Interactions between operator algebras and dynamical systems: Abstracts

The composition series of ideals in the partial-isometric crossed product by a semigroup of extendible endomorphisms

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Suppose (A, Γ^+, α) is a dynamical system consisting of a C^*-algebra A, a positive cone Γ^+ in a totally ordered abelian group Γ, and an action $\alpha : \Gamma^+ \to \mathrm{End}(A)$ by extendible endomorphisms of A. Let $A \times_\alpha^{\mathrm{piso}} \Gamma^+$ and $A \times_\alpha^{\mathrm{iso}} \Gamma^+$ be the partial isometric crossed product and the isometric crossed product of the system. If I is an extendible ideal of A, then $\mathcal{I} := I \times_\alpha^{\mathrm{piso}} \Gamma^+$ embeds naturally as an ideal of $A \times_\alpha^{\mathrm{piso}} \Gamma^+$ such that the quotient is the partial-isometric crossed product of the quotient algebra A/I. We consider a composition series of ideals in $A \times_\alpha^{\mathrm{piso}} \Gamma^+$ given by the two ideals $\mathcal{I}$ and $\ker \phi_A$ where $\phi_A : A \times_\alpha^{\mathrm{piso}} \Gamma^+ \to A \times_\alpha^{\mathrm{iso}} \Gamma^+$ is induced by the canonical isometric pair in $A \times_\alpha^{\mathrm{iso}} \Gamma^+$.

For a distinguished system $(A, \Gamma^+, \alpha) = (B_{\Gamma^+}, \Gamma^+, \tau)$ and $I = B_{\Gamma^+,\infty}$, we show that this composition series of ideals gives the structure theorem of $B_{\Gamma^+} \times_\tau^{\mathrm{piso}} \Gamma^+$ in Lindiarni-Raeburn. If $\Gamma^+ = \mathbb{N}$, then we can go further, describing the topology of the primitive ideal space of the algebra. This is joint work with Saeid Zahmatkesh

Classification of Cuntz-Krieger algebras and beyond

Sara Arklint
University of Copenhagen

Using results of Boyle-Huang on shifts of finite type, Restorff showed in 2003 that the purely infinite Cuntz-Krieger algebras are classified up to stable isomorphism by their reduced K-web or reduced filtered K-theory. In my talk, I will describe how one can, cannot, and perhaps can extend this classification result.

Crossed products and twisted k-graph algebras

Nathan Brownlowe
University of Wollongong

An automorphism of a k-graph induces an automorphism of the k-graph algebra whose crossed product is a $(k+1)$-graph algebra. We examine how this situation generalises in the setting of twisted k-graph algebras. This is joint work with Valentin Deaconu, Alex Kumjian and David Pask.

Graph C^*-algebras and orbit equivalence

Toke Meier Carlsen
Norwegian University of Science and Technology

Recently Matsumoto and Matui proved that if A and B are two irreducible square matrices with entries in $\{0, 1\}$, then the corresponding two-sided topological Markov shifts are flow equivalent if and only if there is an isomorphism between the stabilizations of the Cuntz-Krieger algebras of A and B which maps the canonical

maximal abelian subalgebra onto each other. An important ingredient of their proof of this result is a theorem of Matsumoto which says that there is an isomorphism between the Cuntz-Krieger algebras of A and B which maps the canonical maximal abelian subalgebra onto each other if and only if the one-sided topological Markov shifts corresponding to A and B are continuously orbit equivalent. In this talk, I will report on my attempt with Nathan Brownlowe and Michael Whittaker from the University of Wollongong to generalise the latter result to arbitrary graph algebras.

Purely infinite simple C^*-algebras associated to ample groupoids

Lisa Orloff Clark
University of Otago

An ample groupoid is an étale groupoid that has a basis of compact open sets. The class of C^*-algebras associated to ample groupoids is broad. In fact, in a recent paper, Exel and Pardo show that every purely infinite simple C^*-algebra (in UCT) is isomorphic to one associated to an ample groupoid. This leads to the question: can we find necessary and sufficient conditions on an ample groupoid that ensure the associated C^*-algebra is purely infinite simple? In this talk, I will discuss recent results that answer this question.

Pullbacks and correspondences for Smale spaces

Robin Deeley
Universite Blaise Pascal

We discuss joint work with Brady Killough and Michael Whittaker. This work centers around the functorial properties of the homology for Smale spaces introduced by Ian Putnam. In the case of a shift of finite type this homology theory is Krieger's dimension group; this case will be discussed in detail.

The fundamental object of study are correspondences between Smale spaces; the precise definition will be given in the talk. However, the idea is to encode both types of functorial properties of Smale spaces (with respect to Putnam's homology theory) into a single object. No knowledge of Smale spaces or Putnam's homology is required for the talk.

Classification problems for shift spaces and their C^*-algebras

Søren Eilers
University of Copenhagen

It was discovered already in the 1970's that the classification theory for dynamical systems over zero-dimensional spaces is closely related to the classification theory for C^*-algebras, and that a rich transport of ideas and methods is possible. The notion that these problems can be studied in tandem have lead to a lot of insight since, a recent culmination being the results of Matsumoto and Matui explaining precisely which relation of C^*-algebras associated to shifts of finite type translates the concept of flow equivalence.

There is a lot of beautiful material to draw from, and I will try to provide examples of key ideas and notions without drowning in technicalities. A tentative plan is

Lecture one: Coarse classification problems for shift spaces Flow equivalence: Definition both via suspension flows and the Parry-Sullivan theorem. Franks' theorem, the Bowen-Franks invariant. Orbit and strong orbit equivalence of minimal systems, dimension groups. Sturmian shifts.

Lecture two: C^*-algebras associated to shift spaces and their classification Crossed products, Cuntz-Krieger algebras, Matsumoto algebras. The Cuntz splice. Classification theory NTK, including K-theory. RÃ¸rdam's classification of Cuntz-Krieger algebras. Classification of crossed products.

Lecture three: The Matsumoto-Matui theorem MASAs. One-sided versus two-sided orbit equivalence.

Lecture four: Perspectives Further classes of shift spaces and their C^*-algebras: sofic shifts, beta-shifts, substitutional systems. Graph C^*-algebras and their geometric classification.

Transfer operators and dynamics

Gary Froyland
University of New South Wales

Transfer operators provide a global description of dynamics and carry information that is difficult to extract by trajectory simulation. We describe theory and numerical methods for analysing finite-dimensional chaotic dynamical sytems, and applications in the natural and physical sciences.

Two stability results for non-autonomous dynamical systems

Cecilia Gonzalez-Tokman
University of New South Wales

Stability properties of dynamical systems are of fundamental interest to applied scientists, because models are imperfect representations of reality. In this talk, we will discuss recent stability results which are relevant for the study of transport phenomena in non-autonomous dynamical systems. They cover perturbations arising from numerical approximation schemes and random noise. The first result concerns stability of non-autonomous counterparts of stationary distributions or physical invariant measures — so-called random acims (absolutely continuous invariant measures) — in the context of piecewise expanding interval maps. The second one concerns stochastic stability of Oseledets splittings and Lyapunov exponents for semi-invertible matrix cocycles. (Joint work with Gary Froyland and Anthony Quas.)

Analysing slow-fast systems using spectral properties

Andy Hammerlindl
University of Sydney and *University of New South Wales*

Multiscale or "slow-fast" dynamical systems exhibit different behaviours at different time scales. This talk will show how numerical techniques involving the Perron-Frobenius and Koopman operators and their spectra can be used to test for the presence of slow-fast behaviour and to analyse both the slow and fast dynamics in isolation.

KMS states on C^*-algebras associated to local homeomorphisms

Astrid an Huef
University of Otago

For every Hilbert bimodule over a C^*-algebra, there are natural gauge actions of the circle on the associated Toeplitz algebra and Cuntz-Pimsner algebra, and hence natural dynamics obtained by lifting these gauge actions to actions of the real numbers. I will talk about the KMS states of these dynamics for a family of bimodules associated to local homeomorphisms on compact spaces. This work is joint with Zahra Afsar and Iain Raeburn, and will appear in the International Journal of Mathematics.

Dynamical systems

Douglas Lind
University of Washington

Lecture 1: Shifts of finite type, conjugacy problem, invariants (but not flow stuff, so hopefully this would lay the groundwork for Soren's talks), entropy, Perron numbers and their arithmetic. I want to include the Kim-Ormes-Roush result completely characterizing the nonzero spectrum of a primitive matrix.

Lecture 2: $\mathbb{Z}^d$ shifts of finite type, entropy, the "swamp of undecidability", Hochman and Meyervich's characterization of possible entropies, expansive subdynamics for $\mathbb{Z}^d$-actions.

Lecture 3: Algebraic dynamics, actions of one or several commuting automorphisms of a compact abelian group. Connections with commutative algebra and algebraic geometry, the dynamics/algebra dictionary, characterizations of ergodicity, expansiveness, and entropy, Mahler measure, and the expansive subdynamics of algebraic actions using amoebas.

Lecture 4: Algebraic actions of noncommutative groups like the discrete Heisenberg group, connections with von Neumann algebras (e.g. recent work of Deninger, Li, Schmidt, me, etc). Noncommutative Mahler measure and connections with the Fuglede-Kadison determinant of a related operator, expansiveness.

The critical dimension for G-measures

Daniel Mansfield
University of New South Wales

The critical dimension of an ergodic non-singular dynamical system is the asymptotic growth rate of sums of consecutive Radon-Nikodym derivatives. This has been shown to equal the average coordinate entropy for product odometers with a uniform bound on the size of the coordinate spaces. We extend this result to G-measures with an asymptotic bound on the size of the coordinate spaces. Furthermore, while the Krieger type is not an invariant property on the class of ergodic G-measures; we show that the critical dimension is.

Flow equivalence and graph C^*-algebras

David Pask

University of Wollongong

Shifts of finite type are, up to conjugacy, the edge shifts of directed graphs. The relations defining a graph C^*-algebra encode the connectivity of a directed graph in terms of operators on a Hilbert space. Closer examination of the structure of a graph C^*-algebra reveals deep connections between its internal properties and the dynamical properties of the associated shift of finite type. The first part of the talk will be an introduction to graph C^*-algebras.

It has been known for some time now that flow equivalence on shifts of finite type are related to certain graphical contructions, called splittings and delays, on the underlying directed graph. In the second part of this talk we will examine how the operations of splittings and delays affect the associated graph C^*-algebras. This is joint work with Teresa Bates.

Zappa-Szép product semigroups and associated C^*-algebras

David Robertson
University of Wollongong

Zappa-Szép products of semigroups encompass both the self-similar group actions of Nekrashevych and the quasi-lattice-ordered groups of Nica. We use Li's construction of semigroup C^*-algebras to associate a C^*-algebra to a Zappa-Szép product semigroup and give an explicit presentation of the algebra. There is also a boundary quotient C^*-algebra that generalises the Cuntz-Pimsner algebras for self-similar actions. I will indicate how known examples, previously viewed as distinct classes, fit into this unifying framework. I will specifically discuss the Baumslag-Solitar semigroups, the binary adding machine and the affine semigroup over the natural numbers. This is joint work with Nathan Brownlowe, Jacqui Ramagge and Mike Whittaker.

Graphs, dynamics and C^*-algebras

Aidan Sims
University of Wollongong

Directed graphs are amongst the simplest and most easily manipulated of combinatorial objects, which makes them very useful as models for other more complicated mathematical structures. I will give an introductory discussion of the roles that directed graphs play in the theory of symbolic dynamics and in the theory of C^*-algebras, and outline some of the connections between the two areas that have arisen from the study of graph-based examples.