David Roe

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Education

2011 **Ph.D. in Mathematics**, *Harvard University*, Cambridge, MA.
Ph.D. Thesis
title The Local Langlands Correspondence for Tamely Ramified Groups
supervisor Professor Benedict Gross

2006 **B.S. in Mathematics and in Literature**, *Massachusetts Institute of Technology*, Cambridge, MA.

Employment

2025–present Principal Research Scientist at MIT
2018–2025 Research Scientist at MIT (with Simons Collaboration on Arithmetic Geometry, Number Theory, and Computation)
2015–2017 Postdoctoral Fellow at the University of Pittsburgh (with Thomas Hales)
2014–2015 Postdoctoral Fellow at the University of British Columbia (with Julia Gordon)
2011–2014 Postdoctoral Fellow at the University of Calgary (with Clifton Cunningham)

Research Interests

Computational number theory, arithmetic geometry, mathematical databases, p-adics

Honors and Awards

2024 Simons Scientific Software Research Faculty Award
2022 MIT award for service to the Math Community
2020 2020 COVID-19 Hero Award for creating researchseminars.org
2011 PIMS Postdoctoral Fellow
2006 National Science Foundation: Graduate Research Fellow
2006 National Defense Science and Engineering Graduate Research Fellow
2006 Phi Beta Kappa member
2006 Todd Anderson Award for excellence in teaching at MIT
2004 Summer Program in Undergraduate Research at MIT: Rogers Prize
2002 National Merit Scholar

Preprints

Jordi Guàrdia-Rubies, John Jones, Kevin Keating, Sebastian Pauli, David Roberts, and David Roe, Families of p-adic fields.

Edgar Costa, Taylor Dupuy, Stefano Marseglia, David Roe, and Christelle Vincent, Labeling abelian varieties over finite fields, arXiv:2501.17012.

Lewis Combes, John Jones, Jennifer Paulhus, David Roe, Manami Roy, and Sam Schiavone, Creating a dynamic database of finite groups, arXiv:2409.09189.

Publications

Edgar Costa, Kiran Kedlaya and David Roe, Hypergeometric L-functions in average polynomial time II, Res. number theory **11**, 32 (2025).

Taylor Dupuy, Kiran Kedlaya, David Roe and Christelle Vincent, Counterexamples to a conjecture of Ahmadi and Shparlinski, Experimental Mathematics **23** (2023), no. 3, pp. 540–544.

Clifton Cunningham and David Roe, Commutative character sheaves and geometric types for supercuspidal representations, Annales Henri Lebesgue **4** (2021), pp. 1389-1420.

Alex Best, Jonathan Bober, Andrew Booker, Edgar Costa, John Cremona, Maarten Derickx, David Lowry-Duda, Min Lee, David Roe, Andrew Sutherland, John Voight, Computing classical modular forms, Arithmetic Geometry, Number Theory, and Computation, Simons Symposia, Springer, 2021.

Taylor Dupuy, Kiran Kedlaya, David Roe and Christelle Vincent, Isogeny classes of abelian varieties over finite fields in the LMFDB, Arithmetic Geometry, Number Theory, and Computation, Simons Symposia, Springer, 2021.

Edgar Costa and David Roe, Zen and the art of database maintenance, Arithmetic Geometry, Number Theory, and Computation, Simons Symposia, Springer, 2021.

Edgar Costa, Kiran Kedlaya and David Roe, Hypergeometric L-functions in average polynomial time, The Open Book Series **4**, Fourteenth Algorithmic Number Theory Symposium, 2020.

David Roe, The inverse Galois problem for p-adic fields, Proceedings of the 13th Algorithmic Number Theory Symposium (ANTS-XIII). Open Book Series **2**, Math. Sci. Pub., Berkeley CA, 2019, pp 393-409.

Clifton Cunningham and David Roe, From the function-sheaf dictionary to quasicharacters of p-adic tori, J. Inst. Math. Jussieu **17** (2018), no. 1, pp. 1–37.

Xavier Caruso, David Roe and Tristan Vaccon, `ZpL`: a p-adic precision package, Proceedings of the 2018 ACM on International Symposium on Symbolic and Algebraic Computation. ACM, New York, 2018, pp 119–126.

Xavier Caruso, David Roe and Tristan Vaccon, Characteristic polynomials of p-adic matrices, Proceedings of the 2017 ACM on International Symposium on Symbolic and Algebraic Computation. ACM, New York, 2017, pp 389–396.

Xavier Caruso, David Roe and Tristan Vaccon, Division and slope factorization of p-adic polynomials, Proceedings of the 2016 ICM on International Symposium on Symbolic and Algebraic Computation. ACM, New York, 2016, pp. 159–166.

Moshe Adrian and David Roe, Rectifiers and the local Langlands correspondence: the unramified case, Math. Res. Lett. **23** (2016), no. 3, pp. 593–619.

Xavier Caruso, David Roe and Tristan Vaccon, p-adic stability in linear algebra, Proceedings of the 2015 ICM on International Symposium on Symbolic and Algebraic Computation. ACM, New York, 2015, pp. 101–108.

Julia Gordon and David Roe, The canonical measure on a reductive p-adic group is motivic, Ann. Sci. Éc. Norm. Supér. **50** (2015), no. 2, pp. 345–355.

David Roe, The 3-adic eigencurve at the boundary of weight space, Int. J. Number Theory **10** (2014), no. 7, pp. 1791–1806.

Xavier Caruso, David Roe and Tristan Vaccon, Tracking p-adic precision, LMS J. Comput. Math. **17** (Special issue A) (2014), 274–294.

David Roe, Constructing local L-packets for tame unitary groups, arXiv:1311.7456.

David Roe, The local Langlands correspondence for tamely ramified groups, Ph.D. thesis, Harvard University, 2011.

Timothy G. Abbott, Kiran Kedlaya and David Roe, Bounding Picard numbers of surfaces using p-adic cohomology, in *Arithmetic, Geometry and Coding Theory (AGCT 2005), Séminaires et Congrès 21, Societé Mathématique de France*, 2009, 125-159.

Software and Databases

2008–2025 **L-functions and Modular Forms Database (LMFDB)**, www.lmfdb.org.
Serve on editorial board, develop site-wide infrastructure, add content (described below)

2016–2025 **LMFDB: Abelian varieties over finite fields**, www.lmfdb.org/Variety/Abelian/Fq.

2018–2021 **LMFDB: Classical modular forms**, www.lmfdb.org/ModularForm/GL2/Q/holomorphic.

2019–2025 **LMFDB: Finite groups**, beta.lmfdb.org/Groups/Abstract.

2020–2025 **LMFDB: Hypergeometric motives**, beta.lmfdb.org/Motive/Hypergeometric/Q/.

2022–2025 **LMFDB: Modular curves**, beta.lmfdb.org/ModularCurve/Q/.

2006–2025 **SageMath**, sagemath.org.
Most of my effort has gone to creating p-adics module, but also worked on finite fields, elliptic curves, number fields, the transition to git and github, and the coercion system. I also serve on the Code of Conduct Commitee.

2020–2022 **Research Seminars**, researchseminars.org.
Cofounder of online index of online seminars worldwide

2021–2022 **Pset Partners**, psetpartners.mit.edu.
Helped with initial setup and matching algorithm

2019–2022 **Psycodict**, github.com/roed314/psycodict.
Python-SQL interface, used in LMFDB, researchseminars and pset partners

Invited Talks

Jan 2025 Hypergeometric L-functions in average polynomial time (JMM2025)
Jul 2024 How to win the lottery (MathRoots)
Jun 2025 Finite groups and K3 surfaces in the LMFDB (BIRS: Computational Geometry)
Sep 2023 Modular curves in the LMFDB (Modular curves and Galois representations)
Mar 2023 Modular curves and finite groups (COUNT)
Jan 2023 Modular curves and finite groups (2023 Simons meeting)
May 2022 The L-functions and modular forms database (Big Data in Pure Mathematics)

Feb 2021	Algebraic structures in Sage (Sage-Oscar Days)
Nov 2019	A database of p-adic tori (UBC number theory seminar)
Sep 2019	A database of p-adic tori (p-adic Langlands conference)
Jun 2019	A database of p-adic tori (CMS Summer meetings)
Jul 2018	Inverse Galois problem for p-adic fields (ANTS 13)
Feb 2018	Using lattice to track p-adic precision (Numerical methods for algebraic curves)
Sep 2017	How to win the lottery (Reed College colloquium)
Aug 2017	Introduction to p-adics in Sage (Sage Days 88)
July 2017	Introduction to p-adics in Sage (Sage Days 87)
June 2017	Makdisi's algorithm for Jacobians of p-adic curves (Sage Days 86.5)
May 2017	Computing with modular forms (UNCG Summer School)
Feb 2017	Modular forms and modular symbols in Sage (CLap-CLap)
Sep 2016	Algebraic tori and a computational inverse Galois problem (PANTS 26)
Mar 2016	Overconvergent modular symbols (Sage Days 71)
Sep 2015	Overconvergent modular symbols in Sage (RIMS conference on computer algebra)
July 2015	Positive slope pieces of the eigencurve via interpolation (Comp. Rep. Theory in N.T.)
May 2015	Positive slope pieces of the eigencurve via interpolation (Explicit Methods for Ab. Var.)
June 2014	Geometrizing the Langlands correspondence in mixed characteristic (CNTA XIII)
May 2014	A function-sheaf dictionary for tori over local fields (FRG on periods and L-functions)
Feb 2014	Numerical Methods in p-adic Linear Algebra (Lethbridge Number Theory Seminar)
Jan 2014	A function-sheaf dictionary for tori over local fields (AMS Session: the Langlands Program)
Dec 2013	Quasicharacter sheaves for tori (Quebec-Vermont Number Theory Seminar)
Dec 2013	An Introduction to the local Langlands correspondence (UQAM combinatorics seminar)
June 2013	Geometrizing characters of tori (PRIMA 2013)
May 2013	Geometrizing characters of tori (Alberta Number Theory Days)
Jan 2013	Geometrizing quasicharacters of tori (UCSC Number Theory Seminar)
Jan 2013	Geometrizing quasicharacters of tori (AMS Session: Witt Vectors, Lifting and Descent)
May 2012	The local Langlands correspondence for tamely ramified groups (Pacific Northwest Number Theory Conference)
Apr 2012	The local Langlands correspondence for tamely ramified groups (University of Utah)
Mar 2012	Precision models for arithmetic in local fields (UBC Number Theory Seminar)
Feb 2012	The state of p-adics in Sage (Sage Days 36)
Jun 2011	Zeta functions with p-adic cohomology (Geocrypt 2011)
Jun 2011	Precision models for arithmetic in local fields (Théorie de Hodge p-adique, équations différentielles p-adiques et leurs applications)
Jan 2011	The local Langlands correspondence for tamely ramified groups (University of Calgary)
Nov 2010	p-Adics in Sage: present and future (University Rennes 1)
Oct 2010	The local Langlands correspondence for tamely ramified groups (CCR West)
Oct 2010	The local Langlands correspondence for tamely ramified groups (Quebec-Maine Number Theory Conference)
Apr 2010	Zeta functions with p-adic cohomology (Counting Points: Theory, Algorithms and Practice)
Mar 2008	A bound for the number of automorphisms of an arithmetic Riemann surface (group project presentation, Arizona Winter School)
Sep 2007	p-Adic arithmetic in Sage (Sage Days 5)
Jun 2007	p-Adics in Sage (Sage Days 4)

Teaching Experience

Summer 2022, 2023 — **Supervisor: Undergraduate Research Opportunities Program**, *Dept. of Mathematics, MIT*.
Ran 3 undergraduate research projects

Fall 2020 — **Instructor: Arithmetic geometry**, *Dept. of Mathematics, MIT*.
Instructor, online due to covid

Spring 2019 — **Instructor: p-adic analysis**, *Dept. of Mathematics, MIT*.
Independent study with 3 students

Fall 2017 — **Instructor: Intro. Abstract Algebraic Structures**, *Dept. of Mathematics, Pitt*.
Sole instructor.

Fall 2017 — **Lecturer: Calculus 1**, *Dept of Mathematics, Pitt*.

Spring 2017 — **Lecturer: Calculus 3**, *Dept. of Mathematics, Pitt*.

Fall 2016 — **Lecturer: Calculus 1**, *Dept. of Mathematics, Pitt*.

Fall 2016 — **Lecturer: Discrete Mathematical Structures**, *Dept. of Mathematics, Pitt*.

Spring 2016 — **Instructor: Intro. Abstract Algebraic Structures**, *Dept. of Mathematics, Pitt*.
Sole instructor.

Fall 2015 — **Lecturer: Calculus 1**, *Dept. of Mathematics, Pitt*.
Lectured for two sections.

Fall 2014 — **Lecturer: Multivariable Calculus**, *Dept. of Mathematics, UBC*.
Lectured for two sections.

Fall 2013 — **Lecturer: Linear Methods**, *Dept. of Mathematics, Calgary*.
Lectured for a 140-person section of science majors.

Fall 2012 — **Instructor: Computational Number Theory**, *Dept. of Mathematics, Calgary*.
Designed and taught this joint undergraduate/graduate course.

Fall 2008 — **Course Assistant: Algebraic Number Theory**, *Dept. of Mathematics, Harvard*.
Taught recitations, assisted students in preparing for weekly student talks, and graded.

Fall 2007, 2008 — **Teaching Fellow: Magic of Numbers**, *Core Program, Harvard*.
Taught recitations, wrote homework and tests, and graded.

Summers 2007-2009 2011 2016 — **Mentor and Academic Coordinator**, *Canada/USA Mathcamp*.
Taught short courses at this camp for high school students, including Unique Factorization, Algebraic Topology, p-Adics, Elliptic Curves, Modular Forms, Coxeter Groups, Factoring Algorithms.

Spring 2006 — **Teaching Assistant: Project Lab in Mathematics**, *Dept. of Mathematics, MIT*.
Assisted small groups of students with carrying out and writing up a series of research projects.

Fall 2005 Spring 2005 Fall 2003 — **Instructor: Multivariable Calculus**, *Experimental Study Group, MIT*.
Sole instructor. Lectured, wrote homework and tests, and graded.

Conferences Organized

April 2024 — Hypergeometric curves workshop (MIT)

March 2024 — Modular curves workshop 3 (MIT)

November 2022 — Modular curves workshop 2 (MIT)

April 2022	Explicit methods in modularity (online)
March 2022	Modular curves workshop (MIT)
July 2017	Sage Days 87: p-adics in Sage (University of Vermont)
Mar 2016	Explicit p-adic Methods in Number Theory (Oxford)
Dec 2015	CMS Winter Meeting: Representation Theory session (Montreal, QC)
May 2013	Alberta Number Theory Days (Banff, AB)
Feb 2013	Sage Days 44: p-adic overconvergent symbols in Sage (University of Wisconsin)
March 2012	Sage Days 40.5: Bug fixing workshop (Seattle, WA)
Feb 2012	Sage Days 36: p-adics in Sage (University of California, San Diego)

Other Activities

2023	Served on NSF grant review panel
2020–2023	Served on LMFDB editorial board
2020	Created researchseminars.org
Summer 2016	Academic Coordinator for Canada/USA Mathcamp
Fall 2014	Organizer of the number theory video seminar at UBC
Fall 2012	Organizer of the ABC seminar at University of Calgary
2008-2011	Organizer of the Alcove Seminar, a graduate number theory seminar at Harvard
2002-2009	Volunteer teacher at Splash, a program for high school students run by MIT's Educational Studies Program
1998-2002	Founder and coach of one MATHCOUNTS team (www.mathcounts.org), coach of another

References

Professor Clifton Cunningham, *University of Calgary*, cunning@math.ucalgary.ca.
Postdoctoral supervisor, collaborator

Professor Julia Gordon, *University of British Columbia*, gor@math.ubc.ca.
Postdoctoral supervisor, collaborator

Professor Benedict Gross, *Harvard University*, gross@math.harvard.edu.
Ph.D. thesis advisor

Professor Thomas Hales, *University of Pittsburgh*, hales@pitt.edu.
Postdoctoral supervisor

Professor Kiran Kedlaya, *University of California, San Diego*, kedlaya@ucsd.edu.
Undergrad research supervisor, collaborator

Andrew Sutherland, *MIT*, drew@math.mit.edu.
Research supervisor

Professor John Voight, *Dartmouth College*, john.voight@dartmouth.edu .
LMFDB editor, collaborator