Grant Molnar Curriculum Vitae

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Education

PhD, Mathematics, *Dartmouth College*, Hanover, NH — Fall 2018 - Spring 2023
Advisor: John Voight
Thesis: *Counting elliptic curves with a cyclic m-isogeny over $\mathbb{Q}$*

MA, Mathematics, *Dartmouth College*, Hanover, NH — Fall 2018 - Winter 2020
Advisor: John Voight

MS, Mathematics, *Brigham Young University*, Provo, UT — Winter 2017 - Summer 2018
Advisors: Michael Griffin and Paul Jenkins
Thesis: *The arithmetic of modular grids*

BS, Mathematics, *Brigham Young University*, Provo, UT — Fall 2013 - Fall 2016

Professional Experience

Academic Researcher at BYU and Dartmouth — Fall 2013 - Spring 2023

At BYU, I proved results about modular forms and algorithms on graphs. At Dartmouth, I instigated successful research into summing divergent series, the Prisoner's Dilemma, and the Ramanujan-Robin criterion. My thesis develops the arithmetic statistics of elliptic curves with cyclic m-isogeny. See Research Publications and Preprints *below.*

Math Instructor at BYU and Dartmouth — Winter 2017 - Spring 2023

I taught 30-student calculus courses in three different styles: lecturing, virtually with a "flipped classroom", and with handouts and group exercises. I TAed for lower-division courses, and by special request for upper-division courses as well. See Teaching Experience *below.*

Computer Skills

Fluent in...
Bash • Git • Go • LaTeX • Python • R • SageMath

Experience with...
C++ • HTML • Magma • Mathematica • MatLab • MongoDB • PARI/GP • Rust

Research Publications

Counting elliptic curves over the rationals with a 7-isogeny, *with John Voight*
Research in Number Theory **9**, 75 (2023). arXiv: 2212.11354

We count by height the number of elliptic curves over the rationals, both up to isomorphism over the rationals and over an algebraic closure thereof, that admit a cyclic isogeny of degree 7.

Reactive means in the Iterated Prisoner's Dilemma, *with Caroline Hammond and Feng Fu*
Applied Mathematics and Computation **458** 128201 (2023). arXiv: 2302.13909

The Iterated Prisoner's Dilemma (IPD) is a well studied framework for understanding direct reciprocity and cooperation in pairwise encounters. However, measuring the morality of various IPD strategies is still largely lacking. Here, we partially address this issue by proposing a suit of plausible morality metrics to quantify four aspects of justice. We focus our closed-form calculation on the class of reactive strategies because of their mathematical tractability and expressive power. We define reactive means as a tool for studying how actors in the IPD and Iterated Snowdrift Game (ISG) behave under typical circumstances. We compute reactive means for four functions intended to capture human intuitions about "goodness" and "fair play". Two of these functions are strongly anticorrelated with success in the IPD and ISG, and the other two are weakly anticorrelated with success. Our results will aid in evaluating and comparing powerful IPD strategies based on machine learning algorithms, using simple and intuitive morality metrics.

The arithmetic of modular grids, *with Michael Griffin and Paul Jenkins*
Mathematika **68**, 1080-1119 (2022). arXiv: 2012.14403

A modular grid is a pair of sequences $(f_m)_m$ and $(g_n)_n$ of weakly holomorphic modular forms such that for almost all m and n, the coefficient of q^n in f_m is the negative of the coefficient of q^m in g_n. Zagier proved this coefficient duality in weights $1/2$ and $3/2$ in the Kohnen plus space, and such grids have appeared for Poincaré series, for modular forms of integral weight, and in many other situations. We give a general proof of coefficient duality for canonical row-reduced bases of spaces of weakly holomorphic modular forms of integral or half-integral weight for every group $\Gamma \subseteq \mathrm{SL}_2(\mathbb{R})$ commensurable with $\mathrm{SL}_2(\mathbb{Z})$. We construct bivariate generating functions that encode these modular forms, and study linear operations on the resulting modular grids.

Odd, spoof perfect factorizations, *with the BYU Computational Number Theory Group*
Journal of Number Theory **234**, 31-47 (2022). Quanta article. arXiv: 2006.10697

We investigate the integer solutions of Diophantine equations related to perfect numbers. These solutions generalize the example, found by Descartes in 1638, of an odd, "spoof" perfect factorization $3^2 \cdot 7^2 \cdot 11^2 \cdot 22021^1$. More recently, Voight found the spoof perfect factorization $3^4 \cdot 7^2 \cdot 11^2 \cdot 19^2 \cdot (-127)^1$. No other examples appear in the literature. We compute all nontrivial, odd, primitive spoof perfect factorizations with fewer than seven bases – there are twenty-one in total. We show that the structure of odd, spoof perfect factorizations is extremely rich, and there are multiple infinite families of them. This implies that certain approaches to the odd perfect number problem that use only the multiplicative nature of the sum-of-divisors function are unworkable. On the other hand, we prove that there are only finitely many nontrivial, odd, primitive spoof perfect factorizations with a fixed number of bases.

Zagier duality for level p weakly holomorphic modular forms, *with Paul Jenkins*
The Ramanujan Journal **50**, 93–109 (2019). arXiv: 1709.10023

We prove Zagier duality between the Fourier coefficients of canonical bases for spaces of weakly holomorphic modular forms of prime level p with $11 \leq p \leq 37$ with poles only at the cusp at ∞, and special cases of duality for an infinite class of prime levels. We derive generating functions for the bases for genus 1 levels.

Graphs with the strong Havel-Hakimi property, *with Michael Barrus*
Graphs and Combinatorics **32**, 1689–1697 (2016). arXiv: 1505.00085

The Havel–Hakimi algorithm iteratively reduces the degree sequence of a graph to a list of zeroes. As shown by Favaron, Mahéo, and Saclé, the number of zeroes produced, known as the residue, is a lower bound on the independence number of the graph. We say that a graph has the strong Havel–Hakimi property if in each of its induced subgraphs, deleting any vertex of maximum degree reduces the degree sequence in the same way that the Havel–Hakimi algorithm does. We characterize graphs having this property (which include all threshold and matrogenic graphs) in terms of minimal forbidden induced subgraphs. We further show that for these graphs the residue equals the independence number, and a natural greedy algorithm always produces a maximum independent set.

Research Preprints

A database of basic numerical invariants of Hilbert modular surfaces, *with Eran Assaf, Angelica Babei, Ben Breen, Edgar Costa, Juanita Duque-Rosero, Aleksander Horawa, Jean Kieffer, Avinash Kulkarni, Sam Schiavone, and John Voight*
Preprint. arXiv: 2301.10302

We describe algorithms for computing geometric invariants for Hilbert modular surfaces, and we report on their implementation.

Multiplicative summations into algebraically closed fields, *with Robert Dawson*
Preprint. arXiv: 2111.09938

In this paper, extending our earlier program, we derive maximal canonical extensions for multiplicative summations into algebraically closed fields. We show that there is a well-defined analogue to minimal polynomials for a series algebraic over a ring of series, the "scalar polynomial". When that ring is the domain of a summation $\mathfrak{S}$, we derive the related concepts of the $\mathfrak{S}$-minimal polynomial for a series, which is mapped by $\mathfrak{S}$ to a scalar polynomial. When the scalar polynomial for a series has the form $(t-a)^n$, a is the unique value to which the series can be mapped by an extension of the original summation.

Telescopic, multiplicative, and rational extensions of summations, *with Robert Dawson*
Preprint. arXiv: 2105.04592

A summation is a shift-invariant R-module homomorphism from a submodule of R to R or another ring. Dawson formalized a method for extending a summation to a larger domain by telescoping. In this paper, we revisit telescoping, we study multiplicative closures of summations (such as the usual summation on convergent series) that are not themselves multiplicatively closed, and we study rational extensions as a generalization of telescoping.

Expository Notes

Fast-growing series are transcendental, *with Robert Dawson*
Unpublished. arXiv: 2102.12995

Let R be a subring of $\mathbb{C}[[z]]$, and let $X \in \mathbb{C}[[z]]$. The Newton-Puiseux Theorem implies that if the coefficients of X grow sufficiently rapidly relative to the coefficients of the series in R, then X is transcendental over R. We provide an alternative proof of this result by establishing a relationship between the coefficients of $A(X)$ and $A'(X)$, where $A(T)$ is a polynomial over $\mathbb{C}[[z]]$.

Manuscripts in Preparation

A family of analogues to the Ramanujan-Robin criterion, *with Steve Fan and Mits Kobayashi*

Odd, spoof quasiperfect factorizations, *with Jonathon Hales*

Visualizing Basel's problem, *with Mits Kobayashi*

Selected Git Projects

Spoof Quasiperfect Factorizations Fall 2021
`https://github.com/grantmolnar/Spoof-Quasiperfect-Factorizations`

Awards and Fellowships

Dartmouth Graduate Fellowship — Fall 2018 - Summer 2023
Gridley Fund for Graduate Mathematics — Fall 2018 - Summer 2019
NSF Graduate Research Fellowship Honorable Mention — April 2018

BYU Academic Scholarship — Spring 2015 - Winter 2016
BYU Math Department Scholarship — Fall 2016
BYU Math Department Scholarship — Fall 2015
BYU Academic Scholarship — Fall 2013 - Winter 2014

Teaching Experience

Dartmouth College, Hanover, NH (Instructor)
Math 8 (Calculus of One and Several Variables) — Fall 2021
Math 1 (Algebra and Calculus) — Fall 2020

Dartmouth College, Hanover, NH (Teacher's Assistant)
Math 100 / Computer Science 49/149 (Random Walk) — Spring 2022
Math 100 / Computer Science 49/149 (Decision Theory) — Spring 2021
Math 23 (Differential Equations) — Winter 2020
Math 3 (Calculus) — Fall 2019
Math 22 (Linear Algebra) — Spring 2019
Math 22 (Linear Algebra) — Fall 2018

Brigham Young University, Provo, UT (Instructor)
Math 112 (Calculus I) — Summer 2017

Brigham Young University, Provo, UT (Teacher's Assistant)
Math 112 (Calculus I) — Fall 2017
Math 113 (Calculus II) — Winter 2017

Brigham Young University, Provo, UT (Grader)
Math 570 (Matrix Analysis) — Winter 2017
Math 112 (Calculus I) — Fall 2015

Thesis Defenses

Counting elliptic curves with a cyclic m-isogeny over $\mathbb{Q}$ — April 24, 2023
Dartmouth College PhD Thesis Defense

The arithmetic of modular grids — June 22, 2018
BYU Master's Thesis Defense

Invited Talks

Counting elliptic curves with a cyclic m-isogeny — February 9, 2023
Job Talk at Metron

Counting elliptic curves with a 7-isogeny — January 19, 2023
BYU Colloquium

Counting elliptic curves with a 7-isogeny — January 11, 2023
Simons Collaboration Annual Meeting

Counting 7-isogenies — January 6, 2023
2023 Joint Mathematics Meeting

A family of analogues to the Ramanujan-Robin Criterion October 27, 2022
BYU Number Theory Seminar

Other Conference Talks

Intersecting varieties with transcendental graphs March 8, 2023
Arizona Winter School 2023: Unlikely Intersections

The LCM product and Grönwall's theorem October 3, 2021
2021 Maine-Québec Number Theory Conference (virtual)

Formal summation of divergent series September 26, 2020
2020 Conférence de Théorie des Nombres Québec-Maine (virtual)

The arithmetic of modular grids October 5, 2019
2019 Maine-Québec Number Theory Conference

The arithmetic of modular grids March 8, 2019
33^{rd} Automorphic Forms Workshop

The arithmetic of modular grids July 17, 2018
Building Bridges: 4th EU/US Summer School + Workshop on Automorphic Forms

Zagier duality in level p modular spaces March 21, 2018
32^{nd} Automorphic Forms Workshop

Zagier duality in level p modular spaces March 3, 2018
2018 BYU Student Research Conference

Zagier duality in level p modular spaces May 24, 2017
Modular Forms are Everywhere Conference

Weakly holomorphic modular forms of level 11 March 7, 2017
31^{st} Automorphic Forms Workshop

Weakly holomorphic modular forms of level 11 March 4, 2017
2017 BYU Student Research Conference

Congruence relations in modular forms of prime levels greater than 7 March 21, 2015
2015 BYU Student Research Conference

Residues and independence numbers of graphs March 15, 2014
2014 BYU Student Research Conference

Other Seminar Talks

The Fox H-function March 28, 2023
Dartmouth Graduate Student Seminar

Geometric deep learning February 14, 2023
Dartmouth Graduate Student Seminar

Nearing nearrings September 14, 2022
Dartmouth Graduate Student Seminar

Universal algebra and coalgebra March 30, 2022
Dartmouth Graduate Student Seminar

Cogalois theory February 16, 2022
Dartmouth Graduate Student Seminar

Cyclic resolution of singularities January 25, 2022
Reading Seminar on Hilbert Modular Surfaces

What if the Riemann hypothesis is false? January 19, 2022
Dartmouth Graduate Student Seminar

Inverse semigroups: groups without identity November 9, 2021
Dartmouth Graduate Student Seminar

Counting 7-isogenies November 8, 2021
Dartmouth Algebra and Number Theory Seminar

A sober look at pointless topology September 21, 2021
Dartmouth Graduate Student Seminar

Fast-growing series are transcendental April 21, 2021
Dartmouth Graduate Student Seminar (virtual)

Coalgebras and Hopf algebras April 15, 2021
Reading Seminar on Affine Group Schemes (virtual)

Absurd equalities and Runge's method: the degenerate case March 30, 2021
Dartmouth Algebra and Number Theory Seminar (virtual)

p-adic Hodge theory March 2, 2021
Reading Seminar on Classical and Quadratic Chabauty (virtual)

Odd, spoof quasiperfect factorizations February 9, 2021
Dartmouth Algebra and Number Theory Seminar (virtual)

A primer in social choice theory January 20, 2021
Dartmouth Graduate Student Seminar (virtual)

Examples of Kedlaya's algorithm November 19, 2020
Reading Seminar on Classical and Quadratic Chabauty (virtual)

The LCM product and Grönwall's theorem November 17, 2020
Dartmouth Algebra and Number Theory Seminar (virtual)

Reactive means and the prisoner's dilemma October 7, 2020
Dartmouth Graduate Student Seminar (virtual)

Formal summation of divergent series: an algebraic approach April 28, 2020
Dartmouth Algebra and Number Theory Seminar (virtual)

On the infinitude of the natural numbers February 12, 2020
Dartmouth Graduate Student Seminar

Variations of Hodge structures November 26, 2019
Reading Seminar on Shimura Varieties

Hodge structures November 14, 2019
Reading Seminar on Shimura Varieties

Savage's expected utility and making good decisions November 13, 2019
Dartmouth Graduate Student Seminar

Geometric and generalized calculus October 8, 2019
Dartmouth Graduate Student Seminar

Summing divergent series July 31, 2019
Dartmouth Graduate Student Seminar

Real analysis: a nonstandard approach April 17, 2019
Dartmouth Graduate Student Seminar

Why save the universe? Set theory with a universal set January 16, 2019
Dartmouth Graduate Student Seminar

The arithmetic of modular grids September 26, 2018
Dartmouth Graduate Student Seminar

Dioids and idempotent geometry II March 13, 2018
BYU Algebra Seminar

Dioids and idempotent geometry I February 27, 2018
BYU Algebra Seminar

Zagier duality in level p modular spaces February 22, 2018
BYU Number Theory Seminar

Average values of arithmetic functions October 12, 2017
BYU Number Theory Seminar

Weakly holomorphic modular forms of level 11 February 9, 2017
BYU Number Theory Seminar

Generating functions for canonical bases of certain level 11 weakly holomorphic modular forms January 26, 2017
BYU Number Theory Seminar

High rank elliptic curves with prescribed torsion December 1, 2016
BYU Number Theory Seminar

Heuristics for elliptic curves of high rank October 20, 2016
BYU Number Theory Seminar

A lemma regarding the Feit-Thompson conjecture November 12, 2015
BYU Number Theory Seminar

Algebraic number theory and the Feit-Thompson conjecture October 1, 2015
BYU Number Theory Seminar

Congruence relations in modular forms of prime levels greater than 7 March 19, 2015
BYU Number Theory Seminar

Hensel's lemma February 12, 2015
BYU Number Theory Seminar

Newton polynomials March 27, 2014
BYU Number Theory Seminar

Leadership and Community Service

Referee

Journal of Number Theory 2018 - Present
Mathematische Zeitschrift 2022 - Present

Reviewer

zbMATH Open 2021 - Present

K-12 Outreach

Utah Math Olympiad Committee Member 2015 - Present
Activity Leader at Dartmouth Science Day (Games & Surreal Numbers) April 8, 2023
Activity Leader at Lebanon Ward Pi Day (Trachtenberg Arithmetic & Random Walk) March 25, 2023
Session Leader at Dartmouth Sonia Kovalevsky Day (Trachtenberg Arithmetic) May 21, 2022

Activity Leader at Lebanon Ward Pi Day (Random Walk) — April 8, 2022
Exploring Mathematics Camp Leader (Graph Theory) — July 27-31, 2020
Exploring Mathematics Camp Leader (Cryptography) — July 13-17, 2020
Activity Leader at Lebanon Ward Pi Day (Random Walk) — March 7, 2020
Volunteer at Dartmouth Sonia Kovalevsky Day — May 11, 2019
Activity Leader at Dartmouth Science Day (Nim) — May 4, 2019
Math Circles Guest Speaker (Tropical Algebra) — February 24, 2018
Math Circles Guest Speaker (Continued Fractions) — October 21, 2017
Proofreader for Utah State Math Contest — February 2017

Dartmouth Graduate Student Council

Ad Hoc Healthcare Committee Founder and Co-Chair — 2022 - 2023
- *Budget Committee Member* — Summer 2022

Finance Officer — 2021 - 2022
- *Budget Committee Member* — Summer 2021

Representative for Math Department — 2020 - 2021
- *Service Committee Member* — 2020 - 2021
- *Budget Committee Member* — Summer 2020

Dartmouth Directed Reading Program

Mentor (Fuzzy Logic) — Winter 2023
Mentor (Decision Theory) — Spring 2022
Mentor (Fractional Calculus) — Winter 2022

Other

LMFDB Contributor — 2019 - 2023
Dartmouth Algebra and Number Theory Seminar Organizer — 2019 - 2022
BYU Putnam Team Captain — 2014 - 2016
Math Circles Counselor — 2013 - 2015

Other

Achievements and Honors

3^{rd} Place in Virginia Tech Regional Math Competition — October 2016
2^{nd} Place in Search for High Rank Elliptic Curve at 2016 Connecticut Summer School in Number Theory — August 2016
Gold Palm Eagle Scout — December 2012
Black Belt (Taekwondo) — August 2012

Special Training

Dartmouth Mathematics Teaching Seminar — Spring 2020
BYU Mathematics Teaching Seminar — Fall 2018

Academic Interests

Analytic Number Theory • Arithmetic Geometry • Game Theory • Logic

Personal Interests

Reading • Writing • Philosophy • Hiking

Conferences and Workshops Attended

2024 *Simons Collaboration on Arithmetic Geometry, Number Theory, and Computation Annual Meeting* — January 11-12, 2024
Virtual (Simons Foundation's Gerald D. Fischbach Auditorium, New York City)

Big Data Conference 2023 — August 31 - September 1, 2022
Virtual (Harvard University, Cambridge)

Hilbert Modular Forms Infrastructure Week 4 — May 8-12, 2023
Dartmouth College, Hanover

Arizona Winter School 2023*: Unlikely Intersections* — March 4-8, 2023
University of Arizona, Tucson

2023 *Simons Collaboration on Arithmetic Geometry, Number Theory, and Computation Annual Meeting* — January 11-12, 2023
Simons Foundation's Gerald D. Fischbach Auditorium, New York City

2023 *Joint Mathematics Meetings* — January 4-7, 2023
Hynes Convention Center, Boston

Hilbert Modular Forms Infrastructure Week 3 — December 12-16, 2022
Dartmouth College, Hanover

Modular Curves Workshop 2 — November 5-9, 2022
MIT, Boston

Big Data Conference 2022 — August 26, 2022
Virtual (Harvard University, Cambridge)

Explicit Methods for Modularity — April 11-15, 2022
Virtual (Simons Collaboration)

Arizona Winter School 2022*: Automorphic Forms Beyond* GL_2 — March 5-9, 2022
Virtual (University of Arizona, Tucson)

Hilbert Modular Forms Infrastructure Week 2 — February 21-25, 2022
Dartmouth College, Hanover

2021 *Maine-Québec Number Theory Conference* — October 2-3, 2021
Virtual (University of Maine, Orono)

Spring 2021 *Algebraic Geometry Northeastern Series* — May 4-5, 2021
Virtual (Brown University, Providence)

21^{st} *Algebra, Geometry and Combinatorics Day* — April 10, 2021
Virtual (University of Notre Dame, Notre Dame)

2021 *Joint Mathematics Meetings* — January 6-9, 2021
Virtual (American Math Society, Mathematical Association of America)

Fall 2020 *Algebraic Geometry Northeastern Series* — October 23-25, 2020
Virtual (Stony Brook University, Stony Brook)

2020 *Conférence de Théorie des Nombres Québec-Maine* — September 26-27, 2020
Virtual (Université Laval, Québec)

14^{th} *Algorithmic Number Theory Symposium* — June 29 - July 4, 2020
Virtual (University of Auckland, Auckland)

UNCG Summer School in Computational Number Theory and Algebra: Ergodic Theory with Applications to Continued Fractions — May 18-22, 2020
Virtual (University of North Carolina, Greensboro)

2019 *Maine-Québec Number Theory Conference* — October 5-6, 2019
University of Maine, Orono

Fall 2019 *Algebraic Geometry Northeastern Series* — September 20-22, 2019
Boston College, Boston

33^{rd} *Automorphic Forms Workshop* — March 6-10, 2019
Duquesne University, Pittsburgh

Building Bridges: 4^{th} *EU/US Summer School + Workshop on Automorphic Forms and Related Topics* — July 9-20, 2018
Alfréd Rényi Institute of Mathematics, Budapest

32^{nd} *Automorphic Forms Workshop* — March 19-22, 2018
Tufts University, Medford

Modular Forms are Everywhere — May 15-26, 2017
Max Planck Institute for Mathematics, Bonn

31^{st} *Automorphic Forms Workshop* — March 6-9, 2017
East Tennessee State University, Johnson City

2017 *BYU Student Research Conference* — March 4, 2017
Brigham Young University, Provo

2016 *Connecticut Summer School in Number Theory* — August 8-14, 2016
University of Connecticut, Storrs

2015 *BYU Student Research Conference* — March 21, 2015
Brigham Young University, Provo

2014 *BYU Student Research Conference* — March 15, 2014
Brigham Young University, Provo