Date	Speaker	Seminar
25 June 2020 10.00 - 11.00	David Ridout (University of Melbourne) Via Zoom	**A new approach to W-algebras** W-algebras are a class of vertex algebras that find many applications in both mathematics and mathematical physics. While some classes of examples are fairly well-understood, they are still quite mysterious. Here, I want to review some of what's known and then sketch (in a not-too-technical fashion) a promising new approach to W-algebras and their representations based on old work of Semikhatov and recent work of Adamović.
4 June 2020	Owen Tanner (Cardiff University - Online Project Viva) Via Zoom	**Knizhnik-Zamolodchikov Equations** In this talk, I aim to give an accessible introduction to the much-celebrated Knizhnik-Zamolodchikov (KZ) Equations. These are a set of ODEs, arising (somewhat unexpectedly!) from representations of affine Lie algebras. The solutions to these equations have proven useful in a diverse range of fields within Mathematical Physics. However, the main focus of this talk will be to talk about the various mathematical objects and the key elements of underlying Lie algebra representation theory that are needed to understand the KZ equations. We give an outline of an elegant derivation which makes use of the Sugawara-Segal construction.
30 April 2020	Konstanze Rietsch (King's College London) Via Zoom	**The codimension 2 index obstruction to positive scalar curvature** We address the following general question: Given a (compact without boundary) manifold M, does M admit a metric of positive scalar curvature. Very classically, the Gauss-Bonnet theorem implies that among the (connected orientable compact) surfaces only the 2-sphere has this property. In higher dimensions, the most powerful information uses the Dirac operator and its index, and an old observation of Schroedinger ("Über das Diracsche Elektron im Schwerefeld") coupling scalar curvature to the latter. We will quickly introduce classical and more modern ("higher") index theory approaches to this problem, and then discuss a special implementation: How and why certain submanifolds of codimension 2 act as a vaccine (or poison, depending on your point of view) and prevent the occurrence of positive scalar curvature metrics. Realistically, there won't be too much time to talk about that.
23 April 2020	Manjil P. Saikia (Cardiff University) via Zoom	**The Remarkable Sequence 1, 1, 2, 7, 42, 429, …** The sequence in the title counts several combinatorial objects, some of which I will describe in this talk. The major focus would be one of these objects, alternating sign matrices (ASMs). ASMs are square matrices with entries in the set {0,1,-1}, where non-zero entries alternate in sign along rows and columns, with all row and column sums being 1. I will discuss some questions that are central to the theme of ASMs, mainly dealing with their enumeration.
27 February 2020	André Henriques (University of Oxford) Room M/0.34	**Constructing conformal field theories** 30 years after their initial formulation, checking the Segal axioms of conformal field theory remains an elusive task, even for some of the simplest examples. I will give a gentle introduction on conformal field theory à la Segal, and highlight some of the difficulties. I will

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		then sketch a joint project with James Tener whose goal it is to verify the Segal axioms.
20 February 2020	Jelena Grbic (University of Southampton) Room M/0.34	**Homology theory of super-hypergraphs** Hypergraphs can be seen as incomplete abstract simplicial complexes in the sense that taking subsets is not a closed operation in hypergraphs. This notion can be extended to Δ-sets with face operations only partially defined, these objects we name super-hypergraphs. In this talk I will set foundations of homology theory of these combinatorial objects.
6 February 2020	Clemens Koppensteiner (University of Oxford) Room M/0.34	**Logarithmic Riemann-Hilbert Correspondences** The classical Riemann-Hilbert Correspondence provides a deep connection between geometry and topology. In its simplest form it stipulates an equivalence between the categories of vector bundles with a flat connection on a complex manifold and local systems on the topological space underlying the manifold. If one allows the connection to have poles, the situation becomes considerably more subtle. We discuss work of Kato-Nakayama and Ogus on this "logarithmic" setting. This in turn motivates recent joint work with Mattia Talpo on a further generalisation to logarithmic D-modules. We discuss what form the conjectural log Riemann-Hilbert Correspondence should take and the progress that has been achieved so far. We will not assume any familiarity with D-modules or logarithmic geometry.
30 January 2020	Yue Ren (Swansea University) Room M/0.34	**Tropical algebraic geometry - Algorithms and applications** This talk is an introductory overview of the many facets of tropical geometry on the basis of its many applications in- and outside mathematics. These include enumerative geometry, linear optimization, phylogenetics in biology, auction theory in economics, and celestial mechanics in physics. Special emphasis will be put on constructive algorithms and the mathematical challenges that they entail. We will conclude the talk with possible future applications that are the basis of my UKRI fellowship in Swansea, made possible by recent advances in both theory and software.
12 December 2019	Iain Moffatt (Royal Holloway, University of London) Room M/0.34	**The Tutte polynomial of a graph and its extensions** This talk will focus on graph polynomials, which are polynomial valued graph invariants. Arguably, the most important and best studied graph polynomial is the Tutte polynomial. It is important not only because it encodes a large amount of combinatorial information about a graph, but also because of its applications to areas such as statistical physics (as the Ising and Potts models) and knot theory (as the Jones and homfly polynomials). Because of its importance the Tutte polynomial has been extended to various classes of combinatorial object. For some objects there is more than one definition of a "Tutte polynomial". For example, there are three different definitions for the Tutte polynomial of graphs in surfaces: M. Las Vergnas' 1978 polynomial, B. Bolloba's and O. Riordan's 2002 ribbon graph polynomial, and V. Kruskal's polynomial from 2011. On the other hand, for some objects, such as digraphs, there is no wholly satisfactory definition of a Tutte polynomial. Why is this? Why are there three different

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		Tutte polynomials of graphs in surfaces? Which can claim to be the Tutte polynomial of a graph in a surface? More generally, what does it mean to be the Tutte polynomial of a class of combinatorial objects? In this talk I will describe a way to canonically construct Tutte polynomials of combinatorial objects, and, using this framework, will offer answers to these questions.
5 December 2019	John Harvey (Swansea)	**Estimating the reach of a submanifold** The reach is an important geometric invariant of submanifolds of Euclidean space. It is a real-valued global invariant incorporating information about the second fundamental form of the embedding and the location of the first critical point of the distance from the submanifold. In the subject of geometric inference, the reach plays a crucial role. I will give a new method of estimating the reach of a submanifold, developed jointly with Clément Berenfeld, Marc Hoffmann and Krishnan Shankar.
28 November 2019	Xin Li (Queen Mary, London)	**Constructing Cartan subalgebras in all classifiable C∗-algebras** I will explain how to construct Cartan subalgebras in all classifiable stably finite C∗-algebras, and I will discuss the Jiang-Su algebra as a particular example.
21 November 2019	Christian Bönicke (Glasgow)	**On the K-theory of ample groupoid algebras** It is a difficult problem to compute the K-theory of a crossed product of a C∗-algebra by a groupoid. One approach is given by the Baum-Connes conjecture, which asserts that a certain assembly map from the topological K-theory of the groupoid G with coefficients in a G-C∗-algebra A into the K-theory of the associated reduced crossed product is an isomorphism. In this talk I will present a method that allows one to deal with certain questions concerning the left hand side of the assembly map: The Going-Down principle. This principle can be used in two ways, both of which I will illustrate by an example: 1) Obtain results about the Baum-Connes conjecture, and 2) in cases where the conjecture is known to hold, prove something about the K-theory of crossed products.
14 November 2019	Andreas Fring (City University of London)	**Nonlocal gauge equivalent integrable systems** We demonstrate how new integrable nonlocal systems in space and/or time can be constructed by exploiting certain parity transformations and/or time reversal transformations possibly combined with a complex conjugations. By employing Hirota's direct method as well as Darboux-Crum transformations we construct explicit multi-soliton solutions for nonlocal versions of Hirota's equation that exhibit new types of qualitative behaviour. We exploit the gauge equivalence between these equations and an extended version of the continuous limit of the Heisenberg equation to show how nonlocality is implemented in those latter systems and an extended version of the Landau-Lifschitz equation.
7 November 2019	Francesca Arici (Leiden University)	**Circle and sphere bundles in noncommutative geometry** In this talk I will recall how Pimsner algebras of self Morita equivalences can be thought of as total spaces of quantum circle bundles, and the associated six term exact sequence in K-theory can be interpreted as an operator algebraic version of the classical

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		Gysin sequence for circle bundles. After reviewing some results in this direction, I will report on work in progress concerning the construction of higher dimensional quantum sphere bundles in terms of Cuntz–Pimsner algebras of sub-product systems.
24 October 2019	Ko Sanders (Dublin City University)	**Killing fields and KMS states in curved spacetimes** In quantum physics, every thermal equilibrium state satisfies the KMS condition. This condition is formulated in terms of the evolution in time. In general relativity, however, there is no preferred time flow on spacetime, but there can be several natural choices of a flow, given by Killing vector fields. Physically relevant examples arise especially in the context of black hole spacetimes, where the Killing fields are often timelike only in some region of spacetime, but they are spacelike or lightlike elsewhere. In this talk, based on work with Pinamonti and Verch, I will address the question for which Killing fields the existence of KMS states can be ruled out, because the KMS condition forces the two-point distributions of such states to be physically ill-behaved.
17 October 2019	Joan Bosa (Universitat Autònoma de Barcelona)	**Classification of separable nuclear unital simple C*-algebras. History and final results.** Over the last decade, our understanding of simple, nuclear C∗C∗-algebras has improved a lot. This is thanks to the the interplay between certain topological and algebraic regularity properties, such as nuclear dimension of C∗C∗-algebras, tensorial absorption of suitable strongly self-absorbing C∗C∗-algebras and order completeness of homological invariants. In particular, this is reflected in the Toms-Winter conjecture. In this talk I will speak about this problem, and explain the general classification of nuclear simple C∗C∗-algebras using the finite nuclear dimension (done in two groundbreaking articles by Elliott-Gong-Lin-Niu and Tikuisis-White-Winter). If time permits, I will also show some research built up from the classification just explained.
10 October 2019	Ian Short (The Open University)	**Integer tilings and Farey graphs** In the 1970s, Coxeter studied certain arrays of integers that form friezes in the plane. He and Conway discovered an elegant way of classifying these friezes using triangulated polygons. Recently, research in friezes has revived, in large part because of connections with cluster algebras and with certain infinite arrays (or tilings) of integers. Here we explain how much of the theory of integer tilings can be interpreted using the geometry and arithmetic of an infinite graph embedded in the hyperbolic plane called the Farey graph. We also describe how other types of integer tilings (such as integer tilings modulo n) can be interpreted using variants of the Farey graph obtained by taking quotients of the hyperbolic plane.
3 October 2019	Victor Przyalkowski (Steklov/HSE, Moscow)	**Hodge minimality of weighted complete intersections** We discuss Fano varieties whose Hodge diamonds are close to minimal ones. We discuss several conjectures related to them, and classify those of them who can be represented as smooth Fano weighted complete intersections. It turns out that the minimality has derived categories origin.

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9 May 2019	n/a	**There is no GAPT seminar on this day due to the COW seminar taking place in Cardiff**
11 April 2019	Lorenzo De Biase (Cardiff University)	**Generalised braid actions** In this talk, after giving some background on autoequivalences of derived categories of smooth projective varieties, I will define the generalised braid category and describe its action on the derived categories of (the cotangent bundles of) full and partial flag varieties. Generalised braids are the braids whose strands are allowed to touch in a certain way. The basic building blocks of their action on flag varieties are spherical and non-split P-functors together with the twist equivalences they induce. I will describe our present progress and future expectations. This is a joint project with Rina Anno and Timothy Logvinenko.
4 April 2019	Christian Voigt (Glasgow University)	**The Plancherel formula for complex semisimple quantum groups (joint with R. Yuncken)** The Plancherel formula for complex semisimple Lie groups, due to Gelfand-Naimark and Harish-Chandra, is a basic ingredient in their harmonic analysis. In this talk I'll present a computation of the Plancherel formula for the quantum deformations of these groups obtained via the Drinfeld double construction. The quantum groups obtained this way have featured prominently in the study of property (T) for tensor categories and subfactors in recent years. While the "quantum" Plancherel formula itself looks very similar to its classical counterpart – and is essentially a deformation thereof - the proof is completely different; it relies on the BGG-resolution and an application of the Hopf trace formula. Starting from the classical Plancherel Theorem, I'll give extensive background/motivation to all of the above, and then outline the key part of our proof.
21 March 2019	Alvaro Torras Casas (Cardiff University)	**Input-Distributive Persistent Homology** Persistent Homology has been developed as the main tool of Topological Data Analysis, with numerous applications in science and engineering. However, for very large data sets this tool can be very expensive to compute, both in terms of computational time and hard-disk memory. We will present a new distributive algorithm which takes part directly on the input data. This has some theoretical difficulties since we need to work within the category of persistence modules. In particular, we will see a solution to the extension problem for the Persistent Mayer-Vietoris spectral sequence. At the end we speculate that this approach might give us more information than ordinary Persistent Homology
7 March 2019	Farzad Fathizadeh (Swansea University)	**Heat kernel expansion of the Dirac-Laplacian of multifractal Robertson-Walker cosmologies** I will talk about a recent work in which we find an explicit formula for each Seeley-deWitt coefficient in the full heat kernel expansion of the Dirac-Laplacian of a Robertson-Walker metric with a general cosmic expansion factor. We use the Feynman-Kac formula and combinatorics of Brownian bridge integrals heavily. The extension of the result to the inhomogeneous case, where the spatial part of the model has a fractal structure, will also be presented. This is joint work with Yeorgia Kafkoulis and Matilde Marcolli.

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28 February 2019	Clelia Pech (University of Kent)	**Mirror symmetry for cominuscule homogeneous varieties** In this talk reporting on joint work with K. Rietsch and L. Williams, I will explain a new version of the construction by Rietsch of a mirror for some varieties with a homogeneous Lie group action. The varieties we study include quadrics and Lagrangian Grassmannians (i.e., Grassmannians of Lagrangian vector subspaces of a symplectic vector space). The mirror takes the shape of a rational function, the superpotential, defined on a Langlands dual homogeneous variety. I will show that the mirror manifold has a particular combinatorial structure called a cluster structure, and that the superpotential is expressed in coordinates dual to the cohomology classes of the original variety. I will also explain how these properties lead to new relations in the quantum cohomology, and a conjectural formula expressing solutions of the quantum differential equation in terms of the superpotential. If time allows, I will also explain how these results should extend to a larger family of homogeneous spaces called cominuscule homogeneous spaces.
21 February 2019	Tyler Kelly (University of Birmingham)	**Open Mirror Symmetry for Landau-Ginzburg Models** Mirror Symmetry provides a link between different suites of data in geometry. On one hand, one has a lot of enumerative data that is associated to curve counts, telling you about important intersection theory in an interesting moduli problem. On the other, one has a variation of Hodge structure, that is, complex algebro-geometric structure given by computing special integrals. While typically one has focussed on the case where we study the enumerative data for a symplectic manifold, we here will instead study the enumerative geometry of a Landau-Ginzburg model. A Landau-Ginzburg model is essentially a triplet of data: an affine variety X [think C^n] with a group G acting on it and a G-invariant algebraic function W from X to the complex numbers. We will describe what open enumerative geometry looks like for this gadget for the simplest examples (W=x^r) and explain what mirror symmetry means in this context. This is joint work in preparation with Mark Gross and Ran Tessler.
14 February 2019	Enrico Fatighenti (Loughborough University)	**Fano varieties of K3 type and IHS manifolds** Subvarieties of Grassmannians (and especially Fano varieties) obtained from sections of homogeneous vector bundles are far from being classified. A case of particular interest is given by the Fano varieties of K3 type, for their deep links with hyperkähler geometry. This talk will be mainly devoted to the construction of some new examples of such varieties. This is a work in progress with Giovanni Mongardi.
7 February 2019	Ulrich Pennig (Cardiff University)	**Exponential functors, R-matrices and higher twists** R-matrices are solutions to the Yang-Baxter equation, which was introduced as a consistency equation in statistical mechanics, but has since then appeared in many other research areas, for example integrable quantum field theory, knot theory, the study of Hopf algebras and quantum information theory. Twisted K-theory on the other hand is a variant of topological K-theory that allows local coefficient systems called twists. Twists over Lie groups gained increasing importance in the subject due to a result by Freed, Hopkins and Teleman that relates the twisted equivariant K-theory of the group to the Verlinde ring of the associated loop

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		group. In this talk I will discuss how involutive R-matrices give rise to a natural generalisation of the twist appearing in this theorem via exponential functors.
31 January 2019	Vincenzo Morinelli (Tor Vergata, Rome)	**Scale and Möbius covariance in two-dimensional Haag-Kastler net** The relation between conformal and dilation covariance is a controversial problem in QFT. Although many models which are dilation covariant are indeed conformal covariant a complete understanding of this implication in the algebraic approach to QFT is missing. In this talk we present the following result: Given a two-dimensional Haag-Kastler net which is Poincare-dilation covariant with additional properties, we prove that it can be extended to a conformal (Möbius) covariant net. Additional properties are either a certain condition on modular covariance, or a variant of strong additivity. Time permitting we further discuss counterexamples. Based on a joint work with Yoh Tanimoto arXiv:1807.04707.