Noncommutative L_p-spaces, Operator spaces and Applications

June 27 - July 2, 2010

MEALS

*Breakfast (Buffet): 7:00 - 9:00, Sally Borden Building, Monday-Friday
*Lunch (Buffet): 12:00 - 14:00, Sally Borden Building, Monday-Friday
*Dinner (Buffet): 17:30 - 19:30, Sally Borden Building, Sunday-Thursday
***Please remember to scan your meal card at the host/hostess station in the dining room for each meal.**

MEETING ROOMS

All lectures will be held in Max Bell 159 (Max Bell Building accessible by walkway on 2nd floor of Corbett Hall). LCD projector, overhead projectors and blackboards are available for presentations. Further meeting space designated for BIRS is the lower level of Max Bell, Rooms 155-159. All other space has been contracted to other Banff Centre guests.

SCHEDULE

Sunday

16:00 Check-in begins (Front Desk - Professional Development Centre - open 24 hours)

17:30 - 19:30 Buffet Dinner, Sally Borden Building

20:00 Informal gathering in 2nd floor lounge, Corbett Hall (if desired)
Beverages and a small assortment of snacks are available on a cash honor system.

Monday

8:45 - 9:00 Introduction and Welcome by BIRS Station Manager, Max Bell 159

9:00 - 9:45 **Uffe Haagerup** (University of Southern Denmark):
Herz-Schur multipliers and spherical functions on groups and trees

9:55 - 10:20 **Coffee break**

10:20 - 11:05 **Javier Parcet** (Instituto de Ciencias Matematicas; Madrid):
A Hörmander type multiplier theorem for arbitrary discrete groups

11:15 - 12:00 **Tao Mei** (University of Illinois at Urbana-Champaign):
BMO spaces associated with semigroups of completely positive operators

13:20 - 13:55 **Guided Tour of The Banff Centre**: meet in the 2nd floor lounge, Corbett Hall

14:00 - 14:30 **Stephen Avsec** (University of Illinois at Urbana-Champaign):
A new example of a "good" noncommutative semigroup

14:40 - 15:10 **Coffee break**

15:10 - 15:40 **Mathilde Perrin** (Université de Franche-Comté):
H_p theory for continuous filtrations

15:10 - 16:20 **Hun Hee Lee** (Chungbuk National University):
Hypercontractivity on the q-Araki-Woods algebras

16:30 - 17:30 **Stanislaw Szarek** (Université de Paris):
The interface between quantum information theory and functional analysis.
Additivity conjectures and Dvoretzky's theorem

Tuesday

9:00 - 9:45 **David Kribs** (University of Guelph):
A family of norms with applications in quantum information theory

9:55 - 10:20 **Coffee break**

10:20 - 11:05 **Peter Shor** (MIT):
TBA

11:15 - 12:00 **Andreas Winter** (University of Bristol):
Zero-error communication via quantum channels, non-commutative graphs and a quantum Lovasz theta function

13:50 - 14:00 **Group Photo**: meet on the front steps of Corbett Hall

14:00 - 14:40 **Carlos Palazuelos** (Universidad Complutense de Madrid):
Violation of Bell inequalities via operator spaces

14:50 - 15:20 **Coffee break**

15:20 - 15:50 **Volkher Scholz** (Leibniz University of Hannover):
TBA

16:00 - 16:40 **Fedor Sukochev** (University of NSW):
Spectral shift of higher order, I

16:50 - 17:20 **Denis Potapov** (University of NSW):
Spectral shift of higher order, II

Wednesday

9:00 - 9:45 **Andreas Thom** (University of Leipzig):
Finite-dimensional approximation properties of groups and tracial algebras

9:55 - 10:20 **Coffee break**

10:20 - 11:05 **Eric Ricard** (Université de Franche-Comté):
Completely bounded radial multipliers on the free Araki-Woods algebras and applications.

11:15 - 12:00 **Eric Carlen** (Rutgers University):
Remarks on Lieb-Robinson bounds and operator inequalities

Thursday

9:00 - 9:45 **Magdalena Musat** (University of Copenhagen):
Factorization and dilation problems for completely positive maps on von Neumann algebras

9:55 - 10:20 **Coffee break**

10:20 - 11:05 **Benoît Collins** (University of Ottawa):
Random matrices and random quantum channels

11:15 - 12:00 **Christopher King** (Northeastern University):
Some remarks on matrix norms for bipartite spaces

14:00 - 14:40 **Zhong-Jin Ruan** (University of Illinois at Urbana-Champaign):
Completely bounded multipliers of locally compact quantum groups

14:50 - 15:20 **Coffee break**

15:30 - 16:00 **Tom Cooney** (University of Illinois at Urbana-Champaign):
Fourier multipliers acting on noncommutative L_p-spaces

16:00 - 16:30 **Yoann Dabrowski** (UCLA):
A non-commutative path space approach to stationary solutions of free SDEs

16:40 - 17:10 **Kate Juschenko** (Texas A & M University):
Logmodular subalgebras of C*-algebras

20:00 - 20:40 **Problem session**

Friday

9:00 - 9:45 **Vern Paulsen** (University of Houston):
Tensor products of Operator Systems

9:55 - 10:20 **Coffee break**

10:20 - 11:05 **David Blecher** (University of Houston):
Noncommutive function theory and HSAs

11:15 - 12:00 **Marek Bożejko** (University of Wroclaw):
Completely bounded multipliers and lacunary sets on discrete groups with applications to noncommutative probability

ABSTRACTS

- **Stephen Avsec**: A new example of a "good" noncommutative semigroup

  Abstract: Varopoulos called a semigroup "good" if its corresponding BMO space is complimented in a corresponding martingale BMO space. In this talk, we shall provide some new, noncommuatative examples of semigroups which are good derived from the classical theory.

- **David Blecher**: Noncommutive function theory and HSAs

  Abstract: We discuss new developments in noncommutative function theory. What we mean by this is the noncommutative version, involving operator algebras on Hilbert space, of function theory relative to an algebra of functions. We also discuss the accompanying theory of HSAs.

- **Marek Bożejko**: Completely bounded multipliers and lacunary sets on discrete groups with applications to noncommutative probability

  Abstract: We will consider the following subjects:

  1) New examples of positive definite functions on Coxeter and free groups - radial length functions and Riesz-Coxeter products.
  2) Generalization of Banach theorem on existence of lacunary $\Lambda(p)$ systems in finite von Neumann algebras.
  3) Completely bounded Sidon sets and amenability of discrete groups.
  4) New factors arising from deformations of Coxeter groups of type B.

- **Eric Carlen**: Remarks on Lieb-Robinson bounds and operator inequalities

  Abstract: Lieb-Robinson bounds were first proved in the 70's to establish the existence of dynamics for infinite dimensional quantum statistical mechanical systems. They have since turned out to have a great many applications, some to questions in operator theory, including Hasting's quantitative version of Lin's Theorem on the almost commuting-nearly commuting problem. In this talk I will explain the context, several open problems, and discuss work in progress toward the resolution of some of these.

- **Benoît Collins**: Random matrices and random quantum channels

  Abstract: In this talk I will describe how random matrix theory and free probability theory (and in particular, results of Haagerup and Thorbjornsen) can give insight into the problem of understanding all possible eigenvalues of the output of important classes of random quantum channels. I will also describe applications to the minimum output entropy additivity problems.

- **Tom Cooney**: Fourier multipliers acting on noncommutative L_p-spaces

  Abstract: If G is a locally compact group, then $L_1(G)$ acts by convolution on $L_p(G)$. We also have that the Fourier algebra $A(G)$ acts on $L_p(VN(G))$, the noncommutative L_p-space associated with the group von Neumann algebra. We show that these two examples can be treated simultaneously when viewed as multipliers of Kac algebras acting on noncommutative L_p-spaces.

- **Yoann Dabrowski**: A non-commutative path space approach to stationary solutions of free SDEs

  Abstract: By defining tracial states on a non-commutative analog of a path space, we construct Markov dilations of certain conservative completely Markov semigroups on finite von Neumann algebras. Our construction applies for semigroups which exponentiate generators of (non-symmetric) Dirichlet forms for which the non-symmetric part is a derivation (this of course includes the symmetric case).

  For well chosen semigroups those dilations give rise to stationary solutions of certain free SDEs previously considered by D. Shlyakhtenko.

  We also briefly explain two applications : a non-commutative Talagrand's inequality for non-microstate free entropy and the combination of our dilation results with techniques of Popa-Ozawa and Peterson giving the proof that any finitely generated group with CMAP and positive first L^2 betti number has no Cartan subalgebras.

- **Uffe Haagerup**: Herz-Schur multipliers and spherical functions on groups and trees

  Abstract: In order to establish the CBAP for the reduced C*-algebra of discrete subgroups of $SO(n,1)$, $SU(n,1)$ and $Sp(n,1)$ back in the 80'es J. DeCanniere, M. Cowling and the lecturer had to obtain good estimates for the Herz-Schur norm (i.e. the completely bounded Fourier multiplier norm) of the sperical functions on these groups. Recently T. Steenstrup computed the exact values of the Herz-Schurs norm of the spherical functions on $SO(n,1)$ and in collaboration with T. Steenstrup and R. Szwarc (Wroclaw) we have found closed expressions for the Herz-Schur multiplier norm of the spherical functions on free groups and other groups acting on homogeneous trees, eg. the p-adic groups $PSL(2,Q_p)$. In the lecture we will give a survey on these results and also comment on a related recent result with S. Mller (Odense) about estimating the cb-norm of "radial" maps on general reduced free products of C*-algebras.

- **Kate Juschenko**: Logmodular subalgebras of C*-algebras

  Abstract: We will discuss logmodularity property of (non self-adjoint) subalgebras of C*-algebras. The property is interesting in a connection with the problem of extension of homomorphism. It was proved by V. Paulsen and M. Raghupathi that a contractive homomorphism of a logmodular algebra is completely contractive if and only if its second amplification is contractive. There are no known examples of logmodular algebras with contractive but not completely contractive homomorphisms. We will describe logmodular subalgebras of matrix algebras, which would imply that that every contractive homomorphism of them is automatically completely contractive.

- **Christopher King**: Some remarks on matrix norms for bipartite spaces

  Abstract: We review the non-commutative versions of the classical $L^q(L^p)$ norm on the product matrix algebras $\mathcal{M}_n \otimes \mathcal{M}_m$. One of these versions arose from the work of Carlen and Lieb on convex functions on matrix spaces, and we present an overview of these ideas. The other version was defined by Pisier and others using results from the theory of operator spaces. Some examples are given to illustrate the inequivalence of the norms.

- **David Kribs**: A family of norms with applications in quantum information theory

  Abstract: I will discuss recent work with Nathaniel Johnston in which we consider a family of operator norms that quantify the degree of entanglement in quantum states. The norms are defined by the Schmidt decomposition theorem for quantum states, and they can be used to tackle two fundamental problems in quantum information theory: the classification problem for k-positive linear maps and entanglement witnesses, and the existence problem for non-positive partial transpose bound entangled states. Time dependent, I'll discuss some properties of the norms and their applications.

- **Hun Hee Lee**: Hypercontractivity on the q-Araki-Woods algebras

  Abstract: Extending a work of Carlen and Lieb, Biane has obtained the optimal hypercontractivity of the q-Ornstein-Uhlenbeck semigroup on the q-deformation of the free group algebra. In this note, we look for an extension of this result to the type III situation, that is for the q-Araki-Woods algebras. We show that hypercontractivity from L^p to L^2 can occur if and only if the generator of the deformation is bounded.

- **Tao Mei**: BMO spaces associated with semigroups of completely positive operators

  Abstract: I will introduce our recent work on BMO (= Bounded Mean Oscillation) spaces associated with semigroups of operators on von Neumann algebras. A motivation of our research is to understand the boundedness of fourier multipliers on noncommutative L_p spaces. The talk is based on joint works with S. Avsec, M. Junge and J. Parcet.

  Given a semigroup of selfadjoint, (completely) positive operators (T_t) on a von Neumann algebra $\mathcal{M}$, one may define a BMO seminorm as

  $$\|x\|_{BMO_c} = \sup_t \|T_t|x - T_t x|^2\|^{\frac{1}{2}},$$

  for $x \in \mathcal{M}$. We study the associated BMO space and apply the result to the boundedness of associated fourier multipliers. A particular example of such multipliers is the imaginary powers A^{is}, where A is the infinitesimal generator of $(T_t)_t$, $s \in \mathbb{R}$. Assume (T_t) admits a Markov dilation, we prove an interpolation result so that the associated BMO space serves as an end point of the noncommutative L_p spaces associated with $\mathcal{M}$. If time permitted, I will also talk on an analogue of Stein-Fefferman's $H_1 - BMO$ duality in this setting.

- **Magdalena Musat**: Factorization and dilation problems for completely positive maps on von Neumann algebras

  Abstract: We study factorization and dilation properties for completely positive unital, trace-preserving maps (for short, c.p.u.t. maps) on von Neumann algebras. The starting point for our work has been the question of existence of non-factorizable Markov maps, as formulated by Anantharaman-Delaroche in 2004. We provide simple examples of non-factorizable c.p.u.t. maps on the $n \times n$ matrices for $n \geq 3$, as well as an example of a one-parameter semigroup $(T_t)_{t\geq 0}$ of c.p.u.t. maps on the 4×4 matrices such that T_t fails to be factorizable for all small values of $t > 0$. This work has revealed nice applications to finding estimates for the best constant in the noncommutative little Grothendieck inequality. Also, by using these techniques we have very recently solved an open question concerning an asymptotic version of the quantum Birkhoff conjecture. Joint work with Uffe Haagerup.

- **Carlos Palazuelos**: Violation of Bell inequalities via operator spaces

  Abstract: In this talk we will explain how Operator Space Theory provides a natural framework for the study of Bell inequalities. We will illustrate the power of this connection by showing new results about unbounded violations of Bell inequalities, the maximally entangled state and relaxations for the problem of computing the classical and the quantum value of Bell inequalities.

- **Javier Parcet**: A Hörmander type multiplier theorem for arbitrary discrete groups

  Abstract: Given a discrete group G, consider a Fourier multiplier

  $$T_m : \sum_{g\in \mathrm{G}} \widehat{f}(g)\lambda(g) \mapsto \sum_{g\in \mathrm{G}} m(g)\widehat{f}(g)\lambda(g).$$

If $\mathcal{L}_p(\mathrm{G})$ denotes the standard L_p space over its group von Neumann algebra, it is a classical problem to determine sufficient conditions for the boundedness of T_m on $\mathcal{L}_p(\mathrm{G})$. Hörmander smoothness condition

$$\left|\partial_\xi^\beta \widetilde{m}(\xi)\right| \lesssim |\xi|^{-|\beta|} \quad \text{for all multi-indices} \quad |\beta| \leq \left[\frac{n}{2}\right] + 1$$

applies when $\mathrm{G} = \mathbb{Z}^n$ and $\widetilde{m} : \mathbb{R}^n \to \mathbb{C}$ is a *lifting multiplier* for m, a smooth function whose restriction to $\mathbb{Z}^n$ coincides with m. In the general case there is no canonical differential structure to work with and no sufficient differentiability conditions are known for the L_p-boundedness of T_m. Our main result generalizes Hörmander's multiplier theorem to this setting. Our approach is based on an abstract formulation of Calderón-Zygmun theory valid for von Neumann algebras which we will briefly introduce if time permits. (Joint work with M. Junge and T. Mei)

- **Vern Paulsen**: Tensor products of Operator Systems

  Abstract: We outline the theory of tensor products of operator systems. There are many parallels with the theory of tensor products of operator spaces, but there are also some surprises. For example there exist operator systems that are not completely order isomorphic to any C*-algebra, yet have the property that their minimal and maximal operator system tensor product with any C*-algebra are the same. We obtain an operator system tensor product equivalence of Kirchberg's conjecture.

- **Mathilde Perrin**: H_p theory for continuous filtrations

  Abstract: The theory of stochastic integrals and the theory of martingales with continuous parameter are well-developed in the commutative case, and in the noncommutative setting quantum stochastic calculus is now also well-known. The aim of the work (joint with Marius Junge) presented in this talk is to study martingales with respect to continuous filtrations in the general setting of von Neumann algebras. The long term goal is to develop a satisfactory theory of stochastic integrals in von Neumann algebras. Since in this noncommutative setting we can not define the stochastic integrals pathwise, the first step is to focus on the variation bracket $[x, x]$ and to study H_p spaces.

  In this talk, we will point out the difficulties encountered in this study. The main problem is to find a good definition of H_p spaces. On the one hand, we have a potential candidate for the bracket, considering a weak*-limit of the discrete brackets over an ultrafilter on the set of finite partitions. On the other hand, in order to deduce results from the well-known discrete case, it is also natural to consider the limit of the discrete norms. Our main result states that these two norms actually coincide, and are independent of the choice of the ultrafilter. We also establish the continuous analog of the Burkholder-Gundy inequalities and Feffermann-Stein duality. The key trick in this work is to consider the diagonal spaces h_p^d and the conditioned spaces h_p^c, which are more practical to work with. Since we can describe H_p^c spaces with these spaces by the conditioned Davis' decomposition

  $$H_p^c = \begin{cases} h_p^d + h_p^c & \text{if } 1 \leq p \leq 2 \\ h_p^d \cup h_p^c & \text{if } 2 \leq p < \infty \end{cases},$$

  we get results for H_p^c from the study of h_p^d and h_p^c.

- **Denis Potapov**: Spectral shift of higher order, II

  Abstract: The talk continues the presentation of F. Sukochev. It gives some details of the recently proved result that the spectral shift of higher order is summable. The talk is based on the joint work with F. Sukochev and A. Skripka.

- **Eric Ricard**: Completely bounded radial multipliers on the free Araki-Woods algebras and applications

  Abstract: Haagerup and Szwarc gave a characterization of completely bounded radial multipliers on free groups. We show a similar result for another type of multipliers on the free Araki-Woods algebras. We also prove that the latter have the completely contractive approximation property.

- **Zhong-Jin Ruan**: Completely bounded multipliers of locally compact quantum groups

  Abstract: Multipliers and completely bounded multipliers have played very important role in harmonic analysis. In this talk, I will discuss recent results on completely bounded multipliers of a locally compact quantum group. I will also show some applications, and related approximation properties. If time is available, I will also explain the possible extension of these multipliers to noncommutative L_p spaces associated with the quantum groups.

- **Volkher Scholz**:

  Abstract:

- **Peter Shor**:

  Abstract:

- **Fyodor Sukochev**: Spectral shift of higher order, I

  Abstract: It was recently proved that every Lipschitz function is operator-Lipschitz with respect to the Schatten classes S^p with $1 < p < \infty$. The talk will discuss the connection of the result above with the spectral shift function of higher order. In particular, it will show that every spectral shift function of higher order is summable.

- **Stanislaw Szarek**: The interface between quantum information theory and functional analysis. Additivity conjectures and Dvoretzky's theorem

  Abstract: The talk will consist of two parts. In the first part we will go over some of the paradigms, concepts and notation that are encountered in quantum information theory, mostly employing the functional analytic/geometric point of view. This part is directed to non-specialists. In the second part we will indicate how the recent work of Hayden-Winter and Hastings' on the additivity conjectures for the minimal output p-Renyi and von Neumann entropy can be simplified (at least conceptually) by appealing to Dvoretzky's theorem on almost spherical sections of convex bodies. The second part is based on joint work with G. Aubrun and E. Werner (arxiv:0910.1189 and 1003.4925).

- **Andreas Thom**: Finite-dimensional approximation properties of groups and tracial algebras

  Abstract: This talk is about various approximation properties a discrete group (or more generally a tracial algebra) can have or fail to have. All notions will be motivated and explained in detail. We give an example of a group which is locally embeddable into finite groups (in particular sofic and hence hyperlinear) but does not have Kirchberg's factorization property. This group provides also an example of a sofic Kazhdan group which is not residually finite, answering a question of Elek and Szabo. I will point out a mistake in an assertion of Kirchberg and provide an example of a group which does not have the factorization property and is still a subgroup of a connected finite-dimensional Lie group. Finally, I will comment on recent work (joint with Tim Netzer) which provided a proof of an analogue of the Connes Embedding Problem in a setting of algebras with traces, which are not necessarily bounded.

- **Andreas Winter**: Zero-error communication via quantum channels, non-commutative graphs and a quantum Lovasz theta function

  Abstract: We study the quantum channel version of Shannon's zero-error capacity problem. Motivated by recent progress on this question, we propose to consider a certain operator space as the quantum generalisation of the adjacency matrix, in terms of which the plain, quantum and entanglement-assisted capacity can be formulated, and for which we show some new basic properties. Most importantly, we define a quantum version of Lovasz' famous theta function, as the norm-completion (or stabilisation) of a "naive" generalisation of theta. We go on to show that this function upper bounds the number of entanglement-assisted zero-error messages, that it is given by a semidefinite programme, whose dual we write down explicitly, and that it is multiplicative with respect to the natural (strong) graph product. We explore various other properties of the new quantity, which reduces to Lovasz' original theta in the classical case, give several applications, and propose to study the operator spaces associated to channels as "non-commutative graphs", using the language of Hilbert modules. This is a joint work with S Severini and R Duan (arXiv:1002.2514).