

Michael R. Klug

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Professional Positions

- ◇ **NSF Mathematics Postdoctoral Research Fellow**, University of Chicago (2022-Present)
- ◇ **L.E. Dickson Instructor**, University of Chicago (2021-Present)
- ◇ **Visiting Researcher**, Max Planck Institut für Mathematik – Bonn, Germany (Intermittent 2018-Present)
- ◇ **Graduate Student Researcher/Instructor**, U.C. Berkeley (2015-2020) Researched low dimensional topology resulting in publications, designed and taught courses, organized/participated in conferences and seminars, wrote scripts/libraries in Python/C/Magma for computations.
- ◇ **Data Analyst/Researcher**, Vermont Complex Systems Center (2014): Gathered/cleaned/analyzed large data sets using Python (Numpy, Pandas, Matplotlib) resulting in a publication on the relationship between team dynamics and success. Wrote custom web scrapers.
- ◇ **Computational Researcher**, University of Vermont (2012-2013): Developed/implemented numerical techniques in Magma for computation of rings of modular forms resulting in publication. Created a package for numerical hyperbolic trigonometric computations that output TikZ code used in our paper.
- ◇ **Researcher**, Mann Lab, University of Vermont (2011-2012): Analyzed data on blood protein dynamics.

Education

- ▶ **University of California, Berkeley**, Berkeley, CA
Ph.D. in Mathematics, 2015-2021
Thesis: A relative version of Rochlin's theorem
Thesis advisors: Robion Kirby and Peter Teichner
- ▶ **University of Vermont**, Burlington, VT
B.S. (Honors) and M.S. in Mathematics (Accelerated Masters), 2013
Major: Mathematics. Minors: Biology, Music
Thesis (Mathematics): Computing rings of modular forms using power series expansions
Thesis (Biochemistry): Dynamics of Factor XI activation

Awards

- ◇ NSF Mathematical Sciences Postdoctoral Research Fellowship (\$150,000)
- ◇ L.E. Dickson Fellowship
- ◇ Salah Baouendi Fellowship
- ◇ Sang Kil Nam Scholarship for Excellence in Mathematics

Publications/Preprints

- (1) *Properties of Pin^\pm -structures on surfaces.* (w/ L. Stehouwer) (appearing in *Topology and its App.*) (2023).
- (2) *A group-theoretic framework for low-dimensional topology.* (w/ S. Blackwell, R. Kirby, V. Longo, B. Ruppik) (submitted) (2023).
- (3) *Concordance of spheres in 4-manifolds with an immersed dual sphere.* (w/ M. Miller) (submitted)(2022).
- (4) *Kernels of splitting homomorphisms.* (submitted) (2022).
- (5) *Representing smooth 4-manifolds as loops in the pants complex.* (w/ G. Islambouli) *Mathematical Research Letters*, Volume 28, Number 6, 1703–1738, (2021).
- (6) *Unknotting numbers of 2-spheres in the 4-sphere.* (w/ J. Joseph, B. Ruppik, and H. Schwartz) *Journal of Topology*, Volume 14, Issue 4 1321-1350, (2021).
- (7) *Concordance of surfaces in 4-manifolds and the Freedman-Quinn invariant.* (w/ M. Miller) *Journal of Topology*, Volume 14, Issue 2 (2021), 560-586.
- (8) *Deep and shallow slice knots in 4-manifolds.* (w/ B. Ruppik) *Proc. A.M.S. Ser. B* 8 (2021), 204-218.
- (9) *Counting homomorphisms from surface groups to finite groups.* (submitted) (2021).
- (10) *Building groups from restricted diagrams of groups.* (w/ N. Brody) (2021).
- (11) *Comparison communication protocols.* (2021).
- (12) *A relative version of Rochlin's theorem.* (submitted) (2020).
- (13) *Functoriality of group trisections.*, *PNAS Trisections of 4-Manifolds Issue October 23*, 115 10875-10879 (2018).
- (14) *Calculating the homology and the intersection form from a trisection diagram.* (w/ P. Feller, T. Schirmer, and D. Zemke), *PNAS Trisections of 4-Manifolds Issue October 23*, 115 10869-10874 (2018).
- (15) *Understanding the group dynamics and success of teams.* (with J. Bagrow) *Royal Soc. Open Sci.*, 3(4), (2016).
- (16) *Numerical computation of three-point covers of the projective line.* (w/ M. Musty, S. Schiavone, and J. Voight), *LMS Journal of Computational Math.* 17, no. 1, 379-430 (2014).

Sample of Programming Projects

- ◇ **Numerical computation in Magma:** Developed and implemented numerical techniques to compute presentations of rings of modular forms in Magma. Designed/implemented numerical hyperbolic trigonometry library in Magma to output TikZ code for fundamental domains of Fuchsian groups.
- ◇ **Planar covers of graphs:** Developed a C library to efficiently generate random covers of a graph to probe Negami's conjecture (if a graph has a finite-sheeted planar cover, then it is projective planar). Used C++ Boost library for planarity testing.
- ◇ **Combinatorial group theory applications:** Developed Java programs to illustrate and facilitate computations from combinatorial group theory involving Tietze's theorem for altering presentations of a given group and Newman's theorem for solving the word problem in torsion one-relator groups.
- ◇ **Jupyter notebooks to augment courses:** Wrote assorted Jupyter notebooks that I distributed to students to demonstrate relevant mathematical topics (e.g., the central limit theorem, Newton's method, determinants of random matrices, linear-algebraic algorithms in graph theory).
- ◇ **Nand to Tetris:** Following the book/tutorials by Nisan/Schocken, I designed/wrote HDL specs for a complete CPU (starting from Nand gates), wrote an assembler for an assembly language targeting the CPU architecture, wrote a virtual machine translator targeting the assembly language, wrote a compiler from a higher level language (Jack) targeting the virtual machine language, wrote an operating system for the hardware (in Jack). The assembler/virtual machine translator/compiler were written in Python.

Teaching

- ▶ **Instructor, U. Chicago:** Abstract Linear Algebra, Accelerated Real Analysis Sequence (year long).
- ▶ **Instructor, U.C. Berkeley:** Introduction to Research - Knot Theory, Linear Algebra/Differential Equations.
- ▶ **Graduate Student Instructor, U.C. Berkeley:** Linear Algebra/Differential Equations, Calculus, Multi-variable Calculus, Discrete Mathematics.

Invited Talks

- ◇ Delivered talks about my research at Stanford University, U. Chicago, Max Planck Institute for Mathematics, Banff International Math Research Station, Rice University, U.C. Davis, U.C. Berkeley, University of Vermont, American Institute for Mathematics, IUPUI, Joint Mathematics Meeting, AMS Sectional Meetings, McMaster University, University of Waterloo, Binghamton University, Loyola University, University of Georgia.

Conference/Seminar Organization

- ◇ Organizer for ongoing "No Boundaries" Seminar at University of Chicago.
- ◇ Organizer for the "Topology in Dimensions 3, 3.5, and 4" Conference at U.C. Berkeley.
- ◇ Organized/co-organized and presented in University of California, Berkeley student seminars including the Student Low-Dimensional Topology Seminar, 4-Manifold Seminar, and "Knot-Another-Seminar" Seminar.

Mentorship

- ◇ Chicago REU: Directed REU projects and taught courses on circle packings and graph theory.
- ◇ Directed Reading Program: Directed reading courses for students, culminating in presentations.
- ◇ Camp Euclid Mathematical Research Camp: Helped students to find/work on research problems.

Community Service

- ◇ **Julia Robinson Mathematics Festival, Chicago:** Judged projects/ran sessions for talented students.
- ◇ **Math Circle Instructor, Chicago:** Lectured/ran problem sessions for talented students.
- ◇ **Boy Scouts of America:** Eagle Scout.

Skills

- ◇ **Programming:** Experience in Python (Numpy, Pandas, Matplotlib), C, Magma, GAP.
- ◇ **Jazz Musician:** Perform on upright bass, occasionally piano and drums.
- ◇ **Languages:** English (native), German.