Mathematical Physics Seminars

2010 - 2011

9 September 2010

Speakers: Benjamin Himpel (Aarhus) and George A Elliott (Cardiff, Copenhagen, and Canada Research Chair, Toronto)

Titles: Chern-Simons theory and classical topological invariants (Himpel) and AT (approximate circle) algebras - a microcosm of the world of C*-algebras? (Elliott)

Abstract: We will review how Chern-Simons theory is used to define invariants for knots and 3-manifolds and describe which place the SU(2) Casson invariant takes in this story. Then we will discuss ongoing research on its SU(3) generalization and some progress on rigorously identifying the terms of the asymptotic expansion of the Witten-Reshetikhin-Turaev invariants with classical topological invariants. (Himpel)

15 September 2010

Speaker: Adam Skalski (Lancaster)

Title: On some questions related to 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 bitstream shifts studied by Neshveyev and Stormer and to endomorphisms of Cuntz algebras which show that the connections between the commutative and noncommutative case are actually quite subtle. This suggests the need for better understanding of the collection of classical subsystems of a given quantum dynamical system (it is a dynamical version of the question of looking for maximal abelian subalgebras of a C*-algebra).

7 October 2010

Speaker: Benjamin Doyon (Kings' College London)

Title: The vertex operator algebra of conformal loop ensembles

Abstract: Vertex operator algebra (VOA) is the algebraic setup formalising conformal field theory. It develops in a mathematically complete way the idea of constructing quantum field theory using the algebra of symmetry currents and their modules. On the other hand, conformal loop ensembles (CLE) are measures on random loop configurations that are known, in certain cases, to describe the continuous limit of statistical models at critical points. There is a one-parameter family of such measures, supposed to correspond to all central charges between 0 and 1. These two constructions enjoy complete mathematical rigour, and give the opportunity to understand with more precision the relation between the statistical interpretation of QFT, and its algebraic description. I will describe some of my recent works in this direction: I will explain how to construct the Virasoro VOA (the stress-energy tensor and its descendents) in terms of random objects in CLE. The construction is based on ideas of differentiation on manifolds of conformal maps. No prior knowledge of either VOA or CLE is needed as I will review both subjects.

20 October 2010 - 4pm

Speaker: Stefan Adams (Warwick)

Title: Probabilistic approaches to Boson systems.

Abstract: I will give an overview on probabilistic approaches to Bose-Einstein condensation.

28 October 2010

Speaker: Ed Corrigan FRS (Durham)

Title: Aspects of defects in integrable models

Abstract: Though defects in a general sense are ubiquitous and much-studied within statistical mechanics models it is only recently that they have been considered within integrable field theory. At first sight, defects could be considered disastrous since the property of integrability might be lost. However, it turns out that not only is it possible to have 'integrable defects' but they have a range of interesting properties and cast some new light on traditional features. Several examples will be described, together with their properties in classical and quantum versions of the models.

4 November 2010

Speaker: Mark Haskins (Imperial)

Title: New solutions from old: gluing methods in geometry

Abstract: In many problems complicated geometric objects satisfying nonlinear geometric partial differential equations (metrics of constant scalar curvature, minimal surfaces/soap films), constant mean curvature surfaces/soap bubbles, self-dual metrics, special Lagrangian cones, G2 manifolds etc) can be built as follows: 1. deconstruct families of simple solutions to give building blocks, 2. reassemble these building blocks into more complicated objects which almost solve the equations, 3. perturb these almost solutions to genuine solutions. This is known as a gluing construction and can be thought of as a rigorous geometric version of singular perturbation theory.

This talk will begin with an overview of some of the problems that gluing methods have solved in the last two decades and then concentrate on explaining the method, the technical difficulties and how to overcome them in the case of constant mean curvature surfaces (soap bubbles) in 3-space; this case is easy to visualise and describe but many of the difficulties one must face already appear.

11 November 2010

Speaker: Andreas Fring (City)

Title: Non-Hermitian Hamiltonian systems and antilinear deformations of integrable systems

Abstract: I will provide a brief general introduction into non-Hermitian Hamiltonian systems with real eigenvalue spectra, arguing that they represent well defined self consistent physical systems. Such type of models possess usually an antilinear symmetry, as for instance PT-invariance (simultaneous parity and time reversal) and/or are quasi/pseudo Hermitian. Most crucial is that they allow for a consistent quantum mechanical framework possessing a unitary time evolution. The general framework will be applied to some integrable models, such a quantum spin chains, classical integrable systems associated to differential equations and Calogero-Moser-Sutherland models. I present some recent results.

18 November 2010

Speaker: Edwin Beggs (Swansea)

Title: Combining algorithms and physical systems

Abstract: Joint work with J.V. Tucker and F. Costa.

I will explain what a physical oracle is, and how it is used. After a look at what sort of experiments might constitute a physical oracle, I will look at the theory of such devices. This comes in two parts:
1) How a physical oracle can boost the computational power of a Turing machine.
2) How computation places a limit on the experimental method.
I will end by talking about some areas of current research; measurable numbers, axiomatising physical oracles, and a conjecture on physically aided computation.

2 December 2010

Speaker: Neil O'Connell (Warwick)

Title: Directed polymers and the quantum Toda lattice

Abstract: We characterise the law of the partition function of a Brownian directed polymer model in terms of a diffusion process associated with the quantum Toda lattice.

9 December 2010

Speaker: James Lucietti (Edinburgh)

Title: Higher dimensional near-horizon geometries

Abstract: For any spacetime containing an extremal black hole (or in fact any degenerate horizon), one can define a limiting process which leads to an associated space-time called the near-horizon geometry. Classifying such near-horizon geometries is necessary for solving the more difficult uniqueness/classification problem for extremal black holes, which in turn has important implications within string theory and the gauge/gravity duality. I will review progress on classifying such near-horizon geometries in four and higher spacetime dimensions, focusing on solutions to the vacuum Einstein equations (including a negative cosmological constant). I will also discuss general results on near-horizon symmetry enhancement, horizon topology, as well as a recent construction of an infinite family of near-horizon geometries in higher than five dimensions with novel horizon topology. Finally, I will briefly describe how near-horizon geometries have played a key role in establishing the recent uniqueness theorems for extremal vacuum black holes in four and five dimensions.

20-22 December 2010 WIMCS Annual Meeting

21 December, Mathematical Physics Cluster Plenary Talk - 9am
Speaker: Professor Tim Porter (Bangor, Wales)

21 December, Mathematical Physics Cluster Session - 13.45-18.15

10 January 2011 - 3pm

Speaker: Karin Erdmann (Oxford)

Title: Periodicity and Hochschild cohomology of finite-dimensional algebras

Abstract: We give a homological characterisation of a class of finite-dimensional algebras with periodic bimodule resolutions, which contains the preprojective algebras of Dynkin type ADE. This generalizes and gives rise to algebras associated to non-simply laced Dynkin diagrams. We also explain some results on finite generation of Hochschild cohomology, and connections with complexity of modules.

13 January 2011

Speaker: Mary Rees FRS (Liverpool)

Title: The Mating Construction in Complex Dynamics

Abstract: The mating construction was invented by Adrien Douady and John Hubbard in the 1980's. It is a way of describing the dynamics of some rational maps in terms of the dynamics of two polynomials. It is quite a general construction. For example, it is valid for a positive proportion of critically finite rational maps in degree two (and quite possibly in any degree). The construction not only describes the dynamics of individual rational maps, but also appears to give pictures of parts of parameter space. In some cases these pictures are valid. Positive results are known when one of the polynomials in the mating is star-like, the so-called rabbit polynomial, for example. In other cases, shared mating, the representation of a rational map by a mating in more than one way, means that not all the pictures of parameter space which are suggested by the mating

pictures can be interpreted as simply as might at first be thought. Study of matings with the aeroplane polynomial gives ample indication of the complications that arise.

17 January 2011 - 5pm in Wallace Lecture Theatre, Main Building

Speaker: Sir Michael Atiyah

LSW Frontiers Distinguished Lecture

19 January 2011 - 3pm

Speaker: Ralf Meyer (Goettingen)

Title: Geometric models for equivariant bivariant K-theory I

Abstract: We use correspondences to define a purely topological equivariant bivariant K-theory for spaces with a proper groupoid action. Our notion of correspondence differs slightly from that of Connes and Skandalis. Our construction uses no special features of equivariant K-theory. To highlight this, we construct bivariant extensions for arbitrary equivariant multiplicative cohomology theories.

We formulate necessary and sufficient conditions for certain duality isomorphisms in the topological bivariant K-theory and verify these conditions in some cases, including smooth manifolds with a smooth cocompact action of a Lie group. One of these duality isomorphisms reduces bivariant K-theory to K-theory with support conditions. Since similar duality isomorphisms exist in Kasparov theory, the topological and analytic bivariant K-theories agree if there is such a duality isomorphism.

This is joint work with Heath Emerson, which appeared in Adv. Math. 225 (2010), 2840-2882 and 2883-2919.

20 January 2011 - 3pm

Speaker: Ralf Meyer (Goettingen)

Title: Geometric models for equivariant bivariant K-theory II

25 January 2011 - 2pm in M/2.30

Speaker: Makoto Yamashita (Cardiff and Tokyo University)

Title: Deformation of torus equivariant spectral triples I

Abstract: We describe a way to deform spectral triples with a torus action and a deformation parameter given by a skew symmetric matrix, motivated by previous works of Connes--Landi and Connes--Dubois-Violette. Such deformations are shown to have naturally isomorphic K-theoretic invariants independent of the deformation parameter. Then using a crossed product presentation of such deformations due to Rieffel, we are able to establish a correspondence of the invariant cyclic cohomology cocycles over the deformed algebras.

27 January 2011 - 11.30am in M/2.30

Speaker: Makoto Yamashita (Cardiff and Tokyo University)

Title: Deformation of torus equivariant spectral triples II

27 January 2011

Speaker: John Greenlees (Sheffield)

Title: Hasse squares from algebra, topology and geometry

Abstract: The Hasse square reconstructs the integers from its profinite completion and its rationalization, and it is not surprising that we can reconstruct the category of abelian groups on the same basis. Exactly the same idea can be used to great effect in some less familiar contexts, and the talk will describe some examples. The one from equivariant topology is closest to my heart, but shouldn't dominate the discussion.

1 February 2011 - 2pm

Speaker: Robin Hillier (Rome)

Title: Some cohomology, K-theory, and index pairing theorems for algebraic conformal quantum field theory I

Abstract: This is the first of four talks on noncommutative differential geometry, spectral triples, KK-theory and some index theorems in conformal quantum field theory, in particular, how to associate those objects to given local conformal nets.

1 February 2011 - 4pm in M/2.30

Speaker: Jennifer Maier (Cardiff and Hamburg)

Title: Modular categories and modularization I

3 February 2011

Speaker: Harvey Reall (Cambridge)

Title: Black hole instabilities in higher dimensions

Abstract: Motivated by developments in string theory, there has been great interest in the study of higher dimensional black holes over the last decade. The Einstein equation is known to admit various exotic black hole solutions in higher dimensions. I shall review these solutions and discuss recent progress concerning their classical stability.

4 February 2011 - 2pm

Speaker: Robin Hillier (Rome)

Title: Some cohomology, K-theory, and index pairing theorems for algebraic conformal quantum field theory II

4 February 2011 - 4pm in M/2.30

Speaker: Jennifer Maier (Cardiff and Hamburg)

Title: Modular categories and modularization II

8 February 2011 - 2pm

Speaker: Robin Hillier (Rome)

Title: Some cohomology, K-theory, and index pairing theorems for algebraic conformal quantum field theory III

8 February 2011 - 4pm in M/1.10

Speaker: Christoph Schweigert (Hamburg)

Title: The Drinfeld double and some generalizations: algebraic and geometric aspects

Abstract: For any finite group, the Drinfeld double gives rise to an extended topological field theory. We explain a geometric construction which yiels for any finite crossed module an equivariant extended topological field theory and a weakly equivariant Hopf algebra.

10 February 2011 - 11.30am

Speaker: Robin Hillier (Rome)

Title: Some cohomology, K-theory, and index pairing theorems for algebraic conformal quantum field theory IV

10 February 2011

Speaker: Maxim Nazarov (York)

Title: Generalized Harish-Chandra isomorphism

Abstract: This is a joint work with S.Khoroshkin and E.Vinberg. For any complex reductive Lie algebra g and any locally finite g-module V, we extended to the tensor product of U(g) with V the Harish-Chandra description of g-invariants in the universal enveloping algebra U(g). In our subsequent work with S.Khoroshkin, this result was used to give explicit realizations of all simple finite-dimensional modules of Yangians and their twisted analogues.

24 February 2011

Speaker: Boguslaw Zegarlinski (Imperial)

Title: Ergodicity in large interacting systems.

1 March 2011 - 2pm in M/2.30

Speaker: Antti Harju (Cardiff and Helsinki)

Title: On Spectral Geometry of Lie Groups I

3 March 2011 - 11.30am in M/2.30

Speaker: Antti Harju (Cardiff and Helsinki)

Title: On Spectral Geometry of Lie Groups II

3 March 2011

Speaker: Ed Segal (Imperial)

Title: B-branes in Landau-Ginzburg models.

Abstract: The boundary conditions (branes) in the B-model topological field theory on a Calabi-Yau manifold X are described by the derived category of coherent sheaves on X, which is a familiar object in algebraic geometry. I'll explain roughly what this is, and then show how it can be generalized to a Landau-Ginzburg model, i.e. when X also carries a holomorphic superpotential W. Then I'll survey some of the things that can be done with these more general categories of B-branes.

10 March 2011 - 3pm

Speaker: Jouko Mickelsson (Helsinki)

Title: Gerbes, gerbal representations and 3-cocyles.

14 March 2011 - 2pm in M/1.10

Speaker: Nathan Broomhead

Title: Dimer models and non-commutative crepant resolutions I.

Abstract: Dimer models, as studied in theoretical physics, can be used to produce non-commutative crepant resolutions (NCCRs) of all Gorenstein
3-fold affine toric singularities. In this series of talks I will give an introduction to dimer models in this context. In particular I shall explain how to construct a non-commutative algebra and a toric singularity associated to a dimer model. I shall introduce non-commutative toric algebras and discuss some of their properties. I will then give an overview of some of the 'consistency' conditions which can be placed on a dimer model and describe a method of constructing consistent examples. Finally I shall talk about the relationship to Calabi-Yau algebras and NCCRs.

15 March 2011 - 2pm in M/2.06

Speaker: Nathan Broomhead

Title: Dimer models and non-commutative crepant resolutions II.

16 March 2011 - 2pm in M/2.06

Speaker: Nathan Broomhead

Title: Dimer models and non-commutative crepant resolutions III.

17 March 2011

Speaker: Alastair Craw (Glasgow)

Title: Quiver representations in algebraic geometry

Abstract: I plan to give an accessible introduction to algebraic geometry, with a focus on the study of quiver representations. A quiver is simply a directed graph, and a representation of a quiver is nothing more than the assignment of a vector space to each vertex and a linear map to each arrow. This apparently harmless construction enables one to construct classes of projective manifolds that provide well behaved ambient spaces in algebraic geometry. Moreover, the deep geometric information encoded by the derived category of coherent sheaves on these manifolds can be described explicitly by a tilting bundle. I will assume no prior knowledge of algebraic geometry or derived categories.

18 March 2011 - 2pm in M/1.10

Speaker: Nathan Broomhead

Title: Dimer models and non-commutative crepant resolutions IV.

22 March 2011 - 2pm

Speaker: Pavle Goldstein (Zagreb)

Title: Quasi-free actions of finite groups on O_∞.

Abstract: It will be shown that any two faithful quasi-free actions of a finite group on the Cuntz algebra O_∞ are mutually conjugate.

24 March 2011

Speaker: Daniel Ueltschi (Warwick)

Title: Probabilistic representation of quantum correlations.

Abstract: We consider lattice models of quantum spins that can be represented by random loop models in one more dimensions. Such models have been introduced by Toth and Aizenman-Nachtergaele. Long-range correlations are given by loops of macroscopic lengths.

I will discuss the nature of those loops and identify the distribution of their lengths. There are many holes in our mathematical understanding, but I will mention a few rigorous results that back the main claims. This is work in progress with C. Goldschmidt and P. Windridge.

7 April 2011 - Room M/0.34 at 17:00

Speaker: Michael Tuite (Galway)

Title: Vertex Operator Algebras on Riemann Surfaces

Abstract: A Vertex Operator Algebra (VOA) is essentially a rigorous formulation of chiral conformal field theory. This talk describes recent progress in defining and computing the partition function and correlation functions for a VOA on a general Riemann surface formed by sewing together lower genus surfaces. We discuss a number of examples such as the Heisenberg VOA (the bosonic string), lattice VOAs and continuous orbifoldings of the fermionic super VOA.

20 - 21 April 2011

WIMCS workshop on Quantum Field Theory

Speakers include: Henning Bostelmann (York), Romeo Brunetti (Trento), Detlev Buchholz (Göttingen), Christian Jäkel (Cardiff), Gandalf Lechner (Vienna)

2 - 3 May 2011

WIMCS workshop on Representations of Braid and Symmetric Groups
New Approaches, Aberystwyth University

9 - 10 May 2011

WIMCS workshop on Higher Gauge Theory, TQFT's and Categorification.

Speakers include: Aristide Baratin (Orsay, Paris), Benjamin Bahr (Cambridge), Alexander Kahle (Göttingen), Jeffrey Morton (Lisbon), Urs Schreiber (Utrecht), Jamie Vicary (Oxford), Konrad Waldorf (Regensburg), Christoph Wockel (Hamburg)

12 May 2011

Speaker: Martin Bridson (Oxford)

Title: Symmetry, decidability, and finite manifestations.

Abstract: Suppose you have two infinite but finitely-describable systems of symmetry -- more technically, two infinite groups given by finite presentations, or perhaps given by a finite set of integer matrices that generate the group. Suppose that you know (this is automatic in the matrix example) that your can distinguish between any pair of elements of the group by looking at finite quotient groups -- more colloquially, you can understand any finite chunk of the group by looking at its finite manifestations. Suppose you are now told that two infinite groups with this property have the same finite quotients. Are the groups the same? If you know more about the geometry of the context in which the groups arise, might you be able to prove that they are the same? Might it be strictly impossible to prove that they are the same?

2 June 2011

Speaker: Pinhas Grossman (IMPA, Rio)

Title: Quantum subgroups of the Haagerup fusion categories

1 July 2011

WIMCS Mathematical Physics Colloquium

Speakers: Susanne Danz (Oxford), Terry Gannon (Edmonton), Grigory Garkusha (Swansea)

16 - 20 April 2012

INI-WIMCS Meeting on Noncommutative Geometry