Lucien Hennecart

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Employment

The University of Edinburgh — Edinburgh
Postdoctoral Research Assistant. Supervisor: Ben Davison. — *September 2021 –*
Funded by an ERC Starting Grant (2021–2023) and then by the Royal Society (2023–)

Education

Université Paris-Saclay, Département de Mathématiques d'Orsay — Orsay
PhD in Mathematics. Advisor: Olivier Schiffmann — *September 2018 – September 2021*

Université Paris-Saclay, Département de Mathématiques d'Orsay — Orsay
M.Sc. in Fundamental Mathematics, with high honors — *2017 – 2018*

Agrégation de Mathématiques
French diploma for higher education teaching, Rank: 5/305 — *July 2017*

Université Rennes 1 and École Normale Supérieure de Rennes — Rennes and Bruz
First year of M.Sc. in Fundamental Mathematics, with high honors — *2015 – 2016*

Université Rennes 1 and École Normale Supérieure de Rennes — Rennes and Bruz
B.Sc. in Physics — *2014 – 2016*

Université Rennes 1 and École Normale Supérieure de Rennes — Rennes and Bruz
B.Sc. in Fundamental Mathematics, with high honors — *2014 – 2015*

Recruited as a trainee civil servant at the École normale supérieure de Rennes
Competitive exam following the "Classes préparatoires" — *2014*

Lycée Claude Fauriel — Saint-Étienne
Classes préparatoires aux grandes écoles — *2012 – 2014*
Two-year intensive program in preparation for the national "Grandes Écoles" competitive exams

Rewards

1. £1000 for *Exceptional contribution to the School of Mathematics of the University of Edinburgh* (2023)

Publications

Perverse sheaves with nilpotent singular support on the stack of coherent sheaves on an elliptic curve, *Transformation Groups* (2022), 40 pages, arXiv:2101.03813

In this work, we give a new parametrization of the irreducible components of the global nilpotent cone for an elliptic curve. The methods employed can be used to prove an analogous result for weighted projective curves. This gives natural bases for the BPS Lie algebra of these curves, defined mathematically by Ben Davison. Moreover, this new parametrization allows us to prove that the characteristic cycle map on the category of spherical Eisenstein perverse sheaves is bijective. I will use these results in future works.

Microlocal characterization of Lusztig sheaves for affine and g-loops quivers, *Representation Theory of the American Mathematical Society* 26(02) (2022), 17 – 67, 51 pages, arXiv:2006.12780

In this work, we prove a conjecture of Lusztig for affine quivers: a simple perverse sheaf is in the Lusztig category if and only if its singular support is nilpotent. The motivation comes from an attempt to geometrize the constructible Hall algebra of a quiver in order to define a canonical basis, analogous to that of quantum groups.

Asymptotic behaviour of Kac polynomials, *Experimental Mathematics* (2021), 1–19, arXiv:2003.06929

We study some properties of Kac polynomials when we vary the set of edges of the quiver. The motivation comes from the search of the different functorial properties of the constructible Hall algebra of a quiver when the quiver varies.

Isotropic cuspidal functions in the Hall algebra of a quiver, *Int. Math. Res. Not. IMRN*, (15) (2019), 11514 – 11564, 51 pages, arXiv:1903.04378

The cuspidal functions of affine quivers are determined. These give a minimal system of generators of the constructible Hall algebra (Sevenhant and Van den Bergh proved furthermore that this algebra has the structure of a quantum group associated with a generalized Kac–Moody algebra). The goal is to determine canonical bases for Hall algebras. A byproduct of the main result is a new group of symmetries of the Hall algebra of an affine quiver.

Preprints

Nonabelian Hodge isomorphisms for stacks and cohomological Hall algebras, preprint (2023), 37 pages, arXiv:2303.2307.09920

We complete the nonabelian Hodge theory triangle of isomorphisms for stacks between the Borel-Moore homologies of the Dolbeault, Betti and de Rham moduli stacks. We also explain how to realise the category of connections on a smooth projective curve as a subcategory of a 2-Calabi-Yau dg-category. This gives a cohomological Hall algebra structure on the Borel-Moore homology of the stack of connections on a smooth projective curve. In addition, we compare the cohomological Hall algebra structures at the relative and absolute levels for the three sides of NAHT: they all coincide. The comparison of the Borel-Moore homologies of the Dolbeault and Betti moduli stacks was previously considered by the author with Davison and Schlegel Mejia (without taking the cohomological Hall algebra structures into account). This paper completes this study and provides a CoHA enhancement of classical NAHT for curves.

(with Ben Davison and Sebastian Schlegel Mejia) **BPS algebras and generalised Kac-Moody algebras from 2-Calabi-Yau categories**, preprint (2023), 58 pages, arXiv:2303.12592

We define and study the BPS Lie algebra of arbitrary 2-Calabi–Yau categories, satisfying some assumptions (in particular, the stack of objects is an Artin stack having a good moduli space). This BPS Lie algebra is a generalised Kac–Moody algebra whose root datum is determined by the monoid of connected components of the good moduli space, the Euler form of the category and the intersection cohomology of the good moduli space. Consequences include (1) A proof in full generality of the positivity conjecture for absolutely cuspidal polynomials of Bozec-Schiffmann, a strengthening of the Kac positivity conjecture (2) A proof of the cohomological integrality conjecture for local K3 surfaces (3) A lowest weight vector description for the cohomology (in all degrees) of Nakajima quiver varieties.

(with Ben Davison and Sebastian Schlegel Mejia) **BPS Lie algebras for totally negative 2-Calabi–Yau categories and nonabelian Hodge theory for stacks**, preprint (2022), 76 pages, arXiv:2212.07668

We define the relative cohomological Hall algebra of any category whose stack of objects is an Artin stack with good moduli space of objects. When the category under consideration is 2-Calabi–Yau and totally negative, the BPS algebra is shown to be freely generated by the intersection cohomology of the good moduli space. This implies a nonabelian Hodge isomorphism for stacks and the positivity of cuspidal polynomials of quivers.

On geometric realizations of the unipotent enveloping algebra of a quiver, preprint (2022), 29 pages, arXiv:2209.06552

We compare the different constructions of the positive part of the enveloping algebra of the Lie algebra associated to a quiver with possible loops, $U(\mathfrak{n}^+)$: constructible functions or perverse sheaves on the moduli stack of objects, functions on the seminilpotent stack and top-cohomological Hall algebra (CoHA) of the seminilpotent stack. As a byproduct, the top-CoHA of a quiver is shown to be isomorphic to $U(\mathfrak{n}^+)$.

(with Nikolai Perry) **A Quiver Analogue of Higman's Conjecture**, preprint (2022), 17 pages, arXiv:2208.07738

This paper has mainly been written by Nikolai Perry and is the outcome of an undergraduate summer research project at the University of Edinburgh. We define a new generalization of Higman's conjecture to quivers by considering the count of commuting pairs of radical endomorphisms of a projective representation. We prove compatibilities when performing operations on the quiver: reversing of arrows, splitting of a sink or a source,... The conjecture is proved in the first cases, in particular for acyclic quivers with at most three vertices.

Talks

Algebra and Geometry seminar, Liverpool
BPS Lie algebras and action on the cohomology of Nakajima quiver varieties — *23 November 2023*
Algebra and Geometry seminar, Caen
L'algèbre de Lie BPS — *21 November 2023*
Groups, Arithmetic and Algebraic Geometry Seminar (EPFL), Lausanne
Nonabelian Hodge isomorphisms for cohomological Hall algebras — *8 November 2023*
GRIFT seminar, Edinburgh
Instantons and AGT — *17 October 2023*
Algebra and Geometry seminar (HKUST), Hong-Kong
Cohomological integrality for 2-Calabi-Yau categories — *16 October 2023*
Dublin Mathematics Colloquium, Geometry Seminar
Cohomological integrality for 2-Calabi–Yau categories — *28 September 2023*
14th Ukraine algebra conference
BPS algebras and generalised Kac–Moody Lie algebras from 2-Calabi–Yau categories — *4 July 2023*
VBAC webinar
Nonabelian Hodge isomorphisms for stacks — *5 June 2023*
Séminaire SPACE, Université de Tours
Comptage des représentations des algèbres lisses (On the count of representations of smooth algebras) — *10 March 2023*
Université de Picardie Jules Verne, Amiens
Comptage des représentations des algèbres lisses (On the count of representations of smooth algebras) — *9 March 2023*
MFO Oberwolfach (5-day conference)
BPS Lie algebras for 2-Calabi–Yau categories and positivity of cuspidal polynomials — *16 February 2023*
Colloque tournant du GDR TLAG, Reims (3-day workshop)
Positivité des polynômes cuspidaux (Positivity of cuspidal polynomials) — *9 February 2023*
Algebraic geometry seminar, McGill University, Montreal
The BPS Lie algebra of 2-Calabi–Yau categories — *27 January 2023*
Séminaire du LACIM, Université du Québec à Montréal
L'algèbre de Lie associée à un carquois (The Lie algebra associated to a quiver) — *27 January 2023*
Séminaire : Groupes, Représentations et Géométrie, University Paris-Cité
Cohomological Hall algebras and stacky nonabelian Hodge theory — *18 November 2022*

EGRET Seminar, Edinburgh
Structure of cohomological Hall algebras *17 October 2022*

Affine Springer fibers reading seminar, Edinburgh
Equivariant (co)homology of affine Springer fibers *29 March 2022*

EGRET Seminar, Edinburgh
The top-CoHA of a curve *21 March 2022*

Gdt Dualité symplectique, Orsay
Perverse sheaves and hyperbolic localization *17 March 2022*

SERG Reading Group, Edinburgh
Localization of equivariant cohomology *2 February 2022*

Hodge Club
Hall algebras *29 October 2021*

Séminaire d'algèbre
(Canonical) bases of the elliptic Hall algebra *25 October 2021*

Hodge seminar
Polynomiality of the number of representations of the modular group *7 October 2021*

Italian Representation Theory Seminar
Perverse sheaves with nilpotent singular support for curves and quivers *11 June 2021*

Séminaire de la Tortue, Genève
The degree zero BPS Lie algebra of a curve *3 June 2021*

Oberseminar Lie Theory Bochum
Cuspidal functions and Lusztig sheaves for affine quivers *17 Mai 2021*

Réga
Algèbres de Hall (Hall algebras) *7 April 2021*

PhD students Day, Laboratoire de Mathématiques d'Orsay
Microlocal characterization of Lusztig sheaves for affine quivers *15 September 2020*

Thematic trimester program on Representation theory, IHP, Seminar Young researchers
Microlocal characterization of Lusztig sheaves for extended Dynkin quivers *19 February 2020*

PhD student seminar, Laboratoire de Mathématiques d'Orsay
Polynômes de Kac d'un carquois (Kac polynomials of quivers) *22 January 2020*

Séminaire quantique de Strasbourg
Cuspidal functions on the stack of representations of quivers *16 October 2019*

Communication

Imperial College London
Derived Categories, Moduli Spaces, and Counting Invariants *3 – 7 July 2023*
Presentation of a poster "BPS algebras and generalised Kac–Moody algebras from 2-Calabi–Yau categories"

Invited conferences

MFO, 5-day conference Oberwolfach
Representation Theory of Quivers and Finite-Dimensional Algebras *12 – 18 February 2023*

Université de Reims, 3-day workshop Reims
Colloque tournant du GDR TLAG *12 – 18 February 2023*

Scientific visits

EPFL — Lausanne
Visit of Dimitri Wyss and Tanguy Vernet to work on symmetrizable CoHAs — *5 – 12 November 2023*

Columbia University — New–York
Visit of Tudor Padurariu to discuss CoHAs — *5 – 7 February 2023*

McGill University — Montreal
Visit of Joel Kamnitzer to work on the relationship between canonical and semicanonical bases — *25 – 27 January 2023*

Université de Genève — Geneva
Visit of Nicolas Hemelsoet to work on factorizable sheaves — *1 – 4 June 2021*

Undergraduate research experience

Laboratoire de Mathématiques d'Orsay — Orsay
Subject: Structure of the Hall algebra of a quiver. Supervisor: Olivier Schiffmann — *February – August 2018*

Institut Camille Jordan — Lyon
Subject: Topology of real algebraic varieties. Supervisor: Jean-Yves Welschinger — *Mai – June 2016*

Mathematisches Institut of Göttingen — Göttingen
Subject: Binary quadratic forms, the circle method and Waring's problem. Supervisor: Jörg Brüdern — *June – July 2015*

Teaching experience

2023 – 2024 (University of Edinburgh)

- Submission of a proposal for a group project for fourth year students on Deligne categories.

2022 – 2023 (University of Edinburgh)

- First semester: co-lecturer for the course "Introduction to Lie groups" for fifth year students (organized by Pavel Safronov)

2021 – 2022 (University of Edinburgh)

- First semester: Reading course on Lie algebras for two fifth year students (organized with Iain Gordon). One-hour weekly meetings.
- Summer 2022: Supervisor of two summer research projects for third year undergraduate students
  1. Nikolai Perry: Around Higman's conjecture
  2. Yashh Kotecha: The algebra of the Gaudin system

2020 – 2021 (Université Paris-Saclay)

- First semester: Exercise class "Algebra" for first year students, 36 hours
- Exercise class "Introduction to Lie algebras" in the master program AAG (Analyse, Arithmétique, Géométrie) (5-th year students), 12 hours

2019 – 2020 (Université Paris-Saclay)

- Mentoring of two Italian students laureate of an award of the FMJH (Fondation mathématique Jacques Hadamard) to attend the AAG (Analyse, Arithmétique, Géométrie) master program at Orsay
- First semester: Exercise class "Calculus" for first year students, 48 hours
- Second semester: Exercise class "Iterative methods in linear algebra" for third year students, 30 hours

2018 – 2019 (Université Paris-Saclay)

- First semester: Exercise class "Calculus" for first year students, 16 hours
- Second semester: Exercise class "Linear algebra" for first year students, 48 hours

2017 – 2018 (Lycée Blaise Pascal d'Orsay)

- Oral exams of mathematics for second year students, Lycée Blaise Pascal (Orsay). 2 hours per week, 50 hours altogether

Organisation

17 – 21 April 2023

- Workshop on the Isle of Skye, "Vertex algebras and Hall algebras in enumerative geometry"

2021–

- Organisation of the EGRET seminar in Edinburgh with Ben Davison and Sebastian Schlegel Mejia

Expertise

Reviewer for Zentralblatt, Mathscinet.
Reviewer for several journals.

Languages

French: Native speaker
English: Good skills. Toeic: 815/990 (2016); IELTS: Overall Band Score: 7.5 (2021)
German: Level: C1 (Deutsches Sprachdiplom des Kultusministerkonferenz, 2012).

Memberships

London Mathematical Society

Miscellaneous

1. I have been playing the Cello for 20 years. I have played in many different student orchestras over the years, participated to master-classes given by some of the famoust French or Italian cellists (Emmanuelle Bertrand, Xavier Gagnepain, Jean Deplace, Xavier Phillips, Claudio Pasceri). Cellist at the Edinburgh University Symphony Orchestra in 2021–2022 (fully auditioned orchestra). Cellist at the Edinburgh University Chamber Orchestra from 2022–2023 (fully auditioned orchestra). Cellist at the Edinburgh University Symphony Orchestra 2023–2024.
2. Member of the choir of the Edinburgh University Music Society (EUMS) from May 2023.
3. Member of the Edinburgh Young Walkers (EYW).