Recent Advances in Operator Theory and Operator Algebras

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Titles and Abstracts

Expository Talks

Joachim Cuntz
University of Munster

First Talk On

Title: *Linear functionals on C^*-algebras and their commutative subalgebras*
Abstract: Continuity of a linear functional on a C*-algebra is determined by its restriction to commutative subalgebras.

Second and Third Talks On

Title: *C^*-algebras associated with $ax + b$-semigroups over integral rings*
Abstract: Canonical actions, of the additive group and of the multiplicative semigroup of a ring of integers like Z, on a natural Hilbert space give rise to very interesting examples of C*-algebras. Depending on the two possible natural choices for H one obtains a tight version which is purely infinite or a 'Toeplitz version'. The computation of the K-theory is a challenging problem in both cases.

Piotr Nowak
Institute of Mathematics, Polish Academy of Sciences

Four Talks On

Title: *Rigid groups and their algebras*
Abstract: I will discuss the notion of property (T) for locally compact groups, their characterizations and the existence of certain idempotents in group C*-algebras. This will allow to discuss also their importance for Baum-Connes type conjectures. I will also describe new methods, based on a characterization of Ozawa, of proving property (T) for finitely generated groups using semidefinite optimization. Such methods are behind the recent progress on proving property (T) for automorphism groups of free groups.

Stuart White
University of Glasgow

Four Talks On

Title: *Simple amenable operator algebras*
Abstract: The last 5-10 years have seen repeated advances in the structure and classification of simple nuclear C^*-algebras, often driven by parallels with the theory of amenable von Neumann algebras. My aim is to discuss some of these developments and the connections between amenable C^* and von Neumann algebras.

Plenary and Semi-plenary Talks

Jyotishman Bhowmick, Indian Statistical Institute, Calcutta

Title: *Levi-Civita connections in noncommutative geometry*
Abstract: We give a new definition of Levi-Civita connection for a noncommutative pseudo-Riemannian metric on a noncommutative manifold and prove the existence-uniqueness result for a class of modules of one forms over a large class of noncommutative manifolds, including Connes-Landi deformations of spectral triples on Rieffel-deformation of a compact manifold equipped with a free isometric toral action, the matrix geometry on the fuzzy sphere and quantum Heisenberg manifolds. As an application, we compute the Ricci and scalar curvature for a general conformal perturbation of the canonical metric on the noncommutative 2-torus as well as for a natural metric on the quantum Heisenberg manifold. For the latter, the scalar curvature turns out to be a negative constant.

Panchugopal Bikram, NISER

Title: *q-deformed Araki-Wood von Neumann algebra*
Abstract: In this talk we discuss the factoriality of q-deformed Araki-Wood von Neumann algebra. We also discuss the generating masa and classification of type of the q-deformed Araki-Wood von Neumann algebra.

Sameer Chavan, IIT Kanpur

Title: *Weighted join operators on rooted directed trees*
Abstract: We exploit on the order structure of directed trees to introduce and study the classes of weighted join operators and their rank one extensions. In particular, we discuss the issue of closedness, unravel the structure of Hilbert space adjoint and identify various spectral parts of members of these classes. Certain discrete Hilbert transforms arise naturally in the spectral theory of rank one extensions of weighted join operators. This is a joint work with Rajeev Gupta and K. B. Sinha.

Raphaël Clouâtre, University of Manitoba

Title: *Choquet theory on state spaces of* C*-*algebras and the hyperrigidity conjecture*
Abstract: Fifty years ago, Arveson initiated an ambitious program to analyze non self-adjoint operator algebras through the lens of C*-algebras. The so-called C*-envelope was the centrepiece of Arveson's vision, and it has since become a ubiquitous tool in modern operator algebras. At the heart of its construction is a fruitful analogy with the classical Choquet boundary.

In 2011 a tantalizing question was raised, asking whether this non-commutative Choquet boundary could detect a striking rigidity property of the C*-envelope. The difficulty in settling this open problem lies partly in the fact that the "non-commutative boundary points" are $*$-representations, and are thus poorly adapted to the tools of Choquet theory. In this talk, I will consider a linearization of Arveson's analogy, wherein $*$-representations are replaced with states. I will illustrate how this new perspective can be used to gain insight into what is now known as Arveson's hyperrigidity conjecture.

Guillermo P. Curbera, University of Sevilla

Title: *Extension and inversion of the finite Hilbert transform on* $(-1, 1)$
Abstract: The finite Hilbert transform T on $(-1, 1)$ was studied by Tricomi and others on the L^p spaces, finding inversion formulae. It was known that for p different from 2, it was not possible to extend $T : L^p \to L^p$ to a larger domain.

We consider T on a larger family of spaces (which includs Orlicz spaces, Lorentz spaces, Marcinkiewicz spaces, Zygmund spaces...). We study inversion formulae and show that $T : L^2 \to L^2$ cannot be extended to a larger domain.

Joint work with W.J. Ricker and S. Okada.

B. Krishna Das, IIT Bombay

Title: *Isometric dilation and von Neumann inequality for operator tuples*
Abstract: It is well-known that an n-tuple ($n > 2$) of commuting contractions on a Hilbert space does not dilate to an n-tuple of commuting isometries,

in general. In this talk, we will describe a class of n-tuples of commuting contractions, using certain positivity, which admit isometric dilations. The method of finding their explicit isometric dilations will be discussed. This explicit isometric dilation also helps us to establish sharp von Neumann inequality on algebraic varieties for the class of n-tuples of commuting contractions. This is joint work with S. Barik, K. Haria and J. Sarkar.

Karl Grosse-Erdmann, Université de Mons

Title: *A glimpse at linear dynamics*
Abstract: Linear dynamics studies, naturally, the dynamical properties of continu- ous linear operators. Two notions are particularly intriguing, that of linear chaos, by now rather well understood, and that of frequent hypercyclicity, a close cousin but much more elusive. Recent years have seen some remarkable progress on frequently hypercyclic operators and on their relationship with chaotic operators. In this talk we will highlight recent breakthroughs and discuss some open problems.

Priyanka Grover, Shiv Nadar University

Title: *Perturbation bounds for Mostow's decomposition*
Abstract: Matrix factorizations play an important role to explain the interactions between different kinds of entities. Perturbations of many well known factorizations (e.g. polar decomposition, QR, LR etc.) have been studied for a long time and various methods are known. In this talk, we shall describe one of these methods which is adaptable to more general contexts. We shall then give perturbation bounds for Mostow's decomposition theorem which says that every nonsingular matrix Z can be written as $Z = We^{iK}e^{S}$, where W is unitary, S is a real symmetric matrix, and K is a real skew symmetric matrix. To obtain the above mentioned bounds, we shall compute the derivative of the map taking two positive definite matrices to their geometric mean. This is a joint work with Pradip Mishra.

Michael Hartz, FernUniversitat in Hagen

Title: *The analogue of the Hardy space H^1 for a complete Pick space*
Abstract: The weak product of a Hilbert function space plays the role that is played by H^1 in the theory of Hardy spaces. I will talk about several aspects of weak products of Hilbert function spaces with the complete Pick property, including duality, invariant subspaces and the relationship to the Smirnov class. This is joint work with Alexandru Aleman, John McCarthy and Stefan Richter.

Robin Hillier, University Lancaster

Title: *Roots of completely positive maps*
Abstract: We introduce the concept of completely positive roots of unital completely positive maps on operator algebras. We do this in different forms: as asymptotic roots, proper discrete roots and as continuous one-parameter semigroups of roots. We present several general existence and non-existence results, some special results in settings where we understand the situation better, connections with other fields, and a few challenging open problems. (Based on joint work with B.V.R. Bhat, N. Mallick, Vijaya Kumar U.)

Michel Hilsum, CNRS and Institut de Mathematiques de Jussieu-Paris

Title: *Complex analysis and bivariant K-theory.*
Abstract: A question analogous to Novikov conjecture for complex manifold has been raised by J. Rosenberg : are the higher Todd genus of complex manifolds binational invariants ? Using topological K-homology, an affirmative has been given by J. Block and S. Weinberger, for projective algebraic manifolds. Here we shall explain how to generalise this to arbitrary complex spaces, within the framework of bivariant Kasparovs K-theory.

Rohit Dilip Holkar, IISER Bhopal

Title: *Proper topological correspondences*
Abstract: Given two locally compact groupoid (G, α) and (H, β), equipped

with Haar systems, we define a *proper* topological correspondence— this is a pair (X, λ) consisting of a G-H-bispace X and a family of measures λ along the right momentum map satisfying certain invariance properties. With a few more conditions on this pair, the space $\mathrm{C}_c(X)$ completes to a C^*-correspondence, say $\mathcal{X}$, from $\mathrm{C}^*(G, \alpha)$ to $\mathrm{C}^*(H, \beta)$. In this C^* correspondence, the representation of $\mathrm{C}^*(G, \alpha)$ takes values in the compact operators in $\mathcal{X}$. We discuss the KK-cycles produced by such a correspondence. Along the way, we discuss locally free actions of groupoids and also describe the C^*-algebra of compact operators on the Hilbert module $\mathcal{X}$.

Tanvi Jain, Indian Statistical Institute, Delhi

Title: *Matrix versions of the Hellinger distance*
Abstract: On the space of positive definite matrices we consider distance functions of the form

$$d(A, B) = [\mathrm{tr}\mathcal{A}(A, B) - \mathrm{tr}\mathcal{G}(A, B)]^{1/2},$$

where $\mathcal{A}(A, B)$ is the arithmetic mean and $\mathcal{G}(A, B)$ is one of the different versions of the geometric mean. When $\mathcal{G}(A, B) = A^{1/2}B^{1/2}$ this distance is $\|A^{1/2} - B^{1/2}\|_2$, and when $\mathcal{G}(A, B) = (A^{1/2}BA^{1/2})^{1/2}$ it is the Bures-Wasserstein metric. We also study two other cases:

$$\mathcal{G}(A, B) = A^{1/2}(A^{-1/2}BA^{-1/2})^{1/2}A^{1/2},$$

the Pusz-Woronowicz geometric mean, and $\mathcal{G}(A, B) = \exp\left(\frac{\log A + \log B}{2}\right)$, the log Euclidean mean. With these choices $d(A, B)$ is no longer a metric, but it turns out that $d^2(A, B)$ is a divergence. We discuss these divergences and study their connections with other matrix means and relative entropy.

This is the joint work with Rajendra Bhatia and Stephane Gaubert.

Apoorva Khare, Indian Institute of Science

Title: *The metric space of norms, and the normed space of metrics*
Abstract: As is well-known, all norms on $\mathbb{R}^k$ are equivalent. We discuss a new pseudometric on the space of these norms, and study the quotient metric

space $\mathcal{S}_k(\mathbb{R})$. We show this space is complete, connected, and unbounded; thus its topology is strictly coarser than the Banach–Mazur compactum.

Our proof goes through embedding this metric space into a function space with a diameter norm. In particular, the metric on $\mathcal{S}_k(\mathbb{R})$ is itself a norm.

In the second part, we study the (also hitherto unexplored) metric space $\mathcal{S}([n])$ of all metrics on a finite set of n elements, revealing the connection between log-distortion and diameter norms. In particular, $\mathcal{S}([n])$ is also a complete, connected, and unbounded normed space, which is not comparable to the Gromov–Hausdorff space. We will also discuss examples and embedding questions in both of these settings.

Louis Labuschagne, North-West University

Title: *On entropy for general quantum systems*
Abstract: We revisit the notion of relative entropy for both classical and quantum systems, and provide some new descriptions of this notion respectively based on the theories of the Connes cocycle derivative, and noncommutative L^p-spaces. We then introduce the notion of entropy for a single state of a general quantum system, and show that this notion agrees with von Neumann entropy in the case of semifinite von Neumann algebras. In closing we investigate the relationship between this notion of entropy and relative entropy, and identify an Orlicz space which forms the home for all states with "good" entropy.

Constanze Liaw, University of Delaware

Title: *Matrix and operator valued measures in perturbation problems*
Abstract: The Aronszajn-Donoghue theorem provides a reasonably good understanding of the subtle theory of rank one perturbations. For example, Aronszajns result says that the mutual singularity of the singular parts of the spectral measure under rank one perturbations. For higher rank perturbations, the situation for the singular part can behave more complicated. Nonetheless, some results prevail in the finite rank setting and even infinite rank setting.

Daniel Markiewicz, Ben-Gurion University of the Negev

Title: *E_0-semigroups arising from boundary weight maps*

Abstract: An E_0-semigroup of $B(H)$ is a one parameter strongly continuous semigroup of $*$-endomorphisms of $B(H)$ that preserve the identity. The classification of E_0-semigroups up to cocycle conjugacy remains an intriguing problem. In this talk we will discuss it in a slightly different guise: the search for a rich class where classification is possible.

Every E_0-semigroup that possesses a strongly continuous intertwining semigroup of isometries is cocycle conjugate to an E_0-semigroup obtained by the Bhat dilation of a CP-flow over a separable Hilbert space K. And Robert T. Powers showed how to construct CP-flows from boundary weight maps over K.

In this talk we show how to construct and classify all E_0-semigroups (up to cocycle conjugacy) arising from boundary weight maps over finite-dimensional spaces that are q-pure in the following sense. We say an E_0-semigroup α is q-pure if the CP-subordinates β of norm one (i.e. $\|\beta_t(I)\| = 1$ and $\alpha_t - \beta_t$ is completely positive for all $t \geq 0$) are totally ordered in the sense that if β and γ are two CP-subordinates of α of norm one, then $\beta \geq \gamma$ or $\gamma \geq \beta$.

This talk is based on the paper: C. Jankowski, D. Markiewicz and R.T. Powers, "Classification of q-pure q-weight maps over finite dimensional Hilbert spaces", arXiv:1807.09824 [math.OA].

Lajos Molnár, University of Szeged, and Budapest University of Technology and Economics

Title: *Thompson isometries and applications*

Abstract: In this talk we first recall a result by Hatori and Molnár in which we described the structure of all surjective maps between the positive definite cones of C^*-algebras that are isometries with respect to the Thompson part metric. After that we present its various applications concerning, among others, the descriptions of preservers of different types of quantum divergences on density spaces of C^*-algebras.

Kunal Mukherjee, IIT Madras

Title: *On noncommutative joinings*
Abstract: We discuss some recent results on noncommutative dynamics with emphasis on joinings. We focus on ergodicity, mixing phenomena and rigidity in ergodic hierarchy.

Mithun Mukherjee, IISER Thiruvananthapuram

Title: *Two states*
Abstract: D. Bures defined a metric on states of a C^*-algebra as the infimum of the distance between associated vectors in common GNS representations. We take a different approach by looking at the completely bounded distance between relevant joint representations. The notion has natural extension to unital completely positive maps. This study yields new understanding of GNS representations of states and in particular provides a new formula for Bures metric. This is a joint work with B.V. Rajarama Bhat.

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.

Issan Patri, Chennai Mathematical Institute

Title: *Automorphisms of Compact Quantum Groups*
Abstract: In this talk, we will study automorphisms of compact quantum groups, proving basic properties, and properties of the group of automorphisms of a compact quantum group. We will then study actions of discrete groups on compact quantum groups and derive combinatorial conditions for properties like ergodicity, mixing, compactness, etc. We will give several examples to illustrate these properties. Based on joint work with Kunal Mukherjee and with Alex Chirvasitu.

Sasmita Patnaik, IIT Kanpur

Title: *On single commutators of compact operators*
Abstract: A commutator is an operator of the form AB - BA where A and B are operators on a Hilbert space. In finite dimensional Hilbert space, commutators are characterized via the trace condition, i.e., an operator C is a commutator if and only if trace $C = 0$. In the more interesting case of an infinite dimensional Hilbert space, Pearcy and Topping in 1971 had asked which compact operators are single commutators of compact operators. The question still remains a mystery. Nevertheless, there has been progress in this direction and some recent advancement which has been made will be discussed in the talk.

Marek Ptak, University of Agriculture in Kraków

Title: *On the commutants of weighted shifts on directed trees*
Abstract: Generalized multipliers for left-invertible analytic operators will be introduced. It will be shown that they form a Banach algebra and characterize the commutant of such operators in its terms. In the special case, we describe the commutant of balanced weighted shift on directed tree only in terms of its weights.

Joint work with Piotr Dymek, Artur Płaneta.

G. Sankara Raju, IIT Ropar

Title: *Characterizations of majorization in l^1*
Abstract: We discuss majorization on l^1 and investigate properties of the majorization in an infinite dimensional space. We also discuss characterizations of majorization infinite dimensional space.

Jean Renault, Université d́Orléans

Title: *KMS states for graph and groupoid C^*-algebras*
Abstract: I will first review the groupoid description of KMS states for diagonal one-parameter automorphism groups of C^*-algebras. Then, I will show how this description applies to some recent studies of KMS states in graph and higher-rank graph C^*-algebras. I will emphasise the connection with ergodic theory and the thermodynamical formalism.

Sutanu Roy, National Institute of Science Education and Research

Title: *Braided quantum $E(2)$ groups*
Abstract: For $0 < q < 1$ S. L. Woronowicz has introduced q-deformations of $E(2)$ group or quantum $E(2)$ groups in the C^*-algebraic framework. However, for non-zero complex deformation parameters q with non-zero imaginary components, q-deformations of $E(2)$ fails to be ordinary (locally compact quantum) quantum groups. In this talk we shall address this problem. The underlying C^*-algebra of the quantum $E(2)$ groups admit canonical action of the circle group. This gives rise to certain braiding operators governed by this action and we show that there are "braided multiplicative unitaries" which gives rise to "braided" quantum $E(2)$ groups. This is a joint work in progress with Atibur Rahaman (NISER Bhubaneswar).

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.

Alan Sola, Stockholm University

Title: *Cyclic polynomials and rational inner functions in Dirichlet spaces on the bidisk*
Abstract: Reporting on several joint papers with C. Beneteau, K. Bickel, G. Knese, L. Kosinski, C. Liaw, J.E. Pascoe, T.J. Ransford, and D. Seco,

I will survey recent progress on two research directions concerning Dirichlet spaces of several variables. The first part of the talk will be devoted to the characterization of polynomials in two complex variables that are cyclic with respect to the coordinate shifts. In the second, I will discuss membership of inner functions, and in particular rational inner functions, in Dirichlet spaces on the bidisk.

Baruch Solel, Technion

Title: *Homomorphisms of noncommutative Hardy algebras*
Abstract: I will discuss completely contractive homomorphisms among Hardy algebras that are associated with W^*-correspondences. I will present interpolation ("Nevanlinna-Pick type") results and discuss the properties of the maps (on the representation spaces) that induce such homomorphisms.

This is a joint work with Paul Muhly.

Jan Stochel, Jagiellonian University

Title: *Subnormality of operators of class $\mathcal{Q}$*
Abstract: I will discuss the question of subnormality of operators of class

$\mathcal{Q}$, which can be thought of as generalizations of quasi-Brownian isometries investigated in [5, 1] (under the name of $\triangle_T$-regular 2-isometries) and in [2, 3]. In turn, the notion of a quasi-Brownian isometry generalizes that of a Brownian isometry introduced by Agler and Stankus in [1]. We say that an operator $T \in \boldsymbol{B}(\mathcal{H})$ is *of class* $\mathcal{Q}$ if T has the block matrix form

$$T = \begin{bmatrix} V & E \\ 0 & Q \end{bmatrix}$$

with respect to a nontrivial orthogonal decomposition $\mathcal{H} = \mathcal{H}_1 \oplus \mathcal{H}_2$, where $V \in \boldsymbol{B}(\mathcal{H}_1)$, $E \in \boldsymbol{B}(\mathcal{H}_2, \mathcal{H}_1)$ and $Q \in \boldsymbol{B}(\mathcal{H}_2)$ satisfy the following conditions

$$\begin{gathered} V \text{ is an isometry,} \\ V^*E = 0, \\ QE^*E = E^*EQ, \\ Q \text{ is a quasinormal operator.} \end{gathered}$$

It turns out that the subnormality of such an operator can be described in terms of the joint spectrum of the pair $(|Q|, |E|)$.

References

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Xiang Tang, Washington University at St.Louis

Title: *A new index theorem for monomials ideals by resolutions*
Abstract: We will explain an index theorem for the quotient module of a monomial ideal. We obtain this result by resolving the monomial ideal by a sequence of Bergman space like essentially normal Hilbert modules. This is joint work with R. Douglas, M. Jabbari, and G. Yu.

Dan Timotin, Institute of Mathematics of the Romanian Academy

Title: *Algebras of block Toeplitz matrices*
Abstract: Multiplication of Toeplitz (or of block Toeplitz) matrices does not, in general, produce a matrix in the same class. A complete description of maximal algebras of Toeplitz matrices has been obtained by Shalom in 1987: they are precisely the so-called *quasi-circulants*.

The analogous problem for block Toeplitz matrices is harder and its solution has not yet been attempted. The talk will present some steps in this direction. We discuss block Toeplitz matrices with entries in a given maximal commutative algebra of matrices $\mathcal{A}$. We obtain some general results concerning algebras formed by such matrices. Also, for certain types of $\mathcal{A}$ we give a complete classification of maximal algebras of block Toeplitz matrices.

This is joint work with Muhammad Ahsan Khan.

R. Srinivasan Vasanth, Chennai Mathematical Institute

Title: E_0-*semigroups over* $\mathbb{R}^2_+$
Abstract: I will report the recent progress in the $2-$parameter semigroups of endomorphisms. I hope to convince that the $2-$parameter case is more complicated, more rigid and leads to more interesting mathematical objects as invariants than the $1-$parameter theory of E_0-semigroups. This contains works with Anbu Arjunan, S. Sundar, S. P. Murugan and Masaki Izumi.

R. Janusz Wysoczanski, Wroclaw University

Title: *On distribution of sums of weakly monotonne position operators*

Abstract: We study the distribution (with respect to the vacuum state) of a Family of sums of position operators on weakly monotone Fock space. We show that any single operator has the Wigner law, and an arbitrary family of them (with the index set linearly ordered) is a collection of monotone-independent random variables. It turns out that our problem equivalently consists in finding the m-fold monotone convolution of the semicircle law. For $m = 2$, we compute the explicit distribution. For any $m > 2$, we give the moments of the measure and show it is absolutely continuous and compactly supported on a symmetric interval whose endpoints can be found by a recursive formula.

Rongwei Yang, SUNY at Albany and Tianjin Normal University

Title: *Projective Spectrum and the Infinite Dihedral Group*

Abstract: For a tuple $A = (A_1,\ A_2,\ ...,\ A_n)$ of elements in a unital Banach algebra $\mathcal{B}$, its *projective joint spectrum* $P(A)$ is the collection of $z \in \mathbf{C}^n$ such that the multiparameter pencil $A(z) = z_1A_1 + z_2A_2 + \cdots + z_nA_n$ is not invertible. If $\mathcal{B}$ is the group C^*-algebra for a discrete group G generated by $A_1,\ A_2,\ ...,\ A_n$ with respect to a representation ρ, then $P(A)$ is an invariant of (weak) equivalence for ρ. This talk presents some recent work on the projective spectrum $P(R)$ of $R = (1,\ a,\ t)$ for the infinite dihedral group $D_\infty =< a,\ t \mid a^2 = t^2 = 1 >$ with respect to the left regular representation. Results include a description of the spectrum, a formula for the Fuglede-Kadison determinant of the pencil $R(z) = z_0 + z_1a + z_2t$, the first singular homology group of the joint resolvent set $P^c(R)$, and dynamical properties of the spectrum. These results give new insight into some earlier studies on groups of intermediate growth. Moreover, they suggest a link between projective spectrum and the Julia set of dynamical maps. This is a joint work with R. Grigorchuk.

Keywords: projective joint spectrum, the infinite dihedral group, C^*-algebra, weak containment, Maurer-Cartan form, Fuglede-Kadison determinant, Julia set.

Short Talks

Ali Armandnejad, Vali-e-Asr University of Rafsanjan

Title: *Unitarily standard linear operators preserving J-orthogonal matrices*
Abstract: Let $\mathbf{M}_n$ be the set of all $n \times n$ real matrices. For every $P \in \mathbf{M}_n$, the linear operator $T_P : \mathbf{M}_n \to \mathbf{M}_n$ defined by

$$T_P(X) = P^T X P, \ \ \forall\ X \in \mathbf{M}_n,$$

or

$$T_P(X) = P^T X^T P, \ \ \forall\ X \in \mathbf{M}_n,$$

is said to be a standard linear operator corresponding to P. Let $J \in \mathbf{M}_n$ be a signature matrix i.e. J is diagonal and its diagonal entries are ± 1. A matrix $A \in \mathbf{M}_n$ is said to be a J-orthogonal matrix if there exists a signature matrix S such that $A^\top S A = S$. In this paper we find the necessary and sufficient conditions on P, such that T_P preserves the set of J-orthogonal matrices.
Keywords: Linear preservers, J-orthogonal matrix.

Madhav Reddy Bagannagari, ISI Kolkata

Title: *Annular representations of free product categories*
Abstract: C^*-tensor categories are important descriptors of generalized symmetries appearing in non-commutative analysis and mathematical physics. An important algebra associated to a rigid semisimple C*-tensor category $\mathcal{C}$ is the tube algebra $\mathcal{AC}$. The tube algebra admits a universal C^*-algebra, hence has a well behaved representation category. Further, this representation category provides a useful way to describe the analytic properties of initial C^*-tensor categories, such as amenability, the Haagerup property, and property (T).

In this talk, I will provide a description of the annular representation category of the free product of two rigid C^*-tensor categories. We shall see that this representation category decomposes into the direct sum of four full W^*-subcategories.

This is a joint work with Shamindra Kumar Ghosh and Corey Jones.

Keshab Bakshi, Chennai Mathematical Institute

Title: *An angle between intermediate subfactors and its rigidity*

Abstract: We introduce a new angle between intermediate subfactors and prove a uniform 60 to 90 degree bound for the angle between minimal intermediate subfactors of a finite index irreducible subfactor. From this rigidity we can bound the number of minimal (or maximal) intermediate subfactors by the kissing number in geometry. As a consequence, the number intermediate subfactors of an irreducible subfactor has at most exponential growth with respect to the Jones index. This answers a question of Longo published in 2003.

Animesh Bhandari, NIT Meghalaya

Title: *Perturbations on K-Fusion Frames*

Abstract: Every element in a separable Hilbert space $\mathcal{H}$ can be represented as a linear combination of its orthonormal basis using the corresponding Fourier coefficients. In real life problem, the elements of $\mathcal{H}$ can be represented as signals, during signal transmission, due to some technical reason if one of the Fourier coefficients is lost, it is almost impossible to reconstruct signals at the receiver end. Due to this fact an overcomplete system of orthonormal basis is required, such an overcomplete system is called a frame.

In fact, frames are generalizations of orthonormal bases. A collection of elements in $\mathcal{H}$ is said to be a frame if for every unit vector in $\mathcal{H}$, the corresponding Fourier coefficients are square summable and the sum is bounded between two positive constants, which do not depend on the unit vector. The concept of Hilbert space frame was first initiated by Duffin and Schaeffer. After a couple of years, the importance of frame theory was popularized by Daubechies, Grossmann and Mayer.

Frame theory literature became richer through several generalizations, such as, K-frame was introduced by Găvruţa, fusion frame was established by Casazza et. al., K-fusion frame (Atomic subspace) by Bhandari et. al. and these generalizations have been proved to be useful in many applications.

This article characterizes various properties of K-fusion frames. Several perturbation results on K-fusion frames are formulated and analyzed.

Monojit Bhattacharjee, IIT Mumbai

Title: *Characteristic functions of hypercontractions*
Abstract: It is well known that a commuting and pure n-tuple of m-hypercontraction on a Hilbert space is unitarily equivalent to the compression of the (weighted-)Bergman shift to a co-invariant subspace $\mathcal{Q}$ of some vector-valued weighted Bergman space on the unit ball of $\mathbb{C}^n$. The co-invariant subspace $\mathcal{Q}$ is called the model space of the m-hypercontraction. On the other hand, by a Beurling-Lax-Halmos type result, $\mathcal{Q}^\perp = \Phi H^2_n(\mathcal{E})$ for some partial isometric multiplier Φ from some $\mathcal{E}$-valued Drury-Arveson space $H^2_n(\mathcal{E})$ to the weighted Bergman space. In this talk, we will find a general recipe to construct such partial isometric multipliers which we will identify as the characteristic functions of m-hypercontractions. Our characteristic functions determines the corresponding m-hypercontraction up to unitary equivalence. We will also relate characteristic functions with some factorization results. This is a joint work with B. Krishna Das and Jaydeb Sarkar.

Piotr Budzynski, University of Agriculture in Krakow

Title: *Weighted composition operators in L^2-spaces*
Abstract: Given a σ-finite measure space $(X, \mathcal{A}, \mu)$, an $\mathcal{A}$-measurable transformation ϕ of X, and a complex $\mathcal{A}$-measurable function w on X, the weighted composition operator in $L^2(\mu)$ induced by ϕ and w is given by

$$\begin{aligned} \mathcal{D}(C_{\phi,w}) &= \{f \in L^2(\mu) \colon w \cdot (f \circ \phi) \in L^2(\mu)\}, \\ C_{\phi,w} f &= w \cdot (f \circ \phi), \quad f \in \mathcal{D}(C_{\phi,w}), \end{aligned}$$

The talk is aimed at presenting a variety of results concerning normality, seminormality, selfadjointness, and subnormality of bounded and unbounded weighted composition operators acting in L^2-spaces.

The talk is based on joint work with Zenon Jabłoński, Il Bong Jung, and Jan Stochel.

[1] P. Budzyski, Z. J. Jaboski, I. B. Jung, J. Stochel, *Unbounded weighted composition operators in L^2-spaces*, Lecture Notes in Math. 2209 (2018).

Zbigniew Burdak, University of Agriculture in Krakow

Title: *On some extension of pairs of commuting isometries*
Abstract: A general pair of isometries, for any relatively prime, positive integers m, n is shown to have a minimal extension to a pair (U^kV^n, U^lV^m) where U is a unitary operator commuting with an isometry V and $km-ln = 1, 0 < k < n, 0 \leq l < m$. In other words an arbitrary pair of isometries is a part of (U^kV^n, U^lV^m). We present the model of pairs of the form (U^kV^n, U^lV^m) and investigate their joint invariant subspaces by invariant subspaces of V. Especially interesting cases are if V is a unilateral shift.

Sayan Chakraborty, ISI Kolkata

Title: *Classification of crossed products of irrational rotation algebras by cyclic subgroups of $SL_2(\mathbb{Z})$*
Abstract: Let θ be an irrational number and A be a matrix in $SL_2(\mathbb{Z})$ of infinite order. We classify the crossed product C*-algebra $A_\theta \rtimes_A \mathbb{Z}$, where A_θ is the irrational rotation algebra. From the classification theory of C*-algebras we also deduce the isomorphism classes (depending on θ and A) of $A_\theta \rtimes_A \mathbb{Z}$. This is an extension of similar results obtained for A_θ by Elliott and $A_\theta \rtimes F$, F being a finite group, by Echterhoff, Lueck, Phillips, and Walters.

This is a joint work with Boenicke (Muenster), He (Tokyo), and Liao (Ottawa).

Dariusz Cichoń, Jagiellonian University

Title: *An operator approach to orthogonal polynomials in several variables*
Abstract: The theory developed in [1] is a far reaching attempt to generalize the Favard theorem characterizing sequences of polynomials which can be orthogonalized by a measure by means of the three term recurrence relations, which in the one variable case take the form

$$xp_k = a_k p_{k+1} + b_k p_k + a_{k-1} p_{k-1}, \quad k \geqslant 0 \ (a_k, b_k \text{ are real numbers}).$$

In the multi-variable case the polynomials have to be replaced by columns of polynomials of the same degree, and the coefficients take the matrix form. Moreover, if we care for generality, the equality should be replaced by equality

modulo an ideal, which allows us to consider families of orthogonal polynomials which are far from being bases of the space of all polynomials. (This becomes crucial in the multi-variable case.) As expected, the question of existence of orthogonalizing measure becomes much more subtle in the case of two or more variables, and some solutions this problem involve operator theory. Apart from the general theory we intend to provide some new examples as particular cases.

[1] D. Cichoń, J. Stochel, F.H. Szafraniec, Three term recurrence relation modulo ideal and orthogonality of polynomials of several variables, *Journal of Approximation Theory* **134**(2005), 11-64.

Prakash Dabhi, Sardar Patel University

Title: *Multiplier semigroup of a weighted abelian semigroup*
Abstract: Let (S, ω) be a weighted abelian semigroup. We show that a ω-bounded semigroup multiplier on S is a multiplication by a bounded function on the space of ω-bounded generalized semicharacters on S; and discuss a converse. Given a ω-bounded multiplier α on S, we investigate the induced weighted semigroup $(S_\alpha, \omega_\alpha)$. We show that the ω_α-bounded generalized semicharacters on S_α are scalar multiples of ω-bounded generalized semicharacters on S. Moreover, if (S_0, ω_0) is another weighted semigroup formed with some other operation on set S such that ω_0-bounded generalized semicharacters on S_0 are scalar multiples of ω-bounded generalized semicharacters on S, then it turns out that $S_0 = S_\alpha$ under some natural conditions. We shall discuss some examples and counter examples. This strengthens the idea that a weighted semigroup provides a semigroup analogue of a normed algebra for which a Gelfand duality may be searched.

Sandipan De, Indian Statistical Institute, Bangalore

Title: *Quantum double inclusions associated to a family of Kac algebra subfactors*
Abstract: Given a finite-index subfactor, we define the notion of quantum double inclusion - a certain unital inclusion of von Neumann algebras constructed from the given subfactor - which is closely related to that of Oc-

neanu's asymptotic inclusion. In this talk we discuss quantum double inclusions associated to the family of subfactors given by $\{R^H \subset R \rtimes \underbrace{H \rtimes H^* \rtimes \cdots}_{m \text{ times}} : m \geq 0\}$ where H is a finite-dimensional Kac algebra acting outerly on the hyperfinite II_1 factor R and it turns out that the quantum double inclusions associated to this family of subfactors are indeed finite-index hyperfinite subfactors. A natural question arises whether these subfactors are of finite depth. It turns out that all these subfactors are of depth two. When $m = 0$, an interesting phenomenon occurs: Drinfeld double arises from the quantum double inclusion of $R^H \subset R$. To be more precise, we show that the quantum double inclusion of $R^H \subset R$ is isomorphic to $R \subset R \rtimes D(H)^{cop}$ for some outer action of $D(H)^{cop}$ on the hyperfinite II_1 factor R where $D(H)$ is the Drinfeld double of H. If time permits, we will discuss quantum double inclusions of $R^H \subset R \rtimes \underbrace{H \rtimes H^* \rtimes \cdots}_{m \text{ times}}$ with $m > 0$. In this case, quantum double inclusions, being reducible and of depth two, lead to construction of a family of weak Hopf C^*-algebras.

Dhriti Ranjan Dolai, Indian Statistical Institute, Bangalore

Title: *Spectrum of random Schrödinger operators with decaying randomness*
Abstract: We study the Schrödinger operator

$$H^\omega = -\Delta + \sum_{n \in \mathbb{Z}^d} Q(x)\omega_n \chi_{(0,1]^d}(x-n),$$

on $L^2(\mathbb{R}^d)$. Here we take $Q(x) = O(|x|^{-\alpha})$ for large $|x|$ where $\alpha > 0$, and $\{\omega_n\}_{n \in \mathbb{Z}^d}$ are i.i.d real random variables with absolutely continuous distribution μ such that $\frac{d\mu}{dx}(x) = O\big(|x|^{-(1+\delta)}\big)$ *as* $|x| \to \infty$, for some $\delta > 0$. We show that H^ω exhibits exponential localization on negative part of the spectrum independent of the parameters chosen. For $\alpha\delta \leq d$ we show that the spectrum is entire real line almost surely, but for $\alpha\delta > d$ we have $\sigma_{ess}(H^\omega) = [0, \infty)$ and negative part of the spectrum is discrete almost surely. In some cases we show the existence of the absolutely continuous spectrum.

Anindya Ghatak, National Institute of Science Education and Research

Title: *M-ideals in matrix ordered spaces*
Abstract: Let V be a Banach space. Then a closed subspace W of V is an M-ideal if

$$V^* = W^\perp \oplus_1 W^{\perp'}.$$

Let K-be a compact convex set, and let $A(K)$ be the set of all continuous affine functions. Then a closed subspace W of $A(K)$ is an M-ideal in V if and only if $W^\perp \cap K$ is a closed *split face* of K.

In this talk, we would like to present this theorem for non unital ordered Banach spaces. Later we shall explain that this result can be extended for *Completly M-ideals* in the category of ordered operator spaces and such category also contains all (abstract) operator systems. This is a joint work with Anil Kumar Karn.

Gargi Ghosh, IISER Kolkata

Title: *On analytic ChevalleyShephardTodd theorem*
Abstract: For any $f \in \mathbb{D}^2(\mathbb{D}^2)$, we can express f as a linear combination of 1 and $z_1 - z_2$ with $\mathfrak{S}_2$-invariant coefficients. An analogous decomposition of $\mathbb{A}^2(\mathbb{D}^n)$ under the natural action of the group $\mathfrak{S}_n$ is observed, $\mathfrak{S}_n$ is the permutation group on n symbols. In this talk, we expand our scope to the action of pseudo-reflection groups on the ring of holomorphic functions and in order to do that we obtain an extension of well-known Chevalley-Shephard-Todd Theorem. We also mention a purely algebraic determinantal formula that may also be of independent interest.

Zenon Jabłoński, Jagiellonian University

Title: *The Cauchy dual subnormality problem*
Abstract: For a left invertible bounded linear operator T on a complex Hilbert space $\mathcal{H}$, the Cauchy dual T' of T is given by $T' = T(T^*T)^{-1}$. An operator T is said to be a 2-isometry, if $I - 2T^*T + T^{*2}T^2 = 0$. Finally, we say that an operator T satisfies the kernel condition if $T^*T(\ker T^*) \subseteq \ker T^*$. In the talk we discuss some properties of the above mentioned operators.

The talk is based on joint work with A. Anand, S. Chavan and J. Stochel.

Sumesh Kappil, IIT Chennai

Title: *On a generalization of Ando's dilation*
Abstract: We introduce the notion of Q-commuting operators which includes commuting operators. We prove a generalized version of commuting lifting theorem and Ando's dilation theorem in the context of Q-commuting operators. This is a joint work with Nirupama Mallick.

Divya Khurana, The Weizmann Institute of Science

Title: *Greedy Approximations*
Abstract: The "Thresholding Greedy Algorithm" was introduced by Konyagin and Temlyakov in order to study a special basis in Banach spaces. This basis is known as greedy basis and can be characterized by unconditional and democratic properties of the basis. Some of the classical Banach spaces fail to have unconditional basis. This fact motivated many researchers to introduce and study some weaker versions of the greedy basis, namely, quasi-greedy basis, almost greedy basis and partially greedy basis. Almost greedy basis can be characterized by quasi-greediness and democratic property and partially greedy basis can be characterized by quasi-greediness and conservative property. In this talk we will discuss some new characterizations of almost greedy and partially greedy basis. We will also discuss generalizations of greedy basis and its relatives. This is a joint work with Stephen J. Dilworth.

Mahesh Kumar, University of Delhi

Title: *Composition operators which are similar to an isometry on various Banach spaces of Holomorphic Functions on the open unit disc.*
Abstract: We give a complete characterization of those composition operators which are similar to an isometry on various Banach spaces of Holomorphic Functions on the open unit disc such as the Hardy spaces, standard weighted Bergman spaces (finite and infinite order), Bloch space, little Bloch space,

Bloch-type spaces and the Dirichlet space which follows as a consequence of our study of the asymptotic behavior of the powers of a composition operator on these Banach spaces. This is a joint work with Wolfgang Arendt, Isabelle Chalendar and Sachi Srivastava.

Surjit Kumar, Indian Institute of Science

Title: *Von Neumann's inequality for operator-valued multishifts*
Abstract: The von Neumann's inequality says that if T is a contraction on a Hilbert space $\mathcal{H}$, then $\|p(T)\| \leq \sup_{|z|<1} |p(z)|$ for every polynomial p. Generalizing this result, Sz.-Nagy proved that every contraction has a unitary dilation. Later Ando extended this result and showed that every pair of commuting contractions dilates to a pair of commuting unitaries. Surprisingly, it fails for a d-tuple of commuting contractions with $d \geq 3$. Recently, Hartz proved that every commuting contractive classical multishift with non-zero weights dilates to a tuple of commuting unitaries, and hence satisfies von Neumanns inequality. We show that this result does not extend to the class of commuting operator-valued multishifts with invertible operator weights. In particular, we show that if A and B are commuting contractive d-tuples of operators such that B satisfies the matrix-version of von Neumann's inequality and $(1, \ldots, 1)$ is in the algebraic spectrum of B, then the tensor product $A \otimes B$ satisfies the von Neumann's inequality if and only if A satisfies the von Neumann's inequality. We also exhibit several families of operator-valued multishifts for which the von Neumann's inequality always holds.

This is a joint work with Rajeev Gupta and Shailesh Trivedi.

Sneh Lata, Shiv Nadar University

Title: *A class of sub Hardy Hilbert spaces associated with weighted shifts*
Abstract: In this work we study sub-Hardy Hilbert spaces on which the the action of the operator of multiplication by the coordinate function z is assumed to be weaker than that of an isometry. We identify such operators with a class of weighted shifts. The well known results of de Branges and Beurling are deduced as corollaries.

Aneesh M, Indian Statistical Institute, Bangalore

Title: *Linear dynamics in reproducing kernel Hilbert spaces*
Abstract: Let $\mathcal{H}_{\mathcal{E}}(K)$ denote the reproducing kernel Hilbert space associated to an analytic $\mathcal{B}(\mathcal{E})$-valued kernel $K(z,w)$ over the open unit disc in the complex plane, where $\mathcal{B}(\mathcal{E})$ is the space of all bounded operators on a separable Hilbert space $\mathcal{E}$. In terms of the partial derivatives of the kernel $K(z,w)$ at the origin, we provide sufficient conditions for the adjoint of the multiplication operator $M_z(f)(w) = wf(w)$ to be hypercyclic, topologically mixing and chaotic on $\mathcal{H}_{\mathcal{E}}(K)$. We show that these conditions are also necessary in a particular class of reproducing kernel spaces, but not in general. Finally, we present questions on strong forms of hypercyclicity and various notions of chaos for the adjoint M_z^*.

This is a joint work with Jaydeb Sarkar.

Amit Maji, IIIT Guwahati

Title: *Characterization of Invariant subspaces in the polydisc*
Abstract: We give a complete characterization of invariant subspaces for $(M_{z_1}, \ldots, M_{z_n})$ on the Hardy space $H^2(\mathbb{D}^n)$ over the unit polydisc $\mathbb{D}^n$ in $\mathbb{C}^n$, $n > 1$. In particular, this yields a complete set of unitary invariants for invariant subspaces for $(M_{z_1}, \ldots, M_{z_n})$ on $H^2(\mathbb{D}^n)$. As a consequence, we classify a large class of n-tuples of commuting isometries. All of our results hold for vector-valued Hardy spaces over $\mathbb{D}^n$, $n > 1$. Our invariant subspace theorem solves the well-known problem on characterizations of invariant subspaces of the Hardy space over the unit polydisc. This is a joint work with Aneesh Mundayadan, Jaydeb Sarkar and Sankar T. R.

Neha Malik, ISI Bangalore

Title: *A family of genuine integral type operators*
Abstract: We analyze the convergence phenomenon of a sequence of linear positive operators. Some approximation properties including error estimations in terms of modulus of continuity along with a global result, weighted approximation and a quantitative Voronovskaja type asymptotic formula are established. Graphical representation for the convergence behaviour of these

operators is also illustrated using MATLAB.

Tanmoy Paul, IIT Hyderabad

Title: *On strongly Hahn-Banach smooth subspaces of Banach spaces*
Abstract: A closed subspace Y of a Banach space X is said to be Strongly Hahn-Banach smooth subspace if every $f \in Y^*$ pose a unique norm preserving extension to the whole of X and there is a linear projection $P : X^* \to Y^\perp$ such that $\|Px^*\| < \|x^*\|$. M-ideals are natural examples of strongly Hahn-Banach smooth subspaces but the class of strongly Hahn-Banach smooth subspaces is much bigger than the class of M-ideals. We discuss some transitivity properties of strongly Hahn-Banach smoothness, show that this property is separably determined and is stable with respect to discrete c_0 sums.

Pawel Pietrzycki, Jagiellonian University

Title: *A Shimorin-type analytic model for left-invertible operators*
Abstract: In 2001 S. Shimorin obtain a weak analog of the Wold decomposition theorem, representing operator close to isometry in some sense as a direct sum of a unitary operator and a shift operator acting in some reproducing kernel Hilbert space of vector-valued holomorphic functions defined on a disc.

In this talk we will present a new analytic model for left-invertible operators $\mathcal{M}_z : \mathcal{H} \to \mathcal{H}$ given by

$$(\mathcal{M}_z f)(z) = zf(z), \quad f \in \mathcal{H}, \tag{1}$$

where $\mathcal{H}$ denote the vector space of formal Laurent series with vector coefficients of the form

$$U_x(z) = \sum_{n=1}^{\infty} (P_E T^n x) \frac{1}{z^n} + \sum_{n=0}^{\infty} (P_E T'^{*n} x) z^n, \tag{2}$$

and E is such that

$$[E]_{T^*,T'} := \bigvee (\{T^{*n} x \colon x \in E, n \in \mathbb{N}\} \cup \{T'^n x \colon x \in E, n \in \mathbb{N}\}) = \mathcal{H}. \tag{3}$$

Then we will present some applications of this model to composition operators on reproducing kernel Hilbert.

[1] P. Pietrzycki, A Shimorin-type analytic model for left-invertible operators on an annulus and applications. arXiv preprint arXiv:1808.03339 (2018).

[2] S. Shimorin, Wold-type decompositions and wandering subspaces for operators close to isometries. Journal fur die Reine und Angewandte Mathematik 531 (2001): 147-189.

Kallol Paul, Jadavpur University

Title: *Role of Birkhoff-James orthogonality in the study of geometric properties of operator spaces*

Abstract: Birkhoff-James orthogonality plays a very important role in the geometry of the space of bounded linear operators. We first talk about some nice connection between Birkhoff-James orthogonality in the ground space $\mathbb{X}$ and the operator space $B(\mathbb{X})$ and using these results we study the geometric properties like smoothness, strict convexity etc. in the space of bounded linear operators.

This talk is mainly based on the joint work done with Dr Debmalya Sain, Dr Puja Ghosh and Miss Arpita Mal.

Safdar Quddus, Indian Institute of Science

Title: *Group action on non-commutative torus*

Abstract: In this talk we shall talk about some invariants for non-commutative spaces. Applying these invariants on the smooth non-commutative torus, $\mathcal{A}_\theta$ we shall understand some of its properties. Thereafter we shall investigate the same for the algebraic non-commutative torus $\mathcal{A}_\theta^{alg}$. Investigations relveal similarity between the smooth orbifold and the algebraic ones, we shall talk about it.

G. Ramesh, IIT Hyderabad

Title: *On a subclass of norm attaining operators*

Abstract: A bounded linear operator $T : H \to H$, where H is a Hilbert space, is said to be norm attaining if there exists a unit vector $x \in H$ such that $\|Tx\| = \|T\|$. Let $\mathcal{R}_T$ denote the set of all reducing subspaces of T. Define

$$\beta(H) := \{T \in \mathcal{B}(H) : T|_M : M \to M \text{ is norm attaining for every } \ M \in \mathcal{R}_T\}.$$

In this talk, we discuss properties and structure of positive operators in $\beta(H)$ and compare with those of absolutely norm attaining operators ($\mathcal{AN}$-operators). This is a joint work with Hiroyuki Osaka (Ritsumeikan University, Japan)

Reference:

[1] X. Carvajal and W. Neves, Operators that achieve the norm, Integral Equations Operator Theory **72** (2012), no. 2, 179–195. MR2872473 (2012k:47044)

[2] S. K. Pandey and V. I. Paulsen, A spectral characterization of $\mathcal{AN}$ operators, J. Aust. Math. Soc. **102** (2017), no. 3, 369–391. MR3650963

[3] D. Venku naidu, G. Ramesh: On absolutely norm attaining operators; To appear in Proc. Indian Acad. Sci. Math. Sci.

[4] G. Ramesh, Absolutely norm attaining paranormal operators, J. Math. Anal. Appl. **465** (2018), no. 1, 547–556. MR3806716

P. Shankar, ISI Bangalore

Title: *Hyperrigid generators in C^*-algebras*

Abstract: In this talk, we show that, if $S \in \mathcal{B}(H)$ is irreducible and essential unitary, then $\{S, SS^*\}$ is a hyperrigid generator for the unital C^*-algebra $\mathcal{T}$ generated by $\{S, SS^*\}$. We show that, if T is an operator in $\mathcal{B}(H)$ that generates an unital C^*-algebra $\mathcal{A}$ then $\{T, T^*T, TT^*\}$ is a hyperrigid generator for $\mathcal{A}$. As a corollary it follows that, if $T \in \mathcal{B}(H)$ is normal then $\{T, TT^*\}$ is hyperrigid generator for the unital C^*-algebra generated by T and if $T \in \mathcal{B}(H)$ is unitary then $\{T\}$ is hyperrigid generator for the C^*-algebra generated by T. We show that if $V \in \mathcal{B}(H)$ is an isometry (not unitary) that generates the C^*-algebra $\mathcal{A}$ then the minimal generating set $\{V\}$ is not hyperrigid for $\mathcal{A}$.

Srijan Sarkar, Indian Statistical Institute, Bangalore

Title: *Rank of co-doubly commuting Hilbert modules*
Abstract: Let $\mathcal{H}_{K_i}$ be an analytic reproducing kernel Hilbert module over $\mathbb{C}[z]$ with kernel K_i, and let $\mathcal{Q}_i$ be a quotient module of $\mathcal{H}_{K_i}$, $i = 1, \ldots, n$. Then

$$\mathcal{S} = (\mathcal{Q}_1 \otimes \ldots \otimes \mathcal{Q}_n)^{\perp},$$

is said to be a co-doubly commuting submodule of the reproducing kernel Hilbert module $\mathcal{H}_K = \mathcal{H}_{K_1} \otimes \ldots \otimes \mathcal{H}_{K_n}$ over $\mathbb{C}[z_1, \ldots, z_n]$. It follows that (cf. [2])

$$\mathcal{S} = \sum_{i=1}^{n} \mathcal{H}_{K_1} \otimes \ldots \otimes \mathcal{H}_{K_{i-1}} \otimes \mathcal{Q}_i^{\perp} \otimes \mathcal{H}_{K_{i+1}} \otimes \ldots \otimes \mathcal{H}_{K_n},$$

In this talk we will show that, with some natural assumptions, the rank of a finitely generated co-doubly commuting submodule is given by

$$\operatorname{rank}(\mathcal{S}) = \sum_{i=1}^{n} \operatorname{rank}(\mathcal{Q}_i^{\perp}).$$

In particular, this extends a recent result on the Hardy space over bi-disc (see [1]) to the Hardy space over polydisc.

This is a joint work with Arup Chattopahyay and Jaydeb Sarkar.

[1] A. Chattopadhyay, B.K. Das and J. Sarkar, *Rank of a co-doubly commuting submodule is 2*, Proceedings of American Math Society, 146 (2018), 1181–1187.

[2] A. Chattopadhyay, B.K. Das and J. Sarkar, *Tensor product of quotient Hilbert modules*, Journal of Mathematical Analysis and Applications, 424 (2015), 727–747.

[3] R. Douglas and R. Yang, *Operator theory in the Hardy space over the bidisk (I)*, Integral Equations Operator Theory 38 (2000), no. 2, 207–221.

Bipul Saurabh, Harish-Chandra Research Institute

Title: *Spectral dimension of quaternion spheres*

Abstract: Employing ideas of noncommutative geometry, Chakraborty and Pal introduced an in- variant called spectral dimension, for quantum homogeneous spaces. In this talk, we show that spectral dimension of quaternion spheres is same as its dimension as a real differentiable manifold.

Ritabrata Sengupta, IISER Berhampur

Title: *Exchangeable, stationary and entangled chains of Gaussian states*
Abstract: We explore conditions on the covariance matrices of a consistent chain of mean zero finite mode Gaussian states in order that the chain may be exchangeable or stationary. For an exchangeable chain our conditions are necessary and sufficient. Every stationary Gaussian chain admits an asymptotic entropy rate. Whereas an exchangeable chain admits a simple expression for its entropy rate, in our examples of stationary chains the same admits an integral formula based on the asymptotic eigenvalue distribution for Toeplitz matrices. An example of a stationary entangled Gaussian chain is given.
Keywords: Gaussian state, exchangeable, stationary and entangled Gaussian chains, entropy rate.

Michio Seto, National Defense Academy

Title: *Applications of de Branges-Rovnyak decomposition to graph theory*
Abstract: We study increasing sequences of graphs from the viewpoint of functional analysis. As an application of the theory of de Branges-Rovnyak decomposition, some inequalities for graph Laplacians are given. This is joint work with S. Suda and T. Taniguchi.

Dominik Schillo, Universitat des Saarlandes

Title: *K-contractions*
Abstract: We give a generalization of the model theory of Agler, Müller-Vasilescu, Pott, Arveson, Ambrozie-Englis-Müller, Arazy-Englis and Olofsson for a class of reproducing kernel Hilbert spaces on the open unit ball in

$\mathbb{C}^d$. Here, we examine two classes of commuting tuples which coincide for the case of weighted Bergman spaces with m-hypercontractions and for suitable Nevanlinna-Pick spaces with a class of commuting tuples recently studied by Clouatre-Hartz. As an application, we obtain a Beurling-type theorem, where we characterize the invariant subspaces of the shift operator which arise as the image of suitable partially isometric multipliers.

Sanjay Sharma, Central University of Jammu

Title: *Weighted composition operators between spaces of Dirichlet type and related Q_p spaces*

Abstract: Let $\mathbb{D}$ denote the open unit disk in the complex plane $\mathbb{C}$. We will use the notation $H(\mathbb{D})$ for the space of complex valued holomorphic functions on the open unit disk $\mathbb{D}$. Let $\varphi, \psi \in H(\mathbb{D})$ be such that $\varphi(\mathbb{D}) \subseteq \mathbb{D}$. Then the weighted composition operator $W_{\varphi,\psi}$ acting on $H(\mathbb{D})$ is defined as

$$W_{\varphi,\psi}(f)(z) = \psi(z) f(\varphi(z)).$$

When $\psi \equiv 1$, we just have the composition operator C_φ, defined by

$$C_\varphi(f) = f \circ \varphi.$$

Also if $\varphi \equiv I$, the identity function, then we get the multiplication operator M_ψ defined by $M_\psi(f)(z) = \psi(z) f(z)$. Let $dA(z) = \frac{1}{\pi} dxdy$ denote the normalized Lebesgue area measure on $\mathbf{D}$. Also, let $dA_\alpha(z) = (1+\alpha)\,(1-|z|^2)^\alpha\, dA(z)$ denote the weighted Lebesgue area measure on $\mathbf{D}$. For $0 < p < \infty$ and $-1 < \alpha < \infty$, the spaces of Dirichlet type $\mathcal{D}^p_\alpha$ consist of those functions f holomorphic on $\mathbb{D}$ such that

$$\|f\|_{\mathcal{D}^p_\alpha} = \left(|f(0)|^p + \int_{\mathbb{D}} |f^{'}(z)|^p dA_\alpha(z) \right)^{1/p} < \infty.$$

Q_α is the Banach space of function $f \in \mathcal{D}^2_\alpha$ with the norm

$$\|f\|_{Q_\alpha} = |f(0)| + \sup_{\omega \in \mathbb{D}} \|f \circ \varphi_\omega - f\|_{\mathcal{D}^2_\alpha} < \infty,$$

where $\varphi_\omega = \frac{\omega - z}{1 - \bar{\omega} z}$.

In this work we characterize the boundedness and the compactness of weighted

composition operators acting between Dirichlet type spaces by using Carleson measures. We also find the essential norm estimates for these operators.

Sruthymurali, IMSc, Chennai

Title: *On a presentation of the spin planar algebra*
Abstract: The spin planar algebra is a familiar and simple planar algebra from the very first paper of Jones on planar algebras. It has an equivalent description as the planar algebra associated to a certain bipartite graph. In this talk, I would like to give a presentation of this planar algebra in terms of generators and relations. This is a joint work with Vijay Kodiyalam, Sohan Lal Saini and V S Sunder.

Harsh Trivedi, LNM Institute of Information Technology

Title: *Wold decomposition for doubly commuting isometric covariant representations*
Abstract: In recent years there has been an increased interest in Wold decomposition for a variety of objects. The classical Wold decomposition says that every isometry on a Hilbert space is a direct sum of shift and unitary. Muhly and Solel developed extensions, to representations of tensor algebras, of the Wold decomposition theorem and Beurling's theorem for isometries on a Hilbert space, to analyze the invariant subspace structure of certain subalgebras of Cuntz-Krieger algebras. The Wold decomposition for a row isometry by Popescu is a special case of their result. Every such representation corresponds to a covariant representation.

Skaski-Zakarias presented Wold decomposition for doubly commuting isometric covariant representations, which is a higher rank version of M. Slocinski's well-known result for a pair of doubly commuting isometries. In this talk, we generalize this result and give a different proof. This is a joint work with S. Veerabathiran.

Prahlad Vaidyanathan, IISER Bhopal

Title: *Connected Stable Rank of C^*-algebras*

Abstract: Various stable ranks were introduced by Rieffel in the 1980s to study non-stable K-theory for C^*-algebras. In this talk, we discuss one such rank: the connected stable rank. We will describe the kind of questions it answers, and also describe techniques to compute it for certain C^*-algebras.