

Positions

- 2023- **Assistant Professor of Statistics**, *Harvard University*
Fall 2022 **Member**, *Institute for Advanced Study*
2022-2023 **Postdoctoral Scientist**, *Amazon*

Education

- 2018-2022 **PhD in Mathematics**, *Stanford University*
Advised by Andrea Montanari and Sébastien Bubeck
2017-2018 **M.A.St. in Mathematics with Distinction**, *University of Cambridge*
2014-2017 **B.S. in Mathematics**, *MIT*

Selected Fellowships and Awards

- NeurIPS: Outstanding Paper Award 2021
- Symposium on Discrete Algorithms (SODA): Best Paper Award 2020
- Symposium on Discrete Algorithms (SODA): Best Student Paper Award 2020
- William R. and Sara Hart Kimball endowed Stanford Graduate Fellowship 2018-2022
- NSF Graduate Research Fellowship 2017-2022
- William Lowell Putnam Competition: 1st place 2014
- International Mathematical Olympiad: Gold Medalist 2013, 2014

Research

51. Enhanced binding for a quantum particle coupled to scalar quantized field. With Volker Betz and Tobias Schmidt. [arXiv:2410.22569](#).
50. On Marginal Stability in Low Temperature Spherical Spin Glasses. [arXiv:2409.15728](#)
49. Free Energy Universality of Spherical Spin Glasses. With Mehtaab Sawhney. [arXiv:2408.13701](#)
48. Localization of Random Surfaces with Monotone Potentials and an FKG-Gaussian Correlation Inequality. [arXiv:2402.18737](#)
47. No Free Prune: Information-Theoretic Barriers to Pruning at Initialization. With Tanishq Kumar and Kevin Luo. **ICML 2024**. [arXiv:2402.01089](#)
46. Mean square displacement of Brownian paths perturbed by bounded pair potentials. With Volker Betz and Tobias Schmidt. [arXiv:2312.02709](#)
45. A Constructive Proof of the Spherical Parisi Formula. With Brice Huang. [arXiv:2311.15495](#)
44. Sampling from Mean-Field Gibbs Measures via Diffusion Processes. With Ahmed El Alaoui and Andrea Montanari. [arXiv:2310.08912](#)

43. Strong Topological Trivialization of Multi-Species Spherical Spin Glasses. With Brice Huang. arXiv:2308.09677
42. Optimization Algorithms for Multi-Species Spherical Spin Glasses. With Brice Huang. **J. Stat. Phys.**, Vol 191 (2024) no. 29. arXiv:2308.09672
41. Effective mass of the Fröhlich Polaron and the Landau-Pekar-Spohn conjecture. With Rodrigo Bazaes, Chiranjib Mukherjee, and S.R.S. Varadhan. arXiv:2307.13058
40. Shattering in Pure Spherical Spin Glasses. With Ahmed El Alaoui and Andrea Montanari. arXiv:2307.04659
39. Asymptotically Optimal Pure Exploration for Infinite-Armed Bandits. With Xiao-Yue Gong. **NeurIPS 2023**. arXiv:2306.01995.
38. On Size-Independent Sample Complexity of ReLU Networks. **Info. Proc. Lett.**, Vol. 186 (2024), 106482. arXiv:2306.01992
37. Incentivizing Exploration with Linear Contexts and Combinatorial Actions. **ICML 2023**. arXiv:2306.01990
36. The Threshold Energy of Low Temperature Langevin Dynamics for Pure Spherical Spin Glasses. **Comm. Pure Appl. Math.**, Vol. 77 (2024), no. 11, 4065-4099. arXiv:2305.07956
35. Tight Space Lower Bound for Pseudo-Deterministic Approximate Counting. With Ofer Grossman and Meghal Gupta. **FOCS 2023**. arXiv:2304.01438
34. Algorithmic Threshold for Multi-Species Spherical Spin Glasses. With Brice Huang. arXiv:2303.12172
33. Almost Quartic Lower Bound for the Fröhlich Polaron's Effective Mass via Gaussian Domination. **Duke Math Journal**, Vol. 173 (2024), no. 13, 2687-2727. arXiv:2212.14023
32. Improved Lower Bound for Frankl's Union-Closed Sets Conjecture. With Ryan Alweiss and Brice Huang. **Electron. J. Combin.**, Vol. 31 (2024) no. 3, P3.35. arXiv:2211.11731
31. Free Energy Subadditivity for Symmetric Random Hamiltonians. **J. Math. Phys.**, Vol. 64 (2023) no. 4: 043302. arXiv:2208.11279
30. When Does Adaptivity Help for Quantum State Learning? With Sitan Chen, Brice Huang, Jerry Li, and Allen Liu. **FOCS 2023**. Also presented at **QIP 2023**. arXiv:2206.05265
29. Sampling from the Sherrington-Kirkpatrick Gibbs measure via algorithmic stochastic localization. With Ahmed El Alaoui and Andrea Montanari. **FOCS 2022**. arXiv:2203.05093
28. The Pareto Frontier of Instance-Dependent Guarantees in Multi-Player Multi-Armed Bandits with no Communication. With Allen Liu. **COLT 2022**. arXiv:2202.09653
27. Local algorithms for Maximum Cut and Minimum Bisection on locally treelike regular graphs of large degree. With Ahmed El Alaoui and Andrea Montanari. **Random Struct. Alg.**, Vol. 63 (2023), no. 3, 689-715. arXiv:2111.06813
26. Tight Lipschitz Hardness for Optimizing Mean Field Spin Glasses. With Brice Huang. **Comm. Pure. Appl. Math.**, accepted. Conference version in **FOCS 2022**. arXiv:2110.07847

25. Iterative Feature Matching: Toward Provable Domain Generalization with Logarithmic Environments. With Yining Chen, Elan Rosenfeld, Tengyu Ma, and Andrej Risteski. **NeurIPS 2022**. arXiv:2106.09913
24. A Universal Law of Robustness via Isoperimetry. With Sébastien Bubeck. **Journal of the ACM**, Vol. 70 (2023) no. 2, Article 10, 1-18. Conference version in **NeurIPS 2021**. **Outstanding Paper Award**. arXiv:2105.12806
23. Optimizing Mean-Field Spin Glasses with External Field. **Electronic J. Probab.**, Vol. 29 (2024) no. 4, 1-47. arXiv:2105.03506
22. Tensor Quasi-Random Groups. **Proc. AMS Series B**, Vol. 9 (2022), 12-21. arXiv:2103.11048
21. Cutoff for the Asymmetric Riffle Shuffle. **Ann. Probab.**, Vol. 50 (2022) no. 6, 2244-2287. arXiv:2103.05068
20. Metric Transforms and Low Rank Matrices via Representation Theory of the Real Hyperrectangle. With Josh Alman, Timothy Chu, Gary Miller, Shyam Narayanan, and Zhao Song. **NeurIPS 2024 (spotlight presentation)**. arXiv:2011.11503
19. Cooperative and Stochastic Multi-Player Multi-Armed Bandit: Optimal Regret With Neither Communication Nor Collisions. With Sébastien Bubeck and Thomas Budzinski. **COLT 2021**. arXiv:2011.03896.
18. Algorithmic Pure States for the Negative Spherical Perceptron. With Ahmed El Alaoui. **J. Stat. Phys.**, Vol. 189 (2022), no. 27. arXiv:2010.15811
17. Approximate Ground States of Hypercube Spin Glasses are Near Corners. **Comptes Rendus Math.**, Vol. 359 (2021) no. 9, 1097-1105. arXiv:2009.09316
16. Metrical Service Systems with Transformations. With Sébastien Bubeck, Niv Buchbinder, and Christian Coester. **ITCS 2021**. arXiv:2009.08266
15. Vertex Sparsification for Edge Connectivity. With Parinya Chalermsook, Syamantak Das, Bundit Laekhanukit, Yunbum Kook, Yang P. Liu, Richard Peng, and Daniel Vaz. **SODA 2021**. arXiv:2007.07862. (Subsumes *Vertex Sparsifiers for c -Edge Connectivity* with Yang P. Liu and Richard Peng, arXiv:1910.10359.)
14. Online Multiserver Convex Chasing and Optimization. With Sébastien Bubeck and Yuval Rabani. **SODA 2021**. arXiv:2004.07346
13. Covering $\text{Irrep}(S_n)$ With Tensor Products and Powers. **Math. Annalen**, Vol. 388 (2024), 831-865. arXiv:2004.05283
12. The Price of Incentivizing Exploration: A Characterization via Thompson Sampling and Sample Complexity. With Aleksandrs Slivkins. **Operations Research**, Vol. 71 (2023) no. 5, 1706-1732. Conference version in **EC 2021**. arXiv:2002.00558
11. Optimization of Mean-field Spin Glasses. With Ahmed El Alaoui and Andrea Montanari. **Ann. Probab.**, Vol. 49 (2021) no. 6, 2922-2960. arXiv:2001.00904

10. Chasing Convex Bodies Optimally. **GAFASeminar Notes**, 2023. Conference version in **SODA 2020. Best Paper and Best Student Paper**. arXiv:1905.11968
9. Non-Stochastic Multi-Player Multi-Armed Bandits: Optimal Rate With Collision Information, Sublinear Without. With Sébastien Bubeck, Yuanzhi Li, and Yuval Peres. **COLT 2020**. arXiv:1904.12233
8. First-Order Bayesian Regret Analysis of Thompson Sampling. With Sébastien Bubeck. **IEEE Trans. Info. Theory**, Vol. 69 (2023), no. 3, 1795-1823. Conference version in **ALT 2020**. arXiv:1902.00681
7. Competitively Chasing Convex Bodies. With Sébastien Bubeck, Yin Tat Lee, and Yuanzhi Li. **STOC 2019** and **SICOMP Special Issue** 52 (1), 67-81. arXiv:1811.00887
6. Chasing Nested Convex Bodies Nearly Optimally. With Sébastien Bubeck, Bo'az Klartag, Yin Tat Lee, and Yuanzhi Li. **SODA 2020**. arXiv:1811.00999
5. Exact minimum number of bits to stabilize a linear system. With Victoria Kostina, Yuval Peres, and Gireeja Ranade. **IEEE Trans. Auto. Control**, November 2021. Conference version in **IEEE CDC 2018**. arXiv:1807.07686
4. Stabilizing a system with an unbounded random gain using only a finite number of bits. With Victoria Kostina, Yuval Peres, and Gireeja Ranade. **IEEE Trans. Info. Theory**, Vol. 67, no. 4, 2554-2561, Apr. 2021. Conference version in **IEEE ISIT 2018**. arXiv:1805.05535
3. Approximating Continuous Functions by ReLU Nets of Minimal Width. With Boris Hanin. arXiv:1710.11278
2. The Saxl Conjecture for Fourth Powers via the Semigroup Property. With Sammy Luo. **J. Alg. Comb.**, 45 (2017), 33-80. arxiv:1511.02387
1. On the Number of 2-protected Nodes in Tries and Suffix Trees. With Mark Daniel Ward, Jeffrey Gaither, and Yushi Homma. **Discrete Mathematics and Theoretical Computer Science**, Vol. AQ (2012), 381-398

Other Research

3. An Analytical, Mathematical Annuloplasty Ring Curvature Model for Planning of Valve-in-Ring Transcatheter Mitral Valve Replacement. With Matthew Park, Mateo Marin-Cuartas, Pearly Pandya, Yuanjia Zhu, Robert Wilkerson, David Holzhey, Michael Borger, and Y. Joseph Woo. **J. Thoracic and Cardiovascular Surgery (JTCVS) Techniques**, Vol. 20 (August 2023), 45-54.
2. A Novel Accelerated Fatigue Testing System for Pulsatile Applications of Cardiac Devices Using Widely Translatable Cam and Linkage-Based Mechanisms. With Matthew Park, Annabel Imbrie-Moore, Yuanjia Zhu, Mateo Marin-Cuartas, Robert Wilkerson, and Y. Joseph Woo. **Medical Engineering & Physics**, Vol. 109 (2022), 103896.
1. Biomimetic Six-Axis Robots Replicate Human Cardiac Papillary Muscle Motion: Pioneering the Next Generation of Biomechanical Heart Simulator Technology. With Annabel Imbrie-Moore, Matthew Park, Michael Paulsen, Rohun Kulkarni, Hanjay Wang, Yuanjia Zhu, Justin Farry,

Alexandra Bourdillon, Christine Callinan, Haley Lucian, Camille Hironaka, Daniela Deschamps, and Y. Joseph Woo. **J. Royal Society Interface**, Vol. 17 (2020), no. 173.

Invited Talks

77. MIT Probability Seminar: Algorithmic Thresholds for Perceptron Models (2024/12)
76. Brown Probability Seminar: Algorithmic Thresholds for Perceptron Models (2024/12)
75. McGill CRM-ISM Probability Seminar: Algorithmic Spin Glass Theory (2024/11)
74. Cornell Statistics: Provably Efficient Computation of the NPMLE in Gaussian Location Models (2024/10)
73. Princeton Probability: Confinement of Unimodal Probability Distributions and an FKG-Gaussian Correlation Inequality (2024/10)
72. Purdue Computer Science: Algorithmic Spin Glass Theory (2024/08)
71. BIRS Workshop *Frontiers of Statistical Mechanics and Theoretical Computer Science*: Algorithmic Spin Glass Theory (2024/08)
70. Peking University: Confinement of Unimodal Probability Distributions and an FKG-Gaussian Correlation Inequality (2024/07)
69. Stanford Probability: Confinement of Unimodal Probability Distributions and an FKG-Gaussian Correlation Inequality (2024/05)
68. TU Darmstadt: Confinement of Unimodal Probability Distributions and an FKG-Gaussian Correlation Inequality (2024/05)
67. NYU Probability: Confinement of Unimodal Probability Distributions and an FKG-Gaussian Correlation Inequality (2024/04)
66. MIT Stochastics and Statistics: Confinement of Unimodal Probability Distributions and an FKG-Gaussian Correlation Inequality (2024/03)
65. Harvard Theory of Computation: Diffusion Sampling from Spin Glasses (2023/11)
64. Lehigh-Minnesota Online Probability Seminar: The Threshold Energy of Low Temperature Langevin Dynamics for Pure Spherical Spin Glasses (2023/11)
63. Northwestern Probability: Algorithmic Thresholds for Spherical Spin Glasses (2023/11)
62. Harvard CMSA Conference on Big Data: Algorithmic Thresholds for Spherical Spin Glasses (2023/08)
61. Cargèse: Statistical Physics & Machine Learning Back Together Again (2023/08)
60. Santa Fe Institute 2023: On Hardness for Stable Sampling
59. Rhein-Main Kolloquium Stochastik: Gaussian Correlation Inequality and the Polaron (2023/06)
58. TU Darmstadt Colloquium: Algorithmic Thresholds in Mean-Field Spin Glasses (2023/06)

57. Porquerolles: The Threshold Energy of Low Temperature Langevin Dynamics for Pure Spherical Spin Glasses (2023/06)
56. International Purdue Symposium on Statistics: Algorithmic Stochastic Localization for the SK Model (2023/06)
55. Waterloo Probability: Algorithmic Thresholds in Mean-Field Spin Glasses (2023/04)
54. IAS Computer Science and Discrete Mathematics: Algorithmic Stochastic Localization for the SK Model (2022/11)
53. Harvard Statistics: Algorithmic Stochastic Localization for the SK Model (2022/11)
52. Columbia Probability: Algorithmic Stochastic Localization for the SK Model (2022/10)
51. Duke Statistical Science: Algorithmic Stochastic Localization for the SK Model (2022/10)
50. Stony Brook Information Geometry and Machine Learning Webinar: Chasing Convex Bodies (2022/09)
49. IAS Probability: Algorithmic Thresholds in Mean-Field Spin Glasses (2022/09)
48. MIT EECS Group Meeting: Algorithmic Thresholds in Mean-Field Spin Glasses (2022/08)
47. Youth in High Dimensions: A Universal Law of Robustness via Isoperimetry (2022/06)
46. Simons Workshop *Multi-Agent Reinforcement Learning and Bandit Learning*: Multi-Player Bandits without Communication (2022/05)
45. Oxford Statistics Group Meeting: A Universal Law of Robustness via Isoperimetry (2022/04)
44. Google Algorithms: A Universal Law of Robustness via Isoperimetry (2022/04)
43. Lawrence Livermore National Lab: A Universal Law of Robustness via Isoperimetry (2022/03)
42. SIAM Imaging Science Minisymposium *Recent Advances on Stable Neural Networks*: A Universal Law of Robustness via Isoperimetry (2022/03)
41. Purdue Industrial Engineering: A Universal Law of Robustness via Isoperimetry (2022/03)
40. MIT Probability: Tight Algorithmic Thresholds in Mean-Field Spin Glasses (2022/03)
39. Yale Statistics and Data Science: Algorithmic Thresholds in Mean-Field Spin Glasses (2022/03)
38. CMU Computer Science: Geometric Aspects of Optimization, Old and New (2022/02)
37. MIT Group Meeting: Algorithmic Thresholds in Mean-Field Spin Glasses (2022/02)
36. Harvard Statistics: Algorithmic Thresholds in Mean-Field Spin Glasses (2022/02)
35. Wharton Statistics: Algorithmic Thresholds in Mean-Field Spin Glasses (2022/02)
34. Columbia IEOR: Geometric Aspects of Optimization, Old and New (2022/01)
33. NYU Math and Data: Geometric Aspects of Optimization, Old and New (2022/01)

32. MIT Sloan OR/Stat Seminar: Geometric Aspects of Optimization, Old and New (2022/01)
31. Columbia Statistics: Geometric Aspects of Optimization, Old and New (2022/01)
30. University of Chicago Probability: Cutoff for the Asymmetric Riffle Shuffle (2022/01)
29. Simons *Probability, Geometry, and Computation in High Dimensions* Reunion Workshop: Tight Lipschitz Hardness for Optimizing Mean-Field Spin Glasses (2022/01)
28. Yale Statistics and Data Science: Algorithmic Thresholds in Mean-Field Spin Glasses (2021/11)
27. NSF-Simons Collaboration on the Theoretical Foundations of Deep Learning: A Universal Law of Robustness via Isoperimetry (2021/11)
26. UCLA Probability: Algorithms and Hardness for Optimizing Mean-Field Spin Glasses (2021/10)
25. INFORMS Session on *Learning and Optimization in Decision Making*: Chasing Convex Bodies (2021/10)
24. Stanford Probability Seminar: Cutoff for the Asymmetric Riffle Shuffle (2021/10)
23. Stanford ML Group Meeting: A Universal Law of Robustness via Isoperimetry (2021/10)
22. Simons Workshop *Rigorous Evidence for Information-Computation Trade-offs*: Tight Algorithmic Thresholds for Optimizing Mean-Field Spin Glasses (2021/09)
21. BIRS: Algorithmic Pure States for the Negative Spherical Perceptron (2021/08)
20. MSR Redmond: Pareto-Optimal Collision-Free Regret for Multi-Player Bandit (2021/08)
19. Stanford Statistics Group Meeting: A Universal Law of Robustness via Isoperimetry (2021/08)
18. MSR Redmond: The Price of Incentivizing Exploration (2021/07)
17. Montréal MLOpt: A Universal Law of Robustness via Isoperimetry (2021/07)
16. Berkeley EECS Group Meeting: The Price of Incentivizing Exploration (2021/06)
15. NSF-Simons Collaboration on the Theoretical Foundations of Deep Learning: Algorithmic Pure States for the Negative Spherical Perceptron (2021/04)
14. Cornell Probability: Algorithmic Pure States for the Negative Spherical Perceptron (2020/11)
13. Berkeley Theory Lunch: Chasing Convex Bodies (2020/11)
12. Online Geometric Analysis Seminar: Chasing Convex Bodies (2020/11)
11. MIT Algorithms and Complexity Seminar: Chasing Convex Bodies (2020/02)
10. Stanford Theory Lunch: Chasing Convex Bodies (2019/10)
9. TCS+ September 2019: Chasing Convex Bodies (2019/09)
8. University of Washington Theory Lunch: Chasing Convex Bodies (2019/08)

7. MSRI Mathematics of Machine Learning Summer School: Chasing Convex Bodies (2019/08).
6. Microsoft Research NYC: Chasing Convex Bodies (2019/07)
5. Microsoft Research Redmond: Chasing Convex Bodies (2019/07)
4. Microsoft Research Redmond: Small Loss Bounds for Thompson Sampling (2018/09)
3. Brown University: How Wide Does a Neural Net Need to be? (2018/05)
2. Microsoft Research Redmond: How Wide Does a Neural Net Need to be? (2017/09)
1. Purdue Combinatorics Group Meeting: The Saxl Conjecture for Fourth Powers (2015/08)

Conference, Workshop, and Other Presentations

22. NeurIPS 2023: Asymptotically Optimal Pure Exploration for Infinite-Armed Bandits (poster)
21. Harvard Statistics Fall 2023 PhD Student Retreat: Research Overview Lightning Talk
20. ICML 2023: Incentivizing Exploration with Linear Contexts and Combinatorial Actions (poster)
19. FOCS 2022: Algorithmic Stochastic Localization for the Sherrington-Kirkpatrick Model
18. IAS Postdoctoral Short Talk: Algorithmic Spin Glass Theory
17. COLT 2022: The Pareto Frontier of Instance-Dependent Guarantees in Multi-Player Multi-Armed Bandits with no Communication
16. NeurIPS 2021: A Universal Law of Robustness via Isoperimetry (poster and oral)
15. NeurIPS 2021 StratML Workshop: The Price of Incentivizing Exploration (poster)
14. Simons/IFML Joint Symposium 2021: A Universal Law of Robustness via Isoperimetry (poster)
13. Simons 2021 Annual Meeting on Mathematical and Scientific Foundations of Deep Learning: A Universal Law of Robustness via Isoperimetry (poster)
12. COLT 2021: Cooperative and Stochastic Multi-Player Multi-Armed Bandit
11. ICML 2021 Workshop *Overparameterization: Pitfalls & Opportunities*: A Universal Law of Robustness via Isoperimetry (oral spotlight presentation)
10. EC 2021 Workshop *Operations of People-Centric Systems*: The Price of Incentivizing Exploration
9. EC 2021: The Price of Incentivizing Exploration
8. Math Olympiad Program 2021: Introduction to Belief Propagation
7. SODA 2021: Online Multiserver Convex Chasing and Optimization
6. ALT 2020: First-Order Bayesian Regret Analysis of Thompson Sampling
5. SODA 2020: Chasing Convex Bodies Optimally
4. SODA 2020: Chasing Nested Convex Bodies Nearly Optimally

3. STOC 2019: Competitively Chasing Convex Bodies
2. Joint Math Meetings 2016: The Saxl Conjecture for Fourth Powers
1. MIT SPUR 2015: The Saxl Conjecture for Fourth Powers