ABSTRACTS OF TALKS OF 13th WORKSHOP:
NON-COMMUTATIVE HARMONIC ANALYSIS,
11 - 17.07.2010, Będlewo, Poland

1. **Helene Airault (Insset-LAMFA)**

Brownian motion on univalent functions.

Abstract:

References:

[1] Airault-Ren: Modulus of continuity of the canonic Brownian motion on the group of diffeomorphisms of the circle"J. Funct. Anal. 196(2002), 395-426.

[2] Airault-Malliavin-Thalmaier: Canonical Brownian motion on the space of Jordan curves and resolution of Beltrami equations by a continuity method along stochastic flows. J. Math. Pures Apppl. 83 (2004) p. 955-1018.

2. **Hiroshi Ando (Kyoto)**

Lie Group-Lie Algebra Correspondences of Unitary Groups in Finite von Neumann Algebras.

Abstract: We tackle with the old problem of treating infinite dimensional unitary groups in a separable Hilbert space from the operator algebraic viewpoint. For the strongly closed subgroup G of $U(\mathfrak{M})$, where $\mathfrak{M}$ is a separable finite von Neumann algebra, we show that there is a good "Lie algebra", equipped with a nice topology that makes it a complete topological Lie algebra. Also we discuss the necessary and sufficient condition to characterize, among many other unbounded operator algebras, the algebra of closed operators affiliated with separable finite von Neumann algebras from the tensor categorical viewpoint. This talk is based on the joint work with Yasumichi Matsuzawa (Leipzig/Hokkaido University).

3. **Nobuhiro Asai (Aichi)**

The Construction of Various Non-Gaussian Probability Measures on $\mathbb{C}$.

Abstract: In this talk, we shall present how to construct probability measures on $\mathbb{C}$ associated with the Jacobi-Szeg parameters of orthogonal polynomials. We shall show new materials which go farther than previous results, Heat kernel measure and Bessel kernel measure on $\mathbb{C}$ arising from the Meixner class of probability measures on $\mathbb{R}$. Our new results are expressed by the Mellin convolution product of the Bessel kernel measures, which are derived from the Jacobi-Szeg parameters for the continuous dual Hahn polynomials $S_n(x^2, a, b, c)$. $S_n(x^2, a, b, c)$ are orthogonal polynomials with respect to the Wilson distribution on $\mathbb{R}$. One of interesting things is that if the special choice of a, b, c is taken into account, the Wilson distribution becomes the Half-Meixner distribution on $\mathbb{R}_+$ and we can obtain probability measures on $\mathbb{C}$ associated with it, which have not been known for our best knowledge.

4. **Viacheslav Belavkin (Nottingham)**

A Banach Algebra Approach to Noncommutative Integration.

Abstract: We review the basic concepts of stochastic integration and reformulate it in terms of a Banach four-normed $*$-algebra with the associative product given by the stochastic covariation. We show that this nonunital algebra having two nilpotent first and second order $*$-ideals is a generalization of the C^*-algebra corresponding to only one nontrivial norm-the usual operator. The noncommutative generalization of this algebra which we call B^*-algebra leads to the $*$-algebraic theory of quantum stochastic integration developed in [1-5]. The main notions and results of classical and quantum stochastic analysis are reformulated in this unifying approach. The general Le´vy process is defined in terms of the modular B^*-Ito algebra and the corresponding quantum stochastic master equation on the predual space of a W^*-algebra is derived as a noncommutative version of the Zakai equation driven by the process. This is done by a noncommutative analog of the Girsanov transformation, which we introduce in full generality.

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5. **Włodek Bryc (Cincinnati)**

Meixner matrix ensembles.

Abstract: In a conference talk in 2006, M. Anshelevich inquired about matrix ensembles with regression properties that are analogous to classical and free Meixner laws. We show that the Laplace transform of an $n \times n$ matrix ensemble that fits Anshelevich's regression postulates for "Meixner laws on matricesśatisfies a system of PDEs which is explicitly solvable for $n = 2$. By constructing the corresponding 2×2 Meixner matrix ensembles, we establish that for appropriate values of parameters these solution are indeed the Laplace transforms. The talk is based on joint work with Gerard Letac.

6. **Marie Choda (Osaka Kyoiku)**

Positive definite matrices arising from unitaries.

Abstract: We introduce some positive definite matrix by using the tensor product decomposition of a unitary operator. Applying this method to a pair of subalgebras A and B of M, a finite von Neumann algebra (in special case, the $n \times n$ matrix algebra), we give a numerical characterization

for a relative position between A and B via the concept of von Neumann entropy of this positive definite matrix.

7. **P.K. Das (Kolkata)**

Weighted Energy Control of Quantum Mechanical System.

Abstract: In this paper we have derived the weighted energy control of the optimal quantum mechanical system by representing the unitary operator in terms of the projection operators of the Hamiltonian of the control system. The admissible Hilbert space of controllers of the system is expressed as the tensor product of the Hilbert spaces corresponding to the weights of the controllers of the quantum mechanical system. The optimal control which steers the state of the quantum mechanical system from the initial state to a target state, minimizing the weighted energy, is formulated in terms of the controllability operator of the system.

8. **Ken Dykema (Texas A&M)**

Bound on the spectral radius of random walks on nonamenable Baumslag-Solitar groups.

Abstract: The Baumslag-Solitar groups are HNN extensions

$$BS(n,m) = \langle a, t, | ta^n t^{-1} = a^m \rangle.$$

They are amenable if and only if $\min(|n|, |m|) = 1$. We examine the canonical nearest-neighbor random walk on this group and obtain lower bounds on its spectral radius (for certain n and m giving nonamenable groups) by using techniques of free probability theory. This is joint work with Daniel Redelmeier.

9. **Rachid El Harti (Settat)**

Stability results for C*-unitarisable groups.

Abstract: In this work, we introduce the notion of C*-unitarizable groups (= whenever the full group C*-algebra C*(G) satisfies the similarity probem). We then establish some stability results of the C*-unitarisable property for locally compact groups and discuss the connection between this property and the unitarisable property for groups.

10. **Uwe Franz (Besan on)**

On square roots of the Haar state of a compact quantum group.

Abstract: Diaconis and Shahshahani have shown that the Haar measure of a compact group admits a positive square root unless the group is commutative or a product of the eight element group of unit quaternions with cyclic groups of order two. We investigate the analogous question for quantum groups. We show that the Haar state of a compact quantum group admits a square root unless all its unitary irreducible corepresentions are one- or two-dimensional, with an additional condition on the two-dimensional corepresentations that make their dual isomorphic to the division algebra of quaternions. We also study concrete Kac-type examples. This is joint work with Adam Skalski and Reiji Tomatsu.

11. **Takahiro Hasebe (Kyoto)**

Joint cumulants for natural independence.

Abstract: There were several attempts to unify many kinds of independences in non-commutative probability spaces. In such a context, natural independence was introduced and classified by N. Muraki, after the papers on universal independence by M. Sch rmann, R. Speicher and A. Ben Ghorbal. Natural independence consists of five ones: tensor, free, monotone, anti-monotone and Boolean ones. We show how to define joint cumulants associated with a natural independence. Our definition is based on the concept of a dot operation introduced by G.-C. Rota in the context of umbral calculus. We also prove that the highest coefficients of a universal independence are directly related to cumulants. Our approach is different from F. Lehner's approach based on Good's formula.

12. **Takeyuki Hida (Nagoya & Meijo)**

A noise of new type and its generalized functionals.

Abstract: A system of independent, idealized, elemental random variables is called a noise. Typical example is the (Gaussian) white noise which is obtained by taking the time derivative $\dot{B}(t)$ of a Brownian motion $B(t)$. Note that it is parametrized by the time variable t. We shall introduce another noise, which is of Poisson type and is parametrized by a space variable u. It is denoted by $P'(u)$ and is recognized as a typical noise, too. It can be defined as a *generalized* random variable and is taken to be a member of variables of random functions appearing in many applications. We can discuss the analysis of generalized functions of $P'(u)$'s and its applications to the investigation of random phenomena that are described by compound Poisson processes.

13. **Robin Hudson (Loughborough)**

Yangians and quantum stochastic calculus.

Abstract: The Yangian [Mole] $Y(gl^N)$ of the algebra gl^N of all NxN complex matrices is a non-co-commutative Hopf algebra which contains the universal enveloping algebra of the Lie algebra gl^N as a co-commutative sub-Hopf algebra. In this talk I will show how the Yangian is naturally embedded in the so-called sticky shuffle product Hopf algebra [Huds] over gl^N, in which the product describes the multiplication rule for iterated quantum stochastic integrals and the coproduct is related to the continuous tensor product structure of Fock space. Properties of the Yangian, such as the ternary relation and quantum determinant appear quite natural when studied using the methods of quantum stochastic calculus. The Z^2-graded Yangian can be studied similarly using generalized Boson-Fermion equivalence [EyHu].

References:

[EyHu] T. M. W. Eyre and R. L. Hudson, Representations of Lie super-algebras and generalised Boson-Fermion equivalence in quantum stochastic calculus, *CMP* **186**, 87–94 (1997)

[Huds] R. L Hudson, Hopf-algebraic aspects of iterated stochastic integrals, *IDAQP* **12**, 479–496 (2009) .

[Mole] A. Molev, Yangians and classical Lie algebras, *AMS Mathematical Surveys and Momographs* Volume 143 (2007)

14. **Jan Janas (Kraków)**

Decay bounds of eigenfunctions of unbounded Jacobi matrices.

Abstract: In this talk I will present recent estimates of generalized eigenvectors of general selfadjoint Jacobi operator J in l^2, for spectral parameter lying i n gaps of its essential spectrum. These estimates extend our previous results found in the cas e the spectral is outside of the spectrum of J. Examples concerning sharpnees of the estimate s will be discussed. The results were obtained in a joint work with G.Stolz and S.Naboko.

15. **Paweł Kasprzak (Copenhagen)**

Quantum Homogeneous Spaces.

Abstract: The aim of this talk is to present the notion of a quantum homogeneous space. It will be shown to be an appropriate quantum counterpart of the classical notion of homogeneity. Furthermore it provides a unified framework for different classes of examples such as the quotient of a locally compact quantum group by its closed quantum subgroup due to S. Vaes, quantum homogeneous spaces of a compact quantum group studied by P. Podles and the Rieffel deformation of G-homogeneous spaces. Finally, it may be shown that the quantum homogeneous spaces are simple objects in the category of C*-algebras equipped with an action of a given quantum group.

16. **Yasuyuki Kawahigashi (Tokyo)**

$N = 2$ **superconformal field theory and operator algebras.**

Abstract: I present a recent operator algebraic approach to $N = 2$ superconformal field theory. Classification of extensions of the minimal models with central charges below 3 is given. Operator algebraic treatments of the chiral rings, the spectral flow of the $N = 2$ super Virasoro algebras, and the mirror symmetry of the Calabi-Yau manifolds are discussed.

17. **Dorota Kępa (Lublin)**

Euclidean Gibbs States of Quantum Systems on Graphs.

Abstract: Gibbs states of an infinite system of interacting quantum particles are considered. Each particle moves on a compact Riemannian manifold and is attached to a vertex of an irregular graph with a certain metric property, by virtue of which vertices of large degree are located at large distances from each other. We present an extension of the Bassalygo-Dobrushin technique developed in [Theory of Probab. Appl., 31, 572-589 (1986)] to prove uniqueness of corresponding Euclidean Gibbs states of the system. Two kinds of graphs are studied: (a) a general graph with locally finite degree; (b) a graph with globally bounded degree. In case (a), the uniqueness of Gibbs states is shown under the condition that the interaction potentials are uniformly bounded by a sufficiently small constant. In case (b), the interaction potentials are random. In this case, under a certain condition imposed on the probability distribution of these potentials the almost sure uniqueness of Gibbs states has been shown.

18. **Claus K stler (Aberystwyth)**

Symmetry and independence in noncommutative probability.

Abstract: De Finetti's theorem is foundational for the subject of distributional symmetries and invariance principles in probability. It characterizes an exchangeable infinite sequence of random variables to be conditional independent and identically distributed. Here, exchangeability means that the moments of the sequence are invariant under finite permutations of the random variables.

I will review recent progress on the transfer of this fundamental result to noncommutative probability. Among the discussed results are a noncommutative version of Ryll-Nardzewski's extended de Finetti theorem, braidability as an extension of exchangeability, quantum exchangeability as a 'quantized' version of exchangeability. In particular and quite surprisingly, an application of exchangeability to characters of the infinite symmetric group provides a new proof of Thoma's theorem, such that it can be understood as a noncommutative de Finetti theorem.

This is in parts joint work with Rolf Gohm and Roland Speicher.

19. **Seung-Hyeok Kye (Seoul)**

Facial structures of separable and PPT states.

Abstract: A positive semi-definite block matrix (a state if it is normalized) is said to be separable if it is the sum of simple tensors of p.s.d. matrices. A state is said to be entangled if it is not separable.

It is very difficult to detect the border between separable and entangled states. The PPT(positive partial transpose) criterion tells us that the partial transpose(=block transpose) of a separable state is p.s.d., as was observed by M. D. Choi in 1982 from the mathematics side.

Faces of the cone of all PPT block matrices are naturally characterized by pairs of subspaces of (small) matrices. In this talk, we discuss which faces of PPT's induce faces of separable's, and which faces of separable's are induced by PPT's.

20. **Hun Hee Lee (Chungbuk)**

Hypercontractivity on the q-Araki-Woods algebras.

Abstract: We prove the hypercontractivity of the q-Ornstein-Uhlenbeck semigroup on the q-Araki-Woods algebras for $-1 \leq q \leq 1$, which are type III relatives of the von Neumann algebra generated by q-gaussians. The main tools for the proof are A. Nou's twisted baby Fock model, Speicher's central limit procedure and the optimal convexity inequality by Ball/Carlen/Lieb.

21. **Franz Lehner (Graz)**

Free Lamplighter Groups and a Question of Atiyah.

Abstract: We compute the von Neumann dimensions of the kernels of adjacency operators on free lamplighter groups and show that they are irrational, thus providing an elementary constructive answer to a question of Atiyah. This is joint work with Stephan Wagner.

22. **Romuald Lenczewski (Wrocław)**

Matricial freeness and random pseudomatrices.

Abstract: The concept of matricial freeness is a natural generalization of freeness and other fundamental notions of noncommutative independence (monotone and boolean). At the same time, sums of matricially free random variables called random pseudomatrices remind random

matrices as concerns their asymptotic behavior. These concepts as well as the Hilbert space realization of limit joint distributions in terms of matricially free Gaussian operators living in the matricially free product of free and boolean Fock spaces will be discussed.

23. **Marcin Marciniak (Gdańsk)**

On exposed positive maps.

Abstract: The talk is devoted to the problem of classification of positive maps on C^*-a lgebras. We consider the class of positive exposed maps. This is a subclass of extremal p ositive maps. Due to Straszewicz's theorem exposed maps are dense in the set extremal maps. We provide some examples of exp osed and non-exposed maps and discuss their properies.

24. **Masato Mimura (Tokyo)**

Fixed-point and Kazhdan-type theorems for universal lattice on Banach spaces.

Abstract: We show that the universal lattice $SL_n(Z[x_1, ..., x_k])$ for n at least 4 has fixed-point and Kazhdan-type properties on L_p-spaces (p:finite) and Hilbertian spaces. This result generalizes the Shalom–Vaserstein theorem which establishes Kazhdan's property (T) for this group. If time permits, we will see some applications and further directions.

25. **Jolanta Misiewicz (Warszawa)**

Symmetric weakly stable random vector is pseudo-isotropic.

Abstract: A symmetric random vector $\mathbf{X}$ taking values in a separable Banach space $\mathbb{E}$ is weakly stable iff

$$\forall\, a, b \in \mathbb{R}\ \exists \Theta \quad a\mathbf{X} + b\mathbf{X}' \stackrel{d}{=} \mathbf{X}\Theta.$$

A symmetric random vector $\mathbf{X}$ is pseudo-isotropic iff all its one-dimensional projections have the same distribution up to a multiplicative constant, i.e.

$$\forall\, \xi \in \mathbb{E}^*\ \exists\, c(\xi) > 0 \quad < \xi, \mathbf{X} > \stackrel{d}{=} c(\xi) < \xi_0, \mathbf{X} >,$$

where $\xi_0 \neq 0$, $\xi_0 \in \mathbb{E}^*$ is fixed.

We show that every weakly stable random vector is pseudo-isotropic. This result describes a strict connection between the theory of weakly stable random vectors and generalized convolutions with the theory of pseudo-isotropic, ℓ_p-symmetric distributions and distributions with n-dimensional versions. In particular it shows that most of weak generalized distributions is defined by factors of stable distributions.

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Studia Math. **23**, pp. 217–245, 1964.
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26. **Takuho Miyamoto (Tohoku)**

Orbital Approach to Microstate Free Entropy.

Abstract: Motivated by Voiculescu's liberation theory, we introduce the orbital free entropy $\chi_{\rm orb}$ for non-commutative self-adjoint random variables (also for "hyperfinite random multivariables"). Besides its basic properties the relation of $\chi_{\rm orb}$ with the usual free entropy χ is shown. If time allows, we will discuss the dimension counterpart of $\chi_{\rm orb}$ or recent topics of orbital approach.

27. **Naofumi Muraki (Iwate)**

On a certain 'q-deformation' of free independence.

Abstract: We consider the problem of constructing 'q-independence' which should be related to the Bożejko-Speicher q-Brownian motion. The answer is as follows. In a strict sense, there exist no independence (= no universal calculation rule) which coresponds to the q-Brownian motion. But in a weak sense (in the asymptotic sense), there exist an independence (= a universal calculation rule in the setting of C^*-probability spaces) which produces the q-Brownian motion.

28. **Nobuaki Obata (Tohoku)**

Quantum probabilistic aspect to random walks on graphs.

Abstract: Quantum probabilistic approaches have been developed for the (asymptotic) spectral analysis of graphs [1]. The method of quantum decomposition, one of the typical techniques of quantum probability, has been proved with many examples to be particularly useful when a graph admits (asymptotically) one-mode interacting Fock space structure. There are interesting examples, however, that do not allow this structure. In this talk, motivated by Karlin-McGregor

formula [2] and its generalizations, e.g., [3], I will present an attempt to slightly generalize our method going beyond one-mode interacting Fock spaces.

References:

[1] A. Hora and N. Obata: Quantum Probability and Spectral Analysis of Graphs, Springer. 2007.
[2] S. Karlin and J. McGregor: Random walks, Illinois Math. J. 3 (1959), 66–81.
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29. **Mihai Popa (Negev & IMAR)**

Non-commutative functions in operator-valued non-commutative probability.

Abstract: Given two vector spaces, $\mathcal{V}$ and $\mathcal{W}$ over $\mathbb{C}$, a non-commutative function is, briefly, a mapping from a certain class of subsets of the matrix space over $\mathcal{V}$ to the matrix space over $\mathcal{W}$ satisfying some compatibility conditions: it has to respect direct sums and simultaneous similarities, or equivalently, simultaneous intertwinings. The amazing thing is that, first, noncommutative functions admit a very nice differential calculus (more precisely, we develop a formalism which includes both a differential calculus and a calculus of finite differences). Second, they have very strong regularity properties reminiscent of the classical analytic functions, with the compatibility conditions (the respect of direct sums) playing a somewhat analogous role to the Cauchy-Riemann equations.

Our initial motivation came from problems in noncommutative positivity and noncommutative matrix inequalities; non-commutative functions proved also to be a good framework for problems in operator-valued non-commutative probability. Such objects were considered before by J. L. Taylor in his groundbreaking work on the noncommutative spectral theory, and more recently independently by D.-V. Voiculescu in free probability. One can also think of noncommutative functions as functions between operator spaces.

The lecture will survey some applications of this theory in operator-valued non-commutative probability, such as op-valued Cauchy and R-transforms, op-valued semicircle and arcsine distributions, non-commutative free Levy-Hincine formula and Bercovici-Pata bijection. Most of the results presented are joint work with V. Vinnikov and S. Belinschi.

30. **Adam Skalski (Lancaster & Łódź)**

How noncommutative is noncommutative topological entropy?

Abstract: The notion of noncommutative topological entropy for automorphisms of (nuclear) C^*-algebras was introduced in 1995 by Voiculescu as a generalisation of the topological entropy for continuous transformations of compact spaces. Most methods of computing the Voiculescu entropy are related to finding suitable commutative subsystems of noncommutative dynamical systems, which suggests a straightforward relation between the classical and quantum case. In this talk we will discuss some of the properties of the Voiculescu entropy and present recent examples related to endomorphisms of Cuntz algebras and to bitstream shifts studied by Neshveyev and Stormer which show that the connections between the commutative and noncommutative case are actually quite subtle.

31. **Alexander Soshnikov (UC Davis)**

On local distribution of eigenvalues in Wigner random matrices.

Abstract: I will try to make the talk accessible to a wide audience.

In the first half of my talk, I will discuss some recent results of my graduate student Sean O'Rourke about the Gaussian fluctuations of the eigenvalues in a sufficiently wide ensemble of real symmetric random matrices. In his recent paper (just published in the J. Stat. Phys.), O'Rourke extends the results of Jonas Gustavsson (for the GUE case) and Terence Tao and Van Vu (for Hermitian Wigner matrices).

In the second part of my talk, I will discuss a resolvent approach to a universality problem in Wigner matrices. In particular, I will discuss recent results obtained jointly with my graduate students Pierre Dueck and David Renfrew.

32. **Wojciech Szymański (IMADA)**

Endomorphisms of the Cuntz Algebras.

Abstract: We review the recent progress in the study of endomorphisms of the Cuntz algebras. Our focus is on endomorphisms and automorphisms which preserve either the canonical diagonal MASA or the core UHF-subalgebra of $\mathcal{O}_n$.

Regarding the automorphisms, we discuss the group of those automorphisms which globally preserve both the diagonal $\mathcal{D}_n$ and the UHF-subalgebra $\mathcal{F}_n$ and its quotient by those automorphisms which fix the diagonal point-wise (the so called restricted Weyl group of $\mathcal{O}_n$). We show that its image in the outer automorphism group of $\mathcal{O}_n$ is isomorphic with the quotient of the group of automorphisms of the full two-sided n–shift by its center (generated by the shift itself). This result opens the way for two-way applications: of algebraic methods to the study of $Aut(\mathcal{F}_n)$, and of symbolic dynamics methods to the study of $Aut(\mathcal{O}_n)$.

Regarding the proper endomorphisms, we discuss constructions of endomorphisms which globally preserve the core UHF-algebra but which do not correspond to unitaries in $\mathcal{F}_n$ (via the Cuntz $u \to \lambda_u$ correspondence). Similarly, we discuss construction of endomorphisms which globally preserve the diagonal MASA but which do not correspond to unitaries in the normalizer of $\mathcal{D}_n$.

Finally, we also briefle indicated an avenue for extension of some the above mentioned results to the more general case of graph C^*–algebras (or Cuntz-Krieger algebras).

The main part of this talk is based on the recent joint work with Roberto Conti (Pescara) and Jeong Hee Hong (Busan). We also reveiew some earlier results obtained in collaboration with Mikael Rørdam (Copenhagen) and Adam Skalski (Lancaster).

References:

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33. **Wilhelm von Waldenfels (Heidelberg)**

The Singular Coupling Limit for a Simple Pure Number Process.

Abstract: We consider the strongly continuous unitary one parameter group $W(t)$ on $L^2(\mathbb{R})$, which is related to the pure number quantum stochastic process restricted to the one particle subspace $L^2(\mathbb{R})$. We approximate the Hamiltonian of the group by

$$H = i\partial + |g\rangle\langle g$$

and go with g to $\int g(x)dx\delta$. Then the approximating unitary group converges to $W(t)$ in the strong operator topology with a parameter given explicitly.

34. **Stefan Wagner (Darmstadt)**

A new characterization of free group actions and a geometric approach to noncommutative principal $\mathbb{T}^n$-bundles.

Abstract: The *noncommutative geometry* of principal bundles is not really well understood so far. However, there is already an abstract algebraic approach using the theory of Hopf algebras. An important handicap of this approach is the ignorance of any topological and geometrical aspects. In this talk we follow a more geometrical approach involving dynamical systems and irreducible representations of the corresponding transformation group. In particular, we will give a (possible) definition of *noncommutative principal $\mathbb{T}^n$-bundles*.

35. **Hiroaki Yoshida (Tokyo)**

On the free Fisher information distance and the logarithmic Sobolev inequality.

Abstract: We shall introduce the free Fisher information distance which is inspired by the estimation-theoretic representation of the free relative entropy. We shall see the free analogue of the logarithmic Sobolev inequality and also the semicircular approximation of the free Poisson law.

36. **Joachim Zacharias (Nottingham)**

On groups with the invariant translation approximation property.

Abstract: The invariant translation approximation property (ITAP) was introduced by John Roe few years ago in connection with the coarse Baum Connes conjecture. It concerns the way in which the reduced group C^*-algebra sits in the uniform Roe algebra, the C^*-algebra associated to the group considered as a coarse space, namely whether it is the fixed point algebra under right translations. There is also a natural version of this property with coefficients which is slightly stronger. It is still an open problem whether all groups have the ITAP. We present some basic results about the ITAP including some permance properties and connections to other approximation properties. Moreover, we use some recent results of Lafforgue and de la Salle to show that not all discrete groups have the ITAP with coefficients. (This is partly joint work with Jacek Brodski.)

37. **Karol Życzkowski* (Kraków)**

Graph random quantum states and Fuss-Catalan distribution.

Abstract: The density operator is represented by a hermitian, positive matrix ρ with its trace set to unity. We analyze various ensembles of random density operators of a fixed size N and study constructive algorithms to generate them at random. A standard construction is based on generating random pure states (one-dimensional projectors) on a composite Hilbert space $\mathcal{H}_N \otimes \mathcal{H}_M$ according to the unique, unitarily invariant Fubini-Study measure. The random mixed state is then obtained as a marginal by taking the partial trace over the auxiliary M-dimensional subspace. In the symmetric case, $M = N$, one obtains in this way random density matrices of size N distributed according to the Hilbert–Schmidt (Euclidean) measure [1]. A slightly different procedure leads to random mixed states generated according to the Bures measure [2], induced by the Bures distance.

Other measures in the space of density operators can be introduced by using the notion of the random graph states [3]. For any graph consisting of m edges we define an ensemble of random pure states on a composite system with $2m$ subsystems of the same dimension. Each edge corresponds to a maximally entangled state of the two connected subsystems, while each vertex represents a random unitary matrix, distributed according to the Haar measure, which describes an unknown interaction between the subsystems. Selecting an arbitrary partition of the graph into two disjoint parts, A and $\bar{A}$, one defines an ensemble of random mixed states, obtained by partial trace over the subsystems belonging to $\bar{A}$.

We develope tools designed to estimate the average von Neumann entropy of a random graph state and to characterize the resulting spectral density. In several simple cases the spectral density is asymptotically given by the Marchenko-Pastur distribution. Examples of graphs leading to level density described by the Fuss-Catalan distribution of an arbitrary order s are presented. In such a case the density operator has a structure of a product of s independent random Ginibre matrices, multiplied by its adjoint and renormalized,

$$\rho = (G_1 \cdots G_s)(G_1 \cdots G_s)^* / \mathrm{Tr}[(G_1 \cdots G_s)(G_1 \cdots G_s)^*].$$

References:

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