Mathematical Physics Seminars
2014-2015

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

12 May 2016
Speaker: Enrico Fatighenti (Warwick)
Title: Hodge Theory, deformations of affine cones and beyond
Abstract: Hodge Theory and Deformation Theory are known to be closely related. Amongst the many avatars of this friendship we have Griffiths's Residues calculus for hypersurfaces or the Calabi-Yau case, were the first order deformations of a smooth algebraic variety are identified with a special piece of its Hodge structure. In this talk we show how in the more general case of a smooth projective subcanonical variety X we can reconstruct part of its Hodge Theory by looking at a distinguished graded component of the first order deformations module of its affine cone A. In order to get a global reconstruction theorem we then move to the study of the Derived deformations of A (à la Kontsevich), showing how to find amongst them the missing Hodge spaces. We will show then some applications of this new technique, for example to Mukai Varieties.

5 May 2016
Speaker: Sarah Hart (Birkbeck, University of London)
Title: Product-free sets in groups
Abstract: A set S of positive integers is sum-free if for all a,b in S a+b is not in S. Any finite sum-free set of positive integers is contained in a strictly larger sum-free set, so we tend to frame questions in terms of sum-free sets of {1,...,n}. For example, what is the maximum cardinality of a sum-free set of {1,...,n}? How many sum-free sets of {1,...,n} are there; can we categorize sum-free sets that are maximal not by cardinality but by inclusion, how small can such sets be, and so on. Such questions were generalised first to cyclic groups, then abelian groups, and then to general groups, where we speak of `product-free sets'. In this talk I'll give an overview of what's known in the general groups case, before describing some recent work with my PhD student Chimere Anabanti.

21 April 2016
Speaker: Cornelia Drutu (Oxford)
Title: Strong versions of Kazhdan's property (T) and random groups
Abstract: Various strengthened versions of property (T) have been formulated in recent years, relevant in combinatorics, algebra, in relation to the conjectures of Baum-Connes and Novikov, in Riemannian geometry etc. Among them, those involving actions on Lp spaces are particularly interesting, because they manage to achieve a separation between rank one and higher rank lattices, because of their presumed connection to the conformal dimension of the boundary of hyperbolic groups, and because of the increasing role that they play in operator algebras. In this talk I shall explain how random groups have all the strengthened Lp-versions of property (T). This is joint work with J. Mackay.

14 April 2016
Speaker: Sibylle Schroll (Leicester)
Title: Special Algebras
Abstract: This talk starts with an introduction to the representation theory of finite dimensional algebras via quiver and relations. We then introduce some reasonable restrictions on the classes of finite dimensional algebras considered and leads to the introduction of special algebras. This class of algebra contains many well-studied types of algebras but also interesting new types. We will give as much of an overview of their representation theory as time allows.

17 March 2016
Speaker: Xiuping Su (Bath)
Title: Richardson Elements in seaweed Lie algebras of classical type
Abstract: A seaweed Lie algebra, defined by Dergachev and Kirillov, is the intersection of two opposite parabolic subalgebras of a reductive Lie algebra. Consider the adjoint action of a seaweed on its nilpotent radical. We are interested in the existence of an open orbit. In the case of parabolics, Richardson showed that such an open orbit always exists. Elements in the open orbit are therefore called Richardson elements.
In this talk I will first explain how to use representations of quivers to construct Richardson elements for a seaweed when the Lie algebra is of type A. Then, I will explain how to use the existence Richard elements in type A and properties of their stabilisers to prove the existence of Richard elements for seaweeds, when the Lie algebra is of type B, C and D.

10 March 2016
Speaker: Joseph Grant (East Anglia)
Title: The Nakayama automorphism for self-injective preprojective algebras
Abstract: Given a finite graph we can define an algebra known as the preprojective algebra. This algebra was originally defined by Gelfand and Ponomarev using generators and relations, but Baer, Geigle, and Lenzing showed how to construct this algebra from the representation theory of a quiver obtained by choosing an orientation on the graph. I will revise this theory, illustrated explicitly using a small example. The preprojective algebra of a graph is finite-dimensional if and only if the graph is Dynkin, and it is known in this case that the preprojective algebra is self-injective. I will discuss this self-injectivity and a related symmetry known as the Nakayama automorphism, which was originally described by Brenner, Butler, and King. This is related to work by Iyama and collaborators in representation theory, and work by Evans and Pugh on SU(3) modular invariants.

3 March 2016
Speaker: Stephen Moore (Cardiff)
Title: Non-semisimple planar algebras from restricted quantum sl2
Abstract: Planar algebras were introduced in relation to subfactors, with a large number of examples coming from the representation theory of quantum groups, for example the Temperley-Lieb algebra can be constructed from quantum sl2. Previously, these constructions have been focused only on irreducible representations, however recent progress in logarithmic conformal field theory has brought interest to indecomposable

representations, coming from what's known as restricted quantum groups. We give a construction of a planar algebra from restricted quantum sl2.

25 February 2016
Speaker: Henning Bostelmann (York)
Title: Quantum inequalities
Abstract: Measurable quantities that have positive values in classical dynamical systems need not be positive in quantum theory. However, after a suitable coarse-graining process, one typically finds (negative) lower bounds for the operators that represent quantum observables; these bounds are called Quantum Inequalities. For example, consider a free quantum mechanical particle in 1 dimension. There are quantum states in which the particle's velocity is positive with probability 1, but where the probability flux for its position is locally negative; that is, while its velocity points to the right, the particle travels to the left! But as a quantum inequality shows, these effects are small and limited in space and time. Other examples include the energy density, which is positive in classical field theories but can have negative values in quantum field theories. The talk will give a review of these phenomena, and report on recent results and work in progress.

18 February 2016
Speaker: Yuki Hirano (Tokyo Metropolitan)
Title: Equivalences of derived factorization categories of gauged Landau-Ginzburg models
Abstract: For a given Fourier-Mukai equivalence of bounded derived categories of coherent sheaves on smooth quasi-projective varieties, we construct Fourier-Mukai equivalences of derived factorization categories of gauged Landau-Ginzburg (LG) models.
As an application, we obtain some equivalences of derived factorization categories of K-equivalent gauged LG models. As another application, we prove that if the kernel of the Fourier-Mukai equivalence is linearizable with respect to a reductive affine algebraic group action, then the derived categories of equivariant coherent sheaves on the varieties are equivalent.

4 February 2016
Speaker: Christian Böhning (Warwick)
Title: Birational automorphism groups and dynamical degrees
Abstract: We will discuss rationality properties of algebraic varieties, in particular various obstructions to rationality; we will also show how dynamical spectra might be used to better understand the structure of birational automorphism groups and birational types of algebraic varieties, and present some results and computational tools for dynamical degrees.

We will try to make the larger part of the talk accessible to non-experts and develop as much as possible from scratch with minimum prerequisites. In particular, basic concepts from algebraic geometry or dynamical systems will be briefly recalled, in a way that will hopefully make apparent their intuitive meaning and the basic ideas they encapsulate without going into all the technicalities.

28 January 2016
Speaker: Aaron Tikuisis (Aberdeen)
Title: Quasidiagonality and the classification of nuclear C*-algebras
Abstract: Quasidiagonality is a concept first introduced for sets of operators by Halmos, and subsequently studied as a property of C*-algebras by Rosenberg, Voiculescu, Ozawa, and many others. In particular, Voiculescu demonstrated that quasidiagonality is an external approximation property with a topological flavour. Recently, N. Brown introduced quasidiagonal traces, a variation on quasidiagonality of C*-algebras, an idea that has turned out to be essential to classification and structure of nuclear C*-algebras.
In this talk, I will discuss the role played by quasidiagonality in the modern picture of classification of C*-algebras. I will mention a result saying that all faithful traces are quasidiagonal, for separable nuclear C*-algebras that satisfy the UCT. This is joint work with Stuart White and Wilhelm Winter.

14 January 2016
Speaker: Michael Whittaker (Glasgow)
Title: Fractal substitution tilings and applications to noncommutative geometry
Abstract: Starting with a substitution tiling, such as the Penrose tiling, we demonstrate a method for constructing infinitely many new substitution tilings. Each of these new tilings is derived from a graph iterated function system and the tiles typically have fractal boundary. As an application of fractal tilings, we construct an odd spectral triple on a C*-algebra associated with an aperiodic substitution tiling. Even though spectral triples on substitution tilings have been extremely well studied in the last 25 years, our construction produces the first truly noncommutative spectral triple associated with a tiling. My work on fractal substitution tilings is joint with Natalie Frank and Sam Webster, and my work on spectral triples is joint with Michael Mampusti (an honours student at the University of Wollongong).

10 December 2015
COW Meeting
14:00-15:00
Speaker: Alessandra Sarti (Poitiers)
Title: Pell's equation and automorphisms of K3^[2]
Abstract: I present recent results on the automorphism group of the Hilbert scheme of two points on a generic K3 surface of any polarization. In this case the Picard number of the Hilbert scheme is two, which is the minimal possible.
In particular by using ampleness results of Bayer-Macri and a detailed study of the isometries of the Picard lattice, I show the existence of non-natural non-symplectic involutions on some Hilbert scheme, depending on the degree of the polarization. In all the results the solutions of certain Pell's equation play a fundamental role. This is a joint work with S. Boissière, A. Cattaneo, M. Nieper-Wisskirchen.

15:30-16:30
Speaker: Agnieszka Bodzenta-Skibinska (Edinburgh)
Title: Flops and spherical functors
Abstract: I will consider derived categories of a pair X, X+ of n>2 dimensional varieties connected by a flop such that the flopping contractions have fibers of dimension less than 2.

I will define the flop functor from the derived category of X to the derived category of X+ and show that it is an equivalence. The composite of two flop funtors yields a non-trivial auto-equivalence of the derived category of X. I will present this auto-equivalence as a spherical cotwist associated to two spherical functors. I will describe geometric point of view on both spherical functors and a relation between them. This is a joint work with Alexey Bondal.

26 November 2015
Speaker: Michael Wemyss (Edinburgh)
Title: Flops and Coxeter Combinatorics
Abstract: I will begin by explaining, mainly as motivation, what flops are in algebraic geometry, and what structures we expect to see from them. The expectation, now proved in many cases, is that they induce some type of "affine pure braid group" acting on the derived category. I will explain the Coxeter combinatorics background, which is completely independent of the geometric motivation. The remarkable thing is that the geometry predicts unseen phenomenon, like an affine version of the symmetries of the pentagon (which does not exist!), and most of the talk will be motivated by the simplest case of two intersecting flopping curves. Towards the end I will explain how they are related to certain tilings of the plane, although the tilings produced are still somewhat mysterious.

12 November 2015
Speaker: Jan Holland (Leipzig)
Title: Towards the non-perturbative construction of the Operator Product Expansion
Abstract: Our current understanding of quantum field theories, such as the Standard Model of particle physics, is based to a large extent on perturbative - i.e. approximate - methods. Exact constructions in quantum field theory are not only of fundamental conceptual interest, but they offer insights into physical phenomena that are intractable by perturbative means.
In this talk, I present progress on a novel approach towards the non-perturbative construction of the Operator Product Expansion (OPE). The OPE is a structure encoding the complete algebraic skeleton as well as the short distance properties of a quantum field theory. Our method is based on a recently found recursion formula for the OPE, which will be discussed along with recent results on properties of the OPE.

5 November 2015
Speaker: Daniela Cadamuro (Bristol)
Title: Wedge-local fields in integrable models with bound states
Abstract: In the context of constructive quantum field theories in the operator-algebraic approach (namely, with the use of C*-algebraic techniques), wedge-local fields play an important role. After the work of Lechner to construct factorizing scattering matrix models with scalar S-matrices without bound states, we recently extended this construction to scalar S-matrices with poles in the physical strip ('bound states') by exhibiting wedge-local fields which arise as a deformation of Lechner's fields with the so called 'bound state operator'. Similar techniques allow us to extend this construction to the Z(N)-Ising and the sine-Gordon models, namely models with a richer particle spectrum and which are believed

to have bound states. In this talk I will present the construction of wedge-local fields in these models and future work to complete such construction.

23 October 2015
Speaker: Rina Anno (MIT)
WIMCS Invited Mini Lecture Course: Categorical braid actions and tangle calculus IV
16:10 Room M/2.06

22 October 2015
Speaker: Rina Anno (MIT)
WIMCS Invited Mini Lecture Course: Categorical braid actions and tangle calculus III

16 October 2015
Speaker: Rina Anno (MIT)
WIMCS Invited Mini Lecture Course: Categorical braid actions and tangle calculus II
11:10 Room M/2.06

15 October 2015
Speaker: Rina Anno (MIT)
WIMCS Invited Mini Lecture Course: Categorical braid actions and tangle calculus I
Abstract: Categorification has been a powerful tool in geometric representation theory in the past 20 years. Roughly speaking, to categorify is to discover a higher structure underneath a simpler one: we turn integers into sets, sets into categories, and maps into functors, and sometimes a polynomial into a chain complex of vector spaces, or a commutative ring into an abelian category. In these lectures we are going to discuss braid group actions on bounded derived categories of coherent sheaves on certain algebraic varieties which categorify Weyl group actions on their K-theory, and a representation of tangle category that categorifies Khovanov homology.

The simplest and the best known example of an algebraic variety with a categorical braid group action is a resolution of a Kleinian singularity. We will start with this example and proceed to introduce Khovanov-Thomas braid group action on the total space of a cotangent bundle to a flag variety and Bezrukavnikov-Riche affine braid group action on the Springer resolution of a nilpotent cone in a semisimple Lie algebra g (which can be shown to generalize the two previously mentioned examples).

Finally, we will introduce the tangle category, where in particular objects are even non-negative integers and their endomorphism groups are the corresponding braid groups of type A. We will construct a representation of the affine tangle category using certain subvarieties of Springer resolutions for g = sl2n which incorporates the corresponding Bezrukavnikov-Riche actions as the actions of those endomorphism groups. This representation categorifies Khovanov's knot homology via the interpretation of knots and links as (0; 0) tangles which act by endofunctors on the derived category of a point. The latter is the derived category of vector spaces, so endofunctors correspond to chain complexes of vector spaces which compute Khovanov homology.

8 October 2015

Speaker: Konstanze Rietsch (King's)
Title: On mirror symmetry for Grassmannians [Joint work with Robert Marsh]
Abstract: The geometry of Grassmannians is closely tied up with combinatorics, particularly of symmetric functions, via Schubert calculus. We discuss the 'quantum analogue' of Schubert calculus (small quantum cohomology) which gives rise to a connection introduced by Dubrovin and by Givental, and we explain how to find flat sections for this connection using mirror symmetry. As a consequence of these results we obtain formulas for Gromov-Witten invariants of Grassmannians conjectured in the late 90's by Batyrev, Ciocan-Fontanine, Kim and van Straten.