

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 $U_q(F_4^{(1)})$** – joint work with S. Han, Y. Jin and S.-J. Kang 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 $\check{\mathcal{B}}$ on the quantum toroidal algebra $U_q(\mathfrak{g}_{\text{tor}})$ in all untwisted types. In the simply laced cases, using this action and certain involutions of $\check{\mathcal{B}}$ we obtain automorphisms and anti-automorphisms of $U_q(\mathfrak{g}_{\text{tor}})$ 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 Röessler.
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

- April 2024 **Young wall realizations for representations of (affine) quantum groups**
HODGE CLUB SEMINAR, University of Edinburgh
- 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
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- 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
	3 rd year course at the University of Oxford	
Spring 2021	COMPLETED STAGE 1 TEACHING TRAINING	
Spring 2021	Probabilistic Combinatorics	TEACHING ASSISTANT
	Master's / 4 th year course at the University of Oxford	
Autumn 2020	Introduction to Representation Theory	TEACHING ASSISTANT
	3 rd 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