

# JAMES RICKARDS

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<https://github.com/JamesRickards-Canada>

Office 301, Department of Mathematics  
University of Colorado Boulder  
Boulder, CO

## POSITIONS

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<b>Postdoctoral Fellow</b>   <i>Mentor: Katherine E. Stange</i> University of Colorado Boulder	2021 - 2024 Boulder, CO
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## EDUCATION

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<b>Doctor of Philosophy</b>   <i>Advisor: Henri Darmon</i> McGill University <b>Thesis title:</b> Intersections of closed geodesics on Shimura curves	2016 - 2021 Montreal, QC
<b>Master of Arts</b> Trinity College, University of Cambridge	2019 Cambridge, UK
<b>Master of Mathematics</b> Trinity College, University of Cambridge	2015 - 2016 Cambridge, UK
<b>Bachelor of Arts (Hons)</b>   <i>Major: Mathematics</i> Trinity College, University of Cambridge	2012 - 2015 Cambridge, UK

## RESEARCH INTERESTS

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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

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<b>9. Prime and thickened prime components in Apollonian circle packings</b> Elena Fuchs, Holley Friedlander, Piper Harris, Catherine Hsu, James Rickards, Katherine Sanden, Damaris Schindler, Katherine E. Stange Submitted	2024
<b>8. Reciprocity obstructions in semigroup orbits in <math>SL(2, \mathbb{Z})</math></b> James Rickards, Katherine E. Stange Submitted	2024
<b>7. The Local-Global Conjecture for Apollonian circle packings is false</b> Summer Haag, Clyde Kertzer, James Rickards, Katherine E. Stange Submitted	2023
<b>6. The Apollonian staircase</b> James Rickards IMRN, Volume 2024, Issue 2, January 2024, Pages 1340-1372	2024
<b>5. Improved computation of fundamental domains for arithmetic Fuchsian groups</b> James Rickards Math. Comp. <b>91</b> (2022), no. 338, pp. 2929-2954	2022
<b>4. Hecke operators acting on optimal embeddings in indefinite quaternion algebras</b> James Rickards Acta Arith. <b>204</b> (2022) no. 4, pp. 347-367	2022
<b>3. Counting intersection numbers of closed geodesics on Shimura curves</b> James Rickards Res. Number Theory <b>9</b> (2023), no. 2, Paper No. 20, 45 pp.	2023

- 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

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## 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/>

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## 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>
- Apollonian-Prime** PARI/GP  
 Computations for thickened prime components of Apollonian circle packings,  
 Available at <https://github.com/JamesRickards-Canada/Apollonian-Prime>
- 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  $\ell$  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>

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## 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

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<b>Renormalization, computation and visualization in Geometry, Number Theory and Dynamics</b> The not-so-local-global conjecture	Sept 2023 CIRM
<b>LuCaNT</b> Software demo: Computing fundamental domains for congruence arithmetic Fuchsian groups in PARI/GP	Jul 2023 ICERM
<b>Number Theory Informed by Computation</b> Fast fundamental domains for arithmetic Fuchsian groups in PARI/GP	Aug 2022 Park City Mathematics Institute
<b>16<sup>th</sup> Atelier PARI/GP 2022</b> Fundamental Domains for Shimura curves	Jan 2022 U. Franche-Comté (participated online)
<b>Lattices and Cohomology of Arithmetic Groups: Geometric and Computational Viewpoints</b> Improved computation of fundamental domains for arithmetic Fuchsian groups	Oct 2021 BIRS (online)
<b>Front Range Number Theory Day</b> Counting intersection numbers on Shimura curves	Sept 2021 Colorado State University
<b>Front Range Number Theory Day</b> Fast computations of fundamental domains for Shimura curves	Apr 2021 CU Boulder (online)
<b>Quebec-Maine Number Theory Conference</b> Computing with (indefinite) quadratic forms and quaternion algebras in PARI/GP	Sep 2020 Laval University (online)
<b>Quebec-Maine Number Theory Conference</b> Intersection numbers of modular geodesics	Oct 2019 University of Maine
<b>Quebec-Maine Number Theory Conference</b> Intersection numbers of modular geodesics	Oct 2018 Laval University
<b>CMS Summer Meeting</b> Number theoretic intersection numbers on Riemann surfaces	Jun 2018 University of New Brunswick
<b>Montreal-Toronto Workshop in Number Theory</b> Basic background on mock modular forms and weak harmonic Maass forms	Dec 2016 University of Montreal

### SEMINAR TALKS

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<b>PU/IAS Number Theory Seminar</b> TBD	Apr 2024 Princeton University / IAS
<b>Dalhousie Number Theory Seminar</b> TBD	Mar 2024 Dalhousie University
<b>Dalhousie Colloquium</b> TBD	Mar 2024 Dalhousie University
<b>Saint Mary's Colloquium</b> Apollonian circle packings and thin groups	Jan 2024 Saint Mary's University
<b>Virtual Seminar on Geometry and Topology</b> Failure of the local-global conjecture in thin (semi)groups	Nov 2023 KIAS, South Korea
<b>Penn State Algebra and Number Theory Seminar</b> The not-so-local-global conjecture	Oct 2023 Penn State
<b>University of Washington Number Theory Seminar</b> The not-so-local-global conjecture	Oct 2023 University of Washington

<b>Arithmetic Reflection Groups Seminar</b> The not-so-local-global conjecture	Aug 2023 Online
<b>Five College Number Theory Seminar</b> The Apollonian Staircase	Nov 2022 Amherst College
<b>Brown University Algebra and Algebraic Geometry Seminars</b> The Apollonian Staircase	Nov 2022 Brown University
<b>International Seminar on Automorphic Forms</b> Counting intersection numbers on Shimura curves	May 2021 TU Darmstadt/ETH Zurich (online)
<b>Rutgers Number Theory Seminar</b> Intersection numbers of modular geodesics	Oct 2019 Rutgers University
<b>Laval Number Theory Seminar</b> Intersection numbers of modular geodesics	Oct 2019 Laval University

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#### TEACHING EXPERIENCE - UNIVERSITY OF COLORADO, BOULDER (HEAD INSTRUCTOR)

<b>Math 2001</b>   <i>Introduction to Discrete Mathematics</i>	Fall 2022 - 2 sections, Spring 2024
<b>Math 2130</b>   <i>Linear Algebra for Non-Math Majors</i>	Fall 2021, Spring 2022
<b>Math 3001</b>   <i>Analysis 1</i>	Fall 2023
<b>Math 3110</b>   <i>Introduction to the Theory of Numbers</i>	Spring 2022, Spring 2024
<b>Math 8174</b>   <i>Topics in Algebra - Quaternion Algebras (Graduate course)</i>	Spring 2023

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#### TEACHING EXPERIENCE - OTHER

<b>TA for PCMI graduate course</b> TA for Jan Vonk's one week long course at the Park City Mathematics Institute graduate summer school	Summer 2022
<b>Math 141 TA</b>   <i>Integral Calculus</i> McGill University	Fall 2017, Fall 2018

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#### MENTORSHIP

<b>Honours Thesis Advisor</b> Advisor to Clyde Kertzer on symmetries in Apollonian circle packings (Fall 2023 - Spring 2024).	
<b>2023 REU - CU Boulder</b> 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).	
<b>Math camp leader and trainer</b> 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 (week-end).	2015, 2017 - 2019

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#### SCHOLARSHIPS

<b>Vanier Canada Graduate Scholarship</b> \$50,000 CAD/year	2018 - 2021
<b>NSERC CGS D</b>	2018 (Declined)
<b>Schulich Fellowship</b>   <i>McGill University</i> \$25,000 CAD/year	2016 - 2018
<b>Trinity College Woods Scholarship</b> \$25,000 CAD/year	2015 - 2016
<b>Cambridge Trusts Scholarship</b> \$25,000 CAD/year	2015 - 2016

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

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

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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

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INTERNATIONAL MATHEMATICAL OLYMPIAD SERVICE

**Team Canada Leader Observer** 2019

**Team Canada Leader** 2017, 2018

**Team Canada Deputy Leader Observer** 2015

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OTHER MATHEMATICAL OLYMPIAD SERVICE

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

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PAPER REVIEW

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

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OTHER SERVICE

Committee member for three comprehensive oral exams at CU Boulder.

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SKILLS

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

**Programming:**

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