Mathematical Physics Seminars

2012 - 2013

All seminars are held in Room M/2.06 on Thursdays at 3:10pm unless otherwise stated. All are welcome.

Programme Organiser and Contact: Professor David E Evans

4 October 2012

Speaker: John Cardy FRS (Oxford)

Title: Discrete Holomorphicity, Integrability and Parafermions in Two Dimensions.

Abstract: I review the recent process in identifying observables in two-dimensional lattice models which satisfy a discrete version of the Cauchy-Riemann relations. Remarkably these seem to require that the model be both critical and integrable in the sense of Yang-Baxter. The observables obey fractional statistics and are conjectured to correspond to the parafermionic fields of the conformal field theory which describes the scaling limit of the lattice model. In cases when this conjecture can be proven it gives a constructive route to the field theory.

12 October 2012 at 14:10 in M/1.25

Speaker: Sophie Schirmer (Swansea)

Title: Quantum networks: information flow and control of quantum information.

Abstract: A quantum network is a collection of interacting quantum particles. One of the key features of quantum networks is the existence of coherent superpositions of states and interference. This allows a single excitation in a network to be distributed over many nodes and evolve as if taking all possible paths at once, leading to non-classical behaviour. In the talk I will give a general introduction to quantum networks and summarize some recent results about information transfer capacities and network geometry and applications of the latter, control of information flow and controllability.

25 October 2012

Speake: Joshua Cadney (Bristol)

Title: The role of Entropy in Quantum Information.

Abstract: The von Neumann entropy is a crucial concept in quantum information theory. It quantifies the entanglement of bipartite pure quantum states, and the information present in a quantum source (and many other things besides!). I will demonstrate a few of its uses, and introduce another perspective in the study of von Neumann entropy: information inequalities. I will outline some new results in this area.

1 November 2012

Speaker: Anthony Dooley (Bath)

Title: Critical Dimension and entropy in dynamical systems.

Abstract: Click here.

8 November 2012

Speaker: Robin Hillier (Cardiff)

Title: About graded KMS states and algebraic quantum field theory.

Abstract: We recall origin and meaning of KMS states (thermal equilibrium states) in both physics and mathematics and then explain a little bit importance and relations to algebraic quantum field theory. With this background, we can introduce suitable Z/2Z-graded generalisations of KMS states and algebraic quantum field theories allowing for the treatment of supersymmetry. We discuss a few general facts, some examples, relations to the original non-graded versions, and an interesting application using noncommutative geometry.

22 November 2012

Speaker: Daniel Burgarth (Aberystwyth)

Title: Quantum Control: reachability & recurrence.

Abstract: I will give an informal introduction to quantum control, focussing on the concept of reachability. The theory becomes hard in infinite dimensional or open systems, such as quantum optical systems. Recurrent dynamics seems to be the key ingredient to develop a better understanding of these cases. I will show some recent results in this direction.

6 December 2012

Speaker: Andreas Winter (Barcelona and Bristol)

Title: Highly entangled states with almost no secrecy.

Abstract: Despite the technical-sounding title this talk is largely a review
of the theory of bipartite quantum entanglement and its quantification. The plan is to look at various entanglement measures for the specific family of anti-symmetric states (proportional to the anti-symmetric projector) in dxd, on which new results are reported. These are entangled states, which are known to contain distillable pure entanglement, and hence also can be used to establish secret key. We show, using the group symmetry of these states, that several measures associated to entanglement/correlation cost are lower bounded independent of d, whereas the distillable key is bounded inversely with d, thus establishing a kind of asymptotically bound key, analogous to the well-known 'bound entanglement'.
[Joint work with M. Christandl and N. Schuch, CMP 311:397-422, 2012]

13 December 2012

Speaker: Miles Reid FRS (Warwick)

Title: Update on the McKay correspondence

Abstract: I start with a brief historical overview. The McKay correspondence relates the representation theory of a finite group G in SL(n,CC) to the geometry of the quotient CC^n / G and its crepant resolution. The case of finite subgroups of SL(3,CC) is now well under control in several different categories of geometry.

We know that it is not reasonable to expect similar results for general finite subgroups of GL(3,CC) or SL(n,CC) for n >=4, but the monomial calculations used for the SL(3,CC) case suggest some classes of groups that can be treated by similar methods.

See my website + McKay correspondence for the established material and
www.warwick.ac.uk/staff/T.Logvinenko/Traps/ for the more recent story (still in progress).

14 February 2013

Speaker: Jacek Brodzki (Southampton)

Title: Mathematics of networks and data sets.

Abstract: In this talk we will explore various direct links between methods from pure mathematics (metric space techniques, algebraic topology, graph theory, among others) and problems arising in applications. The talk will centre on two main examples. We will first discuss the structure and function of power grids from the point of view of spectral geometry, and secondly we will present some very interesting ideas from algebraic topology and coarse geometry to the study of data sets.

14 March 2013

Speaker: Gwion Evans (Aberystwyth)

Title: Identifying approximately finite-dimensional Cuntz-Krieger algebras of higher-rank graphs.

Abstract: The Cuntz-Krieger algebras of higher-rank graphs have attracted much interest since they were introduced by Kumjian and Pask at the turn of the millennium. They can be analysed in much the same way as Cuntz-Krieger algebras and graph C*-algebras, but they are a richer source of examples than these special cases. For instance, simple (rank one) graph C*-algebras admit an elegant classification theorem: they are either purely infinite or approximately finite-dimensional (AF).

However, this dichotomy no longer holds for rank greater than one (for example, rank 2 higher-rank graph C*-algebras include, up to strong Mortia equivalence, all irrational rotation algebras). As a step towards a classification theorem for higher-rank graph C*-algebras we investigate the question when is the Cuntz-Krieger algebra of a higher-rank graph AF. Our investigations indicate that the question is far more difficult when the rank is greater than one, and leads to the possibility of an alternative presentation that might be particularly useful to study actions of groups on AF-algebras.

This is joint work with Aidan Sims.

15 March 2013 - 14:00-18:00 in M/0.40

COW Algebraic Geometry Seminar (Organized by Timothy Logvinenko)

14:00 - 15:00: **Speaker:** Alastair Craw (Bath)
Title: Identifying approximately finite-dimensional Cuntz-Krieger algebras of higher-rank graphs.
Abstract: A consistent dimer model on a real 2-torus determines a CY3 algebra A whose centre defines a Gorenstein toric threefold X. Results of Ishii-Ueda show that every projective crepant resolution of X can be constructed as a fine moduli space of A-modules such that the tautological bundle T on the moduli space is a tilting bundle. I'll explain what is known about the image of the vertex simple A-modules under a derived equivalence induced by T for the moduli space defined by a special stability parameter. When A is the skew group algebra of a finite abelian subgroup G in SL(3,C), this moduli space is the G-Hilbert scheme, and our results extend work of Cautis-Logvinenko and Logvinenko on 'Geometric Reid's recipe'. Our proof uses variation of GIT quotient and is rather different from the original work of Cautis and Logvinenko. This is joint work with Raf Bocklandt and Alex Quintero Velez.

15:30 - 16:30: **Speaker:** Ed Segal (Imperial)
Title: Mixed braid group actions from B-brane monodromy.
Abstract: Seidel and Thomas famously found a braid group action on the derived category of coherent sheaves on the resolution of a type-A surface singularity. I'll describe a related construction of a whole system of higher-dimensional varieties, indexed by partitions, whose derived categories carry actions of the corresponding 'mixed' braid groups. Heuristically, these actions arise from monodromy in the parameter spaces of some particular quantum field theories. (This is joint work with Will Donovan).

17:00 - 18:00: **Speaker:** Jeff Giansiracusa (Swansea)
Title: Scheme-theoretic tropical geometry.
Abstract: Tropical geometry is a tool in algebraic geometry that transforms certain questions into combinatorial problems by replacing a variety with a polyhedral object called a tropical variety. It has been tempting to try to view tropical varieties as varieties in a more literal sense over the idempotent semiring T of

tropical numbers, and to understand tropicalization as a degeneration taking place not between two disjoint worlds but rather within one common framework. We begin to fulfil this vision. Within the recently developed frameworks for geometry over the field with one element (Toen-Vaquie, Lorscheid, Durov) we define a scheme-theoretic tropicalization for which traditional tropicalization is recovered by taking T-valued points. For projective schemes our tropicalization preserves the Hilbert function. This is joint work with Noah Giansiracusa (Berkeley).

21 March 2013

Speaker: Geoffrey Robinson (Heilbronn)

Title: Fusion and Amalgams.

Abstract: In both finite group theory and representation theory, the question of fusion arises naturally. In the group-theoretic context, this means the question of how the elements and subgroups of a fixed Sylow p-subgroup P of a finite group G are conjugated to each other within G. Alperin showed that this process is controlled "p-locally", that is within the normalizers of non-trivial subgroups of P. An analogous situation occurs in representation theory. One way to model both situations is a categorical construction known as a fusion system, defined on a finite p-group.

Given an abstract fusion system, it may or may not be realised within a finite group. But it can be realised via an infinite group, using the amalgam construction. This apparently circuitous route can lead to new and interesting representations of finite groups. We illustrate with an example using a semidihedral 2-group, which leads to a 5-dimensional representation of a certain amalgam as an S-arithmetic group, which is a "lift" of a 5-dimensional representation of the smallest sporadic simple group M_{11} in characteristic 3.

16 April 2013

LSW Frontiers Distinguished Lecture

Speaker: Sir Vaughan Jones FRS (Vanderbilt)

Title: Flatland, a great place to do algebra.

Abstract: In his book "Flatland, a romance of many dimensions", Edwin Abbott imagines a two-dimensional world inhabited by two-dimensional creatures. The lack of a third dimension might appear to reduce possibilities all round but we will explain how a system of algebra based on two dimensional configurations is in fact very rich. It has even been proposed as the basis for building a quantum computer. The talk, intended for those without too much mathematics background, will be enhanced by a certain number of more or less relevant anecdotes and images and trace the speaker's own mathematical voyage in dimensions.

A poster for the event is available here.

18 April 2013

Speaker: Chris Brav (Oxford)

Title: A Darboux theorem for shifted symplectic derived schemes.

Abstract: We explain the notion of shifted symplectic structure in derived algebraic geometry and prove a Darboux theorem for derived schemes with shifted symplectic structure of degrees. Our results have applications to quantization of moduli spaces and categorification of Donaldson-Thomas.

2 May 2013

Speaker: Yusuke Isono (Tokyo University)

Title: Strong solidity of II_1 factors of free quantum groups.

Abstract: We generalize Ozawa's bi-exactness to discrete quantum groups and give a new sufficient condition for strong solidity, which implies the absence of Cartan subalgebras. As a corollary, we prove that II_1 factors of free quantum groups are strongly solid. We also consider similar conditions on non-Kac type quantum groups, namely, non finite von Neumann algebras.

16 May 2013

Speaker: Bram Mesland (Warwick)

Title: Gauge theory for spectral triples via the unbounded KK-product.

Abstract: Unbounded KK-cycles with connection can be viewed a fibrations of spectral triples. When a noncommutative spectral triple is fibered, via such a cycle, over a commutative base, a natural setting for gauge theory presents itself. By considering gauge trnasformations that are implemented by fibrewise unitaries in the KK-cycle, the fact that commutative algebras do not possess nontrivial inner automorphisms is conveniently accounted for. Moreover, the connection allows for the distinction between horizontal and vertical differential forms on the spectral triple at hand. We will discuss this formalism for the noncommutative torus, and in the topologically nontrivial setting of the noncommutative 3-sphere. This is joint work with Simon Brain (Trieste) and Walter van Suijlekom (Nijmegen).

6 June 2013 at 16:10

Speaker: Miles Reid FRS (Warwick)

Title: The equations defining a variety.

12 June 2013 at 14:15 in M/1.25

Speaker: Stephen Moore (Cardiff)

Title: An introduction to Planar Algebras.

20 June 2013

Speaker: Jon Keating FRS (Bristol)

Title: Primes, Polynomials and Random Matrices - inspired, in part, by a conjecture of Professor C Hooley.

Abstract: The Prime Number Theorem tells us roughly how many primes lie in a given long interval. We have much less knowledge of how many primes lie in short intervals, and this is the subject of a conjecture due to Goldston and Montgomery. Likewise, we also have much less knowledge of how many primes lie in different arithmetic progressions. This is the subject of a conjecture due to Hooley. I will discuss the analogues of these conjectures for polynomials defined over function fields and outline how they can be proved via the theory of random matrices.