WABASH MINI-CONFERENCE, September 15–16, 2018

## Titles and Abstracts

## INVITED TALKS

*MICHAEL BRANNAN*, Texas A&M University

### Quantum permutations and their matrix models

*Abstract*: A quantum permutation matrix is an $N \times N$ matrix $P$ whose entries are orthogonal projections on a Hilbert space $H$ with the property that the rows and columns of $P$ sum to the identity operator on $H$. In the special case where $H$ is the one dimensional Hilbert space, a quantum permutation matrix is simply an ordinary permutation matrix, and can be thought of as describing a symmetry of an $N$ point set. In this talk I will explain how arbitrary quantum permutation matrices describe the "quantum symmetries" of an $N$ point set. Putting all of these quantum permutation matrices together in a cohesive way yields the structure of a quantum group, which is commonly called the Quantum Permutation Group on $N$ letters. Unlike the classical permutation groups, quantum permutation groups turn out to highly infinite and noncommutative objects – in many ways they behave algebraically like the $C^*$- and von Neumann algebras associated to nonabelian free groups. Despite their inherent infiniteness, I will show how quantum permutation groups can still be well-approximated by finite-dimensional structures. In particular, these objects turn out to be residually finite as discrete quantum groups, and this residual finiteness can in fact be achieved using very simple finite-dimensional matrix models which I will describe. (Joint work with Alexandru Chirvasitu and Amaury Freslon.)

*NATE BROWN*, Penn State University

### Noncommutative topological dimension

*Abstract*: The theory of topological spaces can be translated into the language of functions on said spaces. For instance, if X is a compact Hausdorff space and C(X) denotes the continuous complex-valued functions on X, then open sets in X are in one-to-one correspondence with ideals in C(X). Replacing the abelian C*-algebra C(X) by a nonabelian C*-algebra, we can talk about "open sets" (i.e. ideals) in a noncommutative "topological space" (i.e. C*-algebra). This noncommutative generalization of topology has been a source of inspiration and breakthroughs for many decades. In this talk I will discuss how one translates the notion of topological dimension to the level of functions and extends it to general C*-algebras, following Winter and Zacharias. This leads to a bizarre and beautiful noncommutative landscape, of which I will give a guided tour.

*RAPHAEL CLOUATRE*, University of Manitoba

**Residual finite-dimensionality for general operator algebras**

*Abstract*: Finite-dimensional approximation properties have proven to be a fruitful idea in the realm of $C^*$-algebras. It is thus natural to hope that similar ideas can elucidate the structure of general (not necessarily self-adjoint) operator algebras. In this talk we will study residual finite-dimensionality from that perspective. The departure from the self-adjoint world involves some interesting subtleties. For instance, it is well-known that finite-dimensional operator algebras cannot necessarily be represented completely isometrically inside of an algebra of matrices, in contrast with the situation for $C^*$-algebras. As such, it it not immediately obvious what the "natural" definition of this more general notion of residual finite-dimensionality should be. After clarifying this issue, we will explore the extent to which the residual finite-dimensionality of an operator algebra carries over to its $C^*$-envelope or its maximal $C^*$-algebra. This is joint work with Christopher Ramsey.

*ERIK VAN ERP*, Darmouth College

**A groupoid approach to pseudodifferential operators**

*Abstract*: Groupoids play an increasingly important role in the index theory of various pseudodifferential operators (for manifolds with boundaries, with corners, or various singularities, etc). In joint work with Robert Yuncken we identified a simple geometric definition of pseudodifferential calculi in terms of a natural automorphism group of the tangent groupoid. In our approach, once the appropriate groupoid is constructed (often by a simple geometric construction) the calculus (which typically involves a lot of tedious detail) has also been implicitly defined.

*ROLANDO DE SANTIAGO*, University of California at Los Angeles

**Tensor decompositions of $\mathrm{II}_1$ factors arising from extensions of amalgamated free product groups**

*Abstract*: We describe a family of groups whose von Neumann algebras satisfy the following rigidity phenomenon: all tensor decompositions of $L(\Gamma)$ into $\mathrm{II}_1$ factors necessarily arise from direct product decompositions of the group $\Gamma$. This class includes many iterated amalgamated free products groups such as right-angled Artin groups, Burger-Mozes groups, Higman group, integral two-dimensional Cremona groups. As a consequence, we obtain several new examples of groups that give rise to prime factors.

*JACK SPIELBERG*, Arizona State University

**$C^*$-algebras of left cancellative small categories**

*Abstract*: While the $C^*$-algebra of a group is defined to be universal for the unitary representation theory of the group, the analogous definition for a semigroup (using isometries) has not been found useful. Rather, the natural partial order inherent in a semigroup (so called "irreversibility") has led to a general construction unifying many known examples and suggesting new ones. A semigroup that is left cancellative admits a shift map analogous to a Bernoulli shift (on finite words), and there is a natural process that leads to the analog of the space of "infinite words". In fact, all of this works just as well if the semigroup is replaced by a small category, as long as left cancellation still holds. In this talk I will describe this general process. In particular, I will discuss the regular representation, and in the case of an "ordered groupoid", the Wiener-Hopf algebra.

*JIANCHAO WU*, Penn State University

**Dimensions for C*-algebras and topological dynamics**

*Abstract*: A major source of examples throughout the history of C*-algebra theory lies in the construction of crossed products from topological dynamical systems. This bridge between operator algebras and dynamics, valid also in the measure-theoretical setting, has proven immensely fruitful. On the other hand, the dimension theory of C*-algebras, which studies analogs of classical dimensions for topological spaces, is young but has been gaining momentum lately thanks to the pivotal role played by the notion of finite nuclear dimension in the classification program of simple separable nuclear C*-algebras. The confluence of these two themes leads to the question: What type of topological dynamical systems give rise to crossed product C*-algebras with finite nuclear dimension? I will present some recent work on this problem.

## CONTRIBUTED TALKS

*CHRISTOPHER LINDEN, University of Illinois at Urbana-Champaign*:

**Slow continued fractions and permutative representations of Cuntz algebras**

*Abstract*: Iterated function systems can be used to construct permutative representations of the Cuntz algebras $\mathcal{O}_n$. An interested special case of this construction where the function system is given by the Gauss map has been studied by Kawamura, Hayashi, and Lascu, allowing all (unitary equivalence classes of) irreducible permutative representations of $\mathcal{O}_\infty$ to be labeled by the orbits of a $PGL_2(\mathbb{Z})$ action. I will discuss an extension of this result to the algebras $\mathcal{O}_n$ $2 \leq n < \infty$ with the help of slow continued fraction algorithms.