



Banff International Research Station

for Mathematical Innovation and Discovery

Topics in von Neumann algebras, 2008

March 23-28, 2008

MEALS

*Breakfast (Buffet): 7:00–9:30 am, Sally Borden Building, Monday–Friday

*Lunch (Buffet): 11:30 am–1:30 pm, Sally Borden Building, Monday–Friday

*Dinner (Buffet): 5:30–7:30 pm, Sally Borden Building, Sunday–Thursday

Coffee Breaks: As per daily schedule, 2nd floor lounge, Corbett Hall

*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. Please note that the meeting space designated for BIRS is the lower level of Max Bell, Rooms 155–159. Please respect that all other space has been contracted to other Banff Centre guests, including any Food and Beverage in those areas.

SCHEDULE

Sunday

- 16:00** Check-in begins (Front Desk - Professional Development Centre - open 24 hours)
Lecture rooms available after 16:00 (if desired)
- 17:30–19:30** Buffet Dinner, Sally Borden Building
- 20:00** Informal gathering in 2nd floor lounge, Corbett Hall (if desired)
Beverages and small assortment of snacks available on a cash honour-system.

Monday

- 7:00–8:45** Breakfast
- 8:45–9:00** Introduction and Welcome to BIRS by BIRS Station Manager, Max Bell 159
- 9:00–9:50** Narutaka Ozawa: *On a class of II_1 factors with at most one Cartan subalgebra, II*
- 10:00–10:30** Coffee Break, 2nd floor lounge, Corbett Hall
- 10:30–11:20** Jesse Peterson: *von Neumann subalgebras closed under (Γ) -extensions*
- 11:30–12:20** Adrian Ioana: *On the subequivalence relations induced by a Bernoulli action*
- 12:30–13:30** Lunch
- 15:00–15:30** Jason Asher: *A Kurosh-Type Theorem for Type III Factors*
- 15:30–16:00** Coffee Break, 2nd floor lounge, Corbett Hall
- 16:00–16:50** Zhenghan Wang: *Topological phases of matter: classification and application*
- 17:00–17:50** Eric Rowell: *Topological quantum computers: when universality fails*
- 18:00–19:30** Dinner

Tuesday

7:00–9:00 Breakfast

9:00–9:50 Roman Sauer: *l^1 -orbit equivalence rigidity for hyperbolic lattices*

10:00–10:30 Mikael Pichot: *On the Wise group*

10:30–11:00 Coffee Break, 2nd floor lounge, Corbett Hall

11:00–11:50 Cyril Houdayer: *Another construction of II_1 factors with prescribed countable fundamental group*

12:00–13:30 Lunch

13:30–14:20 Guided Tour of The Banff Centre; meet in the 2nd floor lounge, Corbett Hall

14:20–14:30 Group Photo; meet on the front steps of Corbett Hall

14:30–15:20 Dietmar Bisch: *The planar algebra of group-type subfactors*

15:30–16:00 Coffee Break, 2nd floor lounge, Corbett Hall

16:00–16:30 Roman Sasyk: *On the (non)classification of factors*

16:35–17:25 Pinhas Grossman : *Pairs of Intermediate Subfactors*

17:35–19:30 Dinner

Wednesday

7:00–9:00 Breakfast

9:00–9:50 Uffe Haagerup: *Solution of the Effros-Ruan conjecture for bilinear forms on C^* -algebras*

10:00–10:30 Coffee Break, 2nd floor lounge, Corbett Hall

10:30–11:20 Ken Dykema: *Connes's embedding problem and Horn's inequalities*

11:30–12:20 Stefaan Vaes: *An action of the free group F_∞ whose orbit equivalence relation has no outer automorphisms*

12:30–13:30 Lunch

Free afternoon

Thursday

7:00–9:00 Breakfast

9:00–9:50 Roberto Longo: *SUSY in the Conformal World*

10:00–10:30 Coffee Break, 2nd floor lounge, Corbett Hall

10:30–11:20 Feng Xu: *An application of mirror extension*

11:30–12:00 Richard Burstein: *Subfactors Obtained from Hadamard Matrices*

12:05–13:30 Lunch

14:30–15:20 Yasuyuki Kawahigashi: *Super moonshine and operator algebras*

15:30–16:00 Coffee Break, 2nd floor lounge, Corbett Hall

16:00–16:30 V.S. Sunder: *Non-crossing partition \simeq 2-cabled Temperley-Lieb*

16:40–17:30 Marta Asaeda: *Non-existence of finite depth subfactors with certain small indices*

17:40–19:30 Dinner

Friday

7:00–9:30 Breakfast

9:30–10:20 Narutaka Ozawa

10:30–11:00 Coffee Break, 2nd floor lounge, Corbett Hall

12:00–13:30 Lunch

Checkout by 12 noon.

** 5-day workshops are welcome to use the BIRS facilities (2nd Floor Lounge, Max Bell Meeting Rooms, Reading Room) until 3 pm on Friday, although participants are still required to checkout of the guest rooms by 12 noon. **



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ABSTRACTS

(in alphabetic order by speaker surname)

Speaker: **Marta Asaeda** (University of California, Riverside)

Title: *Non-existence of finite depth subfactors with certain small indices*

Abstract: (With S.Yasuda.) In 1991 Haagerup gave the list of graphs as candidates of principal graphs of subfactors with indices within $(4, 3 + \sqrt{3})$. We prove that one of the parametrized series of the graphs are not realized as principal graphs except for the first two, using algebraic number theory.

Speaker: **Jason Asher** (University of California, Los Angeles)

Title: *A Kurosh-Type Theorem for Type III Factors*

Abstract: We will present an extension of the Kurosh-Type Theorem of N. Ozawa to the case of the reduced free product of II_1 factors with non-tracial states. The argument will proceed via a generalization of S. Popa's intertwining-by-bimodules technique.

Speaker: **Dietmar Bisch** (Vanderbilt University)

Title: *The planar algebra of group-type subfactors*

Abstract: Haagerup and I introduced some 10 years ago a class of subfactors associated to outer actions of two finite groups. These subfactors play an important role in the theory, since they provide a very simple mechanism to construct irreducible subfactors whose standard invariant has infinite depth. We will review this construction and describe the planar algebra of these subfactors. We obtain natural IRF models in this way. This is joint work with Paramita Das and Shamindra Ghosh.

Speaker: **Richard Burstein** (University of California, Berkeley)

Title: *Subfactors Obtained from Hadamard Matrices*

Abstract: A subfactor may be obtained from a commuting square via iteration of the basic construction. For certain commuting squares coming from Hadamard matrices, the resulting subfactor may be described using the group construction of Bisch and Haagerup. We will show how this description allows us to find the principal graphs of these subfactors, and how it may lead to a full classification up to subfactor isomorphism.

Speaker: **Ken Dykema** (Texas A&M University)

Title: *Connes's embedding problem and Horn's inequalities*

Abstract: Connes's embedding problem asks whether every separable II_1 -factor can be embedded in the ultrapower of the hyperfinite II_1 -factor; this is equivalent to asking whether every finite set in every II_1 -factor has microstates. Bercovici and Li have related this to a question concerning the possible spectral distributions of $a + b$, where a and b are self-adjoint elements in a II_1 -factor having given spectral distributions. We show that Connes' embedding problem is equivalent to a version of this spectral distribution question with matrix coefficients.

Speaker: **Pinhas Grossman** (Vanderbilt University)

Title: *Pairs of Intermediate Subfactors*

Abstract: An intermediate subfactor is an algebra P in between two factors: $N \subset P \subset M$, where $N \subset M$ is an irreducible inclusion of factors with finite Jones index. For non-commuting pairs of intermediate subfactors, there is a rigidity to the inclusions which severely limits the number of possible configurations, in terms of the indices and the standard invariant. In particular, there are exactly seven non-commuting, irreducible quadrilaterals of factors whose sides have index less than or equal to 4. This is joint work with Masaki Izumi.

Speaker: **Uffe Haagerup** (University of Southern Denmark)

Title: *Solution of the Effros-Ruan conjecture for bilinear forms on C^* -algebras*

Abstract: (Joint work with Magdalena Musat.) In 1991 Effros and Ruan conjectured that a certain Grothendieck type inequality for a bilinear form on a pair of C^* -algebras holds if (and only if) the bilinear form is jointly completely bounded. In 2002 Pisier and Shlyakhtenko proved that this inequality holds in the more general setting of operator spaces, provided that the operator spaces in question are exact, in particular they proved the Effros-Ruan conjecture for pairs of exact C^* -algebras. In a recent joint work with Magdalena Musat we prove the Effros - Ruan conjecture for general C^* -algebras (and with constant one), i.e. for every jointly completely bounded (jcb) bilinear form u on a pair of C^* -algebras A, B there exists states f_1, f_2 on A and g_1, g_2 on B , such that

$$|u(a, b)| \leq \|u\|_{jcb} (f_1(aa^*)g_1(b^*b) + f_2(a^*a)g_2(bb^*))$$

While the approach by Pisier and Shlyakhtenko relied on free probability theory, our proof uses more classical operator algebra methods, namely Tomita Takesaki theory and special properties of the Powers factors of Type III_λ , $0 < \lambda < 1$.

Speaker: **Cyril Houdayer** (University of California, Los Angeles)

Title: *Another construction of II_1 factors with prescribed countable fundamental group.*

Abstract: I will present another construction of such II_1 factors using free products of von Neumann algebras endowed with almost periodic states.

Speaker: **Adrian Ioana** (University of California, Los Angeles)

Title: *On the subequivalence relations induced by a Bernoulli action*

Abstract: Let Γ be a countable group and denote by \mathcal{S} the equivalence relation induced by the Bernoulli action $\Gamma \curvearrowright [0, 1]^\Gamma$, where $[0, 1]^\Gamma$ is endowed with the product Lebesgue measure. I will prove that for any subequivalence relation \mathcal{R} of \mathcal{S} , there exists a partition $\{X_i\}_{i \geq 0}$ of $[0, 1]^\Gamma$ with \mathcal{R} -invariant measurable sets such that $\mathcal{R}|_{X_0}$ is hyperfinite and $\mathcal{R}|_{X_i}$ is strongly ergodic (hence ergodic), for every $i \geq 1$. This is joint work with Ionut Chifan.

Speaker: **Yasuyuki Kawahigashi** (University of Tokyo)

Title: *Super moonshine and operator algebras*

Abstract: We constructed an operator algebraic counterpart of the Moonshine vertex operator algebra with Longo before. Its automorphism group is the Monster group and its character is the modular elliptic j -function without the constant term. We now construct its "super" analogue for Conway's sporadic group Co_1 , following work of Duncan for an enhanced super vertex operator algebra.

Speaker: **Roberto Longo** (University of Rome Tor Vergata)

Title: *SUSY in the Conformal World*

Abstract: The talk concerns part of a recent joint work with S. Carpi and Y. Kawahigashi on the operator algebraic analysis of Superconformal Quantum Field Theory, with an initial step in the program of constructing Noncommutative Geometrical invariants for certain representations.

Speaker: **Narutaka Ozawa** (University of Tokyo)

Title: *On a class of II_1 factors with at most one Cartan subalgebra II*

Abstract: (Joint work with S. Popa.) Extending the scope of our previous result to a large class of discrete groups, and shows several von Neumann algebras has at most one Cartan subalgebra. (The CMAP condition is still required.)

Speaker: **Jesse Peterson** (University of California, Berkeley)

Title: *von Neumann subalgebras closed under (Γ) -extensions*

Abstract: Given a finite von Neumann algebra N , we will say that a diffuse subalgebra B is closed under (Γ) -extensions in N if whenever $P \subset N$ is a subalgebra with $P \cap B$ diffuse and $P' \cap N^\omega$ diffuse for some free ultrafilter ω then we have $P \subset B$. We show that if δ is a densely defined closable derivation into the Hilbert-Schmidt operators which is of the form $\delta(x) = [D, x]$, for some $D \in \mathcal{B}(L^2N)$ then $\overline{\ker(\delta)}$ is closed under (Γ) -extensions in N . In particular if $\ker(\delta)$ is injective then it is maximal injective and we obtain generalizations of results of Popa and Ge on maximal injective subalgebras. Also by applying this result to derivations coming from group cocycles we show that if G is a countable discrete group with a proper ℓ^2 -cocycle and if $H \subset G$ is an infinite maximal amenable subgroup then LH is maximal injective in LG .

Speaker: **Mikaël Pichot** (Institut des Hautes Etudes Scientifiques (IHES))

Title: *On the Wise group*

Abstract: TBA

Speaker: **Eric Rowell** (Purdue University)

Title: *Topological quantum computers: when universality fails*

Abstract: In the topological model for quantum computation, the computational power is controlled by the closed image of the braid group. Universal quantum computers correspond to dense images, while the weakest quantum computers correspond to finite images. We conjecture that finite images occur precisely when the categorical dimensions in the underlying braided category are square-roots of integers. I will present evidence for this conjecture and discuss its potential ramifications.

Speaker: **Roman Sasyk** (University of Ottawa)

Title: *On the (non)classification of factors*

Abstract: We show that the sets of factors of types II_1 , II_∞ , and III_λ , $0 \leq \lambda \leq 1$ on a separable Hilbert space are not classifiable using countable structures. Joint work with A. Tornquist.

Speaker: **Roman Sauer** (University of Chicago)

Title: *l^1 -orbit equivalence rigidity for hyperbolic lattices*

Abstract: (Joint work with Uri Bader and Alex Furman.) We say that two group actions are l^1 -orbit equivalent if the corresponding cocycle satisfies a certain l^1 -integrability condition. This l^p condition interpolates between the extreme cases $p = 0$ (usual orbit equivalence) and $p = \infty$ (implying quasi-isometry). We show that any group that is l^1 -orbit equivalent to a lattice in $SO(n, 1)$ ($n > 2$) is also a lattice in the same Lie group, and the cocycle is cohomologous to a standard cocycle coming from this situation (i.e. it can be straightened). The methods involve a generalization of Thurston's proof of Mostow rigidity and new homological methods.

Speaker: **V.S. Sunder** (IMSc, Chennai)

Title: *Non-crossing partition \simeq 2-cabled Temperley-Lieb*

Abstract: For each complex number $\delta \neq 0$, we consider a planar algebra whose space $NC_n(\delta)$ of ' k -boxes' has a basis consisting of non-crossing partitions of a set of $2k$ points, (usually thought of as being arrayed on two parallel lines, with k points on each line), and with multiplication and other planar algebra structure being defined almost exactly as in the case of the Temperley-Lieb planar algebra $TL(\delta)$. We show that this planar algebra $NC(\delta)$ is a C^* -planar algebra when $\delta > 4$. We do this by showing that $NC(\delta^2)$ is isomorphic to the so-called 2-cabling of $TL(\delta)$.

Speaker: **Stefaan Vaes** (Institut de Mathématiques de Jussieu)

Title: *An action of the free group F_∞ whose orbit equivalence relation has no outer automorphisms*

Abstract: (Joint work with Sorin Popa.) We prove that there exist uncountably many stably orbit inequivalent, essentially free, ergodic, probability measure preserving actions of the free group with infinitely many generators such that their associated orbit equivalence relations have trivial outer automorphism group and trivial fundamental group.

Speaker: **Feng Xu** (University of California, Riverside)

Title: *An application of mirror extension*

Abstract: Mirror extension is a general result about obtaining new nets as mirror of known ones. As an application of this result, in this talk I will discuss construction of new holomorphic conformal nets of central charge 24.

Speaker: **Zhengan Wang**

Title: *Topological phases of matter: classification and application*

Abstract: Topological phases of matter are exotic states of matter with anyonic excitations such as the fractional quantum Hall (FQH) liquids. FQH liquids are described effectively by Witten's Chern-Simons theories. More general topological phases of matter are described by unitary TQFTs or unitary braided tensor categories. I will discuss the mathematical models for topological phases of matter, their emergence from electrons, classification and application to quantum computing.