All talks will be held in the **IT building** (also known as INIT), located at **535 West Michigan St.** on the IUPUI campus.

Plenary speakers

Jorge Garza-Vargas	California Institute of Technology
Constanze Liaw	University of Delaware
Jan Špakula	University of Southampton
Hui Tan	University of California San Diego
Matthew Wiersma	University of Winnipeg
Rufus Willett	University of Hawaii
Zhizhang Xie	Texas A&M University

Invited talks

Timur Akhunov	Wabash College
Forrest Glebe	Purdue University
Pradyut Karmakar	Ohio University
Nicholas LaRacuente	Indiana University
Iason Moutzouris	Purdue University
Michael Pilla	Ball State University
Georgios Tsikalas	Washington University St. Louis

Plenary talks: IT 252. Parallel talks: IT 157 & 159.

Saturday, September 30

9:30–10:00 ☕ Coffee

10:00–10:50 Zhizhang Xie – A new index theorem for manifolds with singularities and its geometric applications

11:00–11:50 Jan Špakula – Some uniformly bounded boundary representations of hyperbolic groups

12:00–2:00 Lunch break

2:00–2:50 Hui Tan – Rigidity results for group von Neumann algebras with diffuse center

3:00–3:25 Michael Pilla – Linear fractional self-maps of the unit ball (IT 157)

3:00–3:25 Pradyut Karmakar – Fourier type convergence in groupoid C*-algebras (IT 159)

3:30–4:00 ☕ Coffee

4:00–4:50 Rufus Willett – The HK and Baum–Connes conjectures

5:00–5:25 Georgios Tsikalas – Denjoy-Wolff points on the bidisc (IT 157)

5:00–5:25 Iason Moutzouris – When amenable groups have real rank zero C*-algebras? (IT 159)

5:30–5:55 Nicholas LaRacuente – Stability or fragility of quantum relative entropy (IT 157)

Sunday, October 1

9:00–9:30 ☕ Coffee

9:30–10:20 Constanze Liaw – Finite-rank perturbations and applications

10:30–11:20 Jorge Garza-Vargas – Spectra of periodic operators on universal covering trees

11:20–11:50 ☕ Coffee

11:50–12:15 Timur Akhunov – Hypoellipticity for degenerate elliptic equation (IT 157)

11:50–12:15 Forrest Glebe – Kazhdan's winding number argument and 2-homology (IT 159)

12:20–1:10 Matthew Wiersma – Traces on locally compact groups

Timur Akhunov – Hypoellipticity for degenerate elliptic equation.

Solutions to a Laplace equation are famously locally smooth. More quantitatively Laplace operator gains two derivates in L^2. A celebrated "Bracket condition" of Hörmander classifies a wide class of degenerate laplacians with a quantitative gain of fewer than two derivatives as well as excludes singularities. What happens in cases more degenerate than the Bracket condition allows? Are singularities possible?

Jorge Garza-Vargas – Spectra of periodic operators on universal covering trees.

Periodic operators on universal covering trees generalize discrete one-dimensional periodic Schrodinger operators, while retaining many of their fascinating spectral properties. On the other hand, periodic operators on universal covering trees govern the spectral behavior of large random lifts of finite graphs, which have been studied in the context of expanders. In fact, these operators are a random matrix limit and can be viewed as an operator-valued matrix with entries in the reduced C^*-algebra of the free group.

In this talk I will discuss recent results and open problems in this direction. I'll be talking about different joint works with Jess Banks, Jonathan Breuer, Archit Kulkarni, Satyaki Mukherjee, Eyal Seelig, and Barry Simon.

Forrest Glebe – Kazhdan's winding number argument and 2-homology.

In 1983 Voiculescu came up with an example of a sequence of pairs of unitary matrices that commute asymptotically in operator norm but remain far, in operator norm, from any commuting pair of unitaries. An elegant proof, called the "winding number argument," that these matrices are far from commuting matrices was developed by Kazhdan and independently by Excel and Loring. More generally, the argument may be used to show that a function that is "close" (in the point operator norm topology) is "far" from a genuine representation. In this talk, I explain how to reinterpret this argument as a pairing between an almost representation and 2-homology class of the group. I will explain how this interpretation has led to a systemic way of making almost representations that are far from genuine representations and showing that finitely generated nilpotent groups are stable in the Frobenius norm if and only if they are virtually cyclic.

Pradyut Karmakar – Fourier type convergence in groupoid C*-algebras.

In the group setting, Bedos and Conti have proved the following. Let Γ be a discrete group with approximation property acting on a compact Hausdorff topological space X, and let $C(X) \rtimes \Gamma$ be its reduced crossed product. If $a \in C(X) \rtimes \Gamma$ has Fourier series $a \sim \sum a_g u_g$, then $a \in \overline{\text{span}}\{a_g u_g : g \in \Gamma\}$.

Later, Brown, Exel, Fuller, Pitts, and Reznikoff have generalized it from groups to groupoids. They have shown that when the étale groupoid is amenable, any arbitrary element f in the reduced C^*-algebra of G can be approximated in the reduced norm by a net of compactly supported functions within the support of f. Recently, Fuller and Karmakar have generalized it further. Indeed, we have shown if an étale groupoid has rapid decay property with respect to a conditionally negative definite length function L, then any element f in the reduced C^*-algebra of G can be approximated in the reduced norm by a net of compactly supported functions within the support of f.

Nicholas LaRacuente – Stability or fragility of quantum relative entropy.

The quantum relative entropy between states on a von Neumann algebra arises from modular theory and has a combination of properties uniquely favored by physics and information. Neither the relative entropy nor its derivatives, however, are uniformly bounded. Tight, state-dependent, additive continuity bounds exist in the literature. In this talk, I focus alternatively on multiplicative continuity. I analyze in which situations one can (or cannot) bound changes in the ratio between relative entropies in terms of trace distance (in finite settings) and semidefinite order comparability between states. Includes joint work with Graeme Smith.

Constanze Liaw – Finite-rank perturbations and applications.

Self-adjoint finite-rank perturbations arise naturally, for example, when several boundary conditions of a differential operator are changed simultaneously. The resulting self-adjoint operators' spectral theory can be described via analytic function theory. This connection has been of interest to the community for some time. Recent advances have shown that (and at times how) their theory is more involved than that of rank one perturbations, beginning with the fact that matrix-valued analytic function theory is required to describe the full picture. We will highlight some key results for finite rank perturbations. Time-permitting, we will discuss applications to some Sturm-Liouville operators and sketch how merging of the theories of boundary triples with finite-rank perturbations provides a more holistic view of an operator's spectral information.

Iason Moutzouris – When amenable groups have real rank zero C*-algebras?

For every torsion free, discrete and amenable group G, the Kadison-Kaplansky conjecture has been verified, so $C^*(G)$ has no nontrivial projections. On the other hand, every torsion element $g \in G$, of order n, gives rise to a projection $\frac{1+g+\ldots+g^{n-1}}{n} \in C^*(G)$. Actually, if G is locally finite, then $C^*(G)$ is an AF-algebra, so it has an abundance of projections. So, it is natural to ask what happens when the group has both torsion and non-torsion elements. A result on this direction came from Scarparo, who showed that for every discrete, infinite, finitely generated elementary amenable group, $C^*(G)$ cannot have real rank zero. In this talk, we will explain why if G is discrete, amenable and $C^*(G)$ has real rank zero, then all elementary amenable normal subgroups with finite Hirsch length must be locally finite.

Michael Pilla – Linear fractional self-maps of the unit ball.

Determining the range of complex maps in several variables plays a fundamental role in the study of several complex variables and operator theory. In particular, one is often interested in determining when a given holomorphic function is a self-map of the unit ball. In this talk, we discuss a class of maps in $\mathbb{C}^N$ that generalize linear fractional maps. We then proceed to determine precisely when such a map is a self-map of the unit ball. We take a novel approach obtaining numerous new results about this class of maps along the way.

Jan Špakula – Some uniformly bounded boundary representations of hyperbolic groups.

We prove that some of the boundary representations of (Gromov) hyperbolic groups are uniformly bounded.

More concretely: 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 conformal dimension of Z. For $1/2 - 1/D < Re(z) < 1/2 + 1/D$, we construct function (Hilbert) spaces on the boundary on which π_z become uniformly bounded. This is joint work with Kevin Boucher.

Hui Tan – Rigidity results for group von Neumann algebras with diffuse center.

W*-rigidity of groups occurs when the group von Neumann algebra remembers the structure or certain properties of the group. We focus on

W*-rigidity of non-ICC groups and consider the direct product of an infinite abelian group and a group from a class of W*-superrigid wreath-like product groups. This gives the first examples of groups with infinite center recognizable from their von Neumann algebras, up to the center. This is joint work with Ionut Chifan and Adriana Fernandez I Quero.

Georgios Tsikalas – Denjoy-Wolff points on the bidisc.
Let f denote a holomorphic self-map of the unit disc $\mathbb{D}$ without any interior fixed points. A classical 1926 theorem of Denjoy and Wolff then asserts that the sequence of iterates $f^{[n]} := f \circ f \circ \cdots \circ f$ converges locally uniformly to a boundary fixed point of f, termed the *Denjoy-Wolff point*. The situation changes dramatically when one considers holomorphic fixed-point-free self-maps F of the bidisc $\mathbb{D}^2$; the presence of large "flat" boundary components in $\partial\mathbb{D}^2$ will, in general, prevent the iterates from converging. The cluster set of the sequence of iterates in this setting was described in a 1954 paper of Hervé.

In this talk, we will discuss extensions of the notion of a Denjoy-Wolff point to $\mathbb{D}^2$. Further, we will describe how imposing additional regularity assumptions on the behavior of the function F at such points can lead to much greater control over the behavior of the iterates. Certain refinements of Hervé's results will thus be obtained. This is joint work with Michael Jury.

Matthew Wiersma – Traces on locally compact groups.
We conduct a systematic study of traces on locally compact groups, in particular traces on their universal and reduced C*-algebras. We introduce the trace kernel, and examine its relation to the von Neumann kernel and to small-invariant neighbourhood (SIN) quotients. In doing so, we introduce the class of residually-SIN groups, which contains both SIN and maximally almost periodic groups. We examine in detail the trace kernel for connected groups. We study traces on reduced C*-algebras, giving a simple proof for compactly generated groups that existence of such a trace is equivalent to having an open normal amenable subgroup, and we display non-discrete groups admitting unique trace. We finish by examining amenable traces and the factorization property. We show for property (T) groups that amenable trace kernels coincide with von Neumann kernels. We show for totally disconnected groups that amenable trace separation implies the factorization property. We use amenable traces to give a simple proof that amenability of the group is equivalent to simultaneous nuclearity and possessing a trace of its reduced C*-algebra. As a final application of the results obtained in the paper, we address the embeddability of group C*-algebras into simple AF algebras. As a consequence, if a locally compact group is amenable and

tracially separated (trace kernel is trivial), then its reduced C*-algebra is quasi-diagonal.

This is based on joint work with B.E. Forrest and N. Spronk.

Rufus Willett – The HK and Baum-Connes conjectures.

Matui's HK conjecture posits an isomorphism between K-theory and homology. For example, for a group G acting on a totally disconnected space X, it says the K-theory of the crossed product C*-algebra should be isomorphic to the group homology of G with coefficients in the G-module of continuous, integer-valued functions on X.

The conjecture has been shown to be true in many interesting cases, but examples of Scarparo show that it can fail in the presence of torsion isotropy for the action, and counterexamples of Deeley show that it can fail in the presence of torsion subgroups in K-theory.

Using ideas of several people (mainly Baum, Connes, Schneider, and Raven), I will discuss what the conjecture 'should' say in the presence of torsion isotropy, and show that the new conjecture holds rationally for a large class of group actions (including all those giving rise to nuclear crossed products).

This is based on joint work with Robin Deeley. I will not assume that the audience knows about the HK or Baum-Connes conjectures, or the necessary homology theories, going into the talk.

Zhizhang Xie – A new index theorem for manifolds with singularities and its geometric applications.

In this talk, I present my joint work with Jinmin Wang and Guoliang Yu on a new index theory for manifolds with singularities (such as manifolds with corners and more generally for manifolds with polyhedral type boundary). Applications of this new index theory include a positive solution to Gromov's dihedral extremality/rigidity conjecture. This conjecture concerns comparisons of scalar curvature, mean curvature and dihedral angles for compact manifolds with polyhedral type boundary, and has very interesting implications in geometry and mathematical physics. Further developments of this new index theory have led us to a positive solution of Gromov's flat corner domination conjecture. As a consequence, we answered positively the Stoker conjecture (a long standing conjecture in discrete geometry since 1968).