

CURRICULUM VITAE

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MAHRUD SAYRAFI

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EMPLOYMENT

- 2025 – 2026 **McMaster University** Britton Postdoctoral Fellow
RESEARCH GROUP: Combinatorial Algebraic Geometry
- 2025 Spring **Fields Institute for Research in Mathematical Sciences** Postdoctoral Fellow
THEMATIC PROGRAM: Commutative Algebra and Applications
- 2024 Fall **Max Planck Institute for Mathematics in the Sciences** Postdoctoral Fellow
RESEARCH GROUP: Nonlinear Algebra

EDUCATION

- 2024 Ph.D. **University of Minnesota, Twin Cities** ADVISOR: Christine Berkesch
THESIS: Diagonalization, Direct Summands, and Resolutions of the Diagonal
- 2017 B.A. **University of California, Berkeley** (with Honors) ADVISOR: David Eisenbud
THESIS: Local Computations in Macaulay2
- 2016 **Math in Moscow** (semester abroad at the Independent University of Moscow)

AWARDS

- 2023 – 2024 Doctoral Dissertation Fellowship, University of Minnesota
- 2020 Honorable Mention, Graduate Research Fellowships Program, NSF
- 2018 – 2020 John Ordway Fellowship, School of Mathematics, University of Minnesota

GRANTS

- 2023 NSF Workshop Grant DMS-2302476 for M2Week
Co-PI and organizer for the Macaulay2 Workshop & Mini-school in Minneapolis, MN.
- 2022 NSF Workshop Grant DMS-2206872 for GradMoCCA
Co-PI and organizer for the Graduate Meeting on Combinatorial Commutative Algebra.
- 2018 Seed Grant, DRP Network
Awarded to the Directed Reading Program (see service section) for purchasing books.

PUBLICATIONS AND PREPRINTS

- 2022 5. “A short resolution of diagonal for smooth projective toric varieties of Picard rank 2”
M. K. Brown. To appear in *Algebra & Number Theory*. [arXiv:2208.00562](#)
4. “Bounds on multigraded regularity”
J. Bruce, and L. Cranton Heller. Submitted. [arXiv:2208.11115](#)
- 2021 3. “Characterizing multigraded regularity on products of projective spaces”
J. Bruce, and L. Cranton Heller. Submitted. [arXiv:2110.10705](#)
- 2020 2. “The virtual resolutions package for Macaulay2”
A. Almousa, J. Bruce, and M. C. Loper. *J. of Software for Algebra & Geometry* **10** (2020), 51–60.
- 2017 1. “What is the optimal way to prepare a Bell state using measurement and feedback?”
L. Martin and K. B. Whaley. *Quantum Sci. & Technol.* **2** (2017), no. 4.

INVITED TALKS (selected)

Conferences

- 2024 May Spring Western AMS Sectional Meeting, San Francisco State University
- Jan. Joint Math Meetings, San Francisco, California
- 2023 Oct. Fall Central AMS Sectional Meeting, Creighton University, Omaha
- Jul. SIAM Applied Algebraic Geometry Conference, Eindhoven University, the Netherlands
- Jul. Géométrie Algébrique en Liberté, University of Warwick, UK
- Apr. CA+ Conference, University of Minnesota, Twin Cities
- Mar. Spring Southeastern AMS Sectional Meeting, Georgia Tech, Atlanta
- 2022 Oct. Fall Western AMS Sectional Meeting, University of Utah, Salt Lake City
- Sep. Fall Central AMS Sectional Meeting, University of Texas, El Paso
- May Macaulay2 Conference, Cleveland State University
- 2021 Apr. Spring Central AMS Sectional Meeting, University of Cincinnati (virtual)
- 2019 Aug. SIAM Applied Algebraic Geometry Conference, Universität Bern, Switzerland
- 2018 Jan. Joint Mathematics Meetings, San Diego, California

Seminars

- 2024 May. University of Oregon, Eugene, Algebra Seminar
- Apr. UC Berkeley, Commutative Algebra and Algebraic Geometry Seminar
- Mar. University of Michigan, Ann Arbor, Commutative Algebra Seminar
- Feb. Georgia Tech, Atlanta, Algebra Semina
- Feb. Washington University in St. Louis, Combinatorics Seminar
- 2023 Nov. University of Notre Dame, Algebraic Geometry and Commutative Algebra Seminar
- Apr. University of Nebraska - Lincoln, Commutative Algebra Seminar
- Feb. Texas A&M University, Algebra and Combinatorics Seminar
- Jan. University of Illinois, Chicago, Commutative Algebra Seminar
- 2022 Oct. University of Utah, Algebraic Geometry Seminar
- Oct. Arizona State University, Number Theory and Algebra Seminar
- 2021 Oct. Georgia Tech, Algebra Seminar
- Oct. Auburn University, Algebra Seminar
- Feb. ICERM semester in Combinatorial Algebraic Geometry, Grad/Postdoc Seminar (virtual)

Posters

- 2024 Jan. Connections Workshop: Commutative Algebra, SLMATH, Berkeley
- 2023 Nov. Western Algebraic Geometry Symposium, Washington University in St. Louis
- May MSRI/SLMATH Summer School in Commutative Algebra, University of Notre Dame
- 2022 Nov. Western Algebraic Geometry Symposium, UC Riverside
- Jun. Pan-American School in Commutative Algebra, CIMAT, Mexico
- 2017 Aug. SIAM Applied Algebraic Geometry Conference, Georgia Tech, Atlanta

TEACHING and MENTORING EXPERIENCE

School of Mathematics, University of Minnesota, Twin Cities

- 2023 Spring MATH 1272: instructor of record for Calculus II (class of approx. 100 students).
- 2022 Fall MATH 8253: graded homework for Algebraic Geometry (graduate course).
- 2022 Spring MATH 1272: instructor of record for Calculus II (class of approx. 90 students).
- 2019 – 2021 MATH 2243: TA for Linear Algebra & Differential Equations (six sections total).
- 2018 Fall MATH 1271: TA for Calculus I (two sections total).

- 2020 Summer REU: mentored P. Cranford, A. Peng, and V. Srinivasan towards [arXiv:2106.12667](https://arxiv.org/abs/2106.12667).
- 2019 & 2022 DRP: mentored five undergraduate students in weekly reading projects.

Department of Mathematics, UC Berkeley

- 2015 Spring Math113: graded homework for Abstract Algebra.
- 2014 Fall Math116: graded homework and assisted the instructor for Mathematical Cryptography.

Math Center, Irvine Valley College

- 2013 – 2014 Tutored lower-div courses including linear algebra, differential equations, and discrete math.

Mathobotix, Irvine, CA

- 2012 – 2014 Developed curriculum for computer science-based problem-solving using Python.

CONFERENCE AND WORKSHOP ORGANIZATION

2023 Jun. Macaulay2 Workshop & Mini-school

Weeklong event in computational commutative algebra bringing about 70 researchers to Minneapolis.

2022 May Graduate Meeting on Combinatorial Commutative Algebra

Weekend graduate event with 12 speakers bringing about 70 students and postdocs to Minneapolis.

MATHEMATICAL SERVICE

- 2018 – 2023 **Directed Reading Program**, University of Minnesota, Co-founder and co-organizer
Matched over 250 undergraduate and graduate students in guided mathematics reading projects.
- 2019 – 2022 **Student Commutative Algebra Meeting**, University of Minnesota, Co-organizer
Held a weekly meetup of friendly neighborhood commutative algebra students.
- 2021 Apr. **Graduate Student Combinatorics Conference**, Session Chair
Chaired the session on Combinatorial Algebraic Geometry.
- 2017 – 2018 **Pauline Sperry Undergraduate Lecture Series**, UC Berkeley, Organizer
Inaugurated an annual lecture aimed at providing a role model for marginalized students in math.

Referee Work:

Journal of Pure and Applied Algebra, Journal of Software for Algebra and Geometry

BROADER OUTREACH

- 2019 – 2023 **Vincent Hall Thespians, University of Minnesota**, Performer
Helped with first-time teaching assistant orientation through situational comedy.
- 2023 Jan. **Minnesota Project in Mathematics**, Counselor
Helped with workshops and mentored two undergraduate projects during the week-long program.
- 2019 – 2020 **AMS Graduate Student Blog**, Staff Writer
Wrote about finding community through mathematical art and history.
- 2018 Jul. **Girls Who Code @ Cloudflare**, Workshop Leader
Instilled an appreciation for mathematics in high school girls using elliptic cryptography puzzles.
- 2016 – 2017 **Mathematics Undergraduate Student Association**, UC Berkeley, President
Helped build an inclusive and diverse community among undergraduate math students at Berkeley.
- 2014 & 2015 **Berkeley mini Math Tournament**, Grader and Lecturer
Instilled an appreciation for knot theory in advanced elementary and middle school students.

OTHER WORK EXPERIENCE

- 2020 & 2022 Fall **Mathematical Sciences Research Institute**, Macaulay2 Developer (see below)
- 2018 Summer **Cloudflare, Inc.** Cryptography Engineering Intern
Launched multiple products involving Tor, Keyless SSL, and distributed randomness generation.
- 2017 Winter **Proton Research, Inc.** Cryptography Research and Development Intern
Added support for elliptic curve cryptography in OpenPGP.js.

WORKSHOPS and SUMMER SCHOOLS (selected)

- 2023 Sep. **Syzygies and mirror symmetry**, American Institute of Mathematics, Pasadena, California
Topics: resolutions of the diagonal for toric varieties, homological mirror symmetry
- Jul. **Géométrie Algébrique en Liberté**, University of Warwick, UK
Topics: Mori Dream Spaces and quiver GIT, klt singularities, the geometry of curves
- Jun. **MRC Derived Categories, Arithmetic and Geometry**, AMS
Topics: Frobenius pushforwards and F -thickness of the blowup $\mathrm{Bl}_5\mathbf{P}^2$
- May **MSRI/SLMath Summer School in Commutative Algebra**, University of Notre Dame
TA for mini-course on the geometry of nonstandard syzygies by Daniel Erman
- 2022 Dec. **RTG Workshop on Birational Complexity**, SCGP, Stony Brook University
Topics: rationality, curves in algebraic varieties, the Cremona group, measures of irrationality
- Jun. **Pan-American School in Commutative Algebra**, CIMAT, Mexico
Topics: positive characteristic methods, toric varieties, DG algebras, modules of differentials
- 2021 Spr. **Combinatorial Algebraic Geometry**, ICERM
Topics: Schubert varieties, toric varieties, tropical varieties, cluster algebras and varieties
- 2018 May **RTG Summer School in Commutative Algebra**, University of Utah
Topics: limits in positive characteristic, symbolic powers, differential operators, and syzygies.
- Mar. **Geometry of Redistricting Workshop**, University of San Francisco
Topics: gerrymandering, voting rights, discrete geometry and graph theory

OPEN SOURCE DEVELOPMENT

Since 2017 **Macaulay2 Internals**

I have contributed to various internal components of Macaulay2, including the engine, interpreter, core mathematical routines, and documentation. I have also contributed to the following packages:

- Since 2023 **DirectSummands**: for decomposing modules and coherent sheaves, with D. Mallory.
- Since 2023 **Varieties**: for computations involving projective varieties, including complexes of coherent sheaves and their morphisms, with D. Mallory, R. Ramkumar, G. Smith, K. VandeBogert.
- Since 2020 **NormalToricVarieties**: added support for pullbacks of coherent sheaves over toric maps, and computations on the Cox ring of toric varieties whose class group has torsion.
- Since 2021 **Truncations**: added support for truncations of modules with respect to arbitrary cones, for instance on simplicial toric varieties where the nef and effective cones differ.
- Since 2020 **Saturation**: improved and added to core routines for computing annihilators, saturations, and quotients of ideals and modules, with J. Chen and M. Stillman.
- Since 2019 **FGLM**: for computing Gröbner bases of zero-dimensional ideals, with D. Peifer.
- Since 2018 **VirtualResolutions**: see paper above, with A. Almousa, J. Bruce, and M. Loper.
- Since 2017 **LocalRings**: for symbolic computations over local rings, with M. Stillman.

PROFESSIONAL

Memberships:

AMS, SIAM Activity Group on Algebraic Geometry.

Programming:

Proficient in Macaulay2, C/C++, Python, and Node.js.
Experienced in Go, Rust, SageMath, and IDL.
Familiar with Julia, Mathematica, MATLAB, and Haskell.

OTHER RESEARCH EXPERIENCE

- 2017 Summer **Institute for Quantum Computing**, University of Waterloo
Topics: quantum error correcting codes from algebraic curves under John Watrous.
- 2015 – 2016 **Berkeley Quantum Information and Computation Center**, UC Berkeley
Topics: control theory & entanglement generation under Leigh Martin and Birgitta Whaley.
- 2014 Summer **Institute for Quantum Information and Matter**, Caltech
Topics: quantum game theory and semi-definite optimization under Thomas Vidick.
- 2013 Summer **Jet Propulsion Laboratory**, NASA
Topics: secure multiparty computation and secret sharing systems under Ed Chow.

REFERENCES

Christine Berkesch cberkes@umn.edu Advisor	David Eisenbud de@berkeley.edu	Daniel Erman erman@hawaii.edu	Craig Westerland cweste1@umn.edu Teaching
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