this talk, I provide a natural condition on (locally compact) spectral triple which implies a number of interesting corollaries: 1) Asymptotic for heat semigroup. Surprisingly, it was not established before even for compact spectral triples. 2) Existence of the heat semigroup asymptotic easily provides analytic continuation of ζ-function to a bigger half-plane. 3) Finally, the Connes Character formula in terms of singular traces on the ideal $\mathcal{L}_{1,\infty}$. This is derived from the analytic continuation of ζ-function to a neighborhood of the pole. For compact spectral triples this condition simply defines the class of all smooth p-dimensional spectral triples. This conditions holds in every situation of practical importance: Riemannian manifolds (without assumption of bounded geometry), noncommutative Euclidean spaces etc.

Operator Spaces and Harmonic Analysis

Organizers: **Guixiang Hong** (Wuhan University)
Zhong-Jin Ruan (University of Illinois at Urbana-Champaign)
Quanhua Xu (Université de Franche-Comté & Harbin Institute of Technology)

Venue: **Room 218, Tianjiabing Building**

Monday, July 23

14:00-14:45 **Christian Le Merdy (Université de Franche-comté)**
Operator multipliers into the trace class

14:50-15:20 **Yong Jiao (Central South University)**
Noncommutative good-λ inequalities

15:20-15:40 **TEA BREAK**

15:40-16:20 **Hun Hee Lee (Seoul National University)**
Twisted Fourier(-Stieltjes) spaces and amenability

16:25-16:55 **Sheng Yin (Universitat des Saarlandes)**
Noncommutative rational functions and Atiyah property

17:00-17:45 **Narcisse Randrianantoanina (Miami University)**
Martingales in noncommutative symmetric spaces

Tuesday, July 24

14:00-14:45 **Javier Parcet (The Instituto de Ciencias Matemáticas)**
Fourier L_p-multipliers in $SL_n(\mathbb{R})$

14:50-15:20 **Simeng Wang (Universitat des Saarlandes)**
Noncommutative maximal ergodic inequalities associated with doubling conditions

15:20-15:50 **TEA BREAK**

15:50-16:20 **Vergara Ignacio (École normale supérieure de Lyon)**
Radial Schur multipliers

16:25-16:55 **Venku Naidu Dogga (Indian Institute of Technology Hyderabad)**
Benedicks' theorem for Weyl transform associated to Heisenberg group

17:00-17:45 **Michael Brannan (Texas A&M University)**
Amenable quantum groups are not always unitarizable

Wednesday, July 25

14:00-14:45 **Nico Spronk (University of Waterloo)**
On operator amenability of Fourier-Steiltjes algebras

14:50-15:20 **Jinsong Wu (Harbin Institute of Technology)**
Noncommutative Fourier Analysis

15:20-15:50 **TEA BREAK**

15:50-16:20 **Li Gao (University of Illinois at Urbana-Champaign)**
Complete Log-Sobolev Inequality for Quantum Markov Semigroups

16:25-16:55 **Zhenhua Wang (University of Houston)**
Real positivity in Jordan operator algebras

17:00-17:45 **Tao Mei (Baylor University)**
Hilbert Transforms type Fourier Multipliers on Free Groups

Speaker: Michael Brannan (Texas A&M University)
Title: *Amenable quantum groups are not always unitarizable*
Abstract: A well-known theorem of Day and Dixmier from around 1950 states that if G is an amenable locally compact group, then any uniformly bounded representation of G on a Hilbert space is similar to a unitary representation. In short, amenable groups are "unitarizable". In this talk, I will focus on the question of whether a version of the Day-Dixmier unitarizability theorem holds in the more general framework of locally compact quantum groups. It turns out that the answer to this question is no: In joint work with Sang-Gyun Youn (Seoul National University), we show that many amenable quantum groups (including all Drinfeld-Jimbo-Woronowicz q-deformations of classical compact groups) admit non-unitarizable uniformly bounded representations.

Speaker: Venku Naidu Dogga (Indian Institute of Technology Hyderabad)
Title: *Benedicks' theorem for Weyl transform associated to Heisenberg group*
Abstract: In this article, we discuss the Benedicks' theorem for Weyl transform associated to Heisenberg group. Suppose $\sigma \in L^2(\mathbb{H}^n \times \mathbb{R}, \mathcal{S}_2, d\nu \times d\mu)$ be a function with compact support and if the Weyl transform W_σ is of finite rank then we show that σ is zero almost everywhere on $\mathbb{H}^n \times \mathbb{R}$. This is a joint work with Partha Sarathi Patra and C. Sivaramakrishnan.

Speaker: Li Gao (University of Illinois at Urbana-Champaign)
Title: *Complete Log-Sobolev Inequality for Quantum Markov Semigroups*
Abstract: The Logarithmic Sobolev Inequality (LSI) for diffusion semigroups is a fascinating interaction between Analysis, Geometry and Probability. For Quantum Markov Semigroups (semigroups of complete positive trace preserving maps), the Complete Log-Sobolev Inequality is the complete bounded version of LSI which is stable under tensorisation of multi-partite quantum systems. In this talk, we will discuss how to use operator algebras/operator spaces tools to show that there are densely many generators of semigroup satisfying complete-LSI in the finite dimensional case. Based on joint work with Marius Junge and Nicholas LaRacuente.

Speaker: Vergara Ignacio (École normale supérieure de Lyon)
Title: *Radial Schur multipliers*
Abstract: Given a nonempty set X, we say that a function $\phi : X \times X \to \mathbb{C}$ is a Schur multiplier if it associates, to each bounded operator $T \in \mathcal{B}(\ell_2(X))$, a new operator $M_\phi T$ defined by multiplication of the matrix coefficients: $(M_\phi T)_{x,y} = \phi(x, y)T_{x,y}$. If the set X is a connected infinite graph, one can look at those multipliers which depend only on the distance between each pair of vertices. Such functions are called radial.

Haagerup, Steenstrup and Szwarc gave a characterisation of radial Schur multipliers on homogeneous trees in terms of certain Hankel matrices and Besov spaces on the torus. I will discuss some extensions of this result to products of trees, products of hyperbolic graphs and CAT(0) cube complexes.

Speaker: Yong Jiao (Central South University)
Title: *Noncommutative good-λ inequalities*

Abstract: We propose a novel approach in noncommutative probability, which can be regarded as an analogue of good-λ inequalities from the classical case due to Burkholder and Gundy (Acta Math **124**: 249-304, 1970). This resolves a longstanding open problem in noncommutative realm. Using this technique, we present new proofs of noncommutative Burkholder-Gundy inequalities, Stein's inequality, Doob's inequality and L^p-bounds for martingale transforms; all the constants obtained are of optimal orders. The approach also allows us to investigate the noncommutative analogues of decoupling techniques and, in particular, to obtain new estimates for noncommutative martingales with tangent difference sequences and sums of tangent positive operators. These in turn yield an enhanced version of Doob's maximal inequality for adapted sequences and a sharp estimate for a certain class of Schur multipliers. We expect the method to be useful in other settings as well. This is a joint work with A.Osekowski and L.Wu.

Speaker: Hun Hee Lee (Seoul National University)
Title: *Twisted Fourier(-Stieltjes) spaces and amenability*
Abstract: In this talk we will revisit the twisted Fourier(-Stieltjes) spaces on locally compact groups. A prime example of this twisting will be, of course, the L^1-space of non-commutative torus. In this twisted setting we recover the results of Bojeko/Fendler, Losert, Ruan characterizing amenability of the underlying group in terms of (cb-)multipliers on twisted Fourier space. The last part of the talk will be emphasizing the fact that twisted Fourier spaces does not allow Banach algebra structures we hoped, but they still have module structures with respect to untwisted Fourier algebra, which opens a door to a new direction of research.

Speaker: Tao Mei (Baylor University)
Title: *Hilbert Transforms type Fourier Multipliers on Free Groups*
Abstract: The L_p boundedness of Hilbert transforms is a fundamental theory in analysis. I will explain an analogue of this theory on free group von Neumann algebras and an extension of the classical Mikhlin multiplier theorem to Free groups (recent joint works with E. Ricard, and with Q. Xu).

Speaker: Christian Le Merdy (Université de Franche-comté)
Title: *Operator multipliers into the trace class*
Abstract: Let H_1, H_2, H_3 be Hilbert spaces and let $M_i \subset B(H_i)$ be von Neumann algebras, $i = 1, 2, 3$. We consider the subspace

$$\mathcal{R}(M_1, M_2, M_3) \subset CB\big(S^2(H_1, H_2)_r \times S^2(H_2, H_3)_c, S^1(H_1, H_3)\big)$$

of all (M_3, M_2, M_1)-trimodule completely bounded maps. In the case when M_2 is injective, we give a characterization of elements of $\mathcal{R}(M_1, M_2, M_3)$ in terms of a factorization property. This result extends a recent characterization of bounded Schur multipliers

$$S^2\big(L^2(\Omega_1), L^2(\Omega_2)\big) \times S^2\big(L^2(\Omega_2), L^2(\Omega_3)\big) \longrightarrow S^1\big(L^2(\Omega_1), L^2(\Omega_3)\big),$$

where $\Omega_1, \Omega_2, \Omega_3$ are measure spaces. Further in the case when $H_3 = H_1$, we are able to characterize completely positive elements of $\mathcal{R}(M_1, M_2, M_3)$. (Joint work with I. Todorov and L. Turowska.)

Speaker: Javier Parcet (Instituto de Ciencias Matemáticas)
Title: *Fourier L_p-multipliers in $SL_n(\mathbf{R})$*
Abstract: Connes rigidity conjecture for factors of $PSL_n(\mathbf{Z})$ provides a strong motivation to study invariants on this class of von Neumann algebras. Lafforgue/de la Salle rigidity theorem opens a door to harmonic analysis in this direction. In this talk, we shall present the first sufficient conditions for L_p-boundedness of Fourier multipliers in the group algebra of $SL_n(\mathbf{R})$ lin the spirit of Hörmander-Mikhlin criterium for Euclidean multipliersl and a major strengthening of Lafforgue/de la Salle rigidity theorem. Joint work with Éric Ricard and Mikael de la Salle.

Speaker: Narcisse Randrianantoanina (Miami University)
Title: *Martingales in noncommutative symmetric spaces*
Abstract: We will discuss the current status of noncommutative martingale inequalities in the context of norms of general noncommutative symmetric spaces. Particular attention will be given to various connections between martingale Hardy spaces associated to these symmetric spaces. We will also discuss a related topic generally referred to as Φ-moments of noncommuting random variables when Φ is a (convex) Orlicz function. Joint work with L. Wu and Q. Xu.

Speaker: Nico Spronk (University of Waterloo)
Title: *On operator amenability of Fourier-Steiltjes algebras*
Abstract: Let G Title be a locally compact group. The Fourier and Fourier-Stieltjes algebras, $A(G)$ and $B(G)$ are dual objects to the group and measure algebras $L^1(G)$ and $M(G)$, respectively, in a manner which generalizes Pontryagin duality. It is now classical that $L^1(G)$ is (operator) amenable exactly when G is amenable, exactly when $A(G)$ is operator amenable. $M(G)$ is (operator) amenable exactly when G is discrete and abelian; hence $B(G)$ ought to be operator amenable exactly when G is compact. This is not true, generally; but is true for connected groups.

Speaker: Simeng Wang (Universitat des Saarlandes)
Title: *Noncommutative maximal ergodic inequalities associated with doubling conditions*
Abstract: In this talk I will present some recent progress on noncommutative maximal inequalities and ergodic theorems associated with doubling conditions. We establish a noncommutative Calderon transference principle for actions by amenable groups. Also we obtain the Hardy-Littlewood maximal inequality on doubling metric spaces for theoperator-valued setting. On the other hand, applying the Gaussian estimates in random walk theory, we may estimate the ergodic averages for group actions with polynomial growth. Based on these results, we may prove several maximal and individual ergodic theorems for group actions on von Neumann algebras. This is joint work with Guixiang Hong and Benben Liao.

Speaker: Zhenhua Wang (University of Houston)
Title: *Real positivity in Jordan operator algebras*
Abstract: In the past decade, Blecher and his collaborators introduced and studies a new notion of (real) positivity in operator algebras, with an eye to extending certain C^*-algebraic

results and theories to more general algebras. Besides, they also defined and characterized a new class of inner ideals in operator algebras, and developed a matching theory of open projections in operator algebras. In this talk, we will discuss how to use these fantastic tools from operator algebras to get corresponding results in Jordan operator algebras which is non-associative. This is joint work with David Blecher.

Speaker: Jinsong Wu (Harbin Institute of Technology)
Title: *Noncommutative Fourier Analysis*
Abstract: In this talk, we will present recent work joint with Jiang, Liu, Wang in operator algebras. We introduced Fourier analysis on subfactors, locally compact quantum groups and modular tensor categories. More precisely, we proved a series of inequalities for them such as Young's inequality, Hausdorff-Young inequality, uncertainty principles, sum set estimates and introduced the Brascamp-Lieb inequalities.

Speaker: Sheng Yin (Universitat des Saarlandes)
Title: *Noncommutative rational functions and Atiyah property*
Abstract: We consider noncommutative rational functions in two settings: in an algebraic context the variables are formal and their rational functions form a division algebra containing noncommutative polynomials; in an analytic context the variables are given by operators from a finite von Neumann algebra and the question of rational functions is treated within the affiliated unbounded operators. We will show that the embedding problem of these rational functions into unbounded operators is equivalent to some Atiyah property.

Operator Theory and Quantum Information

Organizers: **Man-Duen Choi** (University of Toronto)
Hugo J. Woerdeman (Drexel University)

Venue: **Room 206, Tianjiabing Building**

Monday, July 23

14:00-14:25 **Man-Duen Choi (University of Toronto)**
Two by two matrix theory made simpler but deeper

14:30-14:55 **Dániel Virosztek (Institute of Science and Technology Austria)**
Jointly convex quantum Jensen divergences

15:00-15:25 **Yu Yang (National Singapore University)**
On Positive Partial Transpose Squared Conjecture

15:30-16:00 **TEA BREAK**

16:00-16:25 **Runyao Duan (Baidu/University of Technology Sydney)**
Tripartite-to-bipartite Entanglement Transformation by Stochastic Local Operations and Classical Communication and the Structure of Matrix Spaces

16:30-16:55 **Yiu-Tung Poon (Iowa State University)**
Matricial Ranges in Quantum Error Correction

Tuesday, July 24

14:00-14:25 **David Kribs (University of Guelph)**
Operator structures and hybrid classical and quantum information

14:30-14:55 **Seung-Hyeok Kye (Seoul National University)**
Separability of X-shaped multi-qubit states

15:00-15:25 **Chi-Kwong Li (College of William and Mary)**
Mixed unitary channels

15:30-16:00 **TEA BREAK**

16:00-16:25 **Zhengwei Liu (Harvard University)**
Topological design of protocols

16:30-16:55 **Lajos Molnar (University of Szeged)**
Quantum Rényi relative entropies: their symmetries and their essential differences

17:00-17:25 **Kallol Paul (Jadavpur University)**
Role of Birkhoff-James orthogonality in the space of bounded linear operators

Wednesday, July 25

14:00-14:25 **Magdalena Musat (University of Copenhagen)**

Factorizable quantum channels with no finite dimensional representations

14:30-14:55 **Rajesh Pereira (University of Guelph)**

Companion Matrices and Perfect State Transfer on Weighted Graphs

15:00-15:25 **Li Gao (University of Illinois at Urbana-Champaign)**

Entropic Uncertainty Relations via Noncommutative L_p-Space

15:30-16:00 **TEA BREAK**

16:00-16:25 **Jinchuan Hou (Taiyuan University of Technology)**

Fidelity based unitary operation-induced quantum correlation for continuous-variable systems

16:30-16:55 **Nung-Sing Sze (The Hong Kong Polytechnic University)**

Operator Quantum Error Correction for Phase-flip Error

Speaker: Man-Duen Choi (University of Toronto)
Title: *Two by two matrix theory made simpler but deeper*
Abstract: What on earth does a quantum channel mean? With pride and prejudice in quantum information, we seek sense and sensibility of the non-commutative geometry, from practical point of view. There are many deep (but simple) aspects as shown in the down-to-earth structure of two by two matrices.

Speaker: Runyao Duan (Baidu/University of Technology Sydney)
Title: *Tripartite-to-bipartite Entanglement Transformation by Stochastic Local Operations and Classical Communication and the Structure of Matrix Spaces*
Abstract: We study the problem of transforming a tripartite pure state to a bipartite one using stochastic local operations and classical communication (SLOCC). It is known that the tripartite-to-bipartite SLOCC convertibility is characterized by the maximal Schmidt rank of the given tripartite state, i.e. the largest Schmidt rank over those bipartite states lying in the support of the reduced density operator. In this paper, we further study this problem and exhibit novel results in both multi-copy and asymptotic settings. In the multi-copy regime, we observe that the maximal Schmidt rank is strictly super-multiplicative, i.e. the maximal Schmidt rank of the tensor product of two tripartite pure states can be strictly larger than the product of their maximal Schmidt ranks. We then provide a full characterization of those tripartite states whose maximal Schmidt rank is strictly super-multiplicative when taking tensor product with itself. In the asymptotic setting, we focus on determining the tripartite-to-bipartite SLOCC entanglement transformation rate, which turns out to be equivalent to computing the asymptotic maximal Schmidt rank of the tripartite state, defined as the regularization of its maximal Schmidt rank. Despite the difficulty caused by the super-multiplicative property, we provide explicit formulas for evaluating the asymptotic maximal Schmidt ranks of two important families of tripartite pure states, by resorting to certain results of the structure of matrix spaces, including the study of matrix semi-invariants. These formulas give a sufficient and necessary condition to determine whether a given tripartite pure state can be transformed to the bipartite maximally entangled state under SLOCC, in the asymptotic setting. Applying the recent progress on the non-commutative rank problem, we can verify this condition in deterministic polynomial time.

Speaker: Li Gao (University of Illinois at Urbana-Champaign)
Title: *Entropic Uncertainty Relations via Noncommutative L_p-Space*
Abstract: The Heisenberg uncertainty principle states that it is impossible to prepare a quantum particle for which both position and momentum are sharply defined. A natural measure of uncertainty is entropy. The first entropic formulation of uncertainty principle was proved by Hirschman in 1957 and since then entropic uncertainty relations have been obtained for many scenarios, including some recent advances with quantum memory. In this talk, I will present an approach to entropic uncertainty relations using noncommutative L_p norms. We prove a general entropic uncertainty relations for two quantum channels (completely positive trace preserving maps). This talk is based on joint works with Marius Junge and Nicholas LaRacuente.

Speaker: Jinchuan Hou (Taiyuan University of Technology)
Title: *Fidelity based unitary operation-induced quantum correlation for continuous-variable systems*
Abstract: We propose a measure of nonclassical correlations $N_{\mathcal{F}}^{\mathcal{G}}$ in terms of local Gaussian unitary operations based on fidelity for bipartite continuous-variable systems. This quantity is easier to be calculated or estimated and is a remedy for the local ancilla problem associated with the geometric measurement-induced nonlocality. A simple computation formula of $N_{\mathcal{F}}^{\mathcal{G}}$ for any $(1+1)$-mode Gaussian states is presented and an estimation of $N_{\mathcal{F}}^{\mathcal{G}}$ for any $(n+m)$-mode Gaussian states is given. For any $(1+1)$-mode Gaussian states, $N_{\mathcal{F}}^{\mathcal{G}}$ does not increase after performing a local Gaussian channel on the unmeasured subsystem. Comparing $N_{\mathcal{F}}^{\mathcal{G}}(\rho_{AB})$ with other quantum correlations such as Gaussian geometric discord for two-mode symmetric squeezed thermal states reveals that $N_{\mathcal{F}}^{\mathcal{G}}$ is much better in detecting quantum correlations of Gaussian states.

Speaker: David Kribs (University of Guelph)
Title: *Operator structures and hybrid classical and quantum information*
Abstract: In this talk, I will discuss recent work with collaborators on topics in quantum information that involve operator algebras and operator systems and a focus on the simultaneous transmission of classical and quantum information, such as the topic of hybrid quantum error correction for instance.

Speaker: Seung-Hyeok Kye (Seoul National University)
Title: *Separability of X-shaped multi-qubit states*
Abstract: A self-adjoint matrix is called X-shaped when all the entries are zeroes except for diagonal and anti-diagonal entries. Multi-qubit X-shaped states arise naturally in quantum information theory, including Greenberger-Horne-Zeilinger diagonal states. We give a necessary and sufficient criterion for separability of X-shaped multi-qubit states. Because the X-part of a separable state is again separable, this gives rise to a necessary criterion for separability of arbitrary multi-qubit states, which is strong enough to detect nonzero volume of entanglement of positive partial transpose. Main tool is the duality between multi-partite separable states and positive multi-linear maps. This talk is based on a recent cowork [arXiv 1803.00175] with Kyung-Hoon Han and Kil Chan Ha.

Speaker: Chi-Kwong Li (College of William and Mary)
Title: *Mixed unitary channels*
Abstract: A mixed unitary channel is a quantum channel obtained by taking a convex combination of unitary channels, i.e., unitary similarity transformations. We discuss several problems cerning unitary channels.

1. How to check a given quantum channel is a mixed unitary channel?
2. How to approximate a quantum channel by a mixed unitary channel?
3. How to construct a mixed unit channel with some prescribed properties?

Speaker: Zhengwei Liu (Harvard University)

Title: *Topological design of protocols*
Abstract: We will discuss the application of picture language in quantum information. We introduce a new method to design protocols following pictorial intuition. This leads to the discovery of new multiparty communication protocols.

Speaker: Lajos Molnár (University of Szeged & Budapest University of Technology and Economics)
Title: *Quantum Rényi relative entropies: their symmetries and their essential differences*
Abstract: We extend the definitions of different types of Rényi relative entropies from the case of density matrices to density spaces of C^*-algebras. We show that those quantities are essentially different on non-commutative algebras in the sense that one cannot be transformed to another one by any transformation between density spaces unless the underlying algebras are commutative. We also determine the symmetry groups corresponding to each such relative entropy and show that their structures are identical.

Speaker: Magdalena Musat (University of Copenhagen)
Title: *Factorizable quantum channels with no finite dimensional representations*
Abstract: Using very recent results,obtained in joint work with M.Rørdam,concerning non-closure of various sets of quantum correlation matrices,we show that there are factorizable quantum channels that require infinite dimensional ancilla, in every dimension $n \geq 11$, and provide concrete examples.

Speaker: Kallol Paul (Jadavpur University)
Title: *Role of Birkhoff-James orthogonality in the space of bounded linear operators*
Abstract: The notion of Birkhoff-James orthogonality plays a very important role in the study of geometry of operator spaces. We plan to talk of various applications of Birkhoff-James orthogonality in the space of bounded linear operators including smoothness of a bounded linear operator.

Speaker: Rajesh Pereira (University of Guelph)
Title: *Companion Matrices and Perfect State Transfer on Weighted Graphs*
Abstract: We show how companion matrices can be used to find weighted paths which exhibit perfect state transfer between their end vertices. Connections between this problem and some classical inverse eigenvalue problems are discussed. A conjecture on weighted paths with rational weights is given and certain solved special cases are discussed.
This is joint work with S. Kirkland, D. McLaren, S. Plosker and X. Zhang

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Speaker: Yiu-Tung Poon (Iowa State University)
Title: *Matricial Ranges in Quantum Error Correction*
Abstract: By the Knill-Laflamme Theorem, a quantum channel has a k-dimensional quantum error correction code if and only if the associated rank k-numerical range Λ_k is non-empty. Each point in Λ_k gives rise to an error correction code of the quantum information. In the en-

coding process, the ancillary state is usually required to be pure. Since preparation of pure state can be costly, researchers also study noiseless subsystem and more generally, correctable system, for which the ancillary state can be an arbitrary mixed state. The existence of a correctable subsystem is determined by the associated matricial range $\Lambda_{k,q}$, which is a generalization of Λ_k. Recently, researchers also study hybrid codes which can be used to transmit both classical and quantum information simultaneously. The existence of hybrid code is determined by a hybrid range $\hat{\Lambda}_{k,q}$, which is a special case of $\Lambda_{k,q}$. We will discuss some results on these ranges.

Speaker: Nung-Sing Sze (The Hong Kong Polytechnic University)
Title: *Operator Quantum Error Correction for Phase-flip Error*
Abstract: The idea of quantum error correction is to protect quantum information from errors due to decoherence and other quantum noise during the transmission of information in quantum channels. In this talk, we consider the situation when all physical qubits involved in coding suffer from certain phase-flip error. An error correcting scheme and its implementing encoding and decoding circuits for low dimensional quantum system will be presented.

Speaker: Dániel Virosztek (Institute of Science and Technology Austria)
Title: *Jointly convex quantum Jensen divergences*
Abstract: We investigate the quantum Jensen divergences from the viewpoint of joint convexity. It turns out that the set of the functions which generate jointly convex quantum Jensen divergences on positive matrices coincides with the Matrix Entropy Class which has been introduced by Chen and Tropp quite recently.

Speaker: Yu Yang (National Singapore University)
Title: *On Positive Partial Transpose Squared Conjecture*
Abstract: Linear maps that are both completely positive and completely copositive are often called PPT binding maps. Here PPT stands for "positive partial transposition" since the Choi matrix of such a map is positive under partial transpose. The PPT squared conjecture asks whether the composition $\phi_2 \circ \phi_1$ of two PPT maps ϕ_1 and ϕ_2 is entanglement breaking where $\phi_1, \phi_2 \in M_n(\mathbb{C}) \otimes M_n(\mathbb{C})$. We shall talk about our proof of PPT squared conjecture in the case n=3. Another proof is claimed by Alexzander Muller Hermes from University of Copenhagen independently. The validity of PPT squared conjecture in the case $n = 4$ is widely believed to fail but no counterexample is given so far. Co-author(s): Prof. Lin Chen, Prof. Wai-Shing Tang.

Operator Theory on Reproducing Kernel Hilbert Spaces

Organizers: **Raul E. Curto** (University of Iowa)
Nikolai L. Vasilevski (CINVESTAV)
Karlovich Alexei Yur'evich (Universidade Nova de Lisboa)

Venue: **Room 207, Tianjiabing Building**

Tuesday, July 24

14:00-14:25 **Cristina Camara (Instituto Superior Técnico)**
Multipliers between Toeplitz kernels

14:30-14:55 **Turgay Kaptanoglu (Bilkent University)**
Singular Integral Operators with Bergman-Besov Kernels on the Ball

15:00-15:30 **Trieu Le (University of Toledo)**
Inner Functions in Weighted Hardy Spaces

15:30-15:55 **TEA BREAK**

16:00-16:25 **Mee-Jung Lee (Sejong University)**
On power similarity to complex symmetric operators

16:30-16:55 **Samya Kumar Ray (Indian Institute of Technology Kanpur)**
On Functional Calculus For Bi-Ritt Operators

17:00-17:25 **Liming Yang (Virginia Tech University)**
Boundary values in $R^t(K,\mu)$-spaces and invariant subspaces

Wednesday, July 25

14:00-14:25 **Kehe Zhu (State University of New York at Albany)**
Spectral theory of multiplication operators on Bergman spaces

14:30-14:55 **Nikolai Vasilevski (CINVESTAV)**
On the algebras generated by Toeplitz operators

15:00-15:30 **Zeljko Cuckovic (University of Toledo)**
A local weighted Axler-Zheng theorem in $\mathbb{C}^n$

15:30-15:55 **TEA BREAK**

16:00-16:25 **Raul Quiroga Barranco (Centro de Investigación en Matemáticas)**
Toeplitz operators on bounded symmetric domains and Lie groups

16:30-16:55 **Armando Sanchez Nungaray (Universidad Veracruzana)**
Toeplitz operators and moment map on the unit ball

17:00-17:25 **Ruhan Zhao (SUNY at Brockport)**
Weighted composition operators that preserve frames

Thursday, July 26

14:00-14:25 **Artur Planeta (University of Agriculture, Krakow)**

Generalized multipliers for left-invertible analytic operators: commutant and reflexivity

14:30-14:55 **Yanqi Qiu (Institute of Mathematics, AMSS, Chinese Academy of Sciences)**

Patterson-Sullivan measures for point processes and reconstruction of holomorphic functions

15:00-15:30 **Jongrak Lee (Ewha Womans University)**

On m-isometric Toeplitz operators

15:30-15:55 **TEA BREAK**

16:00-16:25 **Srijan Sarkar (Indian Statistical Institute Bangalore)**

Factorizations of Contractions

16:30-16:55 **Dong-O Kang (Chungnam National University)**

On kernels of block Hankel operators

17:00-17:25 **Ayse Sandikci (Ondokuz Mayis University)**

On The Spaces of Bilinear Multipliers

Speaker: Cristina Camara (Instituto Superior Técnico)
Title: *Multipliers between Toeplitz kernels*
Abstract: In this talk we review some classical and more recent results concerning kernels of Toeplitz operators in Hardy spaces. In particular we focus on the existence of so-called maximal vectors, which determine the kernel in a precise sense, and on multipliers between kernels of Toeplitz operators. It turns out that these multipliers can be characterized in terms of certain test functions, which are precisely the maximal vectors. Applications to model spaces, which are themselves Toeplitz kernels of a special kind, are presented.

Based on joint work with Jonathan R. Partington.

Speaker: Zeljko Cuckovic (University of Toledo)
Title: *A local weighted Axler-Zheng theorem in* $\mathbb{C}^n$
Abstract: The well-known Axler-Zheng theorem characterizes compactness of finite sums of finite products of Toeplitz operators on the unit disk in terms of the Berezin transform of these operators. Subsequently this theorem was generalized to other domains including domains in C^n on which the $\overline{\partial}$ -Neumann operator N is compact. In this work we remove the assumption on N, and we study weighted Bergman spaces on smooth bounded pseudoconvex domains. We prove a local version of the Axler-Zheng theorem characterizing compactness of Toeplitz operators in the algebra generated by symbols continuous up to the boundary in terms of the behavior of the Berezin transform at strongly pseudoconvex points. (Joint work with Sonmez Sahutoglu and Yunus Zeytuncu).

Speaker: Dong-O Kang (Chungnam National University)
Title: *On kernels of block Hankel operators*
Abstract: For a matrix-valued function $\Phi \in L^2_{M_{n\times m}}$, it is well-known that the kernel of a block Hankel operator H_Φ is an invariant subspace for the shift operator. Thus, if the kernel is nontrivial, then $\ker H_\Phi = \Theta H^2_{\mathbb{C}^r}$ for a natural number r and an $m \times r$ matrix inner function Θ by Beurling-Lax-Halmos Theorem. It will be shown that the size of the matrix inner function Θ associated with the kernel of a block Hankel operator H_Φ is closely related with a certain independence of the columns of Φ, which is defined in the talk. Some of its application will also be given.

Speaker: Turgay Kaptanoglu (Bilkent University)
Title: *Singular Integral Operators with Bergman-Besov Kernels on the Ball*
Abstract: Although the boundedness of the Bergman-Besov projection operators from Lebesgue classes onto Bergman-Besov spaces has been studied for several decades, the study of the boundedness of the same operators as singular integral operators between different Lebesgue classes are rather new. Some initial work has recently been done by Cheng, Fang, Wang, Yu for the weighted Bergman operator on the unit disc and by Cheng, Hou, Liu for the Drury-Arveson operator. Also Zhao has investigated certain subcases of the same problem as Bergman projections. The methods they employ are sporadic and specific to the particular cases they are interested in.

We employ a global approach to the problem on the unit ball $\mathbb{B}$ of $\mathbb{C}^n$, exhaust all Lebesgue classes L^p_q with weights $(1-|z|^2)^q$, and completely characterize all weighted Bergman-Besov

integral operators $T_{ab} : L^p_q \to L^P_Q$ with kernels $(1-|z|^2)^b K_a(w,z)$, where the K_a are the Bergman-Besov kernels on $\mathbb{B}$, $a, b, q, Q \in \mathbb{R}$, and $1 \leq p, P \leq \infty$, We treat different ranges of the parameters in a unified and systematic way. Our main tools are various forms of the Schur test, integral inequalities, growth estimates of the Bergman-Besov kernels, and a new method that depends on representations of radial fractional derivatives as integral operators and precise inclusion relations between Bergman-Besov and Bloch-Lipschitz spaces and H^∞.

This is joint work with A. Ersin Üreyen of Anadolu University, Eskişehir.

Speaker: Samya Kumar Ray (Indian Institute of Technology Kanpur)
Title: *On Functional Calculus For Bi-Ritt Operators*
Abstract: In this talk, we consider joint functional calculus for commuting n-tuple of Ritt operators. We provide an equivalent characterisation of boundedness for joint functional calculus for Ritt operators on L^p-spaces, $1 < p < \infty$. We also investigate joint similarity problem and joint bounded functional calculus on non-commutative L^p-spaces for n-tuple of Ritt operators. We get our results by proving a suitable multivariable transfer principle between sectorial and Ritt operators as well as an appropriate joint dilation result in a general setting. One of the main tools that we use is the Littlewood-Paley square functions associated to Ritt operators. This is a joint work with Prof. Parasar Mohanty.

Speaker: Trieu Le (University of Toledo)
Title: *Inner Functions in Weighted Hardy Spaces*
Abstract: Inner functions play a central role in function theory and operator theory on the Hardy space over the unit disk. Recent works of Bénéteau et al. and of Seco study inner functions in the more general setting of weighted Hardy spaces. Motivated by their results, we discuss several characterizations of such inner functions and investigate a method to construct analogues of finite Blaschke products.

Speaker: Jongrak Lee (Ewha Womans University)
Title: *On m-isometric Toeplitz operators*
Abstract: This talk focuses on the m-isometric Toeplitz operators T_φ with bounded type symbols. We characterize m-isometric Toeplitz operators T_φ by properties of symbols φ. In addition, we give a necessary and sufficient condition for Toeplitz operators T_φ with analytic symbols φ to be m-expansive or m-contractive.

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Speaker: Mee-Jung Lee (Sejong University)
Title: *On power similarity to complex symmetric operators*
Abstract: In this talk, we study properties of which are similar to complex symmetric operators. In particular, we prove that if T is similar to a complex symmetric operator with the Bishop's property (β), then it is decomposable.

Speaker: Artur Planeta (University of Agriculture, Krakow)
Title: *Generalized multipliers for left-invertible analytic operators: commutant and reflexivity*
Abstract: We study left-invertible analytic operators using analytic function theory approach, which was initiated by Shimorin in [10]. This class of operators is quite large, it contains for example shifts on generalized Dirichlet spaces, shifts on weighted Bergmann space with logarithmically subharmonic weights on the unit disc, and left-invertible weighted shifts on leafless and rooted directed trees (see [6] and [2, Lemma 3.3]).

As shown by Shimorin, every left-invertible analytic operator T on a Hilbert space is unitarily equivalent to a multiplication operator by z on a reproducing kernel Hilbert space of analytic functions on a disc with values in $\mathcal{N}(T^*)$ - the kernel of the adjoint of T.

A characterization of the commutant of a given operator is one of the way of investigation of the operator itself. The classical result on unilateral shift of (the multiplication by the independent variable on the Hardy space H^2) says that its commutant is the algebra of all multiplications by bounded analytic functions. In the case of unilateral shift of arbitrary multiplicity, its commutant is the algebra of all bounded analytic operator–valued functions (see [4,5,8]). It was shown by Shields in [9], that the commutant of unilateral weighted shift of multiplicity one may be identified with the algebra of its multipliers. On the other hand, the multipliers for weighted shifts on rooted directed trees, introduced in [1], are not sufficiently large to determine the whole commutant of the operator. Hence, our motivation was to generalize the notion of multipliers to more general context. Our approach was based on the Cauchy type multiplication of the formal power series, which appeared in papers (see [3,9,7]) by Shields (for classical weighted shifts), Gellar (for general bilateral shifts), Jewell and Lubin (for commuting n-tuple of unilateral shifts).

We defined generalized multipliers for left-invertible analytic operator T using Shimorin's model. This enabled us to characterize the commutant of T. We derived also criterion for re-

flexivity of T, which is based on the characterization of commutant. In particular, we discussed the application of general theory in the case of left-invertible weighted shifts on leafless and rooted directed trees.

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Speaker: Raul Quiroga Barranco (Centro de Investigación en Matemáticas)

Title: *Toeplitz operators on bounded symmetric domains and Lie groups*

Abstract: It is very well known that bounded symmetric domains have two important features. First, they can be described in terms of Lie groups and actions. And second, they carry Bergman spaces and corresponding Toeplitz operators. In this talk we will discuss the relation between these two and how they have been used to obtain interesting C*-algebras generated by Toeplitz operators.

Speaker: Yanqi Qiu (Institute of Mathematics, AMSS, Chinese Academy of Sciences)

Title: *Patterson-Sullivan measures for point processes and reconstruction of holomorphic functions*

Abstract: I will talk about the Patterson-Sullivan measures in random setting for random subsets in hyperbolic spaces. For concreteness, the main part of the talk will be focused on the random configuration generated by the reproducing kernel of Bergman space on hyperbolic unit disc and a reconstruction problem of holomorphic functions including continuous harmonic functions, Hardy functions, Bergman functions from their restrictions to a random uniqueness set. The talk is based on a joint work with Alexander Bufetov.

Speaker: Armando Sanchez Nungaray (Universidad Veracruzana)

Title: *Toeplitz operators and moment map on the unit ball*

Abstract: In this talk we describe the Bergman space over the unit ball using Hamiltonian

coordinates, which are given by the action of maximal abelian subgroup of isometries and the moment map associated to this subgroup. Moreover, we describe Toeplitz operators where the symbol depend of the moment map or is invariant under the action of abelian subgroup non maximal.

Speaker: Ayse Sandikci (Ondokuz Mayis University)
Title: *On The Spaces of Bilinear Multipliers*
Abstract: Let $1 < P_1, P_2 < \infty$, $1 \leq Q_1, Q_2 < \infty$, $1 \leq P_3, Q_3 \leq \infty$. Also let $m(\xi, \eta)$ be a bounded function on $\mathbb{R}^{2d}$. Define

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

for all $f, g \in \mathcal{S}\left(\mathbb{R}^d\right)$. m is said to be a bilinear multiplier on $\mathbb{R}^d$ of type $(P_1, Q_1; P_2, Q_2; P_3, Q_3)$, if there exists $C > 0$ such that

$$\|B_m(f,g)\|_{M(P_3,Q_3)} \leq C\,\|f\|_{M(P_1,Q_1)}\,\|g\|_{M(P_2,Q_2)}$$

for all $f, g \in \mathcal{S}\left(\mathbb{R}^d\right)$. That means B_m extends to a bounded bilinear operator from $M(P_1, Q_1)\left(\mathbb{R}^d\right) \times M(P_2, Q_2)\left(\mathbb{R}^d\right)$to $M(P_3, Q_3)\left(\mathbb{R}^d\right)$, where $M(P, Q)\left(\mathbb{R}^d\right)$ is the set of all tempered distributions $f \in \mathcal{S}'\left(\mathbb{R}^d\right)$ such that the short-time Fourier transform $V_g f$ of f is in the Lorentz mixed norm space $L(P, Q)\left(\mathbb{R}^{2d}\right)$. The study of the some properties of these spaces is investigated and give some examples.

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Speaker: Srijan Sarkar (Indian Statistical Institute Bangalore)
Title: *Factorizations of Contractions*
Abstract: The celebrated Sz.-Nagy and Foias theorem asserts that every pure contraction is unitarily equivalent to an operator of the form $P_{\mathcal{Q}} M_z|_{\mathcal{Q}}$ where $\mathcal{Q}$ is a M_z^*-invariant subspace of a $\mathcal{D}$-valued Hardy space $H^2_{\mathcal{D}}(\mathbb{D})$, for some Hilbert space $\mathcal{D}$.

On the other hand, the celebrated theorem of Berger, Coburn and Lebow on pairs of commuting isometries can be formulated as follows: a pure isometry V on a Hilbert space $\mathcal{H}$ is a product of two commuting isometries V_1 and V_2 in $\mathcal{B}(\mathcal{H})$ if and only if there exist a Hilbert space $\mathcal{E}$, a unitary U in $\mathcal{B}(\mathcal{E})$ and an orthogonal projection P in $\mathcal{B}(\mathcal{E})$ such that (V, V_1, V_2) and (M_z, M_Φ, M_Ψ) on $H^2_{\mathcal{E}}(\mathbb{D})$ are unitarily equivalent, where

$$\Phi(z) = (P + zP^\perp)U^* \quad \text{and} \quad \Psi(z) = U(P^\perp + zP) \qquad (z \in \mathbb{D}).$$

In this talk we will be looking for similar factorization result for pure contractions. More particularly, let T be a pure contraction on a Hilbert space $\mathcal{H}$ and let $P_{\mathcal{Q}}M_z|_{\mathcal{Q}}$ be the Sz.-Nagy and Foias representation of T for some canonical $\mathcal{Q} \subseteq H^2_{\mathcal{D}}(\mathbb{D})$. Then $T = T_1T_2$, for some commuting contractions T_1 and T_2 on $\mathcal{H}$, if and only if there exist $\mathcal{B}(\mathcal{D})$-valued polynomials φ and ψ of degree ≤ 1 such that $\mathcal{Q}$ is a joint (M^*_φ, M^*_ψ)-invariant subspace,

$$P_{\mathcal{Q}}M_z|_{\mathcal{Q}} = P_{\mathcal{Q}}M_{\varphi\psi}|_{\mathcal{Q}} = P_{\mathcal{Q}}M_{\psi\varphi}|_{\mathcal{Q}} \text{ and } (T_1, T_2) \cong (P_{\mathcal{Q}}M_\varphi|_{\mathcal{Q}}, P_{\mathcal{Q}}M_\psi|_{\mathcal{Q}}).$$

Moreover, there exist a Hilbert space $\mathcal{E}$ and an isometry $V \in \mathcal{B}(\mathcal{D}; \mathcal{E})$ such that

$$\varphi(z) = V^*\Phi(z)V \text{ and } \psi(z) = V^*\Psi(z)V \qquad (z \in \mathbb{D}),$$

where the pair (Φ, Ψ), as defined above, is the Berger, Coburn and Lebow representation of a pure pair of commuting isometries on $H^2_{\mathcal{D}}(\mathbb{D})$. As an application, we obtain a sharper von Neumann inequality for commuting pairs of contractions.

This is a joint work with Dr. Jaydeb Sarkar and Dr. B.K. Das.

Speaker: Nikolai Vasilevski (CINVESTAV)
Title: *On the algebras generated by Toeplitz operators*
Abstract: We discuss the structure of C^* and Banach algebras generated by Toeplitz operators with various specific classes of symbols.

Speaker: Liming Yang (Virginia Tech University)
Title: *Boundary values in $R^t(K, \mu)$-spaces and invariant subspaces*
Abstract: For $1 \leq t < \infty$; a compact subset K of the complex plane $\mathbb{C}$; and a finite positive measure supported on K; $R^t(K, \mu)$ denotes the closure in $L^t(\mu)$ of rational functions with poles off K.

We examine the boundary values of functions in $R^t(K, \mu)$ for certain compact subset K and extend the work of Aleman, Richter, and Sundberg on nontangential limits for the closure in $L^t(\mu)$ of analytic polynomials (Theorem A and Theorem C in Aleman, S. Richter, and C. Sundberg, Nontangential limits in $P^t(\mu)$-spaces and the index of invariant subspaces, Ann. of Math., 169 (2): 449-490, 2009). We show that the Cauchy transform of an annihilating measure has some continuity properties in the sense of capacitary density. This allows us to extend Aleman, Richter, and Sundberg's results for $R^t(K, \mu)$ and provide alternative short proofs of their theorems as special cases.

Speaker: Ruhan Zhao (SUNY at Brockport)
Title: *Weighted composition operators that preserve frames*
Abstract: We characterize weighted composition operators that preserve frames, tight frames, or normalized tight frames in the general weighted Hilbert Bergman spaces on the unit ball of $\mathbb{C}^n$. This is a joint work with Jasbir Singh Manhas and Gabriel T. Prajitura.

Speaker: Kehe Zhu (State University of New York at Albany)
Title: *Spectral theory of multiplication operators on Bergman spaces*
Abstract: We study the spectral theory of multiplication operators on a large class of Bergman

type spaces (including the ordinary Bergman space, the Hardy space, the Dirichlet space, the Drury-Arveson space) on the unit ball. Problems considered include the spectrum, the essential spectrum, and the Fredholm index. The talk is based on recent joint work with Guangfu Cao and Li He.

Panel Discussion: Women in Mathematics

Organizer: **Hang Wang** (University of Adelaide & East China Normal University)

Venue: **Room 211, Tianjiabing Building**

Monday, July 23

14:00-14:30	**Quanlei Fang (City University of New York)**
	Hankel operators on Hilbert function spaces
14:30-15:00	**Kun Wang (Texas A&M University)**
	Classification of C^*-algebras and the Invariants
15:00-15:30	**Qihui Li (East China University of Science and Technology)**
	Diagonalization of a normal operator in a semifinite von Neumann algebra
15:30-16:00	TEA BREAK
16:00-16:30	**Dilian Yang (University of Windsor)**
	Self-Similar Higher-Rank Graph C^*-Algebras
16:30-17:00	**Liu Liu (Dalian University of Technology)**
	Stability theory of cuasal linear systems on the Hilbert space –the connection between control theory and nest algebras
17:00-17:30	**Yanni Chen (Shaanxi Normal University)**
	A Beurling theorem for generalized Hardy spaces based on unitarily invariant norms
17:30-18:00	**Yi Wang (Texas A&M University)**
	An Inequality Involving Principal Submodules on Strongly Pseudoconvex Domains
18:00-20:00	Dinner & Pannel Discussion

Speaker: Yanni Chen (Shaanxi Normal University)
Title: *A Beurling theorem for generalized Hardy spaces based on unitarily invariant norms*
Abstract: One of the most celebrated theorem in operator theory is Beurling's invariant subspace theorem, originated by A. Beurling in 1949, and later it was extended to many other directions, including in Arveson's version of noncommutative Hardy spaces. As a more general $\|\cdot\|_p$ norm on the Hardy space, the unitarily invariant norms are very important in the study of function spaces, group representations and in obtaining certain bounds of importance in quantum field theory. In this talk, replacing the $\|\cdot\|_p$ norms with unitarily invariant norms, we are going to introduce the generalized Hardy spaces and extend the Beurling theorem in the commutative and noncommutative Hardy spaces. In this process, many expected results including the dual spaces, the characterization of outer functions have been extended.

Speaker: Quanlei Fang (City University of New York)
Title: *Hankel operators on Hilbert function spaces*
Abstract: Hankel operators serve as a bridge between operator theory and function theory. The investigation of Hankel operators on different Hilbert function spaces has a long history. In this talk we will start with some classical results then discuss some recent developments about Hankel operators and their applications.

Speaker: Qihui Li (East China University of Science and Technology)
Title: *Diagonalization of a normal operator in a semifinite von Neumann algebra*
Abstract: The theory of perturbation of self-adjoint diagonal operators has been studied for more than one hundred years. Our story starts with a well-known result of Hermann Weyl published in 1909 for diagonalization of a self-adjoint operator in a Hilbert space. The first result for diagonalizing a commuting tuple of self-adjoint operators was for commuting pairs given by Berg in 1971. The next leap in the subject was due to the work of Voiculescu in 1979. In this talk, we will extend Voiculescu's result for a normal operator acting on a separable Hilbert space to the setting of semifinite von Neumann algebras. We will also give a generalized version of Kato-Rosenblum theorem in perturbation theory.

Speaker: Liu Liu (Dalian University of Technology)
Title: *Stability theory of cuasal linear systems on the Hilbert space –the connection between control theory and nest algebras*
Abstract: As the development of H^∞ control theory, a lot of insight has been obtained by considering its time-varying analogue on an appropriate complex Hilbert space of input-output signals. In the context of operator theory and operator algebra theory, the algebra of stable, causal, time-varying linear systems can be seen as a nest algebra. In this talk, we introduce some properties of the system representations, factorizations and stabilizability criteria for time-varying linear systems in the framework of nest algebra.

Speaker: Kun Wang (Texas A&M University)
Title: *Classification of C^*-algebras and the Invariants*
Abstract: In my talk, I will review some classification results about C^* algebras and introduce

different invariants including the traditional Elliott invariant, the extended Elliott invariant, the Stevens invariant and also the new invariants $inv_0(\cdot)$, $inv(\cdot)$. I will also talk about some relations between those invariants.

Speaker: Yi Wang (Texas A&M University)
Title: *An Inequality Involving Principal Submodules on Strongly Pseudoconvex Domains*
Abstract: The Arveson-Douglas Conjecture concerns essential normality of submodule and quotient modules of certain reproducing kernel Hilbert modules. An essentially normal quotient module defines an element in the odd K-homology group on the boundary of the variety. In the special case that the corresponding submodule is principal, we show that the conjecture follows by an inequality involving the generator. We prove the inequality for generators that are holomorphic functions in a neighborhood of the closure of a bounded strongly pseudoconvex domain with smooth boundary and therefore obtain new results on the Arveson-Douglas Conjecture. I will also talk about application of this inequality on submodules that are not principal.

Speaker: Dilian Yang (University of Windsor)
Title: *Self-Similar Higher-Rank Graph C^*-Algebras*
Abstract: In this talk, we first generalize the notions of self-similar graphs and their C^*-algebras recently introduced by Exel-Pardo to higher dimensions. Then we study the properties of these C^*-algebras. In particular, we show when they are nuclear, simple and purely infinite. This talk is based on joint work with Hui Li.

Special Week on Operator Algebras

Organizers: **George Elliott** (University of Toronto)
Guihua Gong (University of Puerto Rico & Hebei Normal University)
Zhuang Niu (University of Wyoming)

Venue: **Room 222, Tianjiabing Building**

Monday, July 23

14:00–14:40 **N. Christopher Phillipps (University of Oregon)**
TBA

14:50–15:30 **Hiroyuki Osaka (Ritsumeikan University)**
The tracial Rokhlin property for an inclusion of unital C-algebras*

15:30–16:00 **TEA BREAK**

16:00–16:40 **Yasuhiko Sato (Kyoto University)**
TBA

16:50–17:30 **Xuanlong Fu (East China Normal University)**
TBA

Tuesday, July 24

14:00–14:40 **Masaki Izumi (Kyoto University)**
TBA

14:50–15:30 **Francesc Perera (Autonomous University of Barcelona)**
Existence of infima in Cuntz semigroups and applications to the structure of C-algebras with stable rank one*

15:30–16:00 **TEA BREAK**

16:00–16:40 **Leonel Robert (University of Louisiana at Lafayette)**
TBA

16:50–15:30 **Hui Li (East China Normal University)**
KMS states of self-similar k-graph C-algebras*

Wednesday, July 25

14:00–14:40 **James Mingo (Queen's University)**

The combinatorics of infinitesimal freeness

14:50–15:30 **Shuang Zhang (University of Cincinnati)**

Purely infinite simple C-algebras generated by an isometry and a weighted bilateral shift*

15:30–16:00 **TEA BREAK**

16:00–16:40 **Ping Wong Ng (University of Louisiana at Lafayette)**

TBA

16:50–17:30 **Nasser Golestani (Tarbiat Modares University)**

Weak tracial Rokhlin property for actions on simple non-unital C-algebras*

Thursday, July 26

14:00–14:40 **Liangqing Li (University of Puerto Rico)**

TBA

14:50–15:30 **Joachim Zacharias (University of Glasgow)**

TBA

15:30–16:00 **TEA BREAK**

16:00–16:40 **Jianchao Wu (Penn State University)**

TBA

16:50-17:30 **Xin Ma (Texas A&M University)**

Dynamics and classification of crossed product C-algebras*

Speaker: Nasser Golestani (Tarbiat Modares University)
Title: *Weak tracial Rokhlin property for actions on simple non-unital C^*-algebras*
Abstract: The Rokhlin property was studied in the classification of group actions on von Neumann algebras. Later, the Rokhlin property was investigated for actions on C^*-algebras. Such actions are rare and impose some K-theoretical obstructions. Phillips defined a tracial version of the Rokhlin property for finite group actions on simple unital C^*-algebras, and then the weak tracial Rokhlin property was considered by others. The Rokhlin property was extended to the case of actions on non-unital C^*-algebras by Nawata and Santiago. We introduce the tracial and weak tracial Rokhlin property for finite group actions on simple not necessarily unital C^*-algebras. We discuss that this definition has the desired permanence properties. The crossed products by actions with the tracial Rokhlin property preserve all of the following classes of (not necessarily unital) C^*-algebras: simple C^*-algebras of tracial topological rank zero, simple separable C^*-algebras of real rank zero, simple separable C^*-algebras of stable rank one and real rank zero, and simple separable nuclear $\mathcal{Z}$-stable C^*-algebras. We also discuss classes preserved under the crossed products by actions with the weak tracial Rokhlin property. The talk is based on a joint work with Marzieh Forough (arXiv1711.10818).

Speaker: Hui Li (East China Normal University)
Title: *KMS States of Self-Similar k-Graph C^*-Algebras*
Abstract: We introduce the notion of self-similar k-graph C^*-algebras constructed by Li and Yang, which is a generalization of Exel-Pardo algebras and Nekrashevych algebras. Then we describe the KMS states spaces of self-similar k-graph C^*-algebras. This is joint work with Dilian Yang.

Speaker: Xin Ma (Texas A&M University)
Title: *Dynamics and classification of crossed product C^*-algebras*
Abstract: In this talk I will talk about some dynamical properties and their relation to classification program of crossed products. These properties include dimensions, almost finiteness, comparison, and the small boundary property. In addition, I will talk about some recent classification results for crossed products based on dynamical properties mentioned above.

Some details can be found in my paper: *Invariant Ergodic measures and the classification of crossed product C^*-algebras,* arXiv: 1711.00886.

Speaker: James Mingo (Queen's University)
Title: *The Combinatorics of Infinitesimal Freeness*
Abstract: Infinitesimal freeness was introduced by Belinschi and Shlyakhtenko and has been shown to provide the framework for the $1/N$ correction in some random matrix ensembles. Since the work of Harer and Zagier and later work of Goulden and Jackson it has been known that the coefficients of the $1/N$ expansion enumerate locally orientable surfaces, and is often called a genus expansion. I will show that the $1/N$ term of interest in infinitesimal freeness can be described by planar diagrams. This enables the calculation of the infinitesimal cumulants of some basic random matrix ensembles.

Speaker: Hiroyuki Osaka (Ritsumeikan University)
Title: *The tracial Rokhlin property for an inclusion of unital C*-algebras*
Abstract: We introduce a tracial analogue of the sequentially split $*$-homomorphism between C^*-algebras of Barlak and Szabó and present that several important approximation properties related to the classification theory of C^*-algebras pass from the target algebra to the domain algebra. Then we show that the tracial Rokhlin property of the finite group G action on a C^*-algebra A gives rise to a tracial version of sequentially split $*$-homomorphism from $A \rtimes_\alpha G$ to $M_{|G|}(A)$ and the tracial Rokhlin property of an inclusion C^*-algebras $A \subset P$ with a conditional expectation $E : A \to P$ of a finite Watatani index generates a tracial version of sequentially split map. Moreover, we introduce a notion of Rokhlin property for an inclusion of unital C*-algebras which could have no projections like the Jiang-Su algebra and present related results.
Co-authorr(s) Hyun Ho Lee (University of Ulsan, South Korea)

Speaker: Francesc Perera (Autonomous University of Barcelona)
Title: *Existence of infima in Cuntz semigroups and applications to the structure of C*-algebras with stable rank one*
Abstract: Let A be a C^*-algebra with stable rank one. We show that the Cuntz semigroup of A satisfies Riesz interpolation. If A is also separable, it follows that the Cuntz semigroup of A has finite infima. This has several consequences:

(i) A conjecture of Blackadar and Handelman from 1982 is proved in the case of unital C^*-algebras with stable rank one. This conjecture predicts that the dimension functions on such a C^*-algebra form a Choquet simplex.

(ii) We confirm the global Glimm halving conjecture for unital C^*-algebras with stable rank one. This conjecture may be stated as follows: For each natural number k, the C^*-algebra A has no nonzero representations of dimension less than k if and only if there exists a morphism from the cone over the algebra of $k \times k$ matrices to $A$with full range.

(iii) The rank problem for separable, unital (not necessarily simple) C^*-algebras with stable rank one that have no finite-dimensional quotients is solved, in the following sense: For every lower semicontinuous, strictly positive, affine function f on the Choquet simplex of normalized 2-quasitraces on A, there exists a positive element in the stabilization of A whose rank is precisely f.

This is joint work with Ramon Antoine, Leonel Robert, and Hannes Thiel.

Speaker: Shuang Zhang (University of Cincinnati)
Title: *Purely infinite simple C*-algebras generated by an isometry and a weighted bilateral shift*
Abstract: In this short note we construct a family of separable purely infinite simple C^*-algebras with two special generators, an isometry and a weighted bilateral shift of infinite multiplicity. This family includes all Cuntz algebras and abundant different infinitely purely infinite simple C^*-algebras. The structure of a C^*-algebra in this family depends on the set of limit points of the associated weight sequence, where the weights can be any bounded sequence of nonzero complex numbers.

Spectral Theory and Differential Operators

Organizers: **Jussi Behrndt** (Technische Universität Graz)
Olaf Post (University of Durham)
Carsten Trunk (Technische Universität Ilmenau)

Venue: **Room 221, Tianjiabing Building**

Monday, July 23

14:00-14:25 **Sergey Belyi (Troy University)**
Linear perturbations of L-systems and unimodular trasformations

14:25-14:50 **Jin Liang (Shanghai Jiaotong University)**
Energy decay rates for coupled evolution equations controlled only by local dampings

14:50-15:15 **Tijun Xiao (Fudan University)**
Boundary controllability and observability of coupled wave equations with memory

15:15-15:40 **Chafiq Benhida (Universite de Lille I)**
On symmetric property and some operator transforms

15:40-16:10 **TEA BREAK**

16:10-16:35 **Il Ju An (Ewha Womans University)**
Krein space self-adjoint operators and their $\mathcal{J}$-Fredholm theory

16:35-17:00 **Jonathan Eckhardt (University of Vienna)**
Continued fraction expansions and generalized indefinite strings

17:00-17:25 **Junjie Huang (Inner Mongolia University)**
Invertibility of 2×2 Operator Matrices

17:25-17:50 **Carsten Trunk (Technische Universität Ilmenau)**
On the non-real spectrum for indefinite Sturm-Liouville operators

Tuesday, July 24

14:30-14:55 **Irene Sabadini (Politecnico di Milano)**
An introduction to the spectral theory on the S-spectrum

14:55-15:20 **Fabrizio Colombo (Politecnico di Milano)**
The S-spectrum approach to fractional diffusion processes

15:20-15:45 **Tirthankar Bhattacharyya (Indian Institute of Science)**
Toeplitz operators on the symmetrized bidisc

15:45-16:10 **Markus Seidel (University of Applied Sciences Zwickau)**
Attractors for the Eigenvalues of perturbed large Toeplitz matrices

16:10-16:40 **TEA BREAK**

16:40-17:05 **Igor Popov (ITMO University)**
Model of tunneling through quantum dot for Hamiltonian with spin-orbit interaction

17:05-17:30 **Irina Blinova (Saint Petersburg National Research University of IT)**
Resonance state completeness for quantum graph in a magnetic field

17:30-17:55 **Anton Popov (ITMO University)**
Resonance states for the Dirac operator on hybrid manifold in a magnetic field

17:55-18:20 **Maria Faleeva (ITMO University)**
On the spectrum of Schrodinger operator with an interaction supported by skew lines

Wednesday, July 25

14:00-14:25 **Alexander Motovilov (Bogoliubov Laboratory of Theoretical Physics)**
Solvability of the operator Riccati equation in the Feshbach case

14:25-14:50 **Roland Duduchava (The University of Georgia)**
Boundary value problems for the Laplace-Beltrami equation on a surface with Lipschitz boundary

14:50-15:15 **Marat Markin (California State University)**
On the Smoothness of Weak Solutions of an Abstract Evolution Equation with a Scalar Type Spectral Operator

15:15-15:40 **Peter Massopust (Technical University of Munich)**
Splines and Fractional Differential Operators

15:40-16:10 **TEA BREAK**

16:10-16:35 **James McCoy (University of Newcastle)**
A length-constrained curve diffusion flow

16:35-17:00 **G. Ramesh (IIT Hyderabad)**
Maps preserving $\mathcal{AN}$-operators

17:00-17:25 **Christian Le Merdy (Université de Franche-comté)**
Higher order differentiability of operator functions in Shatten norms

Thursday, July 26

14:00-14:25 **Andrea Posilicano (Università Degli Studi Dell'Insubria)**

Direct and Inverse scattering for Singular Perturbations

14:25-14:50 **Slaviša Djordjević (Benemérita Universidad Autónoma de Puebla)**

Isolated point in the spectrum of linear pencil of operators

14:50-15:15 **Volha Kushel (Shanghai University)**

On diagonal stability and its generalizations

15:15-15:40 **Maria Helena Trybula (Adam Mickiewicz University)**

Hadamard Type Operators on Spaces of Holomorphic Functions

15:40-16:10 **TEA BREAK**

16:10-16:35 **Bertin Zinsou (University of the Witwatersrand)**

Asymptotics of the eigenvalues of self-adjoint fourth order differential operators with separated eigenvalue parameter dependent boundary conditions

16:35-17:00 **Jussi Behrndt (Technische Universität Graz)**

Spectral Shift Functions and Dirichlet-to-Neumann maps

17:00-17:25 **Olaf Post (Universität Trier)**

A distance of operators acting in different Hilbert spaces and operator convergence

17:25-17:50 **Vadim Kostrykin (Johannes Gutenberg University Mainz)**

TBA

Speaker: Il Ju An (Ewha Womans University)
Title: *Krein space self-adjoint operators and their $\mathcal{J}$-Fredholm theory*
Abstract: In this talk we introduce a notion of the $\mathcal{J}$-kernel of a bounded linear operator on a Krein space and study the $\mathcal{J}$-Fredholm theory for operators on a Krein space instead of a Hilbert space. Using such a $\mathcal{J}$-Fredholm theory, we discuss for which Krein space operators $\mathcal{J}$-Weyl's theorem or $\mathcal{J}$-Browder's theorem hold.

Speaker: Jussi Behrndt (Technische Universität Graz)
Title: *Spectral Shift Functions and Dirichlet-to-Neumann maps*
Abstract: For a pair of self-adjoint operators we recall the notion of the spectral shift function ξ and we provide a new representation formula for ξ in terms of an abstract Titchmarsh-Weyl function. We discuss some applications involving elliptic partial differential operators with different boundary and transmission conditions.

This talk is based on joint work with Fritz Gesztesy and Shu Nakamura.

Speaker: Sergey Belyi (Troy University)
Title: *Linear perturbations of L-systems and unimodular trasformations*
Abstract: We study linear perturbations of Donoghue classes of Herglotz-Nevanlinna functions by a real parameter Q and their representations as impedance of conservative L-systems. Classes $\mathfrak{M}^{Q}$, $\mathfrak{M}_{\kappa}^{Q}$, $\mathfrak{M}_{\kappa}^{-1,Q}$ that are impedance functions of the corresponding L-systems are introduced. A unique unimodular transformation of a given L-system with impedance function from the mentioned above classes is found such that the impedance function of a new L-system belongs to $\mathfrak{M}^{(-Q)}$, $\mathfrak{M}_{\kappa}^{(-Q)}$, $\mathfrak{M}_{\kappa}^{-1,(-Q)}$, respectively. As a result we get that considered classes (that are perturbations of the Donoghue classes of Herglotz-Nevanlinna functions with an arbitrary real constant Q) are invariant under the corresponding unimodular transformations of L-systems. The talk is based on joint work with K. A. Makarov and E. Tsekanovskiĭ.

[1] S. Belyi, K. A. Makarov, E. Tsekanovskiĭ, *A system coupling and Donoghue classes of Herglotz-Nevanlinna functions*, Complex Analysis and Operator Theory, **10** (4), (2016), 835-880.

[2] S. Belyi, K. A. Makarov, E. Tsekanovskiĭ, *On unimodular transformations of conservative L-systems*, Operator Theory: Advances and Applications (to appear). ArXiv http://arxiv.org/abs/1608.08583

Speaker: Chafiq Benhida (Université de Lille I, France)
Title: *On symmetric property and some operator transforms*
Abstract: The class of symmetric operators is a quite large class. It contains many standard operators such as normal operators, Hankel matrices, finite Toeplitz matrices, all truncated Toeplitz operators, and Volterra integration operators. We'll present here some recent results on some transforms of symmetric operators.

Speaker: Tirthankar Bhattacharyya (Indian Institute of Science)
Title: *Toeplitz operators on the symmetrized bidisc*

Abstract: The symmetrized bidisc has grabbed a great deal of attention of late because of its rich structure both in the context of function theory and in the context of operator theory. This talk will develop Toeplitz operators on this domain. The distinguished boundary $b\Gamma$ of the symmetrized bidisc is topologically identifiable with the Mobius strip and it is natural to consider bounded measurable functions there. We shall discuss a natural Hilbert space $H^2(\mathbb{G})$. The L^∞ functions on $b\Gamma$ induce Toeplitz operators on this space. Such Toeplitz operators can be characterized through a couple of relations that they have to satisfy with respect to the co-ordinate multiplications on the space $H^2(\mathbb{G})$ which we call the Brown-Halmos relations. A number of results will bring out the similarities and the differences with the theory of Toeplitz operators on the disc as well as the bidisc. The Coburn alternative fails, for example. However, the compact perturbations of Toeplitz operators are precisely the asymptotic Toeplitz operators. The only compact Toeplitz operator turns out to be the zero operator.

Time permitting, we shall deal with dual Toeplitz operators. Just like a Toeplitz operator is characterized by the Brown-Halmos relations with respect to the co-ordinate multiplications, an arbitrary bounded operator X which satisfies the Brown-Halmos relations with respect to a commuting family of Γ-isometries is a compression of a norm preserving Y acting on the space of minimal Γ-unitary extension of the family of isometries. Moreover, if X commutes with the Γ-isometries, then Y is an extension and commutes with the minimal Γ-unitary extensions. This result can be applied to characterize a dual Toeplitz operator.

This work is joint with Bata Krishna Das and Haripada Sau.

Speaker: Irina Blinova (Saint Petersburg National Research University of IT, Mechanics and Optics)
Title: *Resonance state completeness for quantum graph in a magnetic field*
Abstract: Quantum graph having two semi-infinite edges is considered. We deal with plane quantum graph embedded in $\mathbb{R}^3$. Resonances and resonance states for graphs with loops in a magnetic field are found. The completeness of the states in the space of square integrable functions on finite subgraph is analyzed. The technique is related to Sz.-Nagy functional model and Lax-Phillips approach to scattering theory. Factorization theorem for inner matrix-functions is used. The result is compared with the corresponding completeness theorem for the Schrodinger quantum graph without a magnetic field. This is a joint work with I. Y. Popov.

Speaker: Fabrizio Colombo (Politecnico di Milano)
Title: *The S-spectrum approach to fractional diffusion processes*
Abstract: In this talk we show an application of the spectral theory based on the notion of S-spectrum to fractional diffusion process. Precisely, we consider the Fourier law for the propagation of the heat in non homogeneous materials, that is the heat flow is given by the vector operator:

$$T = e_1\, a(x)\partial_{x_1} + e_2\, b(x)\partial_{x_2} + e_3\, c(x)\partial_{x_3}$$

where e_ℓ, $e_\ell = 1, 2, 3$ are orthogonal unit vectors in $\mathbb{R}^3$, a, b, c are given real valued functions that depend on the space variables $x = (x_1, x_2, x_3)$, and possibly also on time. Using the H^∞-version of the S-functional calculus we define fractional powers of quaternionic operators, which contain, as a particular case, the vector operator T. Hence, we can define the non-local version T^α, for $\alpha \in (0, 1)$, of the Fourier law defined by T. We will see how we have to interpret T^α, when we introduce the so called: "The S-spectrum approach to fractional

diffusion processes". This new method allows us to enlarge the class of fractional diffusion and fractional evolution problems that can be defined and studied using the spectral theory based on the S-spectrum for vector operators.

Speaker: Slaviša Djordjević (Benemérita Universidad Autónoma de Puebla)
Title: *Isolated point in the spectrum of linear pencil of operators*
Abstract: Let $A, B \in \mathcal{B}(X, Y)$, then the operator $A - \lambda B$, $\lambda \in \mathbf{C}$, is called the linear pencil (of an ordainer pair (A, B)) of operators. The spectrum of a linear pencil is the set

$$\sigma(A, B) = \{\lambda \in \mathbf{C} : A - \lambda B \text{ is not invertible}\},$$

and $\rho(A, B) = \mathbf{C} \setminus \sigma(A, B)$ is called the resolvent set of linear pencil (A, B). It is clear that $\lambda \in \sigma(A, B)$ if and only if $0 \in \sigma(A - \lambda B)$.

Recall $A \in \mathcal{B}(X)$ is Drazin invertible if there exists $B \in \mathcal{B}(X)$ and an integer $k \in \mathbf{N}$ such that

$$B = BAB, \quad A^k = A^{k+1}B, \quad AB = BA.$$

In this case we denote $B = A^D$. By previous equations we can see that the operator $A(I - AB)$ is nilpotent. If we have that $A(I - AB)$ be quasinilpotent (together with $B = BAB$ and $AB = BA$) we got the generalized Drazin inverse (or Koliha-Drazin inverse) and, in this case, we denote $B = A^d$. The existent of those inverses is strongly connected with spectral properties of A: if 0 is not accumulation point of $\sigma(A)$ (in notation $0 \notin \text{acc}\sigma(T)$), then A has the generalized Drazin inverse.

In this talk we will show that for any $A, B \in \mathcal{B}(X, Y)$, $\lambda_0 \in \text{iso}\sigma(A, B)$ if and only if there exits a pair decomposition of (A, B) such that $\sigma(A_0, B_0) = \{\lambda_0\}$ and $\tilde{\sigma}(A, B) \setminus \{\lambda_0\} = \tilde{\sigma}(A_1, B_1)$. In the case when $X = Y$, $A - \lambda_0 B$ is Koliha-Drazin invertible and

$$(A - \lambda_0 B)^d = 0 \oplus (A_1 - \lambda_0 B_1)^{-1}.$$

This is a joint work with Jasang Yoon.

Speaker: Roland Duduchava (The University of Georgia)
Title: *Boundary value problems for the Laplace-Beltrami equation on a surface with Lipschitz boundary*
Abstract: We study Fredholm property and solvability of different boundary value problems for the Laplace-Beltrami equation on a surface with Lipschitz boundary. Localization is applied to reduce the problem to model problems in angular domains, which are studied by means of Mellin convolution equations in Bessel potential spaces. The latter equations are investigated with the help of results on operator algebras generated by Fourier and Mellin convolution operators in the Lebesgue spaces.

Speaker: Jonathan Eckhardt (University of Vienna)
Title: *Continued fraction expansions and generalized indefinite strings*
Abstract: Stieltjes continued fraction expansions play a decisive role in the solution of the inverse spectral problem for Krein strings. Certain continued fractions of a modified form correspond in the same way to generalized indefinite strings. I will discuss under which conditions

Herglotz-Nevanlinna functions allow such an expansion and use this to solve the inverse spectral problem for generalized indefinite strings with coefficients supported on a discrete set. The results are related to the Hamburger moment problem and multi-soliton solutions of particular nonlinear wave equations.

Speaker: Maria Faleeva (ITMO University)
Title: *On the spectrum of Schrodinger operator with an interaction supported by skew lines*
Abstract: The Schrodinger operator with an interaction supported by sets of zero measure is intensively investigated last time. We consider a potential supported on skew lines in three-dimensional space. The mathematical background for correct introducing of such a potential is given by the theory of self-adjoint extensions of symmetric operators. The spectral problem (and especially the discrete spectrum) is studied. Possible applications of the results in nanoelectronics and biophysics are discussed.

The work was partially supported by grant 16-11-10330 of Russian Science Foundation.

Speaker: Junjie Huang (Inner Mongolia University)
Title: *Invertibility of* 2×2 *Operator Matrices*
Abstract: In this talk, we investigate the invertibility of 2×2 operator matrices. Properties of right invertible row operators, i.e., of 1×2 surjective operator matrices are studied first. This investigation is based on a specific space decomposition. Using this decomposition, we characterize the invertibility of a 2×2 operator matrix. As an application, the invertibility of Hamiltonian operator matrices is investigated. This work were completed jointly with Junfeng Sun, Alatancang Chen and Carsten Trunk.

Speaker: Volha Kushel (Shanghai University)
Title: *On diagonal stability and its generalizations*
Abstract: An $n \times n$ real matrix $\mathbf{A}$ is called *Lyapunov diagonally stable* if there exists a positive diagonal matrix $\mathbf{D}$ such that $\mathbf{DA} + \mathbf{A}^T\mathbf{D}$ is positive definite. Diagonally stable matrices form an important subclass of D-stable matrices (a matrix $\mathbf{A}$ is called *D-stable* if $\mathbf{DA}$ is (positive) stable for every positive diagonal matrix $\mathbf{D}$). In this talk, we consider the generalization of the concept of D-stability, based on the matrix spectra localization inside an arbitrary (symmetric with respect to the real axes) region of the complex plane. We introduce the generalization of diagonal stability for LMI regions and present some results describing the obtained matrix classes.

Speaker: Christian Le Merdy (Université de Franche-Comté)
Title: *Higher order differentiability of operator functions in Shatten norms*
Abstract: Let H be a Hilbert space and for any $1 < p < \infty$, let $S^p(H)$ denote the corresponding Schatten class. Let A be a selfadjoint operator on H. Let $f\colon \mathbb{R} \to \mathbb{C}$ be a C^1-function whose derivative f' is bounded. An outstanding result of Potapov-Sukochev (2011) asserts that

$$f(A+K) - f(A) \in S^p$$

for any selfadjoint $K \in S^p$. Using multiple operator integrals, we will discuss new results

concerning the link between differentiability properties of $K \mapsto f(A+K) - f(A)$ and the regularity of f. This is a joint work with Anna Skripka.

Speaker: Jin Liang (Shanghai Jiaotong University)
Title: *Energy decay rates for coupled evolution equations controlled only by local dampings*
Abstract: We study energy decay rates for coupled evolution equations controlled only by local damping mechanism with local coupling effect, which are produced by local memory/frictional terms; local coupling terms are only on an arbitrary subinterval (not necessarily including the ends), and the intersection of them can be empty. By virtue of the theory of self-adjoint operators and operator calculus, we establish an ideal energy decay rate theorem with the exact uniform decay rates for the solutions to this system. Moreover, polynomial/exponential decay rates are obtained also in the case of the memory kernels decaying polynomially/exponentially. This is joint work with Kun-Peng Jin and Ti-Jun Xiao.

Speaker: Marat Markin (California State University)
Title: *On the Smoothness of Weak Solutions of an Abstract Evolution Equation with a Scalar Type Spectral Operator*
Abstract: Found are conditions on a scalar type spectral operator A in a complex Banach space necessary and sufficient for all weak solutions of the evolution equation

$$y'(t) = Ay(t),\ t \geq 0,$$

which a priori need not be differentiable, to be infinite differentiable or Gevrey ultradifferentiable (in particular, analytic or entire) on $[0, \infty)$ or $(0, \infty)$. Certain inherent smoothness improvement effect is analyzed.

Speaker: Peter Massopust (Technical University of Munich)
Title: *Splines and Fractional Differential Operators*
Abstract: We consider splines of fractional, complex, and quaternionic orders and show how they can be realized using an appropriate fractional differential operator.

Speaker: James McCoy (University of Newcastle)
Title: *A length-constrained curve diffusion flow*
Abstract: We show that any initial closed curve suitably close to a circle flows under length-constrained curve diffusion to a round circle in infinite time with exponential convergence. We provide an estimate on the total length of time for which such curves are not strictly convex. We further show that there are no closed translating solutions to the flow and that the only closed rotators are circles.

Speaker: Alexander Motovilov (Bogoliubov Laboratory of Theoretical Physics)
Title: *Solvability of the operator Riccati equation in the Feshbach case*

Abstract: We consider a bounded block operator matrix of the form

$$L = \begin{pmatrix} A & B \\ C & D \end{pmatrix},$$

where the main-diagonal entries A and D are self-adjoint operators on Hilbert spaces $\mathfrak{H}_{A}$ and $\mathfrak{H}_{D}$, respectively; the coupling B maps $\mathfrak{H}_{D}$ to $\mathfrak{H}_{A}$ and C is an operator from $\mathfrak{H}_{A}$ to $\mathfrak{H}_{D}$. It is assumed that the spectrum σ_{D} of D is absolutely continuous and uniform, being presented by a single band $[\alpha, \beta] \subset \mathbb{R}$, $\alpha < \beta$, and the spectrum σ_{A} of A is embedded into σ_{D}, that is, $\sigma_{A} \subset (\alpha, \beta)$. One more assumption is that, in the spectral representation of D, both the couplings B and C are defined via operator-valued functions of $\lambda \in (\alpha, \beta)$ which are real analytic on (α, β) and admit analytic continuation onto some domain in $\mathbb{C}$. This allows one to perform a complex deformation of L. The latter involves, in particular, the replacement of the original entry D with the operators of multiplication by the complex variable λ running through piecewise smooth Jordan contours obtained from the interval (α, β) by continuous transformations. We formulate conditions under which there are bounded solutions to the operator Riccati equations associated with the complexly deformed block operator matrix L; in such a case the deformed operator matrix L admits a block diagonalization. The same conditions also ensure the Markus-Matsaev-type factorization of the Schur complement $M_{A}(z) = A - z - B(D - z)^{-1}C$ analytically continued onto the unphysical sheet(s) of the complex z plane adjacent to the band $[\alpha, \beta]$. We prove that the operator roots of the continued Schur complement M_{A} are explicitly expressed through the respective solutions to the deformed Riccati equations. This is a joint work with Sergio Albeverio.

Speaker: Anton Popov (ITMO University)
Title: *Resonance states for the Dirac operator on hybrid manifold in a magnetic field*
Abstract: The Dirac operator on a hybrid manifold consisting of sphere and two semi-infinite wires attached is considered. The model operator is constructed in the framework of the theory of self-adjoint extensions of symmetric operators. It allows one to give rigorous mathematical description of coupling of manifolds having different dimensions. Scattering matrix is obtained using the expression for the Green function of the Dirac operator on the sphere. Resonances and resonance states are found and investigated. The completeness of the resonance states is studied. Functional model and Lax-Philips approach to scattering theory is used.

The work was partially supported by grant 16-11-10330 of Russian Science Foundation.

Speaker: Igor Popov (ITMO University)
Title: *Model of tunneling through quantum dot for Hamiltonian with spin-orbit interaction*
Abstract: Solvable mathematical model is suggested for tunneling through quantum dot in a magnetic field. The background is the theory of self-adjoint extensions of symmetric operators. Spin-orbit interaction is taken into account. Krein $Q-$function and Γ-field are constructed. The transmission coefficient is obtained. The transmission coefficient dependence on The result is compared with the case of spin-orbit interaction absence.

Speaker: Andrea Posilicano (Università Degli Studi Dell'Insubria)
Title: *Direct and Inverse scattering for Singular Perturbations*

Abstract: We give a criterion of asymptotic completeness and provide a representation of the scattering matrix for the scattering couple (A_0, A), where A_0 and A are semi-bounded self-adjoint operators in $L^2(M, \mathcal{B}, m)$ such that the set $\{u \in \mathcal{D}(A_0) \cap \mathcal{D}(A) : A_0 u = Au\}$ is dense. No sort of trace-class condition on resolvent differences is required.

Applications to the case in which A_0 corresponds to the free Laplacian in $L^2(\mathbb{R}^n)$ and A describes the Laplacian with self-adjoint boundary conditions on rough compact hypersurfaces are given. For such models, some results about the inverse scattering problem are also provided. This is a joint work with Andrea Mantile, Laboratoire de Mathématiques CNRS, Reims.

Speaker: Olaf Post (Universität Trier, Germany)
Title: *A distance of operators acting in different Hilbert spaces and operator convergence*
Abstract: In applications, one often faces the problem that a sequence of operators act in varying Hilbert spaces, but one nevertheless wants to have some notion of convergence. We establish a convergence in operator norm which generalises operator convergence. It is expressed in a parameter measuring the distance of two operators, generalising operator convergence and unitary equivalence.

Speaker: G. Ramesh (IIT Hyderabad)
Title: *Maps preserving $\mathcal{AN}$-operators*
Abstract: Let H_1 and H_2 be complex Hilbert spaces and $T\colon H_1 \to H_2$ be a bounded linear operator. Then T is said to be *norm attaining* if there exists a unit vector $x_0 \in H_1$ such that $\|Tx_0\| = \|T\|$. If for any closed subspace M of H_1, the restriction $T|M\colon M \to H_2$ of T is norm attaining, then T is called an *absolutely norm attaining* operator or $\mathcal{AN}$-operator. These operators are studied in [1–3]. In this talk we discuss linear maps on $\mathcal{B}(H)$ which preserve $\mathcal{AN}$-operators. This is a joint work with Hiroyuki Osaka.

[1] X. Carvajal and W. Neves, Operators that achieve the norm, Integral Equations Operator Theory **72** (2012), no. 2, 179–195.

[2] G. Ramesh, Structure theorem for $\mathcal{AN}$-operators, J. Aust. Math. Soc. **96** (2014), no. 3, 386–395.

[3] Pandey, Satish K.; Paulsen, Vern I. A spectral characterization of $\mathcal{AN}$ operators. J. Aust. Math. Soc. **102** (2017), no. 3, 369–391.

Speaker: Irene Sabadini (Politecnico di Milano)
Title: *An introduction to the spectral theory on the S-spectrum*
Abstract: In the first half of the last century, G. Birkhoff and J. von Neumann showed that quantum mechanics can be formulated over the real, the complex and the quaternionic numbers. Since then, several papers and books treated this topic in the quaternionic setting, however it is interesting, and somewhat surprising, that an appropriate notion of quaternionic spectrum was not present in the literature. In this talk we explain the facts that led to discovery of the S-spectrum for quaternionic linear operators, the quaternionic analogue of the Riesz-Dunford functional calculus (the so called S-functional calculus), and of some of the difficulties which,

in our opinion, prevented to find earlier these objects.

Speaker: Markus Seidel (University of Applied Sciences Zwickau)
Title: *Attractors for the Eigenvalues of perturbed large Toeplitz matrices*
Abstract: Computing Eigenvalues of matrices is undeniably an interesting and important task, and there are tons of methods and algorithms which are more or less suitable for general matrices, matrices with a particular structure, matrices of particular sizes, etc. Implementations on standard computers are additionally affected and restricted by the finite machine precision in their computations. Therefore typical iterative procedures are doomed to accumulate small imprecisions resulting in incorrectly computed eigenvalues. Surprisingly, these resulting errors are often far away from being "small random errors" but appear to be rather systematic and dominated by certain attractors. Böttcher, Silbermann and Böttcher, Grudsky described this e.g. in [2,1] for the computation of Eigenvalues of large Toeplitz matrices.

The aim of this talk is to present a new approach which gives insight and an explanation for this phenomenon. This approach is based on operator theoretical and algebraic methods which describe the approximation of spectral properties (norms, condition numbers, spectra, and pseudospectra) for band-dominated and similar operators.

[1] A. Böttcher, S. M. Grudsky, *Spectral properties of banded Toeplitz matrices*, Society for Industrial and Applied Mathematics (SIAM), Philadelphia, PA, 2005.

[2] A. Böttcher, B. Silbermann, *Introduction to Large Truncated Toeplitz Matrices*, Springer-Verlag, New York, 1999.

Speaker: Carsten Trunk (Technische Universität Ilmenau)
Title: *On the non-real spectrum for indefinite Sturm-Liouville operators*
Abstract: The non-real spectrum of a singular indefinite Sturm-Liouville operator

$$A = \frac{1}{r}\left(-\frac{d}{dx}\,p\,\frac{d}{dx} + q\right)$$

with a sign changing weight function r consists (under suitable additional assumptions on the real coefficients p, q, r) of isolated eigenvalues with finite algebraic multiplicity which are symmetric with respect to the real line. We present bounds on the absolute values and the imaginary parts of the non-real eigenvalues of A. The bounds depend on the negative part of q, on the L^∞-norm of $1/p$ and in an implicit way on the sign changes and zeros of the weight function.

Speaker: Maria Trybula (Adam Mickiewicz University in Poznan)
Title: *Hadamard Type Operators on Spaces of Holomorphic Functions*
Abstract: We consider multipliers on the space of holomorphic functions of one variables $H(\Omega); \Omega \subset \mathbb{C}$ open, i.e., linear continuous operators for which all monomials are eigenvectors. If zero belongs to Ω and Ω is a domain these operators are just multipliers on the sequences of Taylor coefficients at zero. In particular, Hadamard multiplication operators are multipliers. In the case of Runge open sets we represent all multipliers via a kind of multiplicative convolution with analytic functionals and characterize the corresponding sequences of eigenvalues as moments of suitable analytic functionals. Moreover, we represent multipliers via suitable

germs of holomorphic functions with Laurent or Taylor coefficients equal to the eigenvalues of the operator. We identify which topology should be put on the suitable space of analytic functionals in order that the above mentioned isomorphism becomes a topological one when the space of multipliers inherits the topology of uniform convergence on bounded sets from the space of all endomorphisms on $H(\Omega)$ We also represent multipliers acting on $H(\Omega)$ for an arbitrary open planar set in terms of germs of holomorphic functions on the set $(\hat{\mathbb{C}} \setminus \Omega) \times \Omega$ vanishing at infinity points. In the later we proved that the found representation is actually a topological isomorphism between $\mathsf{M}(\Omega)$ and $H_0((\hat{\mathbb{C}} \setminus \Omega) \times \Omega)$, where the space of germs carries the inductive topology. In the last part of the paper we discuss the obtained characterizations in the case when $0 \in \Omega$ as well as provide several examples of multipliers and the corresponding analytic functionals.

Speaker: Tijun Xiao (Fudan University)
Title: *Boundary controllability and observability of coupled wave equations with memory*
Abstract: With the help of spectral theory of operators and the Riesz property of the associated families of functions, we investigate the boundary controllability and observability problems for a system of coupled wave equations with memory. Because the control functions may be rough, we will consider in this work the existence of solutions in a weak form. Moreover, two different cases, one of which involves two controls and the other only one control. are studied. We establish new and general (direct or indirect) boundary observability inequalities and boundary controllability theorems for this system. This is joint work with Zhe Xu.

Speaker: Bertin Zinsou (University of the Witwatersrand)
Title: *Asymptotics of the eigenvalues of self-adjoint fourth order differential operators with separated eigenvalue parameter dependent boundary conditions*
Abstract: An eigenvalue problem for a regular fourth order ordinary differential equation is considered, where one of the boundary conditions linearly depends upon the eigenvalue parameter. The first four terms in the asymptotic expansion of the eigenvalues are derived.

Graduate Student Forum

Organizer: **Hang Wang** (University of Adelaide & East China Normal University)

Venue: **Room 211, Tianjiabing Building**

Monday, July 23

17:30-17:55 **Yi Wang (Texas A&M University)**
An Inequality Involving Principal Submodules on Strongly Pseudoconvex Domains

Tuesday, July 24

17:15-17:40 **Hao Guo (University of Adelaide)**
Index of Equivariant Callias-Type Operators

Wednesday, July 25

17:15-17:40 **Zhen Wang (East China Normal University)**
Persistence approximation property for maximal Roe algebras

Thursday, July 26

17:15-17:40 **Baojie Jiang (Fudan University)**
Smooth subalgebra of Roe algebra

17:45-18:10 **Jintao Deng (Texas A&M University)**
Maximal and reduced equivariant Roe algebras

Friday, July 27

17:15-17:40 **Xin Ma (Texas A&M University)**
Invariant ergodic measures, the small boundary property and classification of crossed products

17:45-18:10 **Jinghao Huang (University of New South Wales)**
Derivations into ideals of a semifinite von Neumann algebra

Speaker: Jintao Deng (Texas A&M University)
Title: *Maximal and reduced equivariant Roe algebras*
Abstract: Let X be a discrete metric space with bounded geometry, Γ a finitely generated group. Assume Γ acts on X properly and freely by isometries. If the group Γ is amenable and the space X has Property A, then the maximal and reduced equivariant Roe algebras are the same. In the talk, I will also talk about K-theory of the maximal and reduced equivariant Roe algebras.

Speaker: Hao Guo (University of Adelaide)
Title: *Index of Equivariant Callias-Type Operators*
Abstract: Suppose M is a smooth Riemannian manifold on which a Lie group G acts properly and isometrically. In this talk I will explore properties of a particular class of G-invariant operators on M, called G-Callias-type operators. These are Dirac operators that have been given an additional $\mathbb{Z}_2$-grading and a perturbation so as to be "invertible outside of a cocompact set in M". It turns out that G-Callias-type operators are equivariantly Fredholm and so have an index in the K-theory of the maximal group C^*-algebra of G. This index can be expressed as a KK-product of a class in K-homology and a class in the K-theory of the Higson G-corona. In fact, one can show that the K-theory of the Higson G-corona is highly non-trivial, and thus the index theory of G-Callias-type operators is not obviously trivial. As an application of the index theory of G-Callias-type operators, I will mention an obstruction to the existence of G-invariant metrics of positive scalar curvature on M.

Speaker: Jinghao Huang (University of New South Wales)
Title: *Derivations into ideals of a semifinite von Neumann algebra*
Abstract: The derivation problem introduced by Barry Johnson is one of the classical problems in operator algebra theory. The Johnson-Parrott-Popa theorem states that every derivation from a von Neumann subalgebra of $B(H)$ into $K(H)$ of all compact operators on H is inner. In 1985, Kaftal and Weiss showed that every derivation $\delta : A \to L_p(M,\tau) \cap M$, $1 \leq p < \infty$, is inner if A is an abelian (or properly infinite) von Neumann subalgebra of a semifinite von Neumann algebra M, where τ is a faithful semifinite normal trace on M and $L_p(M,\tau)$, $1 \leq p < \infty$, is the non-commutative L_p-space relative to τ. However, the question whether every derivation from an arbitrary von Neumann subalgebra into $L_p(M,\tau) \cap M$, $1 \leq p < \infty$, is inner was left unresolved in that paper. In this talk, I will give an overview of the previous results and outline my work (with Ber, Levitina, Sukochev) which characterizes the ideals of M such that every derivation from a von Neumann subalgebra of M into these ideals is inner. In particular, our result unifies and extends the results by Johnson, Parrott and Popa, and, by Kaftal and Weiss.

Speaker: Baojie Jiang (Fudan University)
Title: *Smooth subalgebra of Roe algebra*
Abstract: For discrete groups considered as metric spaces, we gave a new method to construct a smooth subalgebra of a 'middle subalgebra' (a certain subalgebra in the Roe algebra of a discrete group). The evidence that this is a suitable candidate for the role of smooth subalgebra is given by the fact that under suitable conditions this 'middle subalgebra' and the Roe algebra have the same K-theory groups. The main method here is the use of Lafforgue's KK^{ban}-

Theory. This is a joint work with Xiaoman Chen and Anyi Zhou.

Speaker: Xin Ma (Texas A&M University)
Title: *Invariant ergodic measures, the small boundary property and classification of crossed products*
Abstract: In this talk I would like to talk about some recent results on regularity properties in dynamical systems and their application to the classification of crossed products. These properties include various types of dimensions, comparison, the small boundary properties and almost finiteness.

Speaker: Yi Wang (Texas A&M University)
Title: *An Inequality Involving Principal Submodules on Strongly Pseudoconvex Domains*
Abstract: The Arveson-Douglas Conjecture concerns essential normality of submodule and quotient modules of certain reproducing kernel Hilbert modules. An essentially normal quotient module defines an element in the odd K-homology group on the boundary of the variety. In the special case that the corresponding submodule is principal, we show that the conjecture follows by an inequality involving the generator. We prove the inequality for generators that are holomorphic functions in a neighborhood of the closure of a bounded strongly pseudoconvex domain with smooth boundary and therefore obtain new results on the Arveson-Douglas Conjecture. I will also talk about application of this inequality on submodules that are not principal.

Speaker: Zhen Wang (East China Normal University)
Title: *Persistence approximation property for maximal Roe algebras*
Abstract: Persistence approximation property was introduced by Herve Oyono-Oyono and Guoliang Yu. This property provides a geometric obstruction to Baum-Connes conjecture. In this talk, we mainly discuss the persistence approximation property for maximal Roe algebras.

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- Francesc Perera, Autonomous University of Barcelona, Spain
- Markus Pflaum, University of Colorado, USA
- N. Christopher Phillips, University of Oregon, USA
- Ariel Pinhas, Ben-Gurion University of the Negev, Israel
- Artur Planeta, University of Agriculture, Poland
- Alexei Poltoratski, Texas A&M University, USA
- Yiu-Tung Poon, Iowa State University, USA
- Anton Popov, ITMO University, Russia
- Igor Popov, ITMO University, Russia
- Motke Porat, Ben-Gurion University of the Negev, Israel
- Andrea Posilicano, Università Degli Studi Dell'Insubria, Italy
- Olaf Post, University of Durham, UK
- Alexander Powell, Vanderbilt University, USA
- Xiaofei Qi, Shanxi University, China
- Yaru Qi, Inner Mongolia University of Technology, China
- Zhou Qi, Fudan University, China
- Yu Qiao, Shaanxi Normal University, China
- Yueshi Qin, Chongqing University, China
- Yanqi Qiu, Inst. of Mathematics, Chinese Academy of science, China

- Safdar Quddus, Indian Institute of Science, India
- Raul Quiroga Barranco, Centro de Investigación en Matemáticas, Mexico
- G. Ramesh, IIT Hyderabad, India
- Narcisse Randrianantoanina, Miami University, USA
- Samya Kumar Ray, Indian Institute of Technology Kanpur, India
- Qinggang Ren, Chongqing University, China
- Leonel Robert, University of Louisiana at Lafayette, USA
- Mikael Rørdam, University of Copenhagen, Denmark
- Zhong-Jin Ruan, University of Illinois at Urbana-Champaign, USA
- Irene Sabadini, Politecnico di Milano, Italy
- Guy Salomon, Israel Institute of Technology, Israel
- Armando Sánchez Nungaray, Universidad Veracruzana, Mexico
- Ayse Sandikci, Ondokuz Mayis University, Turkey
- Yuanqi Sang, Chongqing University, China
- Srijan Sarkar, Indian Statistical Institute Bangalore, India
- Yasuhiko Sato, Kyoto University, Japan
- Haripada Sau, Virginia Tech, USA
- Julien Sazadaly, Université de Reims Champagne Ardennes, France
- Markus Seidel, University of Applied Sciences Zwickau, Germany
- Peter Semrl, University of Ljubljana, Slovenia
- Eli Shamovich, University of Waterloo, Canada
- Sumit Kumar Sharma, Kirori Mal College, India
- Yanfeng Shen, Dezhou University, China
- Luoyi Shi, Tianjin Polytechnic University, China
- Rui Shi, Dalian University of Technology, China
- Yanfen Shi, Fudan University, China
- Yanyue Shi, Ocean University of China, China
- Elina Shishkina, Voronezh State University, Russia
- Tara Singh, M.L.S. University, India
- Baruch Solel, Israel Institute of Technology, Israel

- Yanli Song, Washington University in St. Louis, USA
- Roland Speicher, Universität des Saarlandes, Germany
- Nico Spronk, University of Waterloo, Canada
- Karel Stroethoff, University of Montana, USA
- Karen Strung, Radboud University, Netherlands
- Guomin Sun, University of electronic science and technology of China, China
- Jie Sun, Hubei Normal University, China
- Qiyu Sun, University of Central Florida, USA
- Nung-Sing Sze, The Hong Kong Polytechnic University, China
- Kotaro Tanahashi, Tohoku Medical and Pharmaceutical University, Japan
- Xiang Tang, Washington University at St Louis, USA
- Terrence Teh, University of the Philippines-Diliman, Philippines
- Sanne Ter Horst, North-West University, South Africa
- Peng Tian, University of Paris East, France
- Edward Timko, University of Manitoba, Canada
- Andrew Toms, Purdue University, USA
- Cezhong Tong, Hebei University of Technology, China
- Mai Tran, SUNY at Albany, USA
- Carsten Trunk, Technische Universität Ilmenau, Germany
- Zuming Tu, Wuhan institute of technology, China
- Maria Helena Trybula, Adam Mickiewicz University, Poland
- Ryan Tully-Doyle, Hampton University, USA
- Batzorig Undrakh, National University of Mongolia, Mongolia
- Nikolai L. Vasilevski, CINVESTAV, Mexico
- Ignacio Vergara, ENS de Lyon, France
- Victor Vinnikov, Ben Gurion University of the Negev, Israel
- Dániel Virosztek, Institute of Science and Technology Austria, Austria
- Felix Voigtlaender, Technische Universitat Berlin, Germany
- Jurij Volcic, Ben-Gurion University of the Negev, Israel
- Bai-Ling Wang, Australian National University, Australia

- Cangyuan Wang, East China Normal University, China
- Chongchao Wang, Chongqing University, China
- Chunhui Wang, Wuhan University, China
- Fen Wang, Guangdong University of Finance, China
- Hang Wang, East China Normal University, China
- Hua Wang, Inner Mongolia University of Technology, China
- Huan Wang, East China Normal University, China
- Jianfei Wang, Zhejiang Normal University, China
- Kai Wang, Fudan University, China
- Kun Wang, Texas A&M University, USA
- Maofa Wang, Wuhan University, China
- Penghui Wang, Shandong University, China
- Qin Wang, East China Normal University, China
- Qingyun Wang, University of Oregon, USA
- Ruo Fei Wang, Ocean University of China, China
- Simeng Wang, Universitat des Saarlandes, Germany
- Siyu Wang, Northeast Normal University, China
- Wei Wang, Henan Normal University, China
- Xianjin Wang, Chongqing University, China
- Xiaofeng Wang, Guangzhou University, China
- Yanru Wang, East China Normal University, China
- Yi Wang, Texas A&M University, USA
- Yuanyi Wang, College of Science and Technology, Ningbo University, China
- Zhen Wang, East China Normal University, China
- Zhenhua Wang, University of Houston, USA
- Zhonghua Wang, Xi'an Shiyou University, China
- Zipeng Wang, Shaanxi Normal University, China
- Marcus Waurick, University of Strathclyde, UK
- Eric Weber, Iowa State University, USA
- Changguo Wei, Ocean University of China, China

- Sihan Wei, East China Normal University, China
- Zhilan Wei, Chongqing Technology and Business University, China
- Rufus Willett, University of Hawaii, USA
- Hugo J. Woerdeman, Drexel University, USA
- Jianchao Wu, Penn State University, USA
- Jinsong Wu, Harbin Institute of Technology, China
- Shengkun Wu, Chongqing University, China
- Yan Wu, Jiaxing University, China
- Yue Wu, Central University of Finance and Economics, China
- Zhijian Wu, University of Nevada, USA
- Hasi Wulan, Shantou University, China
- Jingbo Xia, SUNY at Buffalo, USA
- Binghuan Xiao, North China Electric Power University, China
- Tijun Xiao, Fudan University, China
- Xiangchun Xiao, Xiamen University of Technology, China
- Zhizhang Xie, Texas A&M University, USA
- Meili Xing, Ocean University of China, China
- An-Bao Xu, Wenzhou University, China
- Anjian Xu, Chongqing University of Technology, China
- Hongkun Xu, Hangzhou Dianzhi University, China
- Jinli Xu, Northeast Forestry University, China
- Quanhua Xu, Université de Franche-Comté & Harbin Institute of Technology, France/China
- Xiaoping Xu, Ocean university of China, China
- Yan Xu (Soochow University, China
- Yuxiang Xu, University of Electronic Science and Technology of China, China
- Yifeng Xue, East China Normal University, China
- Kai Yan, Fuzhou University, China
- Dilian Yang, University of Windsor, Canada
- Liming Yang, Fudan University, China
- Rongwei Yang, The State University of New York at Albany, USA

- Ying-Hui Yang, Henan Polytechnic University, China
- Yixin Yang, Dalian University of Technology, China
- Yu Yang, Chongqing Technology and Business University, China
- Yu Yang, National Singapore University, Singapore
- Yijun Yao, Fudan University, China
- Sheng Yin, Universitat des Saarlandes, Germany
- Seonguk Yoo, Gyeongsang National University, South Korea
- Jasang Yoon, The University of Texas Rio Grande Valley, USA
- Sang-Gyun Youn, Seoul National University, South Korea
- Nicholas Young, Newcastle University& Leeds University, UK
- Bo Yu, China Three Gorges University, China
- Guoliang Yu, Texas A&M University, USA
- Shilin Yu, Texas A&M University, USA
- Tao Yu, Dalian University of Technology, China
- Tianqiu Yu, Heilongjiang University, China
- He Yuan, Jilin Normal University, China
- Jiang Tao Yuan, Henan Polytechnic University, China
- Joachim Zacharias, University of Glasgow, UK
- Dmitry Zanin, University of New South Wales, Australia
- Chao Zhang, Guangdong University of Education, China
- Haixia Zhang, Henan Normal University, China
- Jianping Zhang, Yan'an University, China
- Rui Zhang, Huazhong University of Science and Technology, China
- Shuang Zhang, University of Cincinnati, USA
- Shuyi Zhang, Fudan University, China
- Wei Zhang, Henan University of Economics and Law, China
- Yan Zhang, orth Minzu University, China
- Ye Zhang, Shaanxi Normal University, China
- Yingfang Zhang, Henan Polytechnic University, China
- Yong Zhang, University of Manitoba, Canada

- Yuanhang Zhang, Jilin University, China
- Chong Zhao, Shandong University, China
- Jing Zhao, Beijing University of Technology, China
- Liankuo Zhao, Shanxi Normal University, China
- Ruhan Zhao, State University of New York at Brockport, USA
- Xianfeng Zhao, Chongqing University, China
- Xiangmei Zhao, Ocean University of China, China
- Dechao Zheng, Vanderbilt University, USA
- Cong Zhou, Indiana University, USA
- Jizhen Zhou, Anhui university of science and technology, China
- Dapeng Zhou, East China Normal University, China
- Lifang Zhou, Huzhou University, China
- Xiaoyan Zhou, Dalian Univerisity of Technology, China
- Kehe Zhu, SUNY at Albany, USA
- Yu-Can Zhu, Fuzhou University, China
- Bertin Zinsou, University of the Witwatersrand, South Africa

Practical Information

Group Photo:

A group picture will be taken on Monday (July 23) at 09:30. We will inform you the place to meet. The picture will be posted on our web page.

Banks:

The nearest bank around ECNU is the Industrial and Commercial Bank of China. It's near the east Gate of ECNU(North Zhongshan Road Campus).
Name: ECNU Sub-Branch (Industrial and Commercial Bank of China)
Address: 3665 N. Zhongshan Rd.
Business Hour: 9:15-17:15

At the North Zhongshan Road you can also find Postal Savings Bank of China.
Name: ECNU Sub-Branch (Postal Savings Bank of China)
Address: 3617 N. Zhongshan Rd.
Business Hour: 9:15-17:15

Currency Exchange and Money Matters:

With your passport, foreigners can exchange up to 500 dollars per day in China. You can exchange your money at the Industrial and Commercial Bank of China(ECNU Sub-Branch) .You can also exchange your money at Postal Savings Bank of China(ECNU Sub-Branch). Of course, you can also exchange some money to RMB at the airport.

Currency exchange rate: US$1.00 can roughly be changed to RMB 6.7 in major banks of China. If you do the currency exchange at the airport, a fee might incur, and the rate might not be as good as mentioned above.

The unit of currency is the Chinese RMB (Ren Min Bi). Notes are denominations of ¥(Yuan) 100, 50, 20, 10, 5, 2, 1 and 50cents,. There are coins ¥1, 50cents, 10 cents, 5cents, 2cents and 1 cent. Major credit cards i.e. Visa and Master Card can only be used at big hotels and shopping centers.

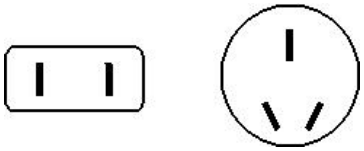
Supermarkets:

CR Vanguard
Address: B1-B2, Global Harbor, 3300 N. Zhongshan Rd(Ningxia Road).
Beside the subway(Jinshajiang Road Station)
Open time: 8:00 a.m.–10:30 p.m.

Carrefour
Address: No. 1018, Changning Rd.
Take bus No.67/754/765/947, get off at Zhongshan Park stop(just one stop).
Open time: 8:00 a.m.–10:00 p.m.

Electricity:

The voltage in China is 220 volts, 50 Hz. The socket standard of China is made up of two types with 2 or 3 flat pins:



Drinking Water :

Tap water is not for direct drinking.

Tipping:

Usually, no tipping is needed (or expected) in China for restaurant and bar waiters, hotel servers, taxi drivers, and doormen.
1) The taxi fare will be showed on the meters on taxi and recorded on receipts.
2) If you want to visit some other place in Shanghai, you can ask us to write the Chinese addresses or other useful Chinese words for you.
3) Should you get lost in any circumstance, the following telephone numbers may be of help (please tell them that you are guest of the East China Normal University).

Transportation around East China Normal University,:

East China Normal University Add:3663 N. Zhongshan Rd.
Public transportation:

1. Bus: 846, 856, 136, 216, 947, 224, 829, 909, 924, 67, 754.

2. Metro Line 3,4,13: get off at Jinshajiang Road Station, 5-10 minutes' walk to ECNU.

Jinshajiang Road Station (First and last trains)

	First Train	Last Train
Line 3 (To Shanghai South Railway Station)	6:14	23:24
Line 3 (To Jiangyang Rd.(N))	5:43	22:48
Line 4 (Inner)	5:39	22:39
Line 4 (Outer)	6:19	23:19
Line 13 (To Shibo Ave.)	5:48	22:48
Line 13 (To Jinyun Road)	6:20	22:59

Useful Chinese Phrases (show them to your taxi driver):

1) Please drop me off at the 3663 N. Zhongshan Rd., Shanghai, and give me a receipt for the taxi fare. Thank you! 请送我到华东师范大学普陀校区，要发票。谢谢！（中山北路3663号）

2) Please drop me off at the Zhongshan Park subway station, and give me a receipt for the taxi fare. Thank you! 请送我到中山公园地铁站，要发票。谢谢！

3) Please drop me off at the People's Square (nearby the Nanjing Walking Street), and give me a receipt for the taxi fare. Thank you! 请送我到人民广场（南京路步行街口），要发票。谢谢！

4) Please drop me off at the the bund (nearby peace hotel), and give me a receipt for the taxi fare. Thank you! 请送我到外滩（近和平饭店），要发票。谢谢！

5) Please drop me off at the Oriental TV Tower, and give me a receipt for the taxi fare. Thank you! 请送我到东方明珠，要发票。谢谢！

6) Please drop me off at the Yuyuan Garden, and give me a receipt for the taxi fare. Thank you! 请送我到豫园，要发票。谢谢！

7) Please drop me off at the the City God Temple, and give me a receipt for the taxi fare. Thank you! 请送我到城隍庙，要发票。谢谢！

Useful Telephone Numbers:

Police: 110 Fire: 119 Ambulance: 120

Taxi Companies：大众公司（Da Zhong） 96822

强生公司（Qiang Sheng）62580000

Airport Inquires(Pudong & Hongqiao): 96990

Shanghai Hongqiao Airport Inquires: 52604620

Restaurants

Shanghai, a vigorous and energetic international metropolis, welcomes people from all over the world to enjoy its special atmosphere. This modern metropolis with its rich heritage of ancient Chinese culture has much to see and do.

Shanghai Snacks

He Feng Lou 和丰楼
He Feng Lou brings all Chinese snacks together and introduces 144 snacks and dishes from 8 major styles and their 16 sub-cuisines. The two-storey restaurant serves on the first floor buffet-style Chinese cuisine numbering 300 in kinds according to their origins such as Shanghai, Sichuan & Hunan, Taiwan, Jiangsu, etc. The second floor is featured with specialty Chinese and overseas snacks including Japanese Teppanyaki, popular with tourists.

Specialty: steamed juicy crab roe bun, marinated pond snail.

Address: 10 Wenchang Road

Lu Bo Lang Restaurant 绿波廊
Lu Bo Lang Restaurant, located by nine-twist-bridge at Old City God Temple, has an archaic, elegant and peaceful surrounding matching the elegance of Mid-Pond-Pavilion tea house next door. It is well-known for carefully selected raw materials and meticulous preparations, highly praised by gourmands form home and abroad. The signature dish “osmanthus cake” is so sticky in texture that gets stuck on plate or chopsticks but not on tooth and feels smooth in the mouth carrying faint fragrance of rice wine, which puzzled former U.S President Clinton who had practiced with chopsticks for one month.

Specialty: eye brow-shaped crispy cake, sticky osmanthus cake.

Address: 115 Yuyuan Road

Nan Xiang Steamed Bun Restaurant 南翔馒头店
Nan Xiang Steamed Bun Restaurant, situated by nine-twist-bridge at Old City God Temple, is an attraction in Yu Garden area, formerly named marble boat hall. In the restaurant with lattice-work windows, it takes a short while to have hot steamed buns served. Without any hurry, you might gently pick one with chopsticks, bite a small hole, suck the juice and then dip into vinegar sauce before putting into your month—smooth, juicy and luscious.

Specialty: recipe-made crabmeat bun, juicy crab roe shrimp ball

Address: 85 Yuyuan Road

Shen Da Cheng Restaurant 沈大成

Shen Da Cheng Restaurant was set up in 6th year of Qing Dynasty Emperor Guang Xu (1875). The founder Shen Ajin combined the best of dim-sum and traditional snacks, careful in selecting row materials and meticulous in preparations. Reputed as "king of dim-sum in Shanghai", some popular specialties include longevity peach-shaped cake, osmanthus cake slices, sticky rice dumpling in bamboo leaves. Shanghai-style dumping in bamboo leaves retain the feature of being fragrant, chewy and tasty, and curry chicken dumpling, the first of its kind, was produced. A glutinous rice dumpling in bamboo leaves going with a bowl of wanton soup sell very well at Shen Da Cheng.

Specialty: sticky rice cake slice, glutinous rice ball with bean paste, spinach-dyed sticky rice ball with red bean paste.

Address: 636 Nanjing Road (E.)

Gong De Lin 功德林

Gong De Lin is the leading restaurant for "veggie food in the shape of meat dishes". The dishes are carefully selected, meticulously prepared and artistically presented. A variety of tasty and nutritional choice are good for health in all seasons. Gong De Lin's vegetarian buns and noodles are popular with diners. The vegetarian moon cakes have won the award "China best moon cake" and "famous Chinese pasty".

Specialty: vegetarian bun, moon cake

Address: 445 Nanjing Road (W.)

De Yue Lou 得月楼

De Yue Lou may be Suzhou's most famous and time-honored restaurant with a history of more than four hundred years. Founded in Ming Dynasty, the restaurant serves food which embodies traditional Suzhou cuisine. Specialties of the restaurant include De Yue spring chicken, squirrel-shaped mandarin fish and ham sliced in honey sauce.

Address: 43 Taijian Nong, Guanqian Rd, Suzhou

Attractions

The Bund 外滩
The Bund is a stretch of shore along the Huangpu River, once the main artery for trade in Shanghai. Today it has become a promenade that offers some of the best views of Shanghai. To the Europeans, the Bund was Shanghai's answer to Wall Street. In the 1930s, the string of buildings hosted the city's financial and commercial centers, and the world's greatest banks and trading empires established a base here.

Nanjing Road Pedestrian Street 南京东路步行街
Nanjing Road Pedestrian Street, the main shopping street of Shanghai, is considered to be the "No. 1 commercial street in China". If you like shopping, do not miss it!

Yuyuan Bazaar 豫园
Yuyuan Bazaar features ancient architectures dated back to Ming and Qing Dynasty, and traditional street market. Built in 1559, the Yuyuan Garden within the Bazaar is one of the best examples of classical gardens in Shanghai and is a must for visitors who want to surround themselves in beauty and Zen.

Shanghai World Financial Center 上海国际金融中心
Shanghai World Financial Center features the highest sightseeing observation decks in the world. There are 3 observation decks in Shanghai World Financial Center. The highest Sky Walk is 474m (1555 ft) high, on the 100th floor.

Shanghai Xintiandi 新天地
As a re-creation born out of the sprawls of Shikumen housing, which is the architectural symbol of Shanghai in the 20th century, Shanghai Xintiandi is an urban tourist attraction imbued with the city's historical and cultural legacies. Shanghai Xintiandi is where "yesterday meets tomorrow in Shanghai today."

Shanghai Museum 上海博物馆
Shanghai Museum is a veritable treasure house of ancient Chinese art and houses 120,000 precious relics. Bronzes, pottery, paintings and calligraphies are distinctive features of the Museum's collection.

Changfeng Park 长风公园
A landscaped park located next to the University. The size of the park is 364,000 square meters. It includes a large lake in the centre of the park. There are various facilities including a Sea Life aquarium and boating on the lake.

Transportation

Routine from ECNU to Airport

- **Hongqiao International Airport:** (The distance is about 14 km)

  By taxi (no transfer)

  It will cost about CNY¥40 for the 30 minutes taxi drive from East China Normal University (ECNU) to Shanghai Hongqiao International Airport.

- **Pudong International Airport:** (The distance is about 55 km)

  By taxi (no transfer)

  It will cost about CNY¥200 for 1 hour taxi drive from ECNU in the daytime and CNY ¥250 at night to Pudong International Airport.

  By subway (transfer twice)

  First, take a taxi to Zhongshan Park station. This will cost CNY¥14 for approximately 7 minutes taxi drive. Then, take subway Line 2 (Identification Color: light green) to Pudong International airport. It takes about 60 minutes from Zhongshan Park station to Pudong International airport stop, with the fare CNY¥7. You will have to transfer from 8-carriage train to 4-carriage train at Guanglan Road station.

  By subway+maglev (transfer twice)

  First, take a taxi to Zhongshan Park subway station. Second, take subway line 2 to Longyang Road station. It takes about 30 minutes from Zhongshan Park station to the Longyang Road station, with the fare about CNY¥4. Third, take the Shanghai Maglev Train to Pudong International Airport. It takes only 8 minutes from the Longyang Road station to the Pudong International airport, with the fare about CNY¥50.

Tip:

Passengers holding public transportation cards are entitled to free transfer and uninterrupted fare charging within 30 minutes after getting out of the following stations :

1.Shanghai Railway Station (Line1,Line3 and Line4),

2.West NanjingRoad (Line2 , Line12 and Line13) ,

3.Hongqiao Airport Terminal2 (Line2 and Line10,in-station transfer is only allowed between a train of line 2 bound for Pudong international Airport and that of line 10 bound for Xinjiangwancheng or Hangzhong Road at this station).

4.Longhua (Line11 and Line12) ,

those holding single journey tickets need to pay for new tickets if they should exit the above stations.

Airport · Railway Station · Maglev Line · Metro Line · Huangpu River · Single-line Station · Interchange Station · Out-of-system Transfer Station

Line 1 · Line 2 · Line 3 · Line 4 · Line 5 · Line 6 · Line 7 · Line 8 · Line 9 · Line 10 · Line 11 · Line 12 · Line 13 · Line 16 · Line 17 · Pujiang Line

SHANGHAI METRO NETWORK MAP