Plenary Talks

Monday

Speaker: Brett Wick

Title: Two Weight Inequalities for Calderón-Zygmund Operators

Abstract: Calderon-Zygmund operators, which arise naturally in partial differential equations and complex analysis, are integral operators that are associated to a kernel possessing a singularity on the diagonal.

Understanding the mapping properties of these operators on various function spaces is an important area of current research. There is a proof strategy that exists, "T1 Theorems", that utilizes natural necessary testing conditions to provide sufficient conditions to verify the boundedness of the Calderon-Zygmund operator. Additional tools in the proof are the use of dyadic harmonic analysis techniques.

In this talk we'll discuss some recent results about the behavior of Calderon-Zygmund operators on weighted spaces in various settings and outline some of the main ideas behind the proof and provide some motivation to consider such questions.

Speaker: Aaron Tikuisis

Title: Classification of C*-algebras

Abstract: The classification of simple regular C*-algebras has been a long endeavor. I will discuss the resulting theorem and an approach to its proof (in the finite case) taken in joint work with José Carrión, Jamie Gabe, Chris Schafhauser, and Stuart White.

Speaker: Judith Packer

Title: Constructing spectral triples for noncommutative solenoids and bounded Bunce-Deddens algebras using length functions and inductive limits

Abstract: Let $\mathbb{L}$ be a length function on a discrete abelian group Γ, and let $\sigma : \Gamma \times \Gamma \to \mathbb{T}$ be a multiplier on Γ. Rieffel and collaborators, following work of Connes, have used $\mathbb{L}$ to construct a "Dirac" operator on $\ell^2(\Gamma)$, giving spectral triples with for the twisted group C^*-algebra $C^*(\Gamma, \sigma)$, concentrating on the case when Γ is finitely generated. These twisted group C^*-algebras give many examples that have appeared frequently in noncommutative geometry, e.g. noncommutative tori. Following Rieffel's work and recent work of Long and Wu, we use length functions with special properties to construct odd spectral triples for noncommutative solenoids $C^*(\mathbb{Z}[\frac{1}{p}]) \times \mathbb{Z}[\frac{1}{p}], \sigma)$ first studied by the author and Latrémolière, which are direct limits of noncommutative tori, and also on certain types of Bunce-Deddens algebras that we call bounded. These Bunce-Deddens algebras are directed limits of matrix algebras over $C(\mathbb{T})$. The spectral triples we construct are **metric**, i.e. the Dirac operators involved can be used to construct a metric on the state space of the twisted group C*-algebras that induces a topology coinciding with the weak-* topology.

This talk is based on joint work with C. Farsi, T. Landry, N. Larsen, and F. Latrémolière.

Tuesday

Speaker: Alexandru Chirvasitu

Title: On the generic paucity of symmetries

Abstract: The talk will catalog a number of instances of the common and familiar pattern of "most" structures of any given type having "few" symmetries. There is much scope for variety in what one means by "most", "few", and 'symmetry', so that individual specific case studies might be more enlightening than overly general formulations; such examples include:

- the fact that compact metric probability spaces with trivial (quantum) automorphism group is residual in the space of all such metric spaces;

- the probability that a finite random graph has a non-trivial quantum automorphism group approaches 1 as the size of the graph increases;

- the space of tuples of matrices generating operator systems admitting non-scalar unitary conjugations is residual;

- for a compact group G acting on a smooth compact manifold M, the space of G-invariant Riemannian metrics whose automorphism group is larger than G is of first category.

All of these have a common flavor, despite the disparate arguments one typically uses in the proofs.

(partly joint with Mateusz Wasilewski).

Speaker: Estelle Basor

Title: Some applications of Fredholm theory

Abstract: This talk will show how the theory of Fredholm determinants ties three different topics together. These are asymptotics of structured matrices, averages over classical groups, and factorizations of certain polynomials. The averages and factorizations arise in some number theory problems.

Speaker: Srivatsav Kunnawalkam Elayavalli

Title: On the story of matrices of high finite order: Then (1942) and now (2022).

Abstract: Matrix ultraproducts are intimidating yet fascinating beasts. In light of the Connes embedding problem, which asks if matrix ultraproducts are embedding universal for separable II_1 factors, their study is of utmost importance to both intrinsic considerations in operator algebras, and also to deep external problems in many other areas including quantum information theory. I will begin by discussing a utterly remarkable and largely neglected paper of von Neumann from 1942 that can be seen a precursor to the modern systematic study of asymptotic representation theory, especially manifesting in the theory of random matrices. This result is proved using a technique which he named the 'volumetric method'. The first result that allowed one to track the isomorphism problem of matrix ultraproducts among other ultrapowers of II_1 factors is this 1942 theorem of von Neumann, that shows that the ultrapower of a factor with property Gamma can never be isomorphic to any matrix ultraproducts. In this talk I will discuss my recent 2022 result joint with I. Chifan and A. Ioana that on the flipside there are examples of non Gamma factors whose ultrapowers can never be isomorphic to any matrix ultraproducts. The core idea of proof uses a sophisticated refinement of the 'volumetric method' in Voiculescu's free entropy theory in the form of the 1-bounded entropy of Jung and Hayes, and crucially features other modern ideas such as Popa's free malleable deformation, Property T and weak spectral gap.

Wednesday

Speaker: Doron Lubinsky

Title: Distribution of Eigenvalues of Toeplitz Matrices with Smooth Entries

Abstract: Eigenvalues of Toeplitz matrices whose entries are trigonometric moments have been studied since the 1920's. Less attention has been given to eigenvalues of Toeplitz matrices whose entries are power series coefficients. The latter case arises in investigating convergence of Pade approximants. We discuss some old and new results, especially when the power series coefficients are in a sense "smooth".

Speaker: Camila Sehnem

Title: C*-envelopes of tensor algebras of product systems

Abstract: The C*-envelope of an operator algebra C is the smallest C*-algebra generated by a completely isometric copy of C. Muhly and Solel showed that the C*-envelope of the tensor algebra $\mathcal{T}(\mathcal{E})^+$ of a correspondence $\mathcal{E}$ is canonically isomorphic to the Cuntz–Pimsner algebra $\mathcal{O}_{\mathcal{E}}$ under certain assumptions on $\mathcal{E}$, which were later removed by Katsoulis and Kribs. In this talk I will report on a generalisation of this result for an arbitrary product system $\mathcal{E}$ over a submonoid of a group G. As a consequence, it follows that the C*-envelope of $\mathcal{T}_\lambda(\mathcal{E})^+$ automatically carries a gauge coaction of G, answering a question left open in recent work of Dor-On, Kakariadis, Katsoulis, Laca and Li.

Speaker: Guoliang Yu

Title: Index theory of the Dirac operator on manifolds with polyhedral boundary and its applications

Abstract: I will introduce a new index theory for Dirac operators on manifolds with polyhedral boundary and discuss how this theory can be applied to solve Gromov's dihedral extremality conjecture on scalar curvature. This is joint work with Jinmin Wang and Zhizhang Xie.This talk will be accessible to non-experts including graduate students.

Thursday

Speaker: Sarah Reznikoff

Title: Notes on regular ideals of C*-algebras

Abstract: We examine regular ideals of C* algebras and discuss the preservation of subalgebra properties under quotients by these ideals. This is joint work with Jonathan Brown, Adam Fuller, and David Pitts.

Speaker: Marcelo Laca

Title: The right Toeplitz algebra of the $ax + b$ semigroup of the natural numbers

Abstract: Our right Toeplitz algebra is the C*-algebra generated by the right regular representation of the semigroup of affine transformations of the natural numbers. We compute enough of its ideal structure to see that the right Toeplitz algebra is very different from the left Toeplitz algebra studied over a decade ago by Iain Raeburn and myself. However, as shown by Cuntz, Echterhoff and Li, K-theory does not see the difference between right and left, and, as we show, the same is true for the crystalline phases; this means that right and left Toeplitz algebras have the same equilibrium state structure at low temperature. We recently discovered that this similarity breaks down completely in the high temperature range; indeed, the right Toeplitz algebra exhibits an unprecedented type III phase transition at supercritical temperatures. This talk is based on recent joint work with Astrid an Huef and Iain Raeburn on the low temperature range, and on current joint work with Tyler Schultz for high temperature.

Speaker: Isaac Goldbring

Title: A nonstandard proof of the spectral theorem for unbounded self-adjoint operators

Abstract: The spectral theorem for Hermitian matrices states that, given an $n \times n$ Hermitian matrix A, if one lists its distinct eigenvalues as $\lambda_1, \ldots, \lambda_k$ and lets $P_1, \ldots, P_k$ denote the orthogonal projections onto the corresponding eigenspaces, then $P_1 + \cdots + P_k$ represents an orthogonal decomposition of the identity operator on $\mathbb{C}^n$ and one has the spectral resolution $A = \sum_{i=1}^{k} \lambda_i P_i$ of A. An important generalization of this result is to the case when one considers infinite-dimensional Hilbert spaces and unbounded self-adjoint operators on this space. In this setting, one replaces finite orthogonal decompositions of the identity by projection-valued measures supported on the spectrum of the operator and the above resolutions of the identity and the operator itself appear in terms of appropriate integrals with respect to these projection-valued measures. The unbounded version of the spectral theorem is of central importance in quantum mechanics, where it is used to provide probability distributions for measurements of observables with continuous spectrum such as position and momentum.

The usual proof of the spectral theorem for unbounded self-adjoint operators usually proceeds by a reduction, via the Cayley transform, to the case of bounded, normal operators on infinite-dimensional Hilbert spaces. Thus, besides needing to first generalize to the intermediate case of bounded operators on infinite-dimensional Hilbert spaces, this approach suffers from the need to leave the realm of self-adjoint operators and work with the larger class of normal operators as well as from the need to motivate the use of the Cayley transform and all of the preliminaries associated with this operation.

In this talk, we present a proof of the spectral theorem for unbounded self-adjoint operators that solely relies on the finite-dimensional version discussed above. The proof uses nonstandard analysis and uses a hyperfinite-dimensional Hilbert space that contains the standard infinite-dimensional space in an appropriate way. An approach of this kind was used by Moore to give a nonstandard proof of the spectral theorem for bounded self-adjoint

operators. Added difficulty arises in the unbounded context in the form of defining the nonstandard hull of an internal operator on a hyperfinite-dimensional Hilbert space whose internal operator norm is not necessarily a finite hyperreal number. We borrow from and add upon the ideas of Raab in his work on a nonstandard approach to quantum mechanics to deal with this issue.

Friday

Speaker: Emily Peters

Title: Categorifying connections

Abstract: The road between subfactors and fusion categories is well-trodden in both directions; subfactors provide examples of fusion categories not seen elsewhere, and fusion category techniques can be applied in, eg, the construction and classification of subfactors. In this talk we translate the main ideas of Ocneanu's paragroup theory into tensor categorical language; we begin by explaining why connections on bipartite graphs correspond to a pair of functors from the Temperley-Lieb-Jones categories into a graph category, and commutator data. This is joint work with David Penneys and Noah Snyder.

Speaker: Fritz Gesztesy

Title: Some recent developments in Hardy-type inequalities

Abstract: We intend to give an overview of some recent results on (optimal) Birman-Hardy-Rellich-type inequalities. In particular, we will discuss power-weighted inequalities and some of their logarithmic refinements in all space dimensions $n \geq 1$. In dimension one we will present a new perturbative Hardy-type inequality which sheds some light on the origin of Hardy inequalities.

Hardy-type inequalities are a basic tool in the spectral theory of differential operators and we intend to briefly illustrate their relevance.

This is based on various joint work with L. Littlejohn, I. Michael, R. Nichols, and M. M. H. Pang.

Speaker: Ben Hayes

Title: Applications of free entropy to the study of tracial von Neumann algebras

Abstract: Voiculescu's free entropy theory led to the discovery of many important results in the study of tracial von Neumann algebras, particularly free group factors. For instance, it led to the first proofs that free group factors are have no Cartan subalgebras and are prime. I will present some recent results of mine in this direction, with connections to Random matrices, Property (T), and the study of absorption properties in von Neumann algebras. This might include a discussion of the Peterson-Thom conjecture on the structure of maximal amenable subalgebras of free group factors, or a discussion of my recent work with Jekel and Kunnawalkam Elayavalli on Property (T) algebras.