

Address

Department of Mathematical Sciences
Durham University
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Education

University of California Santa Cruz

Ph.D. 2010-2014

Thesis title: *Quantitative spectral gap for thin groups of hyperbolic isometries*

Advisor: Alexander Gamburd

University of Cambridge

C.A.S.M. (Part III), Distinction, 2007-2008

B.A. Mathematics, First Class, 2004-2007

Appointments

Professor, Durham University, from July 2021

Assistant Professor, Durham University, September 2017-June 2021.

Associate Research Scientist, Yale University, July 2017-August 2017.

Gibbs Assistant Professor, Yale University, July 2015-June 2017.

Member, School of Mathematics, Institute for Advanced Study Princeton,
September 2014-July 2015.

Editorial

Joint managing editor, Forum of Math (Pi and Sigma), 2026-

Awards

ERC Consolidator Grant CONUREP ‘Convergence of unitary representations’,
€1,981,393, 2025

Philip Leverhulme Prize, 2023

Von Neumann Fellowship, IAS Princeton, 2023

Whitehead prize (London Math. Society), 2021

ERC Starting Grant UBIQGAP ‘The ubiquity of optimal spectral gaps’,
€1,437,000, 2020

N.S.F. award DMS-1701357 “Thin counting in moduli spaces” (Algebra and Number Theory), total amount \$145,295, 2017
University of California Chancellor’s Fellowship, \$54,000 2010

Journal articles

25. *Strong asymptotic freeness of Haar unitaries in quasi-exponential dimensional representations*. With Mikael de la Salle.

Geometric and Functional Analysis (GAFA), to appear.

24. *Strongly convergent unitary representations of right-angled Artin groups*. With Joe Thomas.

Duke Mathematical Journal, to appear.

23. *Strongly convergent unitary representations of limit groups*. With Lars Louder.

Journal of Functional Analysis, vol 288, no. 6, 2025.

(includes an Appendix written jointly with W. Hide)

22. *$SL(4, \mathbb{Z})$ is not purely matricial field*. With Mikael de la Salle.

Comptes Rendus Mathématique, Volume 362 (2024), pp. 903-910.

21. *Explicit spectral gap for Schottky subgroups of $SL(2, \mathbb{Z})$* . With Irving Calderón.

Journal of the European Mathematical Society, to appear.

20. *Quantum Unique Ergodicity for Cayley graphs of quasirandom groups*, with J. Thomas and Y. Zhao.

Communications in Mathematical Physics, Commun. Math. Phys. 402, 3021–3044 (2023)..

19. *Random Unitary Representations of Surface Groups II: The large n limit*.

Geometry and Topology, 29 (2025) 1237–1281.

17. *Near optimal spectral gaps for hyperbolic surfaces*, with W. Hide.

Annals of Mathematics, 198(2): 791-824 (September 2023). DOI: 10.4007/annals.2023.198.2.6 .

16. *Matrix Group Integrals, Surfaces, and Mapping Class Groups II: $O(n)$ and $Sp(n)$* , with D. Puder.

Math. Annalen, <https://doi.org/10.1007/s00208-022-02542-1>. (2022)

15. *A random cover of a compact hyperbolic surface has relative spectral gap $\frac{3}{16} - \varepsilon$* , with F. Naud and D. Puder.

Geometric and Functional Analysis (GAFA), 32 (3). pp. 595-661 (2022).

14. *Core surfaces*, with D. Puder.

Geometriae Dedicata, 216(4):46 (2022).

13. *Random Unitary Representations of Surface Groups I: Asymptotic expansions*.

Communications in Mathematical Physics vol. 391, pages 119–171 (2022)

12. *Explicit spectral gaps for random covers of Riemann surfaces*, with F. Naud.

Publications mathématiques de l’IHÉS 132, pages 137–179 (2020).

11. *Kesten-McKay law for the Markoff surface mod p* , with M. de Courcy-Ireland.

Annales Henri Lebesgue Volume 4 (2021), pp. 227-250.

10. *Surface words are determined by word measures on groups*, with D. Puder.

Israel Journal of Mathematics, 241, pages 749–774 (2021).

9. *On Selberg’s Eigenvalue Conjecture for moduli spaces of abelian differentials*,

Compositio Mathematica 155(12): 2354-2398 (2019)

8. *The cycle structure of a Markoff automorphism over finite fields*, with A. Cerbu, E. Gunther, L. Peilen.

Journal of Number Theory (2019)

7. *An asymptotic formula for integer points on Markoff-Hurwitz varieties*, with A. Gamburd and R. Ronan.

Annals of Mathematics 190(3): 751-809 (2019)

6. *Counting saddle connections in a homology class modulo q* , with R. Rühr.
(includes an Appendix by R. Gutiérrez-Romo)

Journal of Modern Dynamics 15: 237-262 (2019)

5. *Matrix Group Integrals, Surfaces, and Mapping Class Groups I: $U(n)$* , with D. Puder,
Inventiones mathematicae 218(2): 341-411 (2019)

4. *Counting one sided simple closed geodesics on Fuchsian thrice punctured projective planes.*

I.M.R.N. rny112, <https://doi.org/10.1093/imrn/rny112> (2018)

3. *Uniform congruence counting for Schottky semigroups in $SL_2(\mathbb{Z})$* , with H. Oh and D. Winter.
(includes an Appendix written jointly with J. Bourgain and A. Kontorovich)

Journal für die reine und angewandte Mathematik (Crelle's Journal) (753): 89-135 (2019)

2. *Arithmetic, zeros, and nodal domains on the sphere,*

Communications in Mathematical Physics 338, No. 3, 919-951 (2015)

1. *Quantitative spectral gap for thin groups of hyperbolic isometries,*

Journal of the European Mathematical Society (JEMS) No. 1, 151-187 (2015)

Conference proceedings

2. *Strong convergence of unitary and permutation representations of discrete groups.*

Proceedings of the 9ECM, to appear.

1. *Automorphism-invariant positive definite functions on free groups*, with B. Collins and D. Puder.

Proceedings of the 27th International Conference on Operator Theory (2021) arXiv:1906.01518

Conference and Colloquium talks

Stanford University, *Bay Area Algebraic Number Theory and Arithmetic Geometry Day*, 04/26/2014

Rutgers University, *A.M.S. Eastern Sectional Meeting*, 11/14/2015

M.S.R.I., Berkeley, *Advances in Homogeneous Dynamics* workshop, 05/12/2015

I.A.S. Princeton, *Emerging topics workshop: 'Quantum chaos and fractal uncertainty principle'*,
10/11/2017

27th International Conference in Operator Theory, Timișoara, Romania, 07/05/2018

Groups and Geometry in the South East (Warwick University), 06/01/2018

University of St Andrews, *Colloquium*, 11/29/2018

C.R.M. Montreal, *Workshop: Free Probability: the theory, its extensions*, 03/05/2019

H.I.M. Bonn, *Transfer operators in number theory and quantum chaos*, 02/04/2020

University of Paderborn, *Spectra and dynamics on (locally) symmetric spaces*, 02/14/2022

Princeton University, *Colloquium*, 04/06/2022

Northwestern University, *Laplacians on random hyperbolic surfaces and on random graphs*, 06/02/2022

Technion (Haifa), *Summer School 'Paroles Paroles'*, 4 lectures, 17-21 July 2022

University of Zurich, *Groups and Dynamics* (meeting of Swiss Math Soc.), 09/15/2022

Institut Henri Poincaré, *Combinatorics of finite index subgroups*, 11/03/2022
LMS Regional Meeting, Invited talk, Warwick, 03/27/2023
North British Geometric Group Theory meeting, Glasgow, 04/21/2023
Burton Randol Memorial, CUNY, 10/19/2023
Yau Mathematical Sciences Center, Colloquium, 11/17/2023
Rutgers Colloquium 11/29/2023
I.A.S. Princeton Member's Colloquium 01/29/2024
Yale, Mathematics Colloquium 02/28/2024
Princeton, *Visions in Arithmetic and Beyond: Celebrating Peter Sarnak*, 06/03/2024
Manchester, *British Mathematical Colloquium*, Invited Morning Talk, 06/19/2024
Sevilla, *European Congress of Mathematicians*, Invited Talk, 07/19/2024
ICMS Edinburgh, *UK Workshop on Spectral Theory*, 09/09/2024
Sheffield, Pure Mathematics Colloquium, 10/09/2024
C.I.R.M. Luminy (Marseille), *Random hyperbolic surfaces and random graphs*, 11/25/2024
Bristol, Mathematics Colloquium, 01/27/2025
Cardiff, *Operator Algebras in the South*, 03/07/2025
Imperial College London, Oxford-Imperial random systems CDT summer event, 06/23/2025
INI Cambridge, *Spectral gaps workshop (part of Operators, Graphs, Groups)*, 10/10/2025
Collège de France, *Géométrie et spectre des grands objets*, 01/28/2026
INI Cambridge, *Emerging horizons in Geometric Spectral theory* (overview talk), 02/03/2026
Cambridge University, Geometry and Topology Colloquium, 02/11/2026

Invited seminar talks

Yale University, Group Actions and Dynamics seminar, 02/10/2014
Stanford University, Number Theory seminar, 05/23/2014
Institute for Advanced Study, Princeton, Postdoctoral talk, 10/01/2014
Rutgers University, Number Theory seminar, 10/14/2014
University of Wisconsin-Madison, Number Theory seminar, 11/06/2014
Bryn Mawr College, Number Theory seminar, 01/28/2015
Boston College, Number Theory seminar, 03/12/2015
Institute for Advanced Study, Princeton, Spectral Geometry seminar, 04/06/2015
M.I.T., Analysis Seminar, 10/13/2015
Yale University, Geometry and Topology Seminar, 01/26/2016
U.I.U.C, Number Theory Seminar, 03/03/2016
Yale University, Group Actions and Dynamics Seminar, 04/04/2016
Penn State University, Dynamics Seminar, 09/19/2016
U. Chicago, Dynamics Seminar, 10/31/2016
U. Chicago, Danny Calegari's topics class on scl, 11/01/2016
University of Bristol, Ergodic Theory and Dynamical Systems Seminar, 12/15/2016
Tel Aviv University, Number Theory Seminar, 01/04/2017
Temple University, Geometry and Topology Seminar, 04/05/2017
I.A.S. Princeton, Analysis/Math. Physics seminar, 04/19/2017

University of Rome II (Tor Vergata), Seminar, 09/20/2017
Cardiff University, Analysis Seminar, 10/23/2017
Warwick University, Ergodic Theory and Dynamical Systems seminar, 11/7/2017
Warwick University, Geometry and Topology seminar, 11/9/2017
Glasgow University, Geometry and Topology seminar, 11/13/2017
Durham University, Colloquium, 11/20/2017
Weizmann Institute of Science, Midrasha on groups (2 talks), 01/10/2018
Durham University, Geometry and Topology seminar, 01/18/2018
Cambridge University, Geometry and Topology seminar, 01/31/2018
University of Manchester, Analysis and Dynamics Seminar, 04/16/2018
Loughborough University, Dynamical Systems Seminar, 05/23/2018
University of Bristol, Ergodic Theory and Dynamical Systems Seminar, 05/24/2018
R.I.M.S. Operator Algebras Seminar, Kyoto, Japan, 10/02/2018
University of Vienna, Geometry and Analysis on Groups Seminar (2 talks), 11/13/2018
University of Leeds, Geometry seminar, 11/21/2018
Institut Henri Poincaré, 'Plat' seminar, Paris, 03/13/2019
FRUMAM, 'Teich' seminar, Marseille, 03/29/2019
University of Oxford, Topology seminar, 06/10/2019
Durham University, Arithmetic study group, 11/19/2019
Zurich Ergodic Theory and Dynamical Systems seminar, 05/18/2020
Montreal Analysis Seminar, 07/15/2020
U.C. Berkeley Probabilistic Operator Algebras Seminar, 03/29/2021
London Geometry and Topology Seminar, 05/14/2021
Tel Aviv, Doron Puder's seminar, 05/25/2021, 06/01/2021 (2 talks)
IRMA (Strasbourg), Analysis seminar, 06/22/2021
University of Michigan, Geometry seminar, 07/12/2021
Durham University Research day, 09/24/2021
Tel Aviv, Groups and Dynamics seminar 10/21/2021
Brown University Algebra and Number Theory seminar 11/01/2021
NYC Joint Number Theory Seminar 11/04/2021
Spectral Geometry in the Clouds 11/22/2021
Yale University, Group Actions and Dynamics Seminar, 02/21/2022
Irish Geometry Seminar 03/01/2022
Warwick Ergodic Theory and Dynamical Systems seminar, 03/08/2022
London Number Theory Seminar 03/23/2022
University of Wisconsin-Madison, Analysis seminar, 09/27/2022
U.C. Berkeley Probabilistic Operator Algebras seminar, 11/18/2022
Bristol University Geometry and Topology seminar, 01/24/2023
Princeton University, special seminar, two lectures 10/25, 11/01/2023
Caltech, Geometry and Topology seminar (online) 11/10/2023
M.I.T. Probability seminar, 12/11/2023
Temple University, Geometry and Topology Seminar, 03/27/2024
Maryland (UMD) Dynamics Seminar, 04/25/2024

U.C. Berkeley Probabilistic Operator Algebras Seminar, 10/21/2024

University of Oxford, Functional Analysis seminar, 05/10/2025

Queen's University Belfast, special seminar (INI Satellite on groupoid C^* -algebras), 07/07/2025

UCL (London) Geometry seminar, 11/26/2025

PhD student supervision

Will Hide 2020-2024

Ewan Cassidy 2021-2025

Anitej Banerjee 2022-present

Postdoc mentoring

Irving Calderón 2021-2025

Joe Thomas 2021-present

Conference/workshop organization

Mini-workshop on random surfaces, (online workshop), September 2020.

Durham Symposium 2023: Spectral gaps, August 7-11 2023.

Spectral gaps 2025: Portoroz, Slovenia, Sept 2025.

Random and arithmetic models in spectral theory. INI Cambridge, May 2026.

In preparation: Spectral gaps 2027, ETH Zurich, July 2027.

Departmental responsibilities

Analysis research group lead, from inception (2023-)

Progression and Promotion Committee (2024-)

Founding organizer of Durham Spectra/Moduli seminar, October 2021-

Organizer of Pure Mathematics Colloquium, July 2019-July 2020, September 2025-

Internal examiner, Ph.D. thesis of Robert Little (May 2019)

Internal examiner, Ph.D. thesis of John Blackman (July 2020)

External service

External examiner, Ph.D. thesis of Stephen Cantrell, Warwick (June 2020)

Reader, Ph.D. thesis of Pratyush Sarkar, Yale (April 2022)

Grant review panel for DFG Collaborative Research Center (September 2022)

External Examiner, Master's thesis of Yaron Brodsky, Tel Aviv University (Oct 2022)

Professional qualifications

Postgraduate Certificate in Learning and Teaching in Higher Education, Durham University (2020)

Fellow of the UK Higher Education Academy

Teaching experience

Lecturer

Durham University, *Complex Analysis*, Epiphany 2018-Easter 2020.

Yale University, *Number theory*, Spring 2017

Yale University, *Group expansion and number theory*, Spring 2017

Yale University, *Linear Algebra with Applications*, Fall 2016

Yale University, *Spectral Geometry*, Spring 2016

Yale University, *Introduction to Functional Analysis*, Spring 2016

Yale University, *Ordinary Differential Equations*, Fall 2015

UC Santa Cruz, *Calculus with applications*, August 2013

UC Santa Cruz, *Calculus with applications*, August 2012

Teaching assistant

UC Santa Cruz, *Various undergraduate classes*, 2012-2014

Reviews and opinions

For many venues including all top journals.

Non academic work

From 2008-2010 I worked as a software engineer (Manchester, UK, and Irvine, CA, USA).