JAMES RICKARDS

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University of Colorado Boulder
Boulder, CO

POSITIONS

Postdoctoral Fellow | ***Mentor: Katherine E. Stange*** 2021 - 2024
University of Colorado Boulder Boulder, CO

EDUCATION

Doctor of Philosophy | ***Advisor: Henri Darmon*** 2016 - 2021
McGill University Montreal, QC
Thesis title: Intersections of closed geodesics on Shimura curves

Master of Arts 2019
Trinity College, University of Cambridge Cambridge, UK

Master of Mathematics 2015 - 2016
Trinity College, University of Cambridge Cambridge, UK

Bachelor of Arts (Hons) | ***Major: Mathematics*** 2012 - 2015
Trinity College, University of Cambridge Cambridge, UK

RESEARCH INTERESTS

Computational number theory, algebraic number theory, thin (semi)groups, arithmetic Fuchsian/Kleinian groups, binary quadratic forms, quaternion algebras, Shimura curves, circle packings, visualization.

PUBLICATIONS AND PREPRINTS

8. Reciprocity obstructions in semigroup orbits in $\mathbf{SL}(2,\mathbb{Z})$ 2024
James Rickards, Katherine E. Stange
Preprint

7. The Local-Global Conjecture for Apollonian circle packings is false 2023
Summer Haag, Clyde Kertzer, James Rickards, Katherine E. Stange
Submitted

6. The Apollonian staircase 2023
James Rickards
Accepted to IMRN

5. Improved computation of fundamental domains for arithmetic Fuchsian groups 2022
James Rickards
Math. Comp. **91** (2022), no. 338, pp. 2929-2954

4. Hecke operators acting on optimal embeddings in indefinite quaternion algebras 2022
James Rickards
Acta Arith. **204** (2022) no. 4, pp. 347-367

3. Counting intersection numbers of closed geodesics on Shimura curves 2023
James Rickards
Res. Number Theory **9** (2023), no. 2, Paper No. 20, 45 pp.

2. Computing intersections of closed geodesics on the modular curve 2021
James Rickards
J. Number Theory, **225** (2021), pp. 374-408

1. When is a Polynomial a Composition of Other Polynomials? 2011
James Rickards
Amer. Math. Monthly, **118** (2011), no. 4, pp. 358-363

MEDIA

CU students follow their noses, disprove math conjecture 2023
Article about *The Local-Global Conjecture for Apollonian circle packings is false*
Colorado Arts and Sciences Magazine,
https://www.colorado.edu/asmagazine/2023/11/30/cu-students-follow-their-noses-disprove-math-conjecture

The Hidden Connection That Changed Number Theory 2023
Contributed quotes
Quanta Magazine, https://www.quantamagazine.org/the-hidden-connection-that-changed-number-theory-20231101/

Two Students Unravel a Widely Believed Math Conjecture 2023
Article about *The Local-Global Conjecture for Apollonian circle packings is false*
Quanta Magazine, https://www.quantamagazine.org/two-students-unravel-a-widely-believed-math-conjecture-20230810/

CODE

Apollonian PARI/GP
Computations for Apollonian circle packings, including basic operations, generating pictures in LaTeX, and a very efficient implementation for finding all missing curvatures up to a bound.
Available at https://github.com/JamesRickards-Canada/Apollonian

Fundamental domains for Shimura curves PARI/GP
Computation of fundamental domains for arithmetic Fuchsian groups. Improves on the algorithms of Voight and Page, and is significantly more efficient than the live Magma implementation (from 100 to millions of times as fast, depending on the example). Will be integrated into PARI/GP.
Available at https://github.com/JamesRickards-Canada/Fundamental-Domains-for-Shimura-curves

Isogeny PARI/GP, Sage
Computation of supersingular ℓ and L isogeny graphs, significantly more efficient than the live Sage implementation. Includes code to seamlessly use it inside of Sage.
Available at https://github.com/JamesRickards-Canada/Isogeny

Q-Quadratic PARI/GP
Computing with integral binary quadratic forms and quaternion algebras over $\mathbb{Q}$. Includes algorithms to compute intersection numbers of modular geodesics, as described in my thesis and various papers.
Available at https://github.com/JamesRickards-Canada/Q-Quadratic

Semigroup Reciprocity PARI/GP
Computation of orbits of semigroups, including efficient implementation of missing numbers in an orbit. This package accompanies the paper *Reciprocity obstructions in semigroup orbits in* $SL(2,\mathbb{Z})$, and includes methods to check various results.
Available at https://github.com/JamesRickards-Canada/Semigroup-Reciprocity

OTHER ACADEMIC WRITING

A beginner's guide to installing PARI on Windows computers
Tutorial for installing and using PARI/GP on Windows computers.
Available at https://pari.math.u-bordeaux.fr/PDF/PARIwithWindows.pdf

Polynomial Division in Number Theory
Crux Mathematicorum, Vol. 43(10), December 2017

Parametric Solutions to the Generalized Fermat Equation
Part III essay, Cambridge, 2016

Higher Power Reciprocity Laws
Rouse Ball Mathematical Essay, Cambridge, 2015

CONFERENCE TALKS

Renormalization, computation and visualization in Geometry, Number Theory and Dynamics Sept 2023
The not-so-local-global conjecture CIRM

LuCaNT Jul 2023
Software demo: Computing fundamental domains for congruence arithmetic Fuchsian groups in PARI/GP ICERM

Number Theory Informed by Computation Aug 2022
Fast fundamental domains for arithmetic Fuchsian groups in PARI/GP Park City Mathematics Institute

16th Atelier PARI/GP 2022 Jan 2022
Fundamental Domains for Shimura curves U. Franche-Comté (participated online)

Lattices and Cohomology of Arithmetic Groups: Geometric and Computational Viewpoints Oct 2021
Improved computation of fundamental domains for arithmetic Fuchsian groups BIRS (online)

Front Range Number Theory Day Sept 2021
Counting intersection numbers on Shimura curves Colorado State University

Front Range Number Theory Day Apr 2021
Fast computations of fundamental domains for Shimura curves CU Boulder (online)

Quebec-Maine Number Theory Conference Sep 2020
Computing with (indefinite) quadratic forms and quaternion algebras in PARI/GP Laval University (online)

Quebec-Maine Number Theory Conference Oct 2019
Intersection numbers of modular geodesics University of Maine

Quebec-Maine Number Theory Conference Oct 2018
Intersection numbers of modular geodesics Laval University

CMS Summer Meeting Jun 2018
Number theoretic intersection numbers on Riemann surfaces University of New Brunswick

Montreal-Toronto Workshop in Number Theory Dec 2016
Basic background on mock modular forms and weak harmonic Maass forms University of Montreal

Seminar Talks

Virtual Seminar on Geometry and Topology Nov 2023
Failure of the local-global conjecture in thin (semi)groups KIAS, South Korea

Penn State Algebra and Number Theory Seminar Oct 2023
The not-so-local-global conjecture Penn State

University of Washington Number Theory Seminar Oct 2023
The not-so-local-global conjecture University of Washington

Arithmetic Reflection Groups Seminar Aug 2023
The not-so-local-global conjecture Online

Five College Number Theory Seminar Nov 2022
The Apollonian Staircase Amherst College

Brown University Algebra and Algebraic Geometry Seminars Nov 2022
The Apollonian Staircase Brown University

International Seminar on Automorphic Forms May 2021
Counting intersection numbers on Shimura curves TU Darmstadt/ETH Zurich (online)

Rutgers Number Theory Seminar Oct 2019
Intersection numbers of modular geodesics Rutgers University

Laval Number Theory Seminar Oct 2019
Intersection numbers of modular geodesics Laval University

Teaching Experience - University of Colorado, Boulder (head instructor)

Math 2001 | ***Introduction to Discrete Mathematics*** — Fall 2022 - 2 sections, Spring 2024

Math 2130 | ***Linear Algebra for Non-Math Majors*** — Fall 2021, Spring 2022

Math 3001 | ***Analysis 1*** — Fall 2023

Math 3110 | ***Introduction to the Theory of Numbers*** — Spring 2022, Spring 2024

Math 8174 | ***Topics in Algebra - Quaternion Algebras (Graduate course)*** — Spring 2023

Teaching Experience - other

TA for PCMI graduate course — Summer 2022
TA for Jan Vonk's one week long course at the Park City Mathematics Institute graduate summer school

Math 141 TA | ***Integral Calculus*** — Fall 2017, Fall 2018
McGill University

Mentorship

Honours Thesis Advisor
Advisor to Clyde Kertzer on symmetries in Apollonian circle packings (Fall 2023).

2023 REU - CU Boulder
Ran an REU jointly with Katherine E. Stange on Apollonian circle packings. Supervised one undergraduate student (Clyde Kertzer) and one first year graduate student (Summer Haag).

Math camp leader and trainer — 2015, 2017 - 2019
Mentored and trained Canadian high school students interested in contest math at four (week-long) IMO (International Mathematical Olympiad) winter camps, as well as four IMO summer camps (3 weeks long each), and one EGMO (European Girls Mathematical Olympiad) training camp (weekend).

Scholarships

Vanier Canada Graduate Scholarship — 2018 - 2021
$\$50,000$ CAD/year

NSERC CGS D — 2018 (Declined)

Schulich Fellowship | ***McGill University*** — 2016 - 2018
$\$25,000$ CAD/year

Trinity College Woods Scholarship — 2015 - 2016
$\$25,000$ CAD/year

Cambridge Trusts Scholarship — 2015 - 2016
$\$25,000$ CAD/year

Blyth Cambridge Commonwealth Scholarship — 2012 - 2015
$\$50,000$ CAD/year

Lazaridis Olympiad Scholarship to University of Waterloo — 2012 (Declined)

Canadian Mathematical Society Service

Canadian IMO committee chair — 2019 - present

Canadian Junior Mathematical Olympiad coordinator — 2019 - present

Canadian IMO committee member — 2016 - present

Canadian Open Mathematics Challenge problems committee member — 2013 - 2021

International Mathematical Olympiad Service

Team Canada Leader Observer 2019

Team Canada Leader 2017, 2018

Team Canada Deputy Leader Observer 2015

Other Mathematical Olympiad Service

Olympiade Francophone de Mathématiques 2021 - present
Organizer for the Canadian team

Paper review

Reviewed papers for Acta Arithmetica, Communications in Algebra, Indian Journal of Pure and Applied Mathematics, Journal of the European Mathematical Society, Simons Collaboration, and Transactions of the American Mathematical Society.

Other service

Committee member for two comprehensive oral exams at CU Boulder.

Skills

Languages: English (native), French (limited working proficiency)

Programming:

- High proficiency: C, LaTeX, PARI/GP
- Medium proficiency: Python
- Some familiarity: HTML, Magma, Mathematica, Sage