# Yi Sun


**Contact Information**

Address: Department of Mathematics, Columbia University, New York, NY 10027.
Email: yisun@math.columbia.edu
Webpage: yisun.io


**Research Interests**

Representation theory, integrable systems, and applications to probability theory and random matrices.

**Employment**

**Columbia University** New York, NY
Joseph F. Ritt Assistant Professor (2019–present), Simons Fellow (2016–2019).

**Education**

**Massachusetts Institute of Technology** Cambridge, MA
Ph.D., Mathematics (2011–2016), advised by Pavel Etingof.

**University of Cambridge** Cambridge, UK
M.A.St., Mathematics, with distinction (2010–2011).

**Harvard University** Cambridge, MA
A.M., Mathematics (2006–2010).
A.B., Mathematics, *magna cum laude*, with secondary field in Economics (2006–2010).
Phi Beta Kappa (one of 24 juniors inducted)

**Grants Fellowships and Awards**

NSF Grant DMS-1701654, Algebra and Number Theory, 2017–2020.
Simons Junior Fellowship, 2016–2019.
NSF Mathematical Sciences Postdoctoral Research Fellowship, 2016–2019 (declined).
Johnson Prize for best research paper by MIT graduate student in mathematics, 2016.
NSF Graduate Research Fellowship, 2012–2015.
MIT Praecis Presidential Fellowship, 2011–2012.
Churchill Scholarship for study at Cambridge, 2010–2011.
William Lowell Putnam Competition, $10^{\text{th}}$ Place, 2009.
COMAP Math Contest in Modeling, Outstanding Winner, SIAM Prize, 2008 and 2009.
Intel Science Talent Search, $2^{\text{nd}}$ Place, 2006.
International Mathematical Olympiad, Silver Medal, 2006.
Asian Pacific Mathematics Olympiad, Gold Medal, 2005.
International Physics Olympiad, Gold Medal, 2004.

**Mathematics Research**

16. *Principal components in linear mixed models with general bulk* (with Z. Fan and Z. Wang), submitted, 2019. arXiv:1903.09592
15. *Gaussian fluctuations for products of random matrices* (with V. Gorin), submitted, 2018. arXiv:1812.06532
14. *Spiked covariances and principal components analysis in high-dimensional random effects models* (with Z. Fan and I. Johnstone), preprint, 2018. arXiv:1806.09529
13. *Affine Macdonald conjectures and special values of Felder-Varchenko functions* (with E. Rains and A. Varchenko), Selecta Mathematica N. S. **24** (2018), 1549–1591. arXiv:1610.01917
12. *Laguerre and Jacobi analogues of the Warren process* (single author, with an appendix by A. Sarantsev), submitted, 2016. arXiv:1610.01635
11. *Traces of intertwiners for quantum affine algebras and difference equations (after Etingof-Schiffmann-Varchenko)* (single author), Transformation Groups **23** (2018), 1167–1215. arXiv:1609.09038
10. *Matrix models for multilevel Heckman-Opdam and multivariate Bessel measures* (single author), submitted, 2016. arXiv:1609.09096
9. *Traces of intertwiners for quantum affine $\mathfrak{sl}_2$ and Felder-Varchenko functions* (single author), Communications in Mathematical Physics **347** (2016), 573-653. arXiv:1508.03918

8. *The polynomial representation of the type $A_{n-1}$ rational Cherednik algebra in characteristic $p \mid n$* (with S. Devadas), Communications in Algebra **45** (2016), 1926-1934. `arXiv:1505.07891`
7. *A representation-theoretic proof of the branching rule for Macdonald polynomials* (single author), Mathematical Research Letters **23** (2016), 887–927. Extended abstract in FPSAC 2015. `arXiv:1412.0714`
6. *A new integral formula for Heckman-Opdam hypergeometric functions* (single author), Advances in Mathematics **289** (2016), 1157–1204. `arXiv:1406.3772`
5. *Finite dimensional representations of the rational Cherednik algebra for $G_4$* (single author), Journal of Algebra **323** (2010), 2864–2887. `arXiv:0910.5527`

## Computer Science Research

4. D. Kang*, Y. Sun*, D. Hendrycks, T. Brown, and J. Steinhardt, *Testing robustness against unforeseen adversaries*, `arXiv:1908.08016`
3. T. Hashimoto, Y. Sun, and T. Jaakkola, *From random walks to distances on unweighted graphs*, NIPS 2015. `arXiv:1511.00573`
2. T. Hashimoto, Y. Sun, and T. Jaakkola, *Metric recovery from directed unweighted graphs*, NIPS 2014 workshop (Best Student Paper), AISTATS 2015. `arXiv:1411.5720`
1. Y. Sun and M. Sundararajan, *Axiomatic attribution for multilinear functions*, ACM Conf. on Electronic Commerce 2011. `arXiv:1102.0989`

## Research Presentations

42. ICML 2019 Workshop: Uncertainty and Robustness in DL (poster) — June 2019
Transfer of robustness against adversarial and stochastic distortions
41. OpenAI — June 2019
Transfer of robustness against adversarial and stochastic distortions
40. Virginia: Integrable Probability Summer School — June 2019
Fluctuations for products of random matrices
39. UCSD: Probability Seminar — January 2019
Fluctuations for products of random matrices
38. Yale: Geometry, Symmetry, and Physics Seminar — April 2018
Affine Macdonald conjectures and special values of Felder-Varchenko functions
37. Simons Society of Fellows Retreat — February 2018
A probabilistic view on random covariance matrices
36. PCMI: Research Program on Random Matrices — July 2017
Algebraic structures for multilevel eigenvalue densities
35. Rochester: Probability Seminar — April 2017
Laguerre and Jacobi analogues of the Warren process
34. Perimeter Institute: Mathematical Physics Seminar — April 2017
Affine Macdonald conjectures and special values of Felder-Varchenko functions
33. Rutgers: Lie Group / Quantum Mathematics Seminar — April 2017
Affine Macdonald conjectures and special values of Felder-Varchenko functions
32. Columbia-Princeton Probability Day — March 2017
Laguerre and Jacobi analogues of the Warren process
31. ESI: Workshop on Elliptic Hypergeometric Functions — March 2017
Affine Macdonald conjectures and special values of Felder-Varchenko functions
30. Columbia: Probability Seminar — November 2016
Laguerre and Jacobi analogues of the Warren process
29. Columbia: Mathematical Physics Seminar — October 2016
Affine Macdonald conjectures and special values of Felder-Varchenko functions

28. IESC: QIS's, CFT's, and Stochastic Processes (poster) — September 2016
    Laguerre and Jacobi analogues of the Warren process
27. MIT: Infinite-Dimensional Algebra Seminar — March 2016
    Traces of intertwiners for quantum affine $\mathfrak{sl}_2$ and Felder-Varchenko functions
26. MIT: Integrable Probability Seminar — February 2016
    Laguerre and Jacobi analogues of the Warren process
25. HCM: Asymptotic Analysis in Strongly Coupled Systems (poster) — January 2016
    Laguerre and Jacobi analogues of the Warren process
24. NIPS 2015 (poster) — December 2015
    From random walks to distances on unweighted graphs
23. ETH Zurich: ITS Talks in Theoretical Sciences 2015 — November 2015
    Random matrices and representation theory
22. UC Berkeley: RTGC Seminar — November 2015
    Traces of intertwiners for quantum affine $\mathfrak{sl}_2$ and Felder-Varchenko functions
21. ETH Zurich: Mathematical Physics Seminar — October 2015
    Traces of intertwiners for quantum affine $\mathfrak{sl}_2$ and Felder-Varchenko functions
20. NEU: Geometry, Physics and Representation Theory Seminar — October 2015
    Traces of intertwiners for quantum affine $\mathfrak{sl}_2$ and Felder-Varchenko functions
19. Columbia: Mathematical Physics Seminar — October 2015
    Traces of intertwiners for quantum affine $\mathfrak{sl}_2$ and Felder-Varchenko functions
18. Yale: Geometry, Symmetry, and Physics Seminar — September 2015
    Traces of intertwiners for quantum affine $\mathfrak{sl}_2$ and Felder-Varchenko functions
17. FPSAC 2015 (poster) — July 2015
    A representation-theoretic proof of the branching rule for Macdonald polynomials
16. Clay Math Inst.: Random Polymers and Algebraic Combinatorics — May 2015
    A representation-theoretic proof of the branching rule for Macdonald polynomials
15. AISTATS 2015 (poster) — May 2015
    Metric recovery from directed unweighted graphs
14. ICERM: Workshop on Limit Shapes (poster) — April 2015
    A representation-theoretic proof of the branching rule for Macdonald polynomials
13. NIPS 2014: Workshop on Networks (poster) — December 2014
    Metric recovery from directed unweighted graphs
12. UC Berkeley: GRASP Seminar — November 2014
    A representation-theoretic proof of the branching rule for Macdonald polynomials
11. IHP: Workshop on Macdonald Processes and Hecke Algebras — May 2014
    A new integral formula for Heckman-Opdam hypergeometric functions
10. MIT: Integrable Probability Seminar — April 2014
    A new integral formula for Heckman-Opdam hypergeometric functions

## Outreach Presentations

9. Math Olympiad Program 2018 — June 2018
   Threshold signatures
8. MIT "Meta-Math" Meetup 2017 — May 2017
   How to do a Literature Search
7. Summer Program in Applied Rationality and Cognition 2016 — August 2016
   Problem Solving: Contests vs. Real Life
6. Math Olympiad Summer Program 2016 — June 2016
   Distribution Testing: Is this die fair?

5. MIT Open House 2016 — April 2016
   Universality: Mathematics in the real world
4. Math Olympiad Summer Program 2015 — June 2015
   Fair coin flips from unfair coins
3. Math Olympiad Summer Program 2014 — June 2014
   The Ising model
2. Math Olympiad Summer Program 2013 — June 2013
   Random matrices
1. Math Olympiad Summer Program 2012 — June 2012
   Random partitions and Fock space

## Other Publications

6. $54^{th}$ *International Mathematical Olympiad* (with J. Berman and Z. Feng), Mathematics Magazine **86** (2013), 309–313.
5. $53^{nd}$ *International Mathematical Olympiad* (with Z. Feng), Mathematics Magazine **85** (2012), 312–317.
4. $52^{nd}$ *International Mathematical Olympiad* (with Z. Feng), Mathematics Magazine **84** (2011), 316–319.
3. $51^{st}$ *International Mathematical Olympiad* (with Z. Feng and P. Loh), Mathematics Magazine **83** (2010), 320–323.
2. *A simulation based model of traffic circles* (with C. Chang and Z. Fan), The UMAP Journal **30** (2009), 225–244.
1. *`hsolve`: A difficulty metric and puzzle generator for Sudoku* (with C. Chang and Z. Fan), The UMAP Journal **29** (2008), 303–324.

## Teaching

**Columbia University** — Spring 2019
Instructor for introductory graduate reading course on representation theory

**US National Math Olympiad Summer Program** — Summers 2007–2018
Instructor (2010, 2012–2018); Assistant (2007–2009). Design curriculum, give lectures, and personally coach US team to International Mathematical Olympiad.

**Columbia University** — Fall 2017
Instructor for Calculus II. Evaluations: 3.9 (5.0)

**MIT MathROOTS** — Summers 2015–2016
Academic Coordinator. Design curriculum, give lectures, and manage academic team, guest lectures, website, and sponsorships for first two years of outreach program teaching problem solving to underrepresented minority students. Program received media coverage on MIT homepage and in Notices of the AMS.

**MIT Undergraduate Research Opportunities Program** — Fall 2012–2015
Mentor two undergraduate research projects, leading to published research paper.

- Sheela Devadas (rational Cherednik algebras in char $p \leq n$), 2014–2015.
- Ryan Yoo (characters of rational Cherednik algebras in char $p > n$), 2012–2014.

**Massachusetts Institute of Technology** — Spring 2015
Teaching Assistant for Differential Equations. Evaluations: 6.2 (7.0)

**MIT Directed Reading Program** — January 2011
Mentor reading project on representation theory of the symmetric group.

**Harvard University** — Spring 2009
Course Assistant for Probability Theory. Evaluations: 4.3 (5.0)

## Professional Activities

**Columbia Probability Seminar** — Fall 2016–Present
Co-organize weekly probability seminar.

**Summer School in Probability** — Summer 2017

Co-organize graduate summer school "Dyson-Schwinger equations, topological expansions, and random matrices" at Columbia.

**MIT Interacting Particle Systems Learning Seminar** 2012–2013
Organize learning seminar on recent developments in interacting particle systems.

**Google Research** Summer 2010
Research intern. Research attribution and cost-sharing methods, leading to paper published in EC 2010. Mentor: Mukund Sundararajan

SERVICE

Reviewer for: Probability Theory and Related Fields, Selecta Mathematica (N.S.), SIGMA, Journal of Theoretical Probability, Europhysics Letters.

Qualifying Exam committee member for: Ivan Danilenko (Columbia), Maithreya Sitaraman (Columbia)

LANGUAGES

Mandarin (native), French (conversational)

COMPUTER

Sage, Magma, Mathematica, LaTeX, C++, Python

REFERENCES

**Pavel Etingof (advisor)**, Professor, Massachusetts Institute of Technology, `etingof@math.mit.edu`.

**Alexei Borodin**, Professor, Massachusetts Institute of Technology, `borodin@math.mit.edu`.

**Vadim Gorin**, Assistant Professor, Massachusetts Institute of Technology, `vadicgor@math.mit.edu`.

**Eric Rains**, Professor, California Institute of Technology, `rains@caltech.edu`.

**Valerio Toledano-Laredo**, Professor, Northeastern University, `V.ToledanoLaredo@neu.edu`.

**Po-Shen Loh (teaching)**, Associate Professor, Carnegie Mellon University, `ploh@cmu.edu`.

Last updated: August 22, 2019.