Contact Information

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Education

- Ph.D. in Mathematics from UC Berkeley, 2014–2019
  - Advisor: Lauren K. Williams
  - Area: Algebraic Combinatorics and Commutative Algebra
  - Dissertation Title: Matroids and Convex Geometry in Combinatorics and Algebra
- B.S. in Mathematics from University of Florida, 2010–2014
  - Major GPA: 4.0 (with Summa Cum Laude)
  - Undergraduate Thesis Title: Sub-deltas of Block Monoids with Cyclic Class Groups

Employment and Professional Experience

- NSF Ascend Postdoctoral Fellow at MIT, 2022-
- PRIMES Group Research Coordinator at MIT, 2022-
- Communication Editor for Communications in Algebra, 2022-
- NSF Postdoctoral Fellow at MIT, 2020–2022
- Instructor of Applied Mathematics at MIT, 2020–2022
- NSF Postdoctoral Associate at University of Florida, 2019–2020
- Research Assistant at University of Graz (Austria), Summer 2019
- Exchange Scholar at Harvard University, 2018–2019

Research Interest: Algebra and Combinatorics. In algebra, I am mostly interested in the study of the phenomenon of non-uniqueness of factorizations into irreducibles in integral domains and finite-rank monoids using techniques of linear algebra, combinatorics, and number theory. My research in combinatorics focuses on matroids and posets. I am also interested in cluster algebras and polyhedral geometry.

Scientific Publications

1. *Atomic semigroup rings and the ascending chain condition on principal ideals*
   (with B. Li)
   Proceedings of the AMS (to appear)
   Preprint on arXiv: `https://arxiv.org/abs/2111.00170`

2. *On the arithmetic of polynomial semidomains*
(with H. Polo)
Forum Mathematicum (to appear)
Preprint on arXiv: `https://arxiv.org/abs/2203.11478`

3. *On the subatomicity of polynomial semidomains*
(with H. Polo)
In: Algebra and Polynomials: Algebraic, Number Theoretic, and Topological Aspects of Ring Theory (Eds. J. L. Chabert, M. Fontana, S. Frisch, S. Glaz, and K. Johnson). Springer Nature, Switzerland.
(to appear)

4. *Integral domains and the IDF property*
(with M. Zafrullah)
Journal of Algebra, Vol. **614** (2023) 564–591.

5. *Hereditary atomicity in integral domains*
(with J. Coykendall and R. Hasenauer)
Journal of Pure and Applied Algebra, Vol. **227** (2023) 107249.

6. *On the additive structure of algebraic valuations of polynomial semirings*
(with J. Correa-Morris)
Journal of Pure and Applied Algebra, Vol. **226** (2022) 107104.

7. *On semigroup algebras with rational exponents*
Communications in Algebra, Vol. **50** (2022) 3–18.

8. *Divisibility in rings of integer-valued polynomials*
(with B. Li)
New York Journal of Mathematics, Vol. **28** (2022) 117–139.

9. *Bounded and finite factorization domains*
(with D. F. Anderson)
In: Rings, Monoids, and Module Theory (Eds. A. Badawi and J. Coykendall) pp. 7–57, Springer Proceedings in Mathematics & Statistics, vol. **382**, Singapore, 2022.

10. *Length-factoriality in commutative monoids and integral domains*
(with S. T. Chapman, J. Coykendall, and W. W. Smith)
Journal of Algebra, Vol. **578** (2021) 186–212.

11. *Bi-atomic classes of positive semirings*
(with N. R. Baeth and S. T. Chapman)
Semigroup Forum, Vol. **103** (2021) 1–23.

12. *On strongly primary monoids, with a focus on Puiseux monoids*
(with A. Geroldinger and S. Tringali)
Journal of Algebra, Vol. **567** (2021) 310–345.

13. *When is a Puiseux monoid atomic?*
(with S. T. Chapman and M. Gotti)
The American Mathematical Monthly, Vol. **128** (2021) 302–321.

14. *Geometric and combinatorial aspects of submonoids of a finite-rank free commutative monoid*
Linear Algebra and Its Applications, Vol. **604** (2020) 146–186.

15. *Factorization in upper triangular matrices over information semialgebras*
(with N. R. Baeth)
Journal of Algebra, Vol. **562** (2020) 466–496.

16. *The system of sets of lengths and the elasticity of submonoids of a finite-rank free commutative monoid*
Journal of Algebra and its Applications, Vol. **19** (2020) 2050137.

17. *Irreducibility and factorizations in monoid rings*
In: Numerical Semigroups (Eds. V. Barucci, S. T. Chapman, M. D'Anna, and R. Fröberg) pp. 129–139, Springer INdAM Series, vol. **40**, Switzerland, 2020.

18. *On the molecules of numerical semigroups, Puiseux monoids, and Puiseux algebras*
(with M. Gotti)
In: Numerical Semigroups (Eds. V. Barucci, S. T. Chapman, M. D'Anna, and R. Fröberg) pp. 141–161, Springer INdAM Series, vol. **40**, Springer Nature, Switzerland, 2020.

19. *The elasticity of Puiseux monoids*
(with C. O'Neill)
Journal of Commutative Algebra, Vol. **12** (2020) 319–331.

20. *Factorization invariants of Puiseux monoids generated by geometric sequences*
(with S. T. Chapman and M. Gotti)
Communications in Algebra, Vol. **48** (2020) 380–396.

21. *On the atomicity of monoid algebras*
(with J. Coykendall)
Journal of Algebra, Vol. **539** (2019) 138–151.

22. *Systems of sets of lengths of Puiseux monoids*
Journal of Pure and Applied Algebra, Vol. **223** (2019) 1856–1868.

23. *Increasing positive monoids of ordered fields are FF-monoids*
Journal of Algebra, Vol. **518** (2019) 40–56.

24. *How do elements really factor in $\mathbb{Z}[\sqrt{-5}]$?*
(with S. Chapman and M. Gotti)
In: Advances in Commutative Algebra (Eds. A. Badawi and J. Coykendall) pp. 171–195, Springer Trends in Mathematics, Birkhäuser, Singapore, 2019.

25. *Puiseux monoids and transfer homomorphisms*
Journal of Algebra, Vol. **516** (2018) 95–114.

26. *On positroids induced by rational Dyck paths (Extended Abstract)*
Séminaire Lotharingien de Combinatoire, Vol. **80B** (2018) 12pp.

27. *Minimal presentations of shifted numerical semigroups*
(with R. Conaway, J. Horton, C. O'Neill, R. Pelayo, M. Williams, and B. Wissman)
International Journal of Algebra and Computation, Vol. **28** (2018) 53–68.

28. *Dyck paths and positroids from unit interval orders*
(with A. Chavez)
Journal of Combinatorial Theory Series A, Vol. **154** (2018) 507–532.

29. *Atomicity and boundedness of monotone Puiseux monoids*
(with M. Gotti)
Semigroup Forum, Vol. **96** (2018) 536–552.

30. *Dyck paths and positroids from unit interval orders (Extended Abstract)*
(with A. Chavez)
Séminaire Lotharingien de Combinatoire, Vol. **78B** (2017) 12pp.

31. *On the atomic structure of Puiseux monoids*
Journal of Algebra and Its Applications, Vol. **16** (2017) 1750126.

32. *Matroids and convex geometry in combinatorics and algebra*
Ph.D. Dissertation, University of California, Berkeley, 2019.

33. *On delta sets and their realizable subsets in Krull monoids with cyclic class groups*
(with S. T. Chapman and R. Pelayo)
Colloquim Mathematicum, Vol. **137** (2014) 137–146.

Submitted Manuscripts

34. *Positroids induced by rational Dyck paths*
Preprint on arXiv: `https://arxiv.org/abs/1706.09921`

35. *Tilings and matroids on the lattice points of a regular simplex*
(with H. Polo)
Preprint on arXiv: `https://arxiv.org/abs/1802.05633`

36. *Divisibility and a weak ascending chain condition on principal ideals*
(with B. Li)
Preprint on arXiv: `https://arxiv.org/abs/2212.06213`

37. *On the atomic structure of torsion-free monoids*
(with J. Vulakh)
Preprint on arXiv: `https://arxiv.org/abs/2212.08347`

38. *Hereditary atomicity and ACCP in abelian groups*
    Preprint on arXiv: `https://arxiv.org/abs/2303.01039`

Further Research Experience

- Lead Mentor of CrowdMath, MIT-PRIMES/AoPS (2022–)
- Research Mentor at MIT PRIMES (2021–)
- Exchange Scholar (Ph.D. Dissertation Preparation), Harvard University (2018-2019).
- Research Assistant of PURE Math (Factorization Theory), University of Hawaii (2015).
- Undergrad Thesis: *On Sub-deltas of Block Monoids with Cyclic Class Group* (2014).
- PURE Math (Factorization Theory), University of Hawaii at Hilo (2013).
- Princeton Summer Program (Analysis and Geometry), Princeton University (2012).
- Student Researcher (REUT in Semigroup Theory), CSU at Chico (2012).

Invited Talks and Conferences

1. *The Notion of Hereditary Atomicity.* Conference on Rings and Factorizations, at Graz, Austria (Summer 2023).
   Plenary Speaker.
2. *Divisibility and Factorization Theory.* Interuniversity Seminar on Research in the Mathematical Sciences, SIDIM 28-th, at Mayagüez, Puerto Rico (Spring 2023).
   Plenary Speaker.
3. *Atomicity and the ascending chain condition on principal ideals.* Graz Conference on Rings and Polynomials, at Graz, Austria (Summer 2021).
4. *Bounded and Finite Factorization Properties in Integral Domains.* JMM Special Session: Factorization and Arithmetic Properties of Integral Domains and Monoids, Zoom Conference (Spring 2021).
5. *On the Notion of Atomicity in Algebra and Combinatorics.* MIT Lecture Series (Spring 2021).
6. *Atomicity on Generalized Classes of Dedekind Domains.* Algebra Seminar, University of Florida (Fall 2020).
7. *On Strongly Primary Monoids, with a Focus on Puiseux Monoids.* The Third International Conference on Mathematics and Statistics (3$^{\text{rd}}$ ICMS), at Dubai, United Arab Emirates (Spring 2020).

8. *Application of Puiseux Monoids in Commutative Algebra.* Algebra Seminar, Florida Atlantic University (Spring 2020).
9. *Geometry and Combinatorics of Positive Lattice Submonoids.* California Alliance Conference, Stanford University (Fall 2019).
10. *Atomic Properties of Monoid Algebras.* Algebra Seminar, University of Florida (Fall 2019).
11. *The Elasticity of Atomic Monoids and Domains.* Algebra Colloquium, Sam Houston State University (Fall 2019).
12. *The Rational-infinite Elasticity Property and Some Related Conjectures.* Algebra Seminar, University of Florida (Fall 2019).
13. *Philosophical and Mathematical Notion of Atomicity.* Bright Future Conference, Tokyo Institute of Technology, at Tokyo, Japan (Summer 2019).
14. *A Class of Primary Monoids and the Atomicity of Their Monoid Algebras.* Algebra Seminar, University of Graz, at Graz, Austria (Summer 2019).
15. *On the Atomicity of Monoid Algebras of Finite Characteristic.* AMS Sectional Meeting: Factorization and Arithmetic Properties of Integral Domains and Monoids, Honolulu HI (Spring 2019)
16. *On Transfer Properties of Monoid Algebras.* Discrete Mathematics Seminar, University of South Florida (Spring 2019).
17. *A Question by Gilmer on the Atomicity of Monoid Domains.* Algebra Seminar, University of Florida (Spring 2019).
18. *Factorizations in Puiseux Algebras.* Joint Mathematics Meetings (JMM), Baltimore MD (Spring 2019).
19. *On Monoid Algebras with Rational Exponents.* Algebra Seminar, University of Florida (Fall 2018).
20. *On a None-finitely Generated Generalization of Semigroup Algebras.* International Meeting on Numerical Semigroups (IMNS) at Cortona, Italy (Fall 2018).
21. *Positroids Induced by Rational Dyck Paths.* Formal Power Series and Algebraic Combinatorics (FPSAC), Dartmouth College (Summer 2018).
22. *Generalized Affine Semigroups: Their Sets of Lengths and Elasticity.* Algebra and Discrete Mathematics Seminar, UC Davis (Spring 2018).
23. *Tilings and Matroids on the Lattice Points of a Two-dimensional Simplex.* California Alliance Conference, UC Berkeley (Spring 2018).
24. *Systems of Sets of Lengths of Puiseux Monoids.* Conference of Rings and Factorizations at Graz, Austria (Spring 2018).

25. *On Tilings and Matroids on the Lattice Points of a Regular Simplex.* Combinatorics Seminar, University of Miami (Spring 2018).
26. *Dyck Paths and Positroids from Unit Interval Orders.* Formal Power Series and Algebraic Combinatorics (FPSAC) at London, United Kingdom (Summer 2017).
27. *Positroids Induced by Unit Interval Orders.* Combinatorics Seminar, University of Miami (Spring 2017).
28. *Dyck Paths and Positroids from Unit Interval Orders.* Combinatorics Seminar, UC Berkeley (Spring 2017).
29. *Toric Algebra: Semigroup Rings.* Combinatorial Commutative Algebra Seminar, UC Berkeley (Spring 2017).
30. *Monomial Ideals: Stanley-Reisner Ideals.* Combinatorial Commutative Algebra Seminar, UC Berkeley (Spring 2017).
31. *Puiseux Monoids and Their Atomic Structure.* International Meeting on Numerical Semigroups (IMNS) at Levico Terme, Italy (Summer 2016).
32. *Algebra of Symmetric Functions.* Student Combinatorics Seminar, UC Berkeley (Spring 2016).
33. *Incidence Algebras and Möbius Inversion Formula.* Student Combinatorics Seminar, UC Berkeley (Spring 2016).
34. *A Friendly Introduction to Numerical Semigroups.* PURE Math 2015 Symposium, University of Hawaii at Hilo (Summer 2015).
35. *On Realizable Delta Sets of Block Monoids of Cyclic Class Groups.* PURE Math 2013 Symposium, University of Hawaii at Hilo (Summer 2013).

Editorial Service

• Communicating Editor of Communications in Algebra (current)

Journals Refereed

• Acta Arithmetica • American Mathematical Monthly • Australasian Journal of Combinatorics • Canadian Journal of Mathematics • Communications in Algebra • Communications of the Korean Mathematical Society • Discrete Mathematics • Electronic Journal of Combinatorial Number Theory (Integers) • Journal of Algebra • Journal of Applied and Computational Topology • Journal of Applied Mathematics and Computation • Journal of Commutative Algebra • Journal of Pure and Applied Algebra • International Electronic Journal of Algebra • Israel Journal of Mathematics • Lecturas Matemáticas • New York Journal of Mathematics • Semigroup Forum • World Scientific (book review)

Mentoring Activities

As a research mentor in MIT PRIMES, I have supervised six highly enthusiastic high school students, and they have completed the following research projects under my guidance:

- Ben Li (with F. Gotti): *Divisibility in rings of integer-valued polynomials*
  New York Journal of Mathematics, Vol. **28** (2022) 117–139.
  Preprint on arXiv: `https://arxiv.org/abs/2107.11752`
- Sophie Zhu: *Factorizations in evaluation monoids of Laurent semirings*
  Communications in Algebra, Vol. **50** (2022) 2719–2730.
  Preprint on arXiv: `https://arxiv.org/abs/2108.11536`
- Ben Li (with F. Gotti): *Atomic semigroup rings and the ascending chain condition on principal ideals*
  Proceedings of the AMS (to appear).
  Preprint on arXiv: `https://arxiv.org/abs/2111.00170`
- Nancy Jiang, Ben Li, and Sophie Zhu: *On the primality and elasticity of algebraic valuations of cyclic free semirings*
  International Journal of Algebra and Computations (to appear).
  Preprint on arXiv: `https://arxiv.org/abs/2201.01245`
- Ben Li (with F. Gotti): *Divisibility and a weak ascending chain condition on principal ideals.*
  Submitted.
  Preprint on arXiv: `https://arxiv.org/abs/2111.00170`
- Alan Bu, Joseph Vulakh, and Alex Zhao: *Length-factoriality and pure irreducibility.*
  Communications in Algebra (to appear).
  Preprint on arXiv: `https://arxiv.org/abs/2210.06638`
- Joseph Vulakh (with F. Gotti): *On the atomic structure of torsion-free monoids.*
  Submitted.
  Preprint on arXiv: `https://arxiv.org/abs/2212.08347`

During the past few years, I have supervised further research projects for undergrad/graduate students, finding appropriate research questions and guiding my mentees all the way through until the completion of the following papers.

- Khalid Ajran, Juliet Bringas, Ben Li, Easton Singer, and Marcos Tirador: *Factorization in additive monoids of evaluation polynomial semirings.*
  Submitted.
  Preprint on arXiv: `https://arxiv.org/abs/2302.02321`
- Cecilia Aguilera and Andre Hamelberg (with M. Gotti): *Factorizations in reciprocal Puiseux monoids.*
  Submitted.
  Preprint on arXiv: `https://arxiv.org/abs/2112.04048`
- Sofía Albizu-Campos, Juliet Bringas, and Harold Polo: *On the atomic structure of exponential Puiseux monoids and semirings*, Communications in Algebra, Vol. **49** (2021)

850–863.
Preprint on arXiv: `https://arxiv.org/abs/2006.07791`

- Marcos Tirador (with M. Gotti): *On the set of molecules of numerical and Puiseux monoids*. In: Rings, Monoids, and Module Theory (Eds. A. Badawi and J. Coykendall) Springer Proceedings in Mathematics & Statistics Vol. **382**, Singapore, 2022.
Preprint on arXiv: `https://arxiv.org/abs/2008.09904`

- Harold Polo: *On the set of lengths of Puiseux monoids generated by multiple geometric sequences*, Communications of the Korean Mathematical Society, Vol. **35** (2020) 1057–1073.
Preprint on arXiv: `https://arxiv.org/abs/2001.06158`

Teaching Experience

- As an Applied Math Instructor at MIT:
  - 18.211: Combinatorial Analysis (Fall 2021)
  - Ideal Theory and Prüfer Domains (Winter/IAP 2021)
  - 18.02: Multivariable Calculus (Fall 2020)
- As a Graduate Student Instructor (GSI) at UC Berkeley:
  - Math 53W: Multivariable Calculus (Summer 2018)
  - Math 1A: Single Variable Calculus I (Spring 2017)
  - Math 1B: Single Variable Calculus II (Fall 2016)
- As a Teacher Assistant (TA) at University of Florida:
  - MAC 1105: College Algebra (Spring 2014)
  - MAC 1105: College Algebra (Fall 2013)
- As a Student Assistant at University of Havana:
  - Complex Variable (Fall 2008)
  - Mathematics for Biological Sciences (Fall 2007)

Honors and Awards

- MIT Math Department Outstanding Teaching Recognition, Spring 2021
- MIT/NSF Postdoctoral Fellow, 2020-2022
- NSF Postdoctoral Associate at UF, 2019-2020
- UC Berkeley Graduate Division Conference Travel Grant, Spring 2019

- California Alliance Research Exchange Grant, Spring 2019
- UC Dissertation-Year Fellowship, 2018-2019
- NSF-AGEP Fellowship, 2017-2018
- UC Berkeley Graduate Division Conference Travel Grant, Summer 2017
- UC Berkeley Chancellor Fellowship, 2014-2016
- UC Berkeley Department of Mathematics Supplemental Fellowship, 2014-2019

Further Learning/Professional Experiences

- Co-organizer of the Graduate Seminar in Category Theory at University of Florida (Spring 2020)
- Co-organizer of the Graduate Seminar in Algebraic Geometry at University of Florida (Fall 2019)
- Participant in the MSRI Summer Program in Toric Variety at National Center for Theoretical Sciences at Taipei, Taiwan (Summer 2019)
- Organizer of the Graduate Student Seminar in Combinatorial Commutative Algebra at UC Berkeley (Spring 2017)
- Software Developer at Ultimate Software (Summer 2014)
- Participant in the Summer Program in Analysis and Geometry at Princeton University (Summer 2012)

Professional Societies

• American Mathematical Society (AMS) • Mathematical Association of America (MAA) • Alliances for Graduate Education and the Professoriate (NSF-AGEP) • The California Alliance • Berkeley Science Network (BSN) • MIT Postdoctoral Association (MIT-PDA)