George Boole Mathematical Sciences Conference

Theme 1: Boole and Beyond in Quantum Information Theory

17–20 August 2015

Theme 8: Quantum Probabilistic Symmetries & Quantized Boolean Algebras

20–25 August 2015

University College Cork

Participants

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Ivan Todorov, Queen's University Belfast
Anatoly Vershik, Steklov — St. Petersburg
Dan-Virgil Voiculescu, UC Berkeley
Moritz Weber, Saarland University
Sebastian Wieczorek, University College Cork
Stephen Wills, University College Cork
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Michael Wolf, Technische Universität München
John Wright, Carnegie Mellon University
Ping Zhong, Lancaster University

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Monday 17 August	
12.45–13.00	Opening address (Stephen Wills & Patrick Fitzpatrick)
13.00–14.00	Daniel Burgarth
14.00–15.00	Robin Hillier
15.00–16.00	Robert Koenig
16.00–16.30	*Coffee & Tea*
16.30–17.30	Volkher Schulz

Tuesday 18 August	
09.00–10.00	Michael M Wolf
10.00–10.30	*Coffee & Tea*
10.30–11.30	John Wright
11.30–12.30	Jukka Kiukas
12.30–14.00	*Lunch*
14.00–15.00	Michael McGettrick
15.00–16.00	David Sutter
16.00–16.30	*Coffee & Tea*
16.30–17.30	Mauro Paternostro

Wednesday 19 August	
09.00–10.00	B. V. Rajarama Bhat
10.00–10.30	*Coffee & Tea*
10.30–11.30	Andreas Ruschhaupt
11.30–12.30	Weihua Liu
12.30–14.00	*Lunch*
14.00–15.00	Naofumi Muraki
15.00–15.30	Ping Zhong
15.30–16.00	Motohisa Fukuda
16.00–16.30	*Coffee & Tea*
16.30–17.30	Matthias Christandl
19.30–20.00	Reception
20.00–21.00	Hans Maassen (Public lecture)

Thursday 20 August	
09.00–10.00	Allan Greenleaf (Theme 5)
10.00–10.30	*Coffee & Tea*
10.30–11.30	Collin Bleak
11.30–12.30	Tobias Mai
12.30–14.00	*Lunch*
14.00–15.00	Franz Lehner
15.00–16.00	Rolf Gohm
16.00–16.30	*Coffee & Tea*
16.30–17.30	Dan Voiculescu
17.30–18.30	Ivan Todorov
20.00–22.00	GBMS Confence Dinner

Friday 21 August	
09.00–10.00	Hans Maassen
10.00–10.30	*Coffee & Tea*
10.30–11.30	R. Srinivasan
11.30–12.30	Debashish Goswami
12.30–14.00	*Lunch*
14.00–15.00	Uwe Franz
15.00–15.30	Malte Gerhold
15.30–16.00	Shane Mansfield
16.00–16.30	*Coffee & Tea*
16.30–17.30	Michael Christ (Theme 5)

Saturday 22 August	
09.00–10.00	David Evans
10.00–10.30	*Coffee & Tea*
10.30–11.30	Vijay Kodiyalam
11.30–12.00	James Mingo
12.00–12.30	Pierre Tarrago

Monday 24 August	
09.00–10.00	Anatoly Vershik
10.00–10.30	*Coffee & Tea*
10.30–11.30	Magdalena Musat
11.30–12.30	Mikael Rørdam
12.30–14.00	*Lunch*
14.00–15.00	Vlad Sergiescu
15.00–16.00	Collin Bleak
16.00–16.30	*Coffee & Tea*
16.30–17.30	J. Martin Lindsay

Tuesday 25 August	
09.00–10.00	Ilya Shmulevich (Theme 3)
10.00–10.30	*Coffee & Tea*
10.30–11.30	Marius Junge
11.30–12.30	Moritz Weber
12.30–14.00	*Lunch*
14.00–15.00	Roland Friedrich
15.00–16.00	Alex Belton
16.00–16.30	*Coffee & Tea*
16.30–17.30	Dana Scott (Domains XII)

Alexander Belton — Quasi-free Stochastic Processes from Quantum Random Walks

Attal and Joye studied an operator-valued quantum random walk driven by particles in a faithful normal state. They found the quantum stochastic differential equation obeyed by its limit process, and showed that the quantum noises appearing in this Langevin equation satisfy the commutation relations for a certain quasifree state.

Inspired by this example, we report on the development of a general framework to handle such quasifree random walks. The necessary theory of quantum stochastic integration builds on early work of Hudson and Lindsay, together with more recent work of Lindsay, Margetts and Weatherall.

Joint work with Ping Zhong.

B.V. Rajarama Bhat — Symmetric Representations of C^*-algebras and Structure Theorems of Completely Bounded Maps

A homomorphism τ of a C^*-algebra is said to be symmetric if $\tau(a^*) = J\tau(a)^*J$, for a symmetry J ($J = J^*$, $J^2 = I$). We study various families of symmetric homomorphisms and make use of them to get some structure theorems for completely bounded maps.

Joint work with Nirupama Mallick and K. Sumesh.

Collin Bleak — On the Semi-decidability of the Periodicity Problem for Elements of Various Groups (Talk 1)

We prove that both the Higman-Thompson group $2V$ and the rational group R_n of Grigorchuk, Nekrashevych, and Suschanskii have semi-decidable periodicity problems. That is, there are algorithms which can confirm, given an element of one of these groups, that the element has finite order. However, there is no algorithm which can confirm in finite time whether a general element of one of these groups has infinite order. The argument is based on studying the achievable dynamical systems under the partial action of $2V$ on a Cantor space.

Joint work with Jim Belk.

Collin Bleak — On Automorphisms of the Higman Groups $G_{n,r}$ and of the Full One-Sided Shift on n-letters (Talk 2)

We prove that the group of automorphisms of a Higman group $G_{n,r}$ is given as a group of homeomorphisms realisable via finite bijective transducers á-la Grigorchuk, Nekrashevych, and Suschanskii. We embed this group as a subgroup of the automorphisms of the full shift on n-letters, and show (as suggested by Hubbard), that the resulting group is isomorphic, "on the nose," to the group of automorphisms of the one-sided full shift on n-letters. Along the way, we will pass through the beautiful land of De Bruijn automorphisms.

Joint work with Yonah Maissel and Andres Navas, and separately, with Peter Cameron.

Daniel Burgarth — Quantum Computing in Plato's Cave

We show that mere observation of a quantum system can turn its dynamics from a very simple one into a universal quantum computation. This effect, which occurs if the system is regularly observed at short time intervals, can be rephrased as a modern version of Plato's Cave allegory. More precisely, while in the original version of the myth, the reality perceived within the Cave is described by the projected shadows of some more fundamental dynamics which is intrinsically more complex, we found that in the quantum world the situation changes drastically as the "projected" reality perceived through sequences of measurements can be more complex than the one that originated it. After discussing examples we go on to show that this effect is generally to be expected: almost any quantum dynamics will become universal once "observed" as outlined above. Conversely, we show that any complex quantum dynamics can be “purified” into a simpler one in larger dimensions.

Joint work with Paolo Facchi, Vittorio Giovannetti, Hiromichi Nakazato, Saverio Pascazio and Kazuya Yuasa.

Michael Christ — On the Fine Structure of the Fourier Transform and Additive Combinatorics (Theme 5)

Matthias Christandl — Limitations on Quantum Key Repeaters

A major application of quantum communication is the distribution of entangled particles for use in quantum key distribution (QKD). Due to noise in the communication line, QKD is in practice limited to a distance of a few hundred kilometres, and can only be extended to longer distances by use of a quantum repeater, a device which performs entanglement distillation and quantum teleportation. The existence of noisy entangled states that are undistillable but nevertheless useful for QKD raises the question of the feasibility of a quantum key repeater, which would work beyond the limits of entanglement distillation, hence possibly tolerating higher noise levels than existing protocols. Here we exhibit fundamental limits on such a device in the form of bounds on the rate at which it may extract secure key. As a consequence, we give examples of states suitable for QKD but unsuitable for the most general quantum key repeater protocol.

David E. Evans — The Search for the Exotic

Subfactor theory provides a framework for studying modular invariant partition functions in conformal field theory, and candidates for exotic modular tensor categories. I will describe work with Terry Gannon on the search for exotic theories beyond those from symmetries based on loop groups and finite groups.

Uwe Franz — On Conditionally Positive Functions and Functionals

Let A be a unital $*$-algebra and $\varepsilon : A \to \mathbb{C}$ a unital $*$-homorphism. A functional $\psi : A \to \mathbb{C}$ is called *conditionally positive* (or a *generating functional*) on (A, ε) if (a) $\psi(1) = 0$, (b) ψ is hermition, (c) ψ is positive on the kernel of ε. Examples are the linear extensions to the group algebra of negative type functions on groups. Conditionally positive functions classify Lévy processes on groups or involutive bialgebras. I will present new results about the relation between conditionally positive functions and 1-cocycles, and about the existence of a decomposition of such functions into a maximal Gaussian part and a Gauss-free remainder.

Joint work with Biswarup Das, Malte Gerhold, Anna Kula, Adam Skalski, Andreas Thom.

Roland Friedrich — Formal Groups and Probability

In this talk we present our recent results on homogeneous Lie groups and quantum probability. Further we discuss a more general approach to the subject and highlight the fundamental role of generalised pro-unipotent Lie groups which intrinsically arise in connection with any notion of independence.

Motohisa Fukuda — Additivity Violation and Tensor Powers of Quantum Channels

Additivity violation of minimum output entropy of quantum channels implies that entangled inputs can increase the classical capacity of certain quantum channels. In this talk, first we learn about additivity violation, its consequences and open problems. Second, we briefly go over proofs of additivity violation pointing out important techniques: random construction, Dvoretzky’s theorem, etc. Third, we go on to similar problems for tensor powers of quantum channels. To investigate behaviors of such things is important to know more about operational quantities, for example classical capacity of quantum channels.

Malte Gerhold — Positive Hochschild Cocycles

As will be discussed in the talk of Uwe Franz, the question whether all positive 2-cocycles are trivial plays a role in the study of quantum Lévy processes. More precisely, it is a sufficient condition for the possibility to decompose every generator of a quantum Lévy process into a maximal Gaussian part and a purely non-Gaussian remainder (Lévy-Khintchin decomposition). A stronger condition is the vanishing of the second cohomology group. I will present an example of a *-algebra with a character which has the following properties:

1. All positive 2-cocycles are coboundaries.
2. There is a 2-cocycle which is not a coboundary.

So the two above-mentioned sufficient conditions are not equivalent. Furthermore, I will explain a certain exact sequence which helps to calculate second cohomology groups and was proved in the group algebra case by Tim Netzer and Andreas Thom.

Joint work with Uwe Franz and Andreas Thom.

Rolf Gohm — Semi-cosimplicial Objects and Spreadability

To a semi-cosimplicial object (SCO) in a category we associate a system of partial shifts on the inductive limit. We show how to produce an SCO from an action of the infinite braid monoid. In categories of (noncommutative) probability spaces SCOs correspond to spreadable sequences of random variables, hence SCOs can be considered as the algebraic structure underlying spreadability.

This is joint work with Gwion Evans and Claus Köstler.

Debashish Goswami — Quantum Isometry Group of Compact Metric Spaces

After a quick introduction to the formulation of quantum isometric groups in the geometric context, we concentrate on a notion of quantum isometry in the purely metric space set-up. We define isometric actions of compact quantum groups on compact metric spaces. For a given compact metric space belonging to a large class of metric spaces including compact subsets of Euclidean spaces as well as all finite metric spaces, we prove the existence of a universal object (i.e. the quantum isometry group) in the category of compact quantum groups acting isometrically on it. Some concrete examples are given and open questions are discussed.

Allan Greenleaf — Restricted Linear Convolution Inequalities (Theme 5)

Robin Hillier — A Limit Theorem for Dynamical Decoupling and Intrinsic Decoherence

Dynamical decoupling is a key tool in quantum information theory designed to counterfeit environment-induced decoherence. We investigate it from the point of view of analysis, and obtain interesting new descriptions and estimates. Moreover, we prove that dynamical decoupling would not work for (potential) intrinsic/internal decoherence of a closed quantum system and thereby propose a method of partially identifying the latter.

Marius Junge — Actions of q-Gaussian Algebras

We use quantum probabilistic methods to define and investigate analogues of Shlyahktenko's A-valued semicircular algebras. Quantum symmetries and their ergodic properties are used a substitute for actions and co-actions of groups in Popa and Vaes's work on relative amenability.

Joint work with Bodgan Udrea.

Marius Junge — Analysis on Noncommutative Spaces (IMS meeting)

Noncommutative tori are simplest examples for noncommutative mainfolds in noncommutative geometry. For these concrete spaces and their noncompact analogues, we will discuss basic concepts from noncommutative geometry and finite dimensional approximation in the Gromov–Haussdorff sense. Using a semigroup approach one can show that also many tools in classical harmonic analysis concerning convergence of Fourier series and singular integral operators remain valid in the context of noncommutative deformations of classical spaces.

Vijay Kodiyalam — Planar algebras, cabling and the Drinfeld double

We produce explicit embeddings of the planar algebra of a finite-dimensional semisimple and cosemisimple Hopf algebra into the two-cablings of the planar algebras of the dual and opposite Hopf algebras and characterise the images.

Joint work with Sandipan De.

Jukka Kiukas — Information Geometry and Local Asymptotic Normality for the Estimation of Open Quantum Dynamics

Input-output formalism is a well-known framework for describing continual monitoring of a Markovian open quantum system via measurements made on its environment (typically a quantised radiation field); mathematically, the environmental noise is described in terms of quantum stochastic Wiener processes on the field Fock space. We consider the problem of identifying and estimating unknown dynamical parameters (Hamiltonian and the quantum jump operators) from the output field state. For this purpose, we first use quantum Itô calculus to derive an information geometric structure on the set of parameters, arising from the quantum Fisher information of the output state. The geometry comes with an associated CCR-algebra, and we then show that local estimation reduces asymptotically (with long observation times) to a Gaussian estimation problem on that CCR-algebra.

Robert Koenig — Protected Gates for Topological Quantum Field Theories

We give restrictions on locality-preserving unitary automorphisms U, which are protected gates, for 2-dimensional topologically ordered systems. For generic anyon models, we show that such unitaries only generate a finite group, and hence do not provide universality. For non-abelian models, we find that such automorphisms are very limited: for example, there is no non-trivial gate for Fibonacci anyons. More generally, systems with computationally universal braiding have no such gates. For Ising anyons, protected gates are elements of the Pauli group. These results are derived by relating such automorphisms to symmetries of the underlying anyon model: protected gates realize automorphisms of the Verlinde algebra. We additionally use the compatibility with basis changes to characterize the logical action

Joint work with M. Beverland, O. Buerschaper, F. Pastawski, J. Preskill and S. Sijher.

Franz Lehner — Cumulants, Spreadability and Hausdorff Series

We extend the notion of cumulants to spreadability systems, including e.g. monotone cumulants. The combinatorics are based on ordered set partitions and it turns out that instead of being additive, cumulants of independent sums involve the Campbell–Baker–Hausdorff series.

Joint work with T. Hasebe.

J. Martin Lindsay — KMS-Symmetry and quantum Markov semigroups

Two related problems will be discussed: the symmetry associated with time-reversal for quantum sub-Markov semigroups, and the generation of such semigroups. The former calls for an appropriate notion of 'adjoint' for maps between von Neumann algebras with faithful normal semifinite weights; the latter for a 'quantum' notion of Dirichlet form. They both involve inducing maps on associated noncommutative L^p-spaces; specifically, interpolating between the algebra, and its predual, and conversely extrapolating from its standard Hilbert space to the von Neumann algebra. Our profound debt to Uffe Haagerup through his pioneering works will be manifest in this talk.

Joint work with Stanislaw Goldstein and Adam Skalski.

Weihua Liu — Extended de Finetti Theorems for Boolean Independence and Monotone Independence

In this talk, we will define noncommutative spreadability for Boolean and monotone independence. We will show Ryll–Nardzewski type theorems for monotone and Boolean independence: roughly speaking, an infinite bilateral sequence of random variables is monotonically (Boolean) spreadable if and only if the variables are identically distributed and monotone (Boolean) with respect to the conditional expectation onto its tail algebra. For an infinite sequence of noncommutative random variables, Boolean spreadability is equivalent to Boolean exchangeability.

Hans Maassen — The Breakdown of Boolean Logic in Quantum Physics (Public Lecture)

On this bicentenary of George Boole of Cork, we consider the role of Boolean logic in physics, and contrast it with the quantum logic proposed by Birkhoff and von Neumann in 1936. Although the latter work is not widely known, it could arguably be considered as a major breakthrough in our thinking about the material world. Boolean thinking needs replacement in quantum physics. Starting from this point of view we discuss the phenomenon of entanglement, the impossibility of copying quantum information, and some further quantum phenomena.

Hans Maassen — The Ergodic Decomposition of Measurement Records

We consider a finite but otherwise general measurement on a finite quantum system, repeated infinitely often. We prove that observation of the asymptotic or 'macroscopic' behavior of the measurement record amounts to a von Neumann measurement on the system. In the course of time the type of asymptotic behavior can be viewed as establishing itself, or as revealing itself. This phenomenon was known in the 'non-demolition' case and has been named by Fröhlich et al. 'the emergence of facts in quantum mechanics'.

Tobias Mai — Regularity of Distributions of Wigner Integrals

With their seminal work in 1998, P. Biane and R. Speicher founded a non-commutative counterpart of classical stochastic calculus and Malliavin calculus in the realm of free probability. In particular, they introduced the so-called Wigner integrals as the free analogue of the classical Wiener integrals.

In my talk, I will discuss how recent results that were obtained in joint work with R. Speicher and M. Weber, which under certain conditions allowed one to exclude atoms in the distributions of non-constant polynomials in finitely many non-commutative random variables, can be extended and applied to Wigner integrals.

Shane Mansfield — The Reality of the Quantum State: a Stronger Psi-ontology Theorem

The Pusey–Barrett–Rudolph no-go theorem provides an argument for the reality of the quantum state based on certain assumptions, most of which are common to the familiar no-go theorems of Bell, Kochen & Specker, etc. The exception is their assumption of preparation independence, which has been subject to a number of criticisms. We propose a much weaker, physically motivated notion of independence, which merely requires well-defined marginal statistics for joint preparation procedures. This is a minimum requirement for maintaining a reasonable notion of subsystem, and prohibits the possibility of super-luminal causal influences in the preparation process. Under the weaker condition, it is shown that the argument of PBR becomes invalid. We propose an experiment involving randomly sampled preparations that recovers an approximation of the result, which becomes exact in the limit as the sample space of preparations becomes infinite, thereby proving a stronger theorem asserting the reality of the quantum state. The analysis employs a finite version of the de Finetti theorem for conditional probabilities due to Christandl and Toner. Unlike that of PBR, the result holds even in the presence of non-local correlations in the global ontic state.

Michael Mc Gettrick — Quantum Walks

An overview will be provided of our recent results in the analysis of certain models of quantum random walks in 1 and 2 dimensions. In particular, we are interested in the asymptotic behaviour of the probability distribution and how this differs from that for classical random walks. We will present results for alternating walks, walks with history dependence ("memory"), and lazy walks.

James Mingo — Freeness and the Partial Transpose

Wishart matrices can be used to describe a random state. In 2012 Aubrun showed that the partial transpose of a Wishart matrix converges to a shifted semi-circular operator which may or may not be positive. In recent work with M. Popa, we showed that a Wishart matrix, its left and right partial transpose, and its full transpose form an asymptotically free family. I will show that the same applies to a Haar distributed random unitary operator, with the partial transpose converging to a circular operator.

Naofumi Muraki — q-Deformation of Free Independence

Although there is the no-go theorem of Leeuwen–Maassen on the existence of q-convolution, we can construct, in a sense, a notion of q-deformed free independence and the associated notions of q-convolution and q-cumulatnts. The construction is based on the q-product operation for non-commutative probability spaces. In a sense, our construction of q-convolution and q-cumulants is consistent with Anshelevich' s construction of q-Lévy processes.

Magdalena Musat — Quantum error correction and the Connes embedding problem

Work on quantum error correction led J. Smolin, F. Verstraete and A. Winter to formulate in 2005 a restoration in the asymptotic limit of Birkhoff's classical theorem. More precisely, they conjectured that every unital quantum channel might always be well approximated by a convex combination of unitarily implemented ones. In earlier joint work with U. Haagerup we disproved this conjecture by showing that so-called non-factorizable quantum channels, which we construct in all dimensions greater than or equal to 3, are counterexamples. In recent work, we exhibit an asymptotic property of factorizable quantum channels which leads to a reformulation of the Connes embedding problem. I will further discuss recent work with U. Haagerup and M.-B. Ruskai, where we study the convex structure of factorizable quantum channels.

Mauro Paternostro — Distributing Entanglement without any Entanglement

Entanglement is, allegedly, 'the' resource that makes quantum computing more advantageous than its classical counterpart. Some interesting, experimentally motivated architectures for quantum computation are based on distributed networks of computational nodes connected by entangled communication channels. In this context, distributing entanglement between two such nodes is paramount. A way of doing it is by sending a mediator that shuttles between two nodes. However, one would expect that, by doing this, the shuttle will eventually become entangled with the nodes themselves. This was proven not to be necessarily the case. However, the reasons for this remained obscure until recently. In this talk I will demonstrate that quantum discord, a weaker form of quantum correlations, is the responsible for such 'distribution of entanglement without entanglement' to occur and illustrate a recent experiment proving such intriguing relation.

Mikael Rørdam — Just infinite groups and C^*-algebras

A (discrete) group is called just infinite if it is infinite and all its non-trivial normal subgroups have finite index. There is a well-established theory for just infinite groups, and there are interesting examples of just infinite groups (including, for example, the Grigorchuk groups). In a similar way one can define a (unital) C^*-algebra to be just infinite if it is infinite dimensional and all its proper quotients are finite dimensional. Infinite dimensional simple C^*-algebras and essential extensions of simple C^*-algebras by finite dimensional C^*-algebras are just infinite (for trivial reasons). We show that there exist residually finite dimensional just infinite C^*-algebras (that can be chosen to be AF-algebras), and we explain some structure results for just infinite C^*-algebras. The construction of a just infinite residually finite dimensional AF-algebra can be done using an old result by Bratteli and Elliott which says that each totally disconnected spectral space arises as the primitive ideal space of an AF-algebra. We discuss possible connections to just infinite groups.

Joint work (in progress) with R. Grigorchuk and M. Musat.

Andreas Ruschhaupt — Quantum Control with Shortcuts to Adiabaticity

Shortcuts to adiabaticity are mostly-analytical derived schemes for the fast and robust control of quantum systems. In this talk, we review these "shortcut" schemes. We especially concentrate on the optimization of the stability of shortcut schemes versus different sources of errors. We apply these tools to design a trap trajectory for shuttling a single ion in a harmonic trap. We develop trap trajectories with low sensitivity on spring-constant noise and position noise fluctuations for several noise spectra. In addition, we derive shortcuts to adiabatic population inversion of the internal state of an atom. Again, we optimize the stability of the shortcut schemes versus different sources of errors like noise or systematic errors.

Volkher Scholz — Quantum Bilinear Optimization

We study optimization programs given by a bilinear form over noncommutative variables subject to linear inequalities. Problems of this form include the entangled value of two-prover games, entanglement assisted coding for classical channels and quantum-proof randomness extractors. We introduce an asymptotically converging hierarchy of efficiently computable semidefinite programming (SDP) relaxations for this quantum optimization. This allows us to give upper bounds on the quantum advantage for all of these problems. Compared to previous work of Pironio, Navascués and Acín, our hierarchy has additional constraints. By means of examples, we illustrate the importance of these new constraints both in practice and for analytical properties. We also discuss implications of Connes' embedding conjecture to our framework.

Joint work with Mario Berta and Omar Fawzi; `arXiv:1506.08810`

Dana Scott — Setoids/Modest Sets/PERs: Adding and Using Types with a Type-free λ-Calculus (Domains XII)

Vlad Sergiescu — Braided Thompson Groups

The purpose of this talk is to present recent progress on the interaction between Artin braid groups and Thompson's groups of pieces linear homeomorphisms of respectively the interval, the circle and the Cantor set.

Ilya Shmulevich — Probabilistic Boolean Networks: The Modelling and Control of Gene and Regulatory Systems (Theme 3)

R. Srinivasan — Cohomology for Spatial Super-product Systems

Super-product system is a generalization of product system of Hilbert spaces introduced by Bill Arveson. They arise naturally in the theory of E_0-semigroups on factors. We propose a cohomology theory for spatial super-product systems, and describe the 2-cocycles for basic examples. This consequently classifies, up to cocycle conjugacy, a family of E_0-semigroups on type *III* factors associated with canonical anti-commutation relations, and its restrictions to some well-known subalgebras.

Joint work with Oliver T. Margetts.

David Sutter — Relative Entropy, Recovery Maps, and Approximate Quantum Markov Chains

The Shannon and von Neumann entropies quantify the uncertainty in a system. They are operationally motivated by natural information processing tasks such as compression, channel coding or randomness extraction. A mathematical consequence of the postulates of quantum physics are several entropy inequalities such as the strong subadditivity of quantum entropy and the monotonicity of quantum relative entropy under physical processes. A series of recent works showed that these inequalities can be strengthened in the context of recoverability, i.e., by considering the question of how well a physical process can be reversed. This also provides an operational definition of approximate quantum Markov chains. In this talk, I will give an overview about the recent works on recoverability, present some new results, and discuss open problems.

Joint work with Omar Fawzi, Renato Renner (arXiv:1504.07251) and with Marco Tomamichel, Aram Harrow (arXiv:1507.00303).

Pierre Tarrago — Free Wreath Product and Spin Planar Algebras

I will present some recent results on the representations of some particular free wreath products. This description involves the free product of spin planar algebras. In a second part I will give some probabilistic applications of this construction.

Ivan G. Todorov — Quantum Chromatic Numbers of Graphs

The chromatic number of a graph is a well-known and widely used parameter, with far reaching applications both within and outside Graph Theory. It is defined as the smallest number of colours that are needed in order to colour the vertices of the graph in such a way that adjacent vertices receive different colours. A quantum version of the chromatic number was defined in 2007 by P. Cameron, A. Montanaro, M. Newman, S. Severini and A. Winter, utilising an entangled state, shared between two players, and it was demonstrated that this new chromatic number can be strictly smaller than the classical one. In this talk, based on a joint work with S. Severini, D. Stahlke, V. Paulsen and A. Winter, I will describe how ideas from operator algebra theory can be used to define other useful quantum versions of the classical chromatic number. At the heart of this approach lies the connection with quantum correlations between systems sharing entangled states, and their link to tensor theory of operator algebras. Bounds for the quantum chromatic numbers will be displayed, and their connections to Tsirelson's Problem and to Connes' Embedding Problem will be discussed.

Anatoly M. Vershik — The Filtrations of Boolean σ-algebras, Standardness or Hierarchical Independence, and Virtual Metric Spaces with Measure

We consider a new theory of filtrations: classification/notion of standard filtration and generalization of the notion of independence. The applications of the theory include stochastic processes, Bratteli–Vershik diagrams, and C^*-algebras.

Dan-Virgil Voiculescu — Free Probability for Pairs of Faces

We will discuss the recent extension of free probability to systems with left and right variables. This includes the analogues, in the simplest cases, of operations on independent variables and extreme values.

Moritz Weber — Unitary Easy Quantum Groups

The class of easy quantum groups (introduced by Banica and Speicher in 2009) consists of compact matrix quantum groups of combinatorial nature. Many of their quantum algebraic properties are visible in their combinatorial data, in the categories of (set theoretical) partitions. We will briefly introduce easy quantum groups and then focus on their unitary extensions.

Michael M. Wolf — (Un-)decidable Problems in Quantum Theory

In the talk I will review recent results on the (un-)decidability of problems in quantum many-body physics and quantum information theory. In both fields there is a natural integer limit that opens the door to undecidability of some of the central properties: the thermodynamic limit in quantum many-body theory and the large block-size limit in information theory. I will try to illuminate the thin line between computable and uncomputable and to illustrate the physical consequences of unprovable properties.

John Wright — Efficient Quantum Tomography

In the quantum state tomography problem, one wishes to estimate an unknown d-dimensional quantum state given as few copies as possible. In this talk, we describe new work showing that d^2 copies are sufficient, essentially matching known lower bounds. In addition, we show that the top k eigenvalues of an unknown mixed state can be learned using only k^2 copies, independent of the dimension d.

Ping Zhong — Remarks on the Cauchy-Stieltjes Transform of Freely Infinitely Divisible Distributions

Biane found some useful properties of the Cauchy–Stieltjes transform of freely infinitely divisible distributions. This provides a nice tool to study the marginal distributions of free additive Brownian motion and free additive convolution semigroups. Belinschi extended Biane's result further to operator-valued free probability. We report some analogue results for free multiplicative convolutions and their applications.