ZHUO ZHANG

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EDUCATION

University of Illinois at Urbana-Champaign (UIUC) May 2025 (Expected)

B.S. in Mathematics, Minor in Computer Science

- GPA: 4.0/4.0

PUBLICATIONS AND PREPRINTS

"The relative error in the Chebotarev density theorem," with J. Thorner, in preparation.

"On a special metric in cyclotomic fields," with K. Saettone, A. Zaharescu.

"Pattern formation statistics on Fermat quotients," with C. Cobeli, A. Zaharescu.

"An elementary characterization of the Gauss-Kuzmin distribution in the theory of continued fractions," with A.J. Hildebrand, S. Singh.

"On the continued fraction expansion of almost all real numbers," with A.J. Hildebrand, A. Jin, S. Singh, accepted for publication in *Involve*.

RESEARCH EXPERIENCES

Chebotarev Density Theorem and Artin L-functions May 2024 – Present

Mentor: Prof. Jesse Thorner UIUC

- Proved a zero-free region and a zero density estimate of Artin L-functions under the Artin holomorphy conjecture.
- Improved the best-known upper bound on the least norm of a prime ideal with given Artin symbol in Galois extensions of number fields.
- Proved an unconditional version of the Chebotarev density theorem that allows short intervals.
- Proved several new useful representation-theoretic facts about Artin L-functions.

Special Metric in Cyclotomic Fields Jan 2024 – May 2024

Mentor: Prof. Alexandru Zaharescu UIUC

- Defined a special metric on the cyclotomic fields.
- Proved several remarkable properties of the metric, such as invariance under the actions of the Galois group.
- Proved using analytic techniques that, in an appropriate sense, almost all pairs of points are almost equi-distanced from each other under this metric.

Distribution of Fermat Quotients Oct 2023 – Feb 2024

Mentor: Prof. Alexandru Zaharescu UIUC

- Studied the distribution of Fermat quotients modulo large primes.
- Proved two results on the randomness and pair correlations of Fermat quotients, using Heath-Brown's bound, exponential sum techniques, and Erdős-Turán type inequalities.

UChicago Math Summer REU Program June 2023 – Aug 2023

Mentors: Prof. Peter May & Prof. Mark Behrens University of Chicago

- Read the book *Differentiable Periodic Maps* by Conner and Floyd.
- Studied cobordism theory, with an emphasis on the interplay between algebraic and differential topology. Independently verified the Eilenberg-Steenrod axioms of bordism homology.
- Wrote an expository paper and gave a final presentation on a geometric treatment of bordism homology.

A Special Class of Primitive Roots Jan 2023 – May 2023

Mentor: Prof. Bruce Reznick UIUC

- Defined and studied a special class of primes and their exceptional primitive roots.
- Proposed a conjecture about the asymptotic density of such exceptional primitive roots, providing a heuristic argument and relating it to Artin's conjecture on primitive roots.
- Wrote code to collect numerical data, providing strong support for the conjecture.

Gauss-Kuzmin Distribution and Continued Fractions Jan 2022 – Dec 2022

Mentor: Prof. AJ Hildebrand UIUC

- Proved several results on the asymptotic distribution of certain special collections of continued fraction digits.
- Constructed a provably optimal characterization of the Gauss-Kuzmin measure. Extensively studied the properties arising from this characterization.
- Wrote two papers and presented the results of this work at local and national conferences (see below).

SUPERVISED READINGS

Symplectic Geometry Aug 2024 – Present

Mentor: Prof. Eugene Lerman UIUC

- Read *Symplectic and Contact Geometry* by Eslami Rad and *Lectures on Symplectic Geometry* by Cannas.
- Learned fundamental results including Darboux theorem, Lagrangian embedding theorem, Legendre transform, Lie group actions and moment maps, coadjoint representations, Marsden-Weinstein-Meyer reduction, and more.

Vector Bundles and C^∞-Schemes Jan 2024 – May 2024

Mentor: Prof. Eugene Lerman UIUC

- Read the book *Smooth Manifolds and Observables* by Nestruev.
- Learned fundamental results in differential topology, with an emphasis on vector bundles, such as the smooth Serre-Swan theorem, classification of vector bundles, and Lie theory.
- Learned the basic theory of differential spaces and C^∞-schemes by reading papers of Joyce and Lerman.

Homotopy Theory Aug 2023 – Dec 2023

Mentor: Prof. Charles Rezk UIUC

- Read the notes *Homotopy Theories and Model Categories* by Dwyer and Spalinski.
- Learned advanced homotopy theory, higher category theory, and their applications.

Representation Theory May 2022 – Jul 2022

Mentor: Prof. Alexander Yong UIUC

- Read *Linear Representations of Finite Groups* by Serre and learned related topics in algebraic combinatorics.
- Collaborated with other students to create 60 pages of LaTeX notes on representation theory. Gave a 2-hour presentation on Hecke algebras and Kazhdan-Lusztig polynomials at the ICLUE summer seminar.

EXPOSITORY WRITINGS

"The Chebotarev density theorem and Artin L-functions." Jun 2024. [pdf]

"Profinite groups and infinite Galois theory." Jun 2024. [pdf]

"The smooth Serre-Swan theorem." May 2024. [pdf]

"A geometric view of bordism homology." Aug 2023. [pdf]

"Some notes on representation theory." Jul 2022. Created with four other participants of the representation theory program in Summer 2022. [link]

PRESENTATIONS AND TALKS

"Heilbronn's exponential sums and uniform distribution of Fermat quotients." UIUC Analytic Number Theory Course (Math 595), Oct 2024.

"The ternary Goldbach conjecture and Hardy-Littlewood circle method." UIUC Analytic Number Theory Course (Math 595), Oct 2024.

"Distribution of primes and the Möbious function." UIUC Analytic Number Theory Course (Math 531), Oct 2023.

"An introduction to bordism homology." UChicago Math Summer REU, Aug 2023.

"Continued fractions and the Gauss-Kuzmin distribution." UIUC Undergraduate Friday Seminar, Sep 2022.

"On the continued fraction expansion of almost all real numbers," Young Mathematician Conference, Ohio State University, Aug 2022.

"Hecke algebras and Kazhdan-Lusztig polynomials." UIUC Combinatorics Seminar, Jun 2022.

SELECTED COURSES

Honors Courses

- Honors Fundamental Mathematics, Honors Abstract Linear Algebra, Honors Real Analysis, Honors Abstract Algebra, Honors Seminar.

Graduate Courses

- Abstract Algebra, Real Analysis, Complex Variables, Intro to Algebraic Geometry, Differentiable Manifolds I, Differentiable Manifolds II, Analytic Number Theory I, Analytic Number Theory II.
- (Fall 2024) Commutative Algebra, Complex Algebraic Geometry, Advanced Topics in Analytic Number Theory.

Grades = A+ in all 20 math courses taken in college.

SERVICES

President of the Illinois Geometry Lab Outreach Program Aug 2022 – May 2024

- Served as president from Aug 2022 to May 2024; serve as secretary since then.
- Reached out to children and students from local communities and present to them interesting topics in mathematics. Introduced new technologies to children, such as 3D printing.
- Organized outreach events and social events. Coordinated the work between group members.

Mentor of First-year James Scholar Students Aug 2022 – Dec 2022

- Mentored two first-year undergraduate James Scholar students majoring in mathematics.
- Organized mentorship meetings, study sessions and Q&A sessions.
- Helped the mentees find resources for undergraduate research in mathematics and physical sciences.

HONORS AND AWARDS

Most Outstanding Major Award in Mathematics	Nov 2024
LAS Get Experience Scholarship	Apr 2023
Lewis C. Hack Scholarship	Mar 2023
Edmund J. James Scholar	Aug 2021 – Present
Dean's List	Aug 2021 – Present

SKILLS AND TEST SCORES

Programming	Mathematica, LaTeX, Python, C++, Java.
Languages	Chinese (Native), English (Proficient).
GRE Math Subject	970 with percentile 97%.