

OPERATOR K -THEORY IN TOPOLOGY, GEOMETRY AND REPRESENTATION THEORY

Titles and Abstracts

Speaker: Paolo Antonini (SISSA, Trieste)

Title: A Baum–Connes conjecture localized at the unit element of a discrete group

Abstract: We discuss, for a discrete group Γ , a version of the Baum–Connes conjecture which may be called “localized at the unit element”. It is constructed using a model of equivariant KK -theory with real coefficients that is tailored to contain classes defined by traces on C^* -algebras. This form of the conjecture is weaker than the Baum–Connes conjecture but still implies the Novikov conjecture. We explain the construction and two interesting properties of the localized conjecture: the right-hand side is functorial for group morphisms and the relation with the Novikov conjecture follows from a direct comparison, at the level of K -homology with real coefficients, of the classifying space for proper actions $E\Gamma$ with the one for free and proper actions ET . Based on joint work with S. Azzali and G. Skandalis.

Speaker: Alain Connes (IHES and Collège de France)

Title: The role of KK -theory in the geometric quest

Abstract: I will explain the role of Kasparov bivariant theory in the quest for a geometric paradigm for space-time. My starting point will be the work of Sullivan in the seventies. The end point will be to put forward a potential second quantized form of K -homology in connection with the dressing of geometry from quantum field theory

Speaker: Joachim Cuntz (University of Muenster)

Title: Kasparov theory and universal algebras

Abstract: (None provided)

Speaker: Erik van Erp (Dartmouth College)

Title: The Heisenberg calculus and cyclic cohomology

Abstract: Epstein and Melrose investigated the Fredholm index problem for hypoelliptic operators in the Heisenberg calculus on contact manifolds. They placed the problem in the context of Hochschild homology. We revisit this program by studying the index in the context of cyclic cohomology. This is joint work with Alexander Gorokhovsky.

Speaker: Emmanuel Germain (Université de Caen)

Title: How to understand Pimsner’s exact sequences for groups acting on trees?

Abstract: We will review three reinterpretation/generalisation of Pismner exact sequences, starting with Kasparov-Skandalis’ work, then Kei Hasegawa’s and our own with Pierre Fima.

Speaker: Erik Guentner (University of Hawaii)

Title: Operator K -theory for $CAT(0)$ -cubical groups

Abstract: Two decades ago Higson and Kasparov proved the Baum-Connes conjecture for groups which admit an affine, isometric and metrically proper action on a Hilbert space. This was a remarkable advance in the Baum-Connes theory. Among the groups satisfying the hypothesis of this theorem are those which act properly and cellularly on a finite dimensional $CAT(0)$ -cube complex. I will report on an ongoing project whose goal is to understand the operator K -theory of these $CAT(0)$ -cubical groups

directly, using combinatorial arguments arising from the rich geometry of these complexes. The project is joint with J. Brodzki, N. Higson and S. Nishikawa. We wish Gennadi a very happy birthday, and many more.

Speaker: Pierre Julg (Université d'Orléans)

Title: Gennadi's γ -element and discrete series for rank one simple Lie groups

Abstract: Gennadi built in 1983 a representative of the element γ for $SO_0(2n+1, 1)$ living on the flag manifold G/P rather than on the symmetric space G/K . Soon after was discovered by Fox-Haskell, Julg-Kasparov and Chen the necessity, for the cases of $SO_0(2n, 1)$ and $SU(n, 1)$ of the introduction of some discrete series, namely the irreducible components of the L^2 -cohomology of the symmetric space G/K . We shall explain and comment a construction of harmonic forms by Gennadi in our joint paper on $SU(n, 1)$, in view of generalization to $Sp(n, 1)$ or $F_{4(-20)}$.

Speaker: Gennadi Kasparov (Vanderbilt University)

Title: Pseudo-local K -theory and t-elliptic operators

Abstract: I will discuss index theory for elliptic operators with coefficients in a continuous field of unital C^* -algebras over a manifold. This generalizes the Mishchenko-Fomenko index theory. For example, a finite-dimensional vector bundle on which the operator acts can be replaced with a continuous field of vector spaces with jumping dimensions of fibers. This has a natural application to the index theory of transversally elliptic operators. I will also explain how to correct a certain error in my 2016 paper on this subject.

Speaker: Eckhard Meinrenken (University of Toronto)

Title: Twisted K -homology and Hamiltonian loop group spaces

Abstract: Let G be a compact Lie group, and M a compact symplectic manifold with Hamiltonian G -action and equivariant prequantum line bundle L . The index of the associated spin^c Dirac operator gives an element of the representation ring $R(G)$ called the 'quantization' $Q(M)$. In this talk, I will explain how to obtain a similar quantization for proper Hamiltonian spaces of loop groups, with values in the level k fusion ring $R_k(G)$ (Verlinde algebra), and discuss some of its properties. This talk is largely based on my 2012 IMRN article, with some new insights from joint work with Y. Loizides and Y. Song.

Speaker: Bram Mesland (MPI, Bonn)

Title: A category of correspondences for KK -theory

Abstract: In this talk I will present a set of differentiability axioms on the unbounded cycles for Kasparov's KK -theory. The axioms are geometric in spirit, imposing constraints on a naturally defined curvature operator. The composition of two such differentiable correspondences is defined directly through the unbounded Kasparov product and yields a differentiable correspondence. This construction gives rise to a category of unbounded cycles on which the bounded transform gives a surjective functor onto KK -theory. The axioms are satisfied in numerous examples.

Speaker: Omar Mohsen (Université Paris 7)

Title: On the inhomogeneous deformation groupoid

Abstract: Recent work of Debord and Skandalis and Van-Erp and Yuncken shows that the pseudo differential calculus can be understood using deformation groupoids. In the classical case this deformation groupoid was constructed by A. Connes. In the inhomogeneous case this groupoid was constructed by Van-Erp and Yuncken and Choi and Ponge. In this talk I will give an elementary construction of this groupoid.

Speaker: Ryszard Nest (University of Copenhagen)

Title: Around the functional equation

Abstract: The functional equation for the Riemann zeta function is based on analysis of the asymptotic behaviour for $t \approx 0$ of an expression like $\text{Tr}(\exp(-tD^2))$, where D is, say, an elliptic operator on a smooth closed manifold M . In particular, it depends heavily on the fact that the expressions like $\text{Tr}(\exp(-tD^2))$ have a Melin transform which is holomorphic on a subspace of the complex plane of the form $\Re(z) > C$, which is a consequence of finite-dimensionality of M . We will construct an analogue of the meromorphic extension of the Riemann zeta function and prove the corresponding functional equation in the infinite-dimensional limit case.

We will sketch some work in progress which give applications of these constructions to local index formulas for operators associated to infinite dimensional physical systems.

Speaker: Hervé Oyono Oyono (Université Paul Verlaine)

Title: K -theory computability and groupoid decomposition

Abstract: Decomposability for action groupoids was introduced by E. Guentner, R. Willet and G. Yu. The idea was to generalize the «cut and pasting» strategy, developed by G. Yu in order to compute the K -theory of the Roe algebra of a finitely-generated group with finite asymptotic dimension. In this lecture, we show that a groupoid decomposition gives rise to a controlled Mayer-Vietoris six-term exact sequence in quantitative K -theory for crossed product algebra. We give applications to the Künneth formula in K -theory and to the Baum-Connes conjecture.

Speaker: Michael Puschnigg (Aix-Marseille Université)

Title: On the finite summability of Gamma-elements

Abstract: Gamma-elements play a key role in Gennadi Kasparov's work on the Novikov Conjecture. We investigate their summability in the case of word-hyperbolic groups and the case of lattices in simple Lie groups. This is partly joint work with J.-M. Cabrera.

Speaker: Georges Skandalis (Université Paris 7)

Title: Index theory on singular foliations

Abstract: We will discuss the K -theory of the C^* -algebra of a singular foliation as a natural receptacle of longitudinal index theory. We will then outline the construction of a Baum-Connes map — for nice enough singular foliations. (Joint work with I. Androulidakis.)

Speaker: Yanli Song (Washington University)

Title: Cyclic Cocycles, Higher Index and Harish-Chandra's Plancherel Theorem

Abstract: Connes-Moscovici's L^2 -index theorem on the homogeneous space G/K says that the L^2 -index of an equivariant Dirac operator is equal to the Plancherel measure (or formal degree) of the corresponding discrete series representation of G . However, this index always vanishes when the group G has no discrete series, or equivalently is of non-equal rank. To generalize Connes-Moscovici's result to the non-equal rank case, one needs a generalization of the L^2 index. In this talk, I will discuss how to construct higher cyclic cocycles using parabolic subgroups, and compute the higher index pairing using Harish-Chandra's Plancherel theorem. If time permits, I will explain its extension to higher orbital integrals. This is joint work with Xiang Tang.

Speaker: Walter van Suijlekom (Radboud Universiteit)

Title: Factorization of Dirac operators in unbounded KK -theory and curvature

Abstract: We show how unbounded KK -cycles can be used as a geometric refinement of Kasparov's bivariant K -theory, capturing also notions such as curvature. We illustrate this in the case of Riemannian submersions of (compact) Riemannian spin manifolds, where we establish the factorization of Dirac operators. More precisely, we show that the Dirac operator on the total space of such a submersion is unitarily equivalent to the tensor sum of a family of Dirac operators with the Dirac operator on the base space, up to an explicit bounded curvature term. Thus, the latter is an obstruction to having a factorization in unbounded KK -theory, while the tensor sum does represent the bounded KK -product of the corresponding KK -cycles.

Speaker: Jean-Louis Tu (Université de Lorraine)

Title: TBA

Abstract: TBA

Speaker: Hang Wang (East China Normal University)

Title: A K -theoretic Selberg trace formula

Abstract: The close relationship between index theory and representation theory is a classical theme. In particular, the trace formula has been studied through the lens of index theory by several researchers already. In joint work with Bram Mesland and Haluk Sengun, we take this connection further and obtain a formulation of the trace formula in K -theoretic terms. The central objects here are the K -theory groups of the C^* -algebras associated to a semisimple Lie group and its lattices. This work is part of a program which explores the potential role that operator K -theory could play in the theory of automorphic forms.

Speaker: Rufus Willett (University of Hawaii)

Title: Property (T) for groupoids

Abstract: Property (T) is a strong rigidity property for groups. One of its applications is to produce exotic 'Kazhdan projections' in group C^* -algebras; the existence of such projections motivates the use of the reduced rather than the maximal group C^* -algebra in the Baum-Connes conjecture and its relatives. Motivated by this, we develop a ('topological') version of property (T) for groupoids. We discuss the (bad / interesting) ways in which the associated Kazhdan projections interact with the regular representation, and why this causes more problems than in the group case. This is joint work with Clément Dell'Aiera.

Speaker: Zhizhang Xie (Texas A&M University)

Title: Delocalized eta invariants, cyclic cohomology and higher rho invariants

Abstract: In this talk, I will discuss my recent joint work with X. Chen, J. Wang and G. Yu on Higson-Roe's higher rho invariant and Lott's higher eta invariant.

Our first main result is to prove that the convergence of Lott's delocalized eta invariant holds for all operators with a sufficiently large spectral gap at zero. Furthermore, to each delocalized cyclic cocycle, we define a higher analogue of Lott's delocalized eta invariant and prove its convergence when the delocalized cyclic cocycle has at most exponential growth. Our second main result is to construct the delocalized Connes-Chern character of C^* -algebraic secondary invariants for word hyperbolic groups. More precisely, we give an explicit formula for the pairing between C^* -algebraic secondary invariants and delocalized cyclic cocycles of the group algebra. In the case where the C^* -algebraic secondary invariant is a K -theoretic higher rho invariant (in the sense of Higson and Roe), this pairing is precisely the higher analogue of Lott's delocalized eta invariant alluded to above. Our construction uses Puschnigg's smooth dense subalgebra for word hyperbolic groups in an essential way. Moreover, we emphasize that

our construction of the delocalized Connes-Chern character is at the C^* -algebra K-theory level. This is of essential importance for applications to geometry and topology. As a consequence, we compute the pairing between delocalized cyclic cocycles and Atiyah-Patodi-Singer higher index classes for manifolds with boundary, when the fundamental group of the given manifold is hyperbolic.

Speaker: Guoliang Yu (Texas A&M University and Shanghai Center for Mathematical Sciences)

Title: An infinite-dimensional analogue of Kasparov's theorem for the Novikov conjecture and the group of the volume preserving diffeomorphisms

Abstract: In this talk, I will discuss an infinite-dimensional analogue of Gennadi Kasparov's theorem that the Novikov conjecture holds for groups acting properly and isometrically on simply connected and non-positively curved manifolds and apply this result to show the Novikov conjecture for discrete subgroups of the group of the volume preserving diffeomorphisms. This is joint work with Sherry Gong and Jianchao Wu.

Speaker: Vito Zenobi (University of Göttingen)

Title: Higher rho numbers

Abstract: Let Γ be a finitely generated discrete group and let \widetilde{M} be a Galois Γ -covering of a smooth compact manifold M . Let $u: M \rightarrow B\Gamma$ be the associated classifying map. Finally, let $\mathcal{S}_*^\Gamma(\widetilde{M})$ be the K -theory group called "analytic structure group" appearing in the Higson-Roe analytic surgery sequence. Under suitable assumptions on the group Γ we establish a pairing of $\mathcal{S}_*^\Gamma(\widetilde{M})$ with delocalized cyclic cocycles. In particular, we define higher rho numbers associated to the rho class $\rho(\widetilde{D}) \in \mathcal{S}_*^\Gamma(\widetilde{M})$ of an invertible Γ -equivariant Dirac type operator on \widetilde{M} . This applies, for example, to the rho class $\rho(g)$ of a positive scalar curvature metric g on M , if M is spin. This is a joint work with P. Piazza and T. Schick.
