Title/Abstract

- Title: Quantum Gaussians and Central Limit Theorem

  Speaker: Kaifeng Bu

  Abstract: Stabilizer states play an important role in quantum computation, such as quantum error correcting code and measurement-based quantum computation. In this talk, I will introduce a new quantum convolution and a conceptual framework to study states in discrete-variable (DV) quantum systems. Moreover, we establish a quantum central limit theorem, based on iterating the convolution of a quantum state, and show this converges to a stabilizer state, where we suggest the name "Quantum Gaussians " for stabilizer states. This talk is based on the joint work with Weichen Gu, and Arthur Jaffe (arXiv:2302.07841, 2302.08423).

- Title: Variations on Riemann-Roch

  Speaker: Alain Connes

  Abstract : I will explain two versions of the Riemann-Roch formula for the ring of integers, obtained in our collaboration with Katia Consani.

- Title: Nuclear C^*-algebras as inductive limits of finite dimensional C*-algebras

  Speaker: Kristin Courtney

  Abstract: Inductive limits are a central construction in operator algebras because they allow one to use well-understood building blocks to naturally construct more complicated objects whose properties remain tractable. In the classical setting, few nuclear C*-algebras arise as inductive limits of finite-dimensional C*-algebras. However, by generalizing our notion of an inductive system, we can in fact realize any nuclear C*-algebra as the limit of a system of finite dimensional C*-algebras. Though seemingly abstract, these systems arise naturally from completely positive approximations of nuclear C*-algebras. This is based in part on joint work with Wilhelm Winter.

- Title: KK with extra structures in the approach via qA.

  Speaker: Joachim Cuntz

Abstract: An alternative approach to Kasparov's classical KK-theory uses quasi-homomorphisms and the universal algebra qA associated with a given C*-algebra A. One virtue of this approach is a very simple construction of the Kasparov product KK(A,B)× KK(B,C) to KK(A,C). KK-groups have by now been defined and studied for various categories of C*-algebras with extra structures. This includes notably equivariant, nuclear and ideal related KK-theory. We extend and develop the qA-approach to cover these cases. In each case we get a simple description of the corresponding KK and of the product. A nearly automatic consequence is the fact that in each case the KK-functor can be characterized as a universal functor by the usual properties of stability, homotopy invariance and split exactness in the given category. In applications our description of the KK-groups can be readily applied to define explicit KK-elements for each of these categories. This is joint work with J.Gabe.

- Title: The coarse Baum-Connes conjecture for certain relative expanders

  Speaker: Jintao Deng

  Abstract: The coarse Baum-Connes conjecture claims that the geometric K-theory and the analytic K-theory associated with a metric space with bounded geometry are isomorphic via the index map. It has important applications in the study of the existence of Riemannian metrics with positive scalar curvature and the Novikov conjecture concerning the homotopy invariance of higher signatures. In this talk, I will talk about our recent result that the coarse Baum-Connes conjecture holds for the relative expanders constructed by Arzhantseva and Tessera which is not coarsely embeddable into Hilbert space. This is based on a joint work with Guoliang Yu and Qin Wang

- Title: Metric spectral triples and inductive limits

  Speaker: Carla Farsi

  Abstract: Metric spectral triples are spectral triples in which the semi-norm associated to the commutator of the Dirac operator is a norm inducing the weak* topology on the state space of the spectral triple C^*-algebra. After introducing the main definitions, we will review some results that connect metric spectral triples to inductive limits. Based on joint work with: T. Landry, N. Larsen, F. Latremoliere, and J. Packer.

- Title: H-unitality of smooth groupoid algebras

  Speaker: Michael Francis

  Abstract: A theorem of Dixmier-Malliavin says that every element of the smooth convolution algebra $A = C_c^\infty(G)$ of an arbitrary Lie group G can be expressed as a finite sum of products. In other words, the map $A \otimes A \to A$ is a surjection. In previous work, I extended this result to the case where G is a Lie groupoid. Building on the latter result, I obtain that A is in fact H-unital in the sense of Wodzicki, meaning the bar complex $\cdots \to A^{\otimes 3} \to A^{\otimes 2} \to A \to 0$ is exact. I furthermore establish H-unitality of infinite-order vanishing ideals in A associated to invariant submanifolds of the unit space. Consequently, excision holds for these ideals. These results give a principle for calculating cyclic/Hochschild homology of smooth groupoid algebras: localize the calculation around invariant submanifolds. Time permitting, we will look at some applications to singular foliations.

- Title: TBA

  Speaker: Mikhael Gromov

  Abstract: TBA

- Title: The Novikov conjecture, operator K theory, and diffeomorphism groups

  Speaker: Sherry Gong (Texas A&M University)

  Abstract: In this talk, I will discuss some recent work on a version of the Novikov conjecture for certain subgroups of diffeomorphism groups. This talk will be about joint work with Jianchao Wu, Zhizhang Xie, and Guoliang Yu.

- Title: Decomposition complexity, in honor of Guoliang Yu's birthday

  Speaker: Erik Guentner

  Abstract: I intend to survey the ideas behind finite decomposition complexity of metric spaces. This was introduced as a weakening of finite asymptotic dimension and is adapted for the use of controlled methods in the context of both analytic and topological assembly maps. The ideas are the product of a collaboration

with Guoliang and Romain (Tessera) and have since been extended in various directions.

- Title: K-theory for pseudodifferential operators on symmetric spaces

  Speaker: Nigel Higson

  Abstract: A beautiful but difficult theorem of David Vogan asserts that if G is a real reductive group, and if K is a maximal compact subgroup, then every irreducible representation of K occurs as a minimal K-type in precisely one so-called tempiric representation of G, and that each tempiric representation of G has a unique minimal K-type. As I shall explain, this links the representation theories of G and K in a way that is very much reminiscent of the Connes-Kasparov isomorphism in operator K-theory. Vogan has asked if there is a way to reformulate the Connes-Kasparov isomorphism to bring it still closer to his theorem. I shall give one answer that uses order zero pseudodifferential operators on the symmetric space for G. (To make a connection to the work of Guoliang, the answer comes about by shifting emphasis to the fiber of the Connes-Kasparov morphism, which in other contexts is called the analytic structure set.) In real rank one, the reformulated Connes-Kasparov isomorphism essentially implies Vogan's theorem. This is joint work with Peter Debello.

- Title: TBA

  Speaker: Arthur Jaffe

  Abstract: TBA

- Title: Duality in index theory of orbital and transverse operators for a Lie group action on manifolds

  Speaker: Gennadi Kasparov

  Abstract: I will explain some basic ideas of orbital (i.e. leaf-wise) index theory for a compact Lie group action on a manifold. This will involve the definition of the relevant C*-algebras and the use of the appropriate KK-groups. Similar C*-algebras for the transverse index theory are already known. It appears that there

exists an interesting duality and interrelation between the KK-groups associated to these two theories.

- Title: Homotopy type of finitely propagated unitary operators and its application.

  Speaker: Tsuyoshi Kato

  Abstract: In this talk, I will explain our computation of the homotopy type of finitely propagated unitary operators. We found a periodicity of homotopy groups and a new group structure on odd degrees. We apply it to study zeros of vector fields on the covering spaces of compact manifolds.

- Title: Converging Periodic Boundary Conditions and Detection of Topological Gaps on Regular Hyperbolic Tessellations

  Speaker: Fabian R. Lux

  Abstract: In the field of metamaterials, tessellations of the hyperbolic spaces by regular polygons are becoming popular because they support discrete quantum and classical models displaying unique spectral and topological characteristics. Resolving the true bulk spectra and the thermodynamic response functions of these models requires converging periodic boundary conditions and our work delivers a practical solution for this open problem on generic p, q-tessellations. This enables us to identify the true spectral gaps of bulk Hamiltonians and, as an application, we construct all but one topological models that deliver the topological gaps predicted by the K-theory of the lattices. We demonstrate the emergence of the expected topological spectral flows whenever two such bulk models are deformed into each other and, additionally, we prove the emergence of topological channels whenever a soft physical interface is created between different topological classes of Hamiltonians. One can view our work as a real-world application of the methods from noncommutative geometry.

- Title: Prolate spheroidal Dirac operators and the zeros of Zeta

  Speaker: Henri Moscovici

  Abstract. I will talk about my joint work with Alain Connes ex- hibiting an isospectral family of Dirac-type operators, which are square roots of the prolate

spheroidal wave operator, and whose spectrum closely simulates the zeros of Riemann's zeta function.

- Title: Strong hyperbolicity and some of its applications

  Speaker: Bogdan Nica

  Abstract: I will discuss the notion of strong hyperbolicity, whose origin lies in Guoliang's seminal result that hyperbolic groups admit proper isometric actions on Lp-spaces. The talk is partly based on joint work with Jan Spakula.

- Title: Geometry of surface groups

  Speaker: Igor V. Nikolaev

  Abstract: Let $S_{g,n}$ be a two-sided surface of genus g with n boundary components. The fundamental group $\pi_1(S_{g,n})$ encodes the homotopy type of $S_{g,n}$. One can ask what an extra structure of the group $\pi_1(S_{g,n})$ controls geometry of $S_{g,n}$, i.e. when $S_{g,n}$ is a Riemann surface? In our talk we offer an answer to this question using the notion of a cluster C^*-algebra. Reference: arXiv:2206.08103

- Title: On property (T) for automorphism groups of free groups

  Speaker: Piotr Nowak

  Abstract: I will describe a method of proving Kazhdan's property (T) for finitely generated groups by showing an algebraic version of the spectral gap for the Laplacian in the real group ring. I will then show how this method can be used to show property (T) for $\mathrm{Aut}(F_n)$, the automorphism group of free groups, for n at least 5. This is based on joint work with Kaluba and Ozawa (n=5) and Kaluba and Kielak ($n \geq 6$).

  Speaker: Piotr Nowak

- Title : K-theory and geometric decomposability for groupoids

  Abstract : Hervé Oyono-Oyono

  Geometric decomposability for étale groupoids was introduced by E. Guentner, R. Willet and G. Yu. The idea was to generalized the "cut and pasting" strategy developed by G. Yu in his proof of the Novikov conjecture for finitely generated groups with finite asymptotic dimension. In this lecture, we first extend this concept to locally compact Hausdorff groupoids and then provide applications to K-theory computations for crossed-product algebras. As a consequence, we state some hereditary results for the Baum-Connes conjecture with respect to geometric decomposability.

- Title: Bulk-Defect Correspondence Principle by Groupoid Methods and KK-theory

  Speaker: Emil Prodan

  Abstract: In the first part, I will review, with examples, the bulk-defect correspondence principle in materials science, with a focus on architected materials (also known as metamaterials). In the second part, I will present a unifying framework for these physical observations. Specifically, I will show that a collection of identical self-coupling resonators, when viewed as a uniformly discrete pattern of the Euclidean group, induces a canonical etale groupoid. If the physics involved in the coupling of the resonators is Galilean invariant, I will show that the C*-algebra associated to this groupoid is the smallest C*-algebra that covers the Hamiltonians associated with the given resonant structure. Furthermore, I will show that, for a material with a defect, the space of units of the groupoid has a closed invariant subspace, an observation that sets in motion a standard exact sequence. The KK-theory associated with this exact sequence explains all known forms of bulk-defect correspondences.

- Title: Noncommutative geometry and semiclassical analysis.

  Speaker: Raphael Ponge

  Abstract: Semiclassical analysis and noncommutative geometry are distinct fields within the wider area of quantum theory. Bridges between them have been emerging recently. This lays down on operator ideal techniques that are used in both fields. In this talk we shall present semiclassical Weyl's laws for Schrödinger operators on noncommutative manifolds (i.e., spectral triples). This shows that well known semiclassical Weyl's laws in the commutative setting ultimately holds

in a purely noncommutative setting. This extends and simplifies previous work of McDonald-Sukochev-Zanin. In particular, this allows us to get semiclassical Weyl's laws on noncommutative tori of any dimension $n \geq 2$, which were only accessible in dimension $n \geq 3$ by the MSZ approach. There are numerous other examples as well. The approach relies on spectral asymptotics for some weak Schatten class operators. As a further application of these asymptotics we obtain far reaching extensions of Connes' integration formulas for noncommutative manifolds. (For Riemannian closed manifolds, Connes' integration shows that Connes' NC integral recaptures the Riemannian measure.)

- Title: Blow-up Construction, Deformation Spaces, and the Schwartz Algebra

  Speaker: Ahmad Reza

  Abstract: In this talk, we discuss the relation between the Schwartz algebra of the deformation to the normal cone and the blow-up construction. Title: TBA

- Title: Convergence of Fourier truncations for compact quantum groups

  Speaker: Marc Rieffel

  Abstract: I will sketch how to generalize the Fejer-Riesz operator systems defined for the circle group by Connes and van Suijlekom to the setting of compact matrix quantum groups and their ergodic actions on C*-algebras. These Fourier truncations form filtrations of the containing C*-algebra. I will indicate that when these truncations and their containing C*-algebra are equipped with suitable quantum metrics, then under suitable conditions the Fourier truncations converge to the containing C*-algebra for quantum Gromov-Hausdorff distance.

- Title: Violations of bulk-edge correspondence for topological insulators

  Speaker: Tom Stoiber

  The bulk-edge correspondence of topological insulators is one of the most interesting practical applications of K-theory and noncommutative geometry. Using exact sequences and the corresponding connecting maps one relates the bulk invariants of a topological insulator with boundary to the appearance of gap filling surface modes. However, this paradigm has recently been shown to fail in certain

continuous models for topological phases where the Hamiltonians are differential operators furnished with certain local boundary conditions. In this talk I want to reexamine the technical assumptions that go into the K-theoretic bulk-edge correspondence and try to sketch how one can make sense of some of these purported violations. This is joint work with Johannes Kellendonk.

- Title: Laplacian on symmetric spaces and Vogan's minimal K-type theorem.

  Speaker: Yanli Song

  Abstract: Vogan's minimal K-type theorem asserts a bijection between all irreducible, unitary, tempered representations with real infinitesimal character of a real reductive Lie group G and irreducible representation of its maximal compact subgroup K. The main tools in Vogan's theorem is algebraic cohomological induction. I will talk about a possible geometric approach to Vogan's theorem by studying the large time behavior of Laplacian on the corresponding symmetric space G/K. I will also discuss some connection between Vogan's minimal K-type theorem and Connes-Kasparov theorem. This is a joint work with Shu Shen and Xiang Tang.

- Title: Tolerance relations and operator systems

  Speaker: Walter van Suijlekom

  Abstract: We extend the scope of noncommutative geometry by generalizing the construction of the noncommutative algebra of a quotient space to situations in which one is no longer dealing with an equivalence relation. For these so-called tolerance relations, passing to the associated equivalence relation looses crucial information as is clear from the examples such as the relation $d(x, y) < \epsilon$ on a metric space. Fortunately, thanks to the formalism of operator systems such an extension is possible and provides new invariants, such as the C*-envelope and the propagation number. After a thorough investigation of the structure of the (non-unital) operator systems associated to tolerance relations, we analyze the corresponding state spaces. In particular, we determine the pure state space associated to the operator system for the relation $d(x, y) < \epsilon$ on a path metric measure space. (joint work with Alain Connes)

- Title: Some uniformly bounded boundary representations of hyperbolic groups

  Speaker: Jan Spakula

  Abstract: Suppose G is a hyperbolic group, acting geometrically on a (strongly) hyperbolic space X. For this talk, "boundary representations" are linear representations π_z of G coming from the action of G on the Gromov boundary Z of X. These are parametrised by a (complex) parameter z with $0 < Re(z) < 1$; for z=1/2, π_z is the (unitary) quasi-regular representation on $L^2(Z)$. For Re(z) $\neq$ 1/2, there is no obvious unitary structure for π_z. Denote by D the Hausdorff dimension of Z. For $1/2 - 1/D < Re(z) < 1/2 + 1/D$, we construct function spaces on the boundary on which π_z are uniformly bounded. This is joint work with Kevin Boucher.

- Title: Higher rho invariant and delocalized eta invariant at infinity

  Speaker: Hang Wang

  Abstract: In the joint work with Peter Hochs and Bai-Ling Wang, the equivariant Atiyah-Patodi-Singer index theorem can be obtained by choosing a suitable parametrix. This method can be extended to the more general setting of a complete Riemannian manifold with a uniform positive scalar curvature metric outside a compact set. Under this setting we introduce several secondary invariants for Dirac operators and use them to establish a higher index theorem for the Dirac operators. We apply our theory to study the secondary invariants for a manifold with corner with positive scalar curvature metric on each boundary face. This is joint work with Xiaoman Chen, Hongzhi Liu and Guoliang Yu.

- Title: Scalar curvature extremality and rigidity

  Speaker: Jinmin Wang

  Abstract: The scalar curvature extremality and rigidity problem is a central part of Riemannian geometry. In essence, it seeks to comprehend the metric structure of a Riemannian manifold under the condition of scalar curvature. One of the most significant results is a theorem of Schoen-Yau and Gromov-Lawson that any metric on torus with nonnegative scalar curvature is a flat metric. In this talk, I will present a series of scalar curvature extremality and rigidity results using the method of the index theory of Dirac-type operators. The talk is based on joint works with Guoliang Yu and Zhizhang Xie.

- Title: Deformations of antiholomorphic superconnections

  Speaker: Zhaoting Wei

  Abstract: Antiholomorphic flat superconnection, which is a "higher" generalization of cochain complex of holomorphic vector bundles, gives a global differential-geometric description of coherent sheaves on complex manifolds. In this talk I will discuss the deformation theory of antiholomorphic flat superconnections. I will start with some intuitions and then talk about infinitesimal deformations and obstructions of lifting deformations.

- Title: Cobordism and complexity

  Speaker: Shmuel Weinberger

  Abstract: Cobordism plays an important role in our thinking about the manifolds homotopy equivalent to a given one and in the understanding of positive scalar curvature. Last century, Gromov asked about the geometric complexity (as measured by volume of suitable metrics) of cobordisms. Several years ago in joint work with Chambers, Dotterer and Manin we gave some preliminary information about this problem in the smooth case. Unfortunately, we have made no progress on the smooth case since. I will review some of this work, and then explain some recent work with Manin on the PL situation, which has some very different aspects from the smooth case. If there's time, I hope to explain an application of PL cobordism to Cheeger-Gromov rho invariants with Geunho Lim, and the construction of some interesting triangulations of CP^4.

- Title: Rapid decay for twisted étale groupoids

  Speaker: Alex Weygandt

  Abstract: In this talk, I will describe a generalization of the rapid decay property, originally described for groups, to the setting of (twisted) étale groupoids. It turns out that in this setting, the presence of non-isotropy places strong restrictions on which groupoids admit the rapid decay property. I'll describe such restrictions in more detail, and time permitting, proofs and applications.

- Title: Controlled K-homology

Speaker: Rufus Willett

Abstract: K-homology is a generalized homology theory. In one natural model, cycles are given by elliptic operators over the given space, and thus involve infinite-dimensional analysis. I will discuss a 'controlled' or 'quantitative' version of this and two applications: the first to giving finite-dimensional models for the K-cycles coming from elliptic operators, and the second to the so-called universal coefficient theorem in C*-algebra theory. This is based on joint work with Guoliang Yu.

- Title: Quantitative K-theory and its applications — in honor of Guoliang Yu's 60th birthday

  Speaker: Zhizhang Xie

  Abstract: Quantitative K-theory of C*-algebras, pioneered by Guoliang Yu, has made significant strides since its introduction. This approach has led to positive results for various fundamental problems in geometry and topology, both old and new. In this talk, we will review previous applications of quantitative K-theory and also discuss some exciting new applications that have emerged in recent years.