MODULI SPACES AND VERTEX ALGEBRAS

20–22 FEBRUARY 2023

UNIVERSITY OF AUCKLAND

LECTURE SERIES

	Monday in 260-325	Title
10:00–12:00	**Gothen**	*Moduli Spaces of Higgs Bundles*
12:00–1:30	Lunch	
1:30–3:30	**Meinrenken**	*Moduli of Hyperbolic Metrics on Surfaces with Boundary*

RESEARCH TALKS

	Tuesday in 260-325	Wednesday in 260-223
9:00–10:00	**Sala** (Virtual)	**Garcia-Fernandez** (Virtual)
10:00–11:00	**Gothen**	**Linshaw**
11:00–11:30	Break	Break
11:30–12:30	**Meinrenken**	**Onn**
12:30–13:30	Lunch	Lunch
13:30–21:00	Afternoon & Dinner on Waiheke	
17:00–18:30		Music Recital

Lecture Series

Peter Gothen
University of Porto

Title. *Moduli Spaces of Higgs Bundles*

Abstract. This will be an introduction to Higgs bundles on Riemann surfaces and their moduli spaces. It is aimed at graduate students, providing some background for my workshop talk. I will introduce G-Higgs bundles for a real reductive Lie group G and state the non-abelian Hodge theorem which relates the moduli space of G-Higgs bundles and the moduli space of representations of the fundamental group of the Riemann surface in G. I will also explain the use of the natural $\mathbb{C}^*$-action on the moduli space to study its topology.

Eckhard Meinrenken
University of Toronto

Title. *Moduli of Hyperbolic Metrics on Surfaces with Boundary*

Abstract. The Teichmueller space of a compact oriented surface Σ of genus at least 2 may be defined as the moduli space of hyperbolic metrics on Σ, up to diffeomorphims that are isotopic to the identity. It is well-known to be a symplectic manifold of dimension $6g-6$, where $g \geq 2$ is the genus of the surface. One description of this space is as a component of the representation variety for the group $G = PSL(2,R)$. In this lecture, we will consider an extension of this theory to conformally compact hyperbolic metrics on surfaces with boundary. The resulting infinite-dimensional moduli space carries a Hamiltonian action of the Virasoro Lie algebra, with orbits of finite codimension. The talk is based on forthcoming work with Anton Alekseev, however, most of the lecture will be devoted to a description of foundational material.

Titles and Abstracts

Francesco Sala
University of Pisa

Title. *Yangians and Cohomological Hall Algebras of Curves*

Abstract. The talk aims to provide a gentle overview of the theory of 2-dimensional cohomological Hall algebras (COHAs) and its relation to the theory of moduli stacks and spaces, and of vertex algebras. Particular attention will be given to the COHAs associated to the moduli stacks arising from the non-abelian Hodge correspondence, i.e., the moduli stack of Higgs sheaves on a smooth projective complex curve X and the character stack of X. If time permits, the case of the cohomological Hall algebra of the Higgs sheaves on the projective line will be discussed in detail, in particular, its description in terms of affine Yangians.

Peter Gothen
University of Porto

Title. *Moduli Spaces of G-Higgs Bundles and the Cayley Correspondence*

Abstract. Let $\mathcal{M}$ be the moduli space of surface group representations in a real reductive Lie group G. The most basic topological question about $\mathcal{M}$ is the determination of its connected components. Much progress has been made on this problem over the last 30-40 years but it is, in general, still open. A conjectural answer to the question - based on Hitchin's approach via non-abelian Hodge Theory - can be stated in terms of the generalised Cayley correspondence for moduli spaces of G-Higgs bundles, and is closely related to higher Teichmller theory.

The talk based on joint work with Steve Bradlow, Brian Collier, Oscar Garcia-Prada, and Andr Oliveira.

Eckhard Meinrenken
University of Toronto

Title. *On Hamiltonian Virasoro Spaces*

Abstract. The Virasoro Lie algebra is the non-trivial central extension of the Lie algebra of vector fields on the circle. There is a well-known $1-1$ correspondence between the coadjoint orbits in the affine dual of the Virasoro algebra and conjugacy classes in a certain open subset of the universal cover of $SL(2,\mathbb{R})$. I will present recent work with Anton Alekseev, in which we extend the correspondence of orbits to a geometric Morita equivalence, taking into account the Lie-Poisson structure. This leads to a finite-dimensional description of (certain) Hamiltonian Virasoro spaces. Applications include Teichmueller moduli spaces of conformally compact hyperbolic metrics on surfaces with boundary.

Mario Garcia-Fernandez
Universidad Autónoma de Madrid

Title. *$N = 2$ Vertex Algebras from the Hull-Strominger System*

Abstract. Motivated by the programme on (0,2) mirror symmetry, in this talk I will overview the construction of modules for the $N = 2$ superconformal vertex algebra from solutions of the Hull-Strominger system. For this, we characterize the existence of suitable global sections of the Chiral De Rham complex, associated to the Courant algebroid of the solution, in terms of a 'torsion bi-vector'. As an application, we will see how our contruction yields families of $N = 2$ vertex algebra representations parametrized by the moduli space of ASD connections on a $K3$ surface.

Joint work with Luis Alvarez-Consul and Andoni De Arriba de La Hera.

Andrew Linshaw
University of Denver

Title. *Trialities of W-Algebras*

Abstract. W-algebras are an important class of vertex (super)algebras associated to a Lie (super)algebra $\mathfrak{g}$ and an even nilpotent element in $\mathfrak{g}$. Trialities of W-algebras are isomorphisms between the affine cosets of three different W-algebras. A large family of such isomorphisms were conjectured by Gaiotto and Rapcak in 2017, and were recently proven in my joint work with Thomas Creutzig. This result vastly generalizes both Feigin-Frenkel duality and the coset realization of principal W-algebras of classical types. In this talk, I will discuss the Gaiotto-Rapcak trialities, and time permitting, I will describe some possible generalizations of this result to a larger class of W-algebras.

This is a joint work with Thomas Creutzig (University of Alberta) and Vladimir Kovalchuk (University of Denver).

Uri Onn
Australian National University

Title. *A Panorama on Representation Zeta Functions*

Abstract. Representation zeta functions are Dirichlet generating functions whose coefficients enumerate isomorphism classes of irreducible representations of groups. In this talk I will give an overview of their origin, special values which have interpretation as the volume of certain moduli spaces, and their remarkable properties. The groups which will be discussed are finite groups, Lie groups, p-adic groups and arithmetic groups.