Jack Westbrook

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Research interests: Arithmetic geometry; Galois/automorphic representations; elliptic curves (BSD, Selmer/Ш); p-adic Hodge/cohomology; mixed-characteristic commutative algebra

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Education

Imperial College London, MSc in Pure Mathematics — Expected September 2026

MSc thesis (in progress): topic TBA; prospective advisor: **George Boxer** (to be confirmed).

University of Wisconsin–Madison, Bachelor of Arts in Mathematics — May 2025

Graduate Math GPA: 3.91/4.00 · Overall GPA: 3.63/4.00

Publications and Preprints

On Deformation of Perfectoid Purity in Gorenstein Domains, with Baily, Dovgodko, Simpson. *Submitted.* Preprint (arXiv:2504.02966).

Some Applications of the Brenner–Monsky Quartic, with Dovgodko and Simpson. *In preparation (2025).* (Formerly "Hilbert–Kunz Multiplicity in a Two-Parameter Family".) Early draft.

Examples of Lie Algebras with Specified Newton Polygons, with Alwan, K. Huang, T. Huang, Stovall. *In preparation (2025).* (Formerly "Exploring Notions of Curvature in Higher Dimensions".)

Research Experience

Research Assistant (REU), University of Michigan–Ann Arbor — Summer 2024

Supervisor: Dr. Austyn Simpson

– Produced the first *two-parameter family* with varying Hilbert–Kunz multiplicities by combining Monsky/Trivedi density methods with new Segre-product constructions; **co-authored** resulting paper.

– Initiated constructions toward lifting F-purity $\to$ perfectoid purity in mixed characteristic; **co-authored** a submission.

– Implemented Macaulay2 routines for Segre and Veronese presentations; groundwork for a future package release.

Research Assistant (REU), University of Wisconsin–Madison — Summer 2022

Supervisor: Dr. Betsy Stovall

– Computed Newton polygons associated to vector fields in $\mathbb{R}^n$ for $n \leq 14$.

– Developed combinatorial arguments giving bounds in all dimensions; presented results in three venues; **co-authored** a forthcoming paper.

Undergraduate Researcher, Madison Experimental Mathematics Lab — Fall 2022

Supervisor: Dr. Feng Zhu

– Constructed explicit generators in $\mathrm{PSL}(2,\mathbb{R})$ for isometry subgroups of hyperbolic surfaces.

– Studied Teichmüller theory and presented a poster to students and faculty.

Selected Notes & Software

- **Solutions to *The Rising Sea*** — 150+ pp comprehensive solutions and proofs. Link

- **Solutions to *The Arithmetic of Elliptic Curves*** — selected exercises and expanded proofs from the text. Link
- **Proof of Quadratic Reciprocity via Galois Theory** — self-contained exposition from a sketch by Ana Caraiani. Link
- **Macaulay2: Segre Presentations** — prototype algorithms developed during the 2024 UM REU for computing presentations of Segre products of graded rings. Link
- **Macaulay2: Veronese Presentations** — companion package for computing presentations of Veronese subrings in graded rings. Link
- **Original Number Theory Problems** — authored 9 problems with full solutions on Diophantine and modular themes; one used for a UW–Madison Putnam Club meeting where students worked on the problem and I presented the solution. Link

Selected Presentations

- "Hilbert–Kunz Multiplicity in a Two-Parameter Family," *University of Michigan REU*, 2024
- "The Isomorphism Theorems in Abelian Categories," *UW–Madison Math Club*, 2024
- "Constructing Gödel's Constructible Universe," *Directed Reading Program*, 2023
- "Curvature in Families of Curves," *UNC Analysis & PDE Seminar*, 2022

Selected Graduate Coursework

Algebraic Number Theory; Elliptic Curves; Galois Theory; Algebraic Geometry I; Lie Algebras; Topology I–II; Complex Analysis; Measure Theory; Algebra I–II.

Teaching and Mentorship

Directed Reading Program Mentor, Imperial College 2025–2026
– Led a reading group on elliptic curves and introductions to Galois representations; designed tailored study plans.

Course Assistant, Math Learning Center, UW–Madison 2023–2025
– Supported MATH 340, 341, 421, 551 (Linear Algebra/Analysis/Topology); received strong student and faculty feedback.

Athletic Math Tutor, UW–Madison Summer 2023
– Tutored incoming student-athletes for placement exams; created custom study materials and practice sets.

Honors and Technical Skills

Dean's List, UW–Madison — Spring 2023, Fall 2023, Spring 2024.
Programming: Macaulay2 (package dev), SageMath, Python, MATLAB, C++, Rust **Tools:** LaTeX, Git, HTML/CSS

Last updated: November 2025