DUNCAN LAURIE

Mathematical Institute, University of Oxford

Email: duncan.laurie@maths.ox.ac.uk

Personal website: duncanlaurie.xyz

Institute website: www.maths.ox.ac.uk/people/duncan.laurie

Education

2020 – present **PhD in Mathematics**, supervised by Prof. Kevin McGerty — University of Oxford

Research area: **geometric representation theory**. More specifically, focusing on quantum groups, quantum affine algebras, crystal bases, quantum toroidal algebras, quiver varieties, and related topics.

2015 – 2019 **MMath in Mathematics** (Integrated Master's) — University of Oxford

Degree classification: **First-Class Honours** in each year of the programme.
Awarded the Gibbs Prize for coming **top of my cohort** in the master's.

Research papers

2024 **Young wall models for the level 1 highest weight and Fock space crystals of $U_q(E_6^{(2)})$ and $U_q(F_4^{(1)})$** — arXiv:2402.15829

Abstract: In this paper we construct Young wall models for the level 1 highest weight and Fock space crystals of quantum affine algebras in types $E_6^{(2)}$ and $F_4^{(1)}$. Our starting point in each case is a combinatorial realization for a certain level 1 perfect crystal in terms of Young columns. Then using energy functions and affine energy functions we define the notions of reduced and proper Young walls, which model the highest weight and Fock space crystals respectively.

2023 **Young wall realizations of level 1 irreducible highest weight and Fock space crystals of quantum affine algebras in type E** — arXiv:2311.03905

Abstract: We construct Young wall models for the crystal bases of level 1 irreducible highest weight representations and Fock space representations of quantum affine algebras in types $E_6^{(1)}$, $E_7^{(1)}$ and $E_8^{(1)}$. In each case, Young walls consist of coloured blocks stacked inside the relevant Young wall pattern which satisfy a certain combinatorial condition. Moreover the crystal structure is described entirely in terms of adding and removing blocks.

2023 **Automorphisms of quantum toroidal algebras from an action of the extended double affine braid group** — arXiv:2304.06773

Abstract: We construct an action of the extended double affine braid group $\ddot{\mathcal{B}}$ on the quantum toroidal algebra $U_q(\mathfrak{g}_{\mathrm{tor}})$ in all untwisted types. In the simply laced cases, using this action and certain involutions of $\ddot{\mathcal{B}}$ we obtain automorphisms and anti-automorphisms of $U_q(\mathfrak{g}_{\mathrm{tor}})$ which exchange the horizontal and vertical subalgebras. Moreover, they switch the central elements C and $k_0^{a_0} \dots k_n^{a_n}$ up to inverse. This generalises existing results in type A due to Miki, and can be viewed as the analogue, for these quantum toroidal algebras, of the duality for double affine braid groups which Cherednik used to realise the difference Fourier transform in his celebrated proof of the Macdonald evaluation conjectures.

Other research projects

2021 **Quiver varieties, quantum groups and crystal bases** 'Transfer of status' thesis for PhD

Viva with assessors Prof. Balázs Szendrői and Prof. Kobi Kremnitzer.

2020 **Quotients in algebraic geometry** PhD broadening mini-project

2019 **Representations and characters of $GL_n(\mathbb{F}_q)$** Master's dissertation

Supervisor: Prof. Kevin McGerty.
Awarded a **First-Class grade** for the thesis.

2018 **Summer project on λ-rings** Summer project

Supervisor: Prof. Damian Rössler.
Received Rokos internship funding from Pembroke College Oxford.

Awards & Scholarships

2020 – 2024 **EPSRC PhD Studentship** University of Oxford

Research council funding for the duration of my PhD at Oxford.

2020 ⋆ **EPSRC Excellence Award** University of Oxford

Awarded to the **top 3 UK applicants** to Oxford STEM PhDs.

2019 ⋆ **Gibbs Prize** University of Oxford

Awarded for coming **top of my cohort** in the MMath.

2018 **Rokos Funding** Pembroke College, University of Oxford

Funding to carry out my summer research project.

2016, 2017, 2018 **Rokos Scholarship** Pembroke College, University of Oxford

Awarded for excellence in each year of the MMath.

Talks at conferences, seminars & reading groups

December 2023 ⋆ **The structure and representation theory of quantum toroidal algebras**

Algebra and Combinatorics Seminar, IISc Bangalore, **invited by Prof. Vyjayanthi Chari**

November 2023 **Quantum toroidal algebras: braid group actions and automorphisms**

Algebraic and Combinatorial Methods in Representation Theory, ICTS Research Centre Bangalore

October 2023 ⋆ **Quantum toroidal algebras: braid group actions, automorphisms, and representation theory**

Paris Algebra Seminar, Université de Paris, **invited by Prof. David Hernandez**

July 2023 ⋆ **Quantum toroidal algebras: braid group actions, automorphisms, and representations**

Workshop in Noncommutative Algebra and Representation Theory, University of Kent, **invited by Prof. Stéphane Launois**

June 2023 **Borel and parabolic subgroups**

Linear Algebraic Groups Reading Group, University of Oxford

April 2023 **Automorphisms of quantum toroidal algebras from an action of the extended double affine braid group**

RepNet Spring School in Representation Theory, University of Kent

March 2023 **Quantum toroidal algebras and extended double affine braid groups**

Junior Algebra and Representation Theory Seminar, University of Oxford

February 2022 **Descent theory, torsors and principal bundles**

Stacks Reading Group, University of Oxford

November 2021 **An introduction to quivers, quiver representations and quiver varieties**

Junior Algebra and Representation Theory Seminar, University of Oxford

June 2021 **Representations and characters of general linear groups over finite fields**

Junior Algebra and Representation Theory Seminar, University of Oxford

Teaching

Spring 2023 **Representation Theory** Williams-Exeter Programme at Oxford (WEPO) tutor

Designed the course, tutored the classes, wrote and graded the exam

Autumn 2022 **Introduction to Representation Theory** Class tutor (two sets)

3rd year course at the University of Oxford

Summer 2022 **Introduction to Representation Theory** Revision class tutor (two sets)

3rd year course at the University of Oxford

Summer 2022 **Group Theory** Class tutor at Somerville College

2nd year course at the University of Oxford

Spring 2022 **Commutative Algebra** Teaching assistant

3rd year course at the University of Oxford

Autumn 2021 **Introduction to Representation Theory** Class tutor

3rd year course at the University of Oxford

Spring 2021 Completed Stage 1 Teaching Training

Spring 2021 **Probabilistic Combinatorics** Teaching assistant

Master's / 4th year course at the University of Oxford

Autumn 2020 **Introduction to Representation Theory** Teaching assistant

3rd year course at the University of Oxford

Services

2021 – present **PhD Social Secretary for the Algebra Research Group** University of Oxford

2016 – 2017 **Mathematics Subject Representative** Pembroke College, University of Oxford