# Ashvin A. Swaminathan

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# **Current position**

- 2022-27 Benjamin Peirce Fellow, Harvard University
- Fall 2025 Invited Researcher, LodhaMATH Institute, Mumbai
- 2022-24 NSF Postdoctoral Fellow, Harvard University
  - Mentor: Melanie Matchett Wood

# Areas of specialization

Arithmetic statistics, invariant theory, Cohen–Lenstra heuristics, rational points on varieties, Diophantine equations, enumerative geometry.

# Education

- 2017-22 PhD in Mathematics, Princeton University Advisor: Manjul Bhargava Thesis title: 2-Selmer groups, 2-class groups, and the arithmetic of binary forms
- 2016-17 AM in Physics, Harvard University
- 2013-17 AB in Mathematics, Harvard University *summa cum laude* & with highest departmental honors Advisors: Joe Harris & Anand Patel Senior thesis title: Inflection points in families of algebraic curves

### **Selected honors**

Fellowships & grants

- 2022-24 NSF Mathematics Sciences Postdoctoral Research Fellowship
- 2021 US Junior Oberwolfach Fellowship
- 2017-22 NSF Graduate Research Fellowship
- 2017-21 Centennial Fellowship, Princeton University
- 2017-19 Paul and Daisy Soros Fellowship
- 2016 Barry M. Goldwater Scholarship

AWARDS, PRIZES & OTHER RECOGNITION

- 2021 Princeton Engineering Council Teaching Award (Math 202)
- 2018 AMS-MAA-SIAM Frank and Brennie Morgan Prize
- 2017 David B. Mumford Prize (most promising math concentrator at Harvard)
- 2016 Robert Fletcher Rogers Prize (best Math Table talk at Harvard)
- 2015-16 Harvard University Certificate of Distinction in Teaching (3 times, for Math 114, 123, 131)

### **Papers**

PREPRINTS AND SUBMITTED ARTICLES

2024 The second moment of the size of the 2-class group of monogenized cubic fields (with Manjul Bhargava and Arul Shankar)

Preprint available upon request.

- 2024 Universality theorems for zeros of random real polynomials with fixed coefficients (with Matt King) Submitted. arXiv
- 2022 The second moment of the size of the 2-Selmer group of elliptic curves (with Manjul Bhargava and Arul Shankar)

Under review at Annals of Mathematics. (Based on Chapter 4 of my PhD thesis) arXiv

PUBLISHED ARTICLES

- 2024 Counting integral points on symmetric varieties with applications to arithmetic statistics (with Arul Shankar and Artane Siad)
  - Accepted to Proceedings of the London Mathematical Society. arXiv
- 2024 Geometry-of-numbers methods in the cusp (with Arul Shankar, Artane Siad, and Ila Varma) Accepted to *Algebra and Number Theory*. (Based on Chapter 5 of my PhD thesis) arXiv
- 2024 The mean number of 2-torsion elements in the class groups of cubic orders
- Accepted to Commentarii Mathematici Helvetici. arXiv
- 2024 A positive proportion of monic odd-degree hyperelliptic curves of genus  $g \ge 4$  have no unexpected quadratic points (with Jef Laga)
  - Accepted to International Mathematics Research Notices. arXiv
- 2024 Most odd-degree binary forms fail to primitively represent a square
  *Compositio Mathematica*, 160(3), pp. 481-517. (Based on Chapter 3 of my PhD thesis) arXiv
  2023 A new parametrization for ideal classes in rings defined by binary forms, and applications
- *Journal für die reine und angewandte Mathematik*, 2023(789), pp. 143-191. (Based on Chapters 1-2 of my PhD thesis) arXiv
- 2023 Hermite equivalence of polynomials (with Manjul Bhargava, Jan-Hendrik Evertse, Kálmán Györy, and László Remete)
- Acta Arithmetica, 209, pp. 17-58, special volume in honor of Andrzej Schinzel. arXiv
- 2023 Inflectionary invariants for isolated complete intersection curve singularities (with Anand Patel) *Memoirs of the American Mathematical Society*, 282(1397), pp. vii-99. arXiv
- 2021 On the EKL-degree of a Weyl cover (with Joseph Knight and Dennis Tseng) Journal of Algebra, 565(1), pp. 64–81. arXiv
- 2021 Appendix to: An arithmetic count of the lines meeting four lines in  $\mathbf{P}^3$  (with Borys Kadets, Padmavathi Srinivasan, Libby Taylor, and Dennis Tseng)

Transactions of the American Mathematical Society, 374(5), pp. 3447-3448. arXiv

2020 Hyperelliptic curves with maximal Galois action on the torsion points of their Jacobians (with Aaron Landesman, James Tao, and Yujie Xu)

Indiana University Mathematics Journal, 69(7), pp. 2461–2492. arXiv

- 2019 Surjectivity of Galois representations in rational families of abelian varieties (with Aaron Landesman, James Tao, and Yujie Xu)
- Algebra and Number Theory, 13(5), pp. 995–1038. arXiv
- 2018 Elliptic curve variants of the least quadratic nonresidue problem and Linnik's Theorem (with Evan Chen and Peter Park)

International Journal of Number Theory, 4(1), pp. 255–288. arXiv

- 2017 Lifting subgroups of symplectic groups over  $\mathbb{Z}/\ell\mathbb{Z}$  (with Aaron Landesman, James Tao, and Yujie Xu) *Research in Number Theory*, 3(14), pp. 1–12. arXiv
- 2017 Permutations that destroy arithmetic progressions in elementary *p*-groups (with Noam D. Elkies),

	Electronic Journal of Combinatorics, 24(1), pp. 1–10. arXiv
2016	On logarithmically Benford sequences (with Evan Chen and Peter Park)
	Proceedings of the American Mathematical Society, 144(11), pp. 4599–4608. arXiv
2016	On arboreal Galois representations of rational functions
	Journal of Algebra, 448, pp. 104–126. arXiv
2015	Linnik's Theorem for Sato-Tate laws on elliptic curves with complex multiplication (with Evan Chen
	and Peter Park)
	Research in Number Theory, 1(1), pp. 1–11. arXiv
2014	Analysis on surreal numbers (with Simon Rubinstein-Salzedo)
	Journal of Logic and Analysis, 6(5), pp. 1–39. arXiv
	THESES AND EXPOSITORY ARTICLES

2022 2-Selmer groups, 2-class groups, and the arithmetic of binary forms (PhD Thesis). PDF

- 2017 Inflection points in families of algebraic curves (Senior thesis). PDF
- 2016 Lie algebras and Ado's Theorem. PDF
- 2016 An introduction to the theory of valued fields (Junior paper). PDF
- 2015 On the Selberg-Erdős proof of the Prime Number Theorem. PDF
- 2013 Arrow's Impossibility Theorem on social choice systems. PDF

# Talks

2025	"Toward secondary terms for 2-Selmer groups in special families of elliptic curves"
	Number Theory Seminar, Dartmouth College
	Number Theory Seminar, University of Basel
2024	"A positive proportion of hyperelliptic curves have no unexpected quadratic points"
	Algebraic Geometry Seminar, Harvard University
	Algebraic Geometry Seminar, Boston College
	Informal Number Theory Seminar, University of Glasgow
	Lightning Talk, conference on The Mordell conjecture: 100 years later
	Number Theory Seminar, Tufts University
	Five College Number Theory Seminar, Amherst College
2023	Affine symmetric spaces and class groups of cubic fields
	Québec Vermont Number Theory Seminar, McGill University
	Conference on Algebra, Algorithms, and Arithmetic, ICMS Edinburgh
	Symposium on Arithmetic Geometry and its Applications, CIRM Luminy
	Number Theory Tea, Princeton University
2022	"On the distribution of 2-Selmer groups of hyperelliptic Jacobians"
	Workshop on Rational Points on Higher-Dimensional Varieties, ICMS Edinburgh
2021-23	"The second moment of the size of the 2-Selmer group of elliptic curves"
	Special Session on Arithmetic Statistics, JMM, Boston
	Number Theory Seminar, Princeton University/IAS
	Workshop on Explicit Methods in Number Theory, Mathematisches Forschungsinstitut Oberwolfach
2021-22	"2-Selmer groups, 2-class groups, and the arithmetic of binary forms"
	Online Number Theory Seminar, University of Debrecen
	Number Theory Seminar, Fields Institute
	Palmetto Joint Arithmetic and Modularity Series (PAJAMAS) III, Invited Graduate Speaker
2020-23	"Geometry-of-numbers in the cusp, and class groups of orders in number fields"
	Number Theory Seminar, Duke University
	Conference on Arithmetic Statistics, CIRM Luminy
	Number Theory Seminar, MIT

	Montreal Online Biweekly Inter-University Seminar on Analytic Number Theory (MOBIUS ANT)
2020-22	"Most odd-degree binary forms fail to primitively represent a square"
	Lightning Talk, Simons Collaboration on Arithmetic Geometry, Number Theory, and Computation
	Bhargava Seminar, Stanford University
	Bhargava Seminar, Princeton University
2020	"Average 2-torsion in the class groups of rings associated to binary <i>n</i> -ic forms"
	Bhargava Seminar, Princeton University
	Number/Representation Theory Seminar, University of Toronto
2020	"Three lectures on the average size of 2-Selmer groups of elliptic curves"
	Bhargava Seminar, Stanford University
2019	"Most hyperelliptic curves are pointless"
	Bhargava Seminar, Princeton University
2017-18	"Inflectionary invariants for plane curve singularities"
	Special Session on Research in Mathematics by Undergraduates, JMM, San Diego
	Graduate Student Seminar, Princeton University
	Algebraic Geometry Seminar, Stanford University
2017	"Surjectivity of Galois representations in rational families of abelian varieties"
	Algebra, Geometry, and Number Theory Seminar, Tufts University
2017	"Surjectivity of Galois representations in rational families of abelian varieties"
	Special Session on Minimal Integral Models of Algebraic Curves, JMM, Atlanta
2015-17	"Permutations that destroy arithmetic progressions in elementary <i>p</i> -groups"
	JMM, Atlanta
	Harvard Math Table
2015-16	"Elliptic curve variants of the least quadratic nonresidue problem and Linnik's Theorem"
	JMM, Seattle
	Harvard Math Table
2014-15	"On arboreal Galois representations of rational functions"
	JMM, San Antonio
	Harvard Math Table
2012-16	"Analysis on surreal numbers"
	ASL Special Session, JMM, Seattle
	Harvard Math Table
	CMS Summer Meeting

# **Teaching and service**

COURSES TAUGHT

2024-27 Instructor, Harvard University

- Math 223br (Rational points on varieties), expected.
- Math 295x (Arithmetic statistics), Q-score: 5.0/5.0.
- 2019 Assistant instructor, Princeton University
  - Math 202 (Linear algebra with applications), Score: 4.0/5.0.
- 2013-17 Course assistant, Harvard University
  - Math 137 (Introduction to algebraic geometry, with Peter Kronheimer), Q-score: 5.0/5.0.
  - Math 131 (Topology I, with Joe Harris), Q-score: 4.5/5.0.
  - Math 123 (Algebra II, with Arul Shankar), Q-score: 4.9/5.0.
  - Math 114 (Analysis II, with Daniel Cristofaro-Gardiner), Q-score: 4.9/5.0.
  - Math 55b (Honors real and complex analysis, with Dennis Gaitsgory), Q-score: 4.3/5.0.
  - Math 55a (Honors abstract algebra, with Dennis Gaitsgory), Q-score: 4.6/5.0.

#### STUDENTS SUPERVISED

- 2024-25 Eliot Hodges supervised senior thesis on class groups of orders in extensions of global fields
- 2022-24 Matt King coauthored paper on zeros of random real polynomials

### COMMITTEES AND ORGANIZATION

- 2024-25 Assistant Director of Graduate Studies, Harvard Math Department
- 2022-25 Member, Harvard Math Department Community Committee
- 2022-24 Co-organizer, Harvard Number Theory Seminar

### JOURNAL REFEREEING

Advances in Math, Essential Number Theory, Forum of Math Sigma, International Mathematics Research Notices, Involve, Mathematische Annalen, Mathematical Proceedings of the Cambridge Philosophical Society, Proceedings of the American Mathematical Society, Research in the Mathematical Sciences, Research in Number Theory

### OTHER MENTORING

- Extensive experience tutoring students of all ages in math at all levels, from basic arithmetic to advanced graduate courses

- Served as volunteer tutor and class aide at Cambridge Community Learning Center to help immigrants learn math necessary to apply for jobs

- Worked with Davis International Center at Princeton to help students apply for fellowships