Abstracts

Marek Bozejko

Von Neumann algebras connected with generalized Gaussian random variables with some applications to operator spaces

We will consider von Neumann algebras constructed from different types of non-commutative Gaussian random variables like free Gaussian related to free probability and Cuntz algebra, q-Gaussian related to the theta function of Jacobi and q-Hermitian polynomials and other generalizations related to the group von Neumann algebras.

We will give applications to noncommutative (quantum) functional analysis and explain the second quantization functor from the category of Hilbert spaces (with contractions as morphisms) to von Neumann algebras (with completely positive maps as morphisms).

Connections with harmonic analysis on infinite permutation groups will be also presented.

Emmanuel Breuillard

Approximate groups and Hilbert's 5th problem

I will present a recent joint work with Ben Green and Terence Tao, in which we establish a structure theorem for approximate groups. Approximate groups are finite subsets A of an ambient group which are almost closed under multiplication (the product set AA can be covered by a bounded number of translates of A). The proof makes use of ideas of Hrushovski pertaining to model theory as well as a reworking of the proof of the Gleason-Yamabe-Montgomery-Zippin solution to Hilbert's fifth problem about the structure of locally compact groups. The result has applications to the growth of finitely generated groups (including generalizations of Gromov's theorem on polynomial growth) and to Riemannian geometry (e.g. to Ricci almost non-negatively curved manifolds).

Detlev Buchholz

Resolvent Algebras — A New Algebraic Framework For Quantum Physics

The standard algebraic treatment of canonical quantum systems in terms of Weyl algebras frequently causes difficulties in applications since it neither admits the formulation of physically interesting dynamical laws in the Heisenberg picture nor does it incorporate pertinent physical observables. In this talk an alternative C*-algebraic framework is presented which seems to be better suited. The underlying resolvent algebras, describing the canonical degrees of freedom, have an interesting ideal structure which encodes specific information about the underlying system. Moreover, they provide a convenient setting for applications to interacting and constrained quantum systems, as is illustrated by some examples.

Marc Burger

Soft Counting

We study the density at infinity of the set of integer points on an affine variety V which is homogeneous under the action of a semisimple group G. The study of the possible G-orbits, in an appropriate compactification of V, which have positive density leads to a relative fixed point property linking two subgroups of G and generalizing the concept of amenability introduced by J. von Neumann in 1929. This is joint work with J.Portmann.

Ilijas Farah

Von Neumann and higher set theory

I will discuss how structure of higher levels of the set-theoretic universe affects everyday mathematical practice. Some emphasis will be given to problems related to von Neumann's work. Incidentally, the set-theoretic universe as we know it was also defined by von Neumann.

Uffe Haagerup

Spectral subspaces for non-normal operators in finite von Neumann algebras

The talk will be a survey on a series of papers from the last 10 years, which resulted in the construction of spectral subspaces E(T,B) for all operators T in any finite von Neumann algebra, and all Borelsets B in the complex plane (cf. [1]). The Fuglede-Kadison determinant (1952) and L. G. Brown's spectral distribution measure (1986) play a key role in the construction of these spectral subspaces. As an application, it follows that every operator T in a finite von Neumann algebra M has non-trivial closed invariant subspaces affiliated with M, provided its Brown measure is not concentrated in a single point. For normal operators T, the spectral subspaces E(T,B) coinside with the spectral subspaces obtained from the classical spectral resolution of T.

[1] Uffe Haagerup and Hanne Schultz, Invariant subspaces for operators in a general II_1 factor. Publ. Math. IHES 109, pp. 19-111 (2009).

Ursula Hamenstädt

Equidistribution and counting in strata of quadratic differentials

The equidistribution problem for periodic orbits and sharp growth rates for counting functions for hyperbolic systems has a long history. We plan to discuss some of the basic ideas and explain how to establish such sharp equidistribution and counting results for strata in the moduli space of quadratic differential on a Riemann surface of finite type.

Tadeusz Januszkiewicz

Fundamental groups of blowups

Matthias Kreck

Invertible field theories and cut and paste groups

This is joint work with Stephan Stolz and Peter Teichner. I will explain what a topological (or geometric) quantum field theory of dimension d is. The isomorphism classes of field theories form a monoid under the tensor product and one can ask what the units are. This is on the one hand much simpler than looking at all field theories and on the other hand an interesting class of field theories. The partition function of an invertible filed theory ís a SKK-invariant (controllable cut and paste invariant). We determine the kernel and kokernel of the map given by the partition function.

John Lott

Measurable Geometry

The space of probability measures carries a natural metric, related to optimal transport of measures. Properties of this metric space give a notion of (Ricci) curvature for nonsmooth spaces. I will survey these connections and give results on the intrinsic geometry of the space of probability measures.

Alex Lubotzky

Arithmetic groups, Ramanujan graphs and error correcting codes

While many of the classical codes are cyclic, a long standing conjecture asserts that there are no 'good' cyclic codes. In recent years the interest in symmetric codes has been promoted by Kaufman, Sudan, Wigderson and others (where symmetric means that the acting group can be any group). Answering their main question (and in contrary to the common expectation), we show that there DO exist symmetric good codes. In fact, our codes satisfy all the "golden standards" of coding theory. Our construction is based on the Ramanujan graphs contructed by Lubotzky-Samuels-Vishne as a special case of Ramanujan complexes. The crutial point is that these graphs are edge transitive and not just vertex transitive as in prevous constructions of Ramanujan graphs. All notions will be explained. Joint work with Tali Kaufman.

Werner Müller

L^2-invariants of locally symmetric spaces

L^2-invariants are spectral invariants associated to the universal covering of a compact manifold. The definition of L^2-invariants takes the action of the fundamental group into account and is based on the group von Neumann algebra and its trace. We will consider L^2-invariants of locally symmetric spaces, especially the L^2-torsion, and its applications to the cohomology of arithmetic groups.

Amos Nevo

von Neumann's mean ergodic theorem: from amenable to non-amenable groups

von-Neumann original proof of the mean ergodic theorem was based on the spectral theorem for unitary operators, and served as an important motivation for developing this theorem in the first place. An alternative proof was later given by Riesz, which emphasizes the role of another concept originally introduced by von-Neumann, namely amenability.
After briefly recalling these classical proofs, we will survey the development of mean ergodic theorems for non-amenable groups, and in particular, for semisimple algebraic groups and their lattice subgroups. We will comment both on the use of spectral methods, and also on a very recent discovery of a new approach to ergodic theorems which puts amenable groups and non-amenable groups on an equal footing.

Anand Pillay

Definable (or tame) topological dynamics

We adapt abstract topological dynamics to the case of the action on a compact space of a group G equipped with a distinguished G-invariant Boolean subalgebra B of its power set, e.g. where B is the Boolean algebra of definable subsets of G (with respect to some structure). The general theme was initiated by Newelski to give new invariants for definable groups coming from the topological dynamics point of view, as well as to compare with existing model-theoretic tools.

Michael Röckner

Regularization of Ordinary and Partial Differential Equation by Noise

It is well known that there are ordinary differential equations (ODE) which have no or many solutions for a given initial condition, but have a unique solution if one adds a sufficiently large noise. We shall first explain this type of "regularization by noise" on the level of the corresponding Fokker-Planck-Kolmogorov equations both for ODE in finite and infinite dimensional state spaces. Then we shall recall a concrete ODE in finite dimensions given by a merely p-integrable vector field which has a unique strong solution when perturbed by a Brownian noise. Finally, we shall present an analogous new result in infinite dimensions, which is applicable to stochastic partial differential equations.

Christian Rosendal

Isometry groups and maximal symmetry

I shall present some problems and recent results concerning maximal symmetry in Banach spaces. The aim is to understand group invariant renormings of Banach spaces and, in particular, to provide the first known example of a Banach space X without any equivalent maximal norm, or equivalently such that the general linear group GL(X) contains no maximal bounded subgroup. This is done through an analysis of the structure of small subgroups of GL(X), such as the Fredholm group, where X is a separable reflexive Banach space. This is joint work with V. Ferenczi.

Klaus Schmidt

Some facets of multi-parameter ergodic theory

Classical ergodic theory (e.g., in the setting of von Neumann and Birkhoff) deals with actions of single transformations (or one-parameter flows) on probability spaces. If one replaces the acting group (i.e., the integers or the real numbers) by bigger groups some interesting problems and unexpected phenomena emerge – even when restricting attention to actions of higher rank abelian groups. The purpose of this talk is to illustrate some of these problems and surprises with simple examples.

Robert J. Stanton

Quantum mechanics: representation theory, algebra, geometry

During the early years of his career John von Neumann devoted considerable energy toward the rapidly evolving subject "quantum mechanics" . Among his results in this area are the canonical commutation relations, the mathematical foundations via Hilbert space, and algebras of observables. We shall recall the background and content of these results, and then follow their trail as they motivated developments in representation theory, nonassociative algebra, and some current activity related to differential geometry.

Karen Vogtmann

Lie algebras of derivations and Outer space

Motivated by considerations from physics, Kontsevich defined three Lie algebras and showed how to identify their cohomology with the homology of various spaces of graphs. One of these spaces of graphs is known as Outer space, because it has a proper action by the group $\mathrm{Out}(F_n)$ of outer automorphisms of a free group. The homology of the quotient of Outer space by this action is an invariant of $\mathrm{Out}(F_n)$. Very few non-trivial homology classes have been found, but I will show how Kontsevich's theorem can be used to product a large number of cycles, including some which are related to modular forms. In small dimensions we can show (with the help of a computer) that these cycles represent non-trivial homology classes, and we conjecture that they are all non-trivial. Similar methods produce non-trivial homology for mapping class groups as well, and conjecturally for GL(n,Z). This is joint work with J. Conant and M. Kassabov.