GAUGE THEORY AND HIGHER GEOMETRY:
A CONFERENCE IN HONOUR OF MICHAEL MURRAY
TITLES AND ABSTRACTS

David Baraglia
University of Adelaide
Tuesday 16:15 – 17:15

Title. *Special Kahler geometry and topological recursion*

Abstract. The base of a complex algebraic integrable system carries a natural Kahler metric and a natural affine structure which together constitute what is known as special Kahler geometry. In this talk we will focus on the case of the Hitchin integrable system. We show that the special Kahler geometry may be computed using the theory of Eynard-Orantin topological recursion. In particular, we consider the Donagi-Markman cubic, which measures the difference between the Levi-Civita connection and the affine connection, and show that it is given by an Eynard-Orantin invariant. This talk is based on joint work with Zhenxi Huang.

Peter Bouwknegt
Australian National University
Friday 9:30 – 10:30

Title. *Lie algebroid gauge theories and applications*

Abstract. In this talk I will discuss the gauging of a quantum field theory with respect to a Lie algebroid symmetry. In particular, I will discuss the gauging of 2D sigma models with respect to a (possibly non-isometric) Lie algebroid symmetry and the application to T-duality.

Alexander Campbell
Macquarie University
Wednesday 9:30 – 10:30

Title. *A higher categorical approach to Girauds non-abelian cohomology*

Abstract. In this talk I will show how Girauds non-abelian cohomology of degree 2 (defined in terms of gerbes and liens) can be recovered from Grothendiecks definition of non-abelian cohomology, which takes higher stacks as the coefficient objects. The central argument depends on a generalisation of Lawveres construction for associated sheaves, which yields the 2-stack of gerbes over a site as an associated 2-stack; the stack of liens is the 1-stack truncation thereof. I will also outline how the coherence theory of tricategories provides a practicable model of the tricategory of 2-stacks over a site, in whose context the argument can be developed.

Alan Carey
Australian National University
Wednesday 14:00 – 15:00

Title. *Geometric cycles as D-branes*

Abstract. I will outline progress on the subject of the title. The aim is to explain the background, due mainly to Bai-Ling Wang, to recent work of Baum and collaborators.

Mike Eastwood
University of Adelaide
Friday 11:00 – 12:00

Title. *How to recognise the geodesics of a metric*

Abstract. A Riemannian metric gives rise to geodesics. As unparameterised curves, at each point there is one geodesic in every direction. Does this arrangement of curves determine the metric and will any such arrangement of curves determine a metric? These are classical questions. This talk will discuss recent developments in two and three dimensions.

Kelli Francis-Staite
University of Oxford
Wednesday 15:15 – 15:45

Title. *C^∞-Algebraic Geometry*

Abstract. The category of manifolds is not a very nice category. For example, not all fibre products of manifolds exist. There are several ways to enlarge the category of manifolds to a category that does have fibre products. One such way is using the concepts of C^∞-ring and C^∞-scheme, which I will explain in this talk. Time permitting, I will explain how this idea can be extended to manifolds with corners.

Kiyonori Gomi
Shinshu University
Thursday 16:15 – 17:15

Title. *Bott periodicity and Thom isomorphism in Freed-Moore K-theory*

Abstract. The twisted equivariant K-theory introduced by Freed and Moore handles in a unified way known topological K-theories such as the usual complex K-theory and Atiyah's KR-theory. One theme of my talk is the Bott periodicity of this K-theory. As its consequence, some twists turn out to have the effect of degree shifts. The other theme is the Thom isomorphism theorem. In its general form, a variant of spin structures appears.

Rod Gover
University of Auckland
Tuesday 9:30 – 10:30

Title. *The projective geometry of Sasaki-Einstein structures and their compactification*

Abstract. Sasaki geometry is often viewed as the odd dimensional analogue of Kaehler geometry. In particular a Riemannian or pseudo-Riemannian manifold is Sasakian if its standard metric cone is Kaehler or, respectively, pseudo-Kaehler. We show that there is a natural link between Sasaki geometry and projective differential geometry. The situation is particularly elegant for Sasaki-Einstein geometries and in this setting we use projective geometry to provide the resolution of such structures into less rigid components. This is analogous to usual picture of a Kaehler structure: a symplectic manifold equipped also with a compatible complex structure; or as a complex manifold equipped with a suitable Hermitian metric; or finally as a Riemannian manifold with a complex structure that is compatible with the metric and parallel for the Levi-Civita connection. However the treatment of Sasaki geometry this way is locally more interesting and involves the projective Cartan or tractor connection. This enables us to describe a natural type of compactification of complete non-compact pseudo-Riemannian Sasakian geometries. The boundary is a Fefferman space that fibres over a CR manifold.

This is joint work with Katharina Neusser and Travis Willse.

Hao Guo
University of Adelaide
Thursday 15:15 – 15:45

Title. *Positive Scalar Curvature for Proper Co-Compact Actions*

Abstract. Let G be a Lie group acting properly on a G-Spin manifold M with compact orbit space. In this talk I will explain recent work, joint with Mathai Varghese and Hang Wang, on certain obstructions to, and existence of, G-invariant metrics of positive scalar curvature on M. The principal obstruction we obtain comes by proving a vanishing theorem in equivariant index theory, giving as a corollary a recent result of Weiping Zhang. Existence of G-invariant metrics of positive scalar curvature is established under certain general hypotheses on the G-action on M, and makes use of a result of Vilms adapted to the equivariant setting, together with a theorem of Lawson and Yau.

Peter Jarvis
University of Tasmania
Thursday 9:30 – 10:30

Title. *Hidden supersymmetry and quadratic deformations of the space-time conformal superalgebra*

Abstract. We consider quadratic extensions of Lie superalgebras, and the existence of 'zero step' modules for them, wherein the odd generators are identically zero. For the case of the quadratic extensions of the conformal superalgebra in four dimensions, it turns out that the zero step modules include the massless lowest weight unitary irreducible representations of the space-time conformal group, in the standard classification. In terms of massless particle multiplets, this result implies that this form of supersymmetry is unbroken, in that the supercharges annihilate all physical states, but it is hidden, in that there are no super-partners. (Joint work with Luke Yates.)

Frances Kirwan
University of Oxford
Friday 14:00 – 15:00

Title. *Moduli spaces of unstable curves*

Abstract. The construction of the moduli spaces of stable curves of fixed genus is one of the classical applications of Mumford's geometric invariant theory (GIT), developed in the 1960s. Here a projective curve is stable if it has only nodes as singularities and its automorphism group is finite. The aim of this talk is to describe these moduli spaces and outline their GIT construction, and then to explain how recent methods from non-reductive GIT can help us to classify the singularities of unstable curves in such a way that we can construct moduli spaces of unstable curves (of fixed singularity type).

Jouko Mickelsson
University of Helsinki
Thursday 11:00 – 12:00

Title. *Bundle gerbes, moduli spaces of gauge connections and twisted K-theory*

Abstract. Equivariant twisted K theory on compact simple Lie groups can be explicitly constructed using families of Fredholm operators from representation theory of loop groups and the supersymmetric Wess-Zumino-Witten model. A compact Lie group appears a the moduli space of gauge connections on a circle. Thus we ask whether it is possible to apply a similar method in higher dimensions, to the case of a moduli space of gauge connections on a 3-torus. We are only partially successful. Instead of true Fredholm operators we have an algebraic construction in terms of families of sesquilinear forms tranforming covariantly under adjoint action of an abelian extension of the gauge group. The extension comes from a gerbe over the moduli space.

Paul Nobury
University of Melbourne
Tuesday 11:00 – 12:00

Title. *Moduli spaces of spectral curves*

Abstract. Consider a family X of Riemann surfaces parametrised by a space B, so there is a map $X \to B$ with fibres consisting of Riemann surfaces. In this talk I will show how such families of Riemann surfaces can be used to produce a metric, and further structure, on B. I will describe a classical construction of a flat diagonal metric on B, meaning there are two natural sets of coordinates—with respect to which the metric is diagonal, respectively constant. These are known as Darboux-Egoroff metrics which are used in various enumerative problems such as Gromov-Witten theory. Flat coordinates for the metric conveniently appear as periods of a differential along cycles on the Riemann surfaces, and orthogonal, or diagonal, coordinates appear as residues of a differential on the Riemann surfaces. These same periods and residues can be used to produce deeper structure on B.

David Roberts
University of Adelaide
Wednesday 16:15 – 17:15

Title. *Constructions in lower dimensional higher geometry*

Abstract. Bundle gerbes have been very fruitful structures due to the number of different constructions available. When one passes to more general higher geometric structures, even those just beyond abelian gerbes, a stunning paucity of analogous constructions presents itself. I will review several down-to-earth ideas that give rise to prototype constructions in order to fill this gap, focussing on crossed modules of Lie groups as key objects.

Marcy Robertson
University of Melbourne
Wednesday 11:00 – 12:00

Title. *An action of the Grothendieck-Teichmller group on stable curves of genus zero*

Abstract. The Grothendieck-Teichmüller group is an explicitly defined group introduced by Drinfeld which is closely related to (and conjecturally equal to) the absolute Galois group. The idea was based on Grothendieck's suggestion that one should study the absolute Galois group by relating it to its action on the Teichmüller tower of fundamental groupiods of the moduli stacks of genus g curves with n marked points.

In this talk, we give an reimagining of the genus zero Teichmüller tower in terms of a profinite completion of the framed little 2-discs operad. Using this reinterpretation, we show that the homotopy automorphisms of this model for the Teichmüller tower is isomorphic to the (profinite) Grothendieck-Teichmller group. We then show a non-trivial action of the absolute Galois group on our tower.

This talk will be aimed at a general audience and will not assume any previous knowledge of the Grothendieck-Teichmüller group or operads. This is joint work with Pedro Boavida de Brito and Geoffroy Horel.

Matt Spong
University of Melbourne
Tuesday 15:45 – 16:15

Title. *The K-theory of free loop spaces and elliptic cohomology*

Abstract. Let T be a torus. In 1994 Ian Grojnowski wrote down a construction of a T-equivariant elliptic cohomology theory associated to an elliptic curve over the complex numbers. However, as noted by Grojnowski himself, this construction is somewhat ad hoc.

Let M be a T-space and LM the space of free loops in M, so that there is an action of LT on LM, where LT is the group of free loops in the torus. Based on work of Nitya Kitchloo, we construct a version of equivariant K-theory for LT-spaces, and show that the LT-equivariant K-theory of LM is isomorphic to Grojnowskis theory on the T-space M. Since the loop space construction is motivated by the idea of fields on a loop in M, this suggests a physical interpretation of Grojnowskis theory.

Bai-Ling Wang
Australian National University
Thursday 14:00 – 15:00

Title. *Orbifold Lagrangian Floer theory*

Abstract. I will report a joint work with Bohui Chen and Kaoru Ono on Lagrangian Floer theory for orbifold Lagrangian submanifolds. Lagrangian Floer homology is an intersection theory for Lagrangian submanifolds and plays an important role in homological mirror symmetry and the Atiyah-Floer conjecture. Lagrangian orbifold arises as the fixed point submanifold of an anti-symplectic involution on symplectic orbfiolds. I will explain the basis set-up to establish an orbifold version of Fukaya-Oh-Ohta-Onos Lagrangian Floer theory.

Hang Wang
University of Adelaide
Tuesday 14:00 – 15:00

Title. *Twisted Donaldson Invariants*

Abstract. Non-commutative geometry is a useful tool in the study of topology of Riemannian manifolds. Taking into account of the fundamental group in the formulation of a topological invariant, one can obtain a refined topological invariant involving the C^*-algebra of the fundamental group. For example, The Novikov conjecture on homotopy invariance of higher signature has been developed extensively using noncommutative geometry.

In this research, we aim at introducing noncommutative geometry to Donaldson's theory of differential topology of smooth four manifolds. Donaldson's polynomial invariants are topological invariants for compact closed four manifolds and have important applications in smooth structures for four manifolds. We introduce the notion of twisted Donaldson invariants by implementing fundamental groups in the construction of Donaldson's invariants, together with examples and applications when the fundamental group is the group of integers.

This is joint work with T. Kato (Kyoto) and H. Sasahira (Kyushu).