

Luis Alberto Modes Castillo

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“Being happy is the greatest form of success.” – unknown

Research Interests

Algebraic geometry, arithmetic geometry, number theory, and topology

Profile

Languages: English (fluent), Spanish (native), Mandarin (intermediate), and Japanese (intermediate)

Programming: Python, L^AT_EX, and SageMath

Skills: Problem-solving, math olympiad coaching, and mentoring

Education

University of Pennsylvania

Doctor of Philosophy in Mathematics

Philadelphia, PA

August 2025 – present

Massachusetts Institute of Technology

Bachelor of Science in Mathematics

Cambridge, MA

September 2021 – May 2025

Academia Interamericana de Panamá sede Cerro Viento

High School Diploma

Panama, Panama

March 2008 – December 2020

Selected Honors and Awards

Hartley Rogers Jr. Prize for the best project of the MIT Math Department's

Summer Program in Undergraduate Research (SPUR)

August 2024

International Mathematical Olympiad (IMO): Bronze Medal

July 2021

International Mathematical Olympiad (IMO): Bronze Medal

September 2020

Panamanian Mathematical Olympiad: Gold Medal, rank 1st in 2019 and 2020

2016 – 2020

Asian Pacific Mathematical Olympiad (APMO): Silver Medal

2019

Research Experience

Summer Program in Undergraduate Research (SPUR)

MIT 2024 - 2025

- Generalized a theorem that identifies the spherical Hall algebra of $\overline{\text{Spec}(\mathbb{Z})}$ with a shuffle algebra to a theorem about the spherical Hall algebra of $\overline{\text{Spec}(\mathcal{O}_K)}$, where K is a number field with class number 1 and $\mathcal{O}_K$ is its ring of integers. Currently working on generalizing this theorem to any number field K through the Undergraduate Research Opportunities Program (UROP). Our paper can be found here: [arXiv:2411.17055](https://arxiv.org/abs/2411.17055): The spherical Hall algebra of $\overline{\text{Spec}(\mathcal{O}_K)}$.

Reference: Zhiwei Yun

18.821 Project Laboratory in Mathematics

MIT 2024

- Worked with a group on two guided research problems. Wrote a paper and gave a presentation for each of them. The first problem was about exploring the density of integer solutions to the diophantine equation $x^3 + y^3 = z^3 + w^3$. The second problem was about exploring the density and existence of *happy sequences*: sequences of zeroes and ones invariant under replacing 0 with 10 and 1 with 100.

Reference: Roman Bezrukavnikov

Directed Readings and Programs

Directed Reading Program MIT 2023-2024

- Read and made a presentation about h -cobordisms and Smale's theorem.
Reference: Joye Chen
- Read and made a presentation about *Using the Borsuk-Ulam Theorem* by Jiří Matoušek.
Reference: Elia Portnoy

Preliminary Arizona Winter School MIT 2023-2024

- Watched recorded lectures and worked on problem sets with a TA for 9 weeks. The topics were elliptic curves with complex multiplication in 2023 and local fields in 2024.
References: Ju-Lee Kim and Bjorn Poonen

18.099 Independent Study: Low-dimensional topology MIT 2024

- Read *Knots and Links* by Dale Rolfsen.
Reference: Joshua Wang

18.099 Independent Study: The geometry of complex analysis MIT 2023

- Read *An Introduction to the Theory of Analytic Functions of One Complex Variable* by Lars Ahlfors.
Reference: Joshua Wang

Presentations

Isomorphism between Hall algebra and shuffle algebra	MIT 2024
Happy sequences	MIT 2024
Sums of cubes	MIT 2024
The h -cobordism theorem	MIT 2024
Heegard Splittings	MIT 2023
Applications of the Borsuk-Ulam Theorem	MIT 2023

Volunteer Roles, Teaching, and Coaching

HMMT Problem Czar August 2022 – May 2023

- Wrote and chose problems for the February tournament and helped with the November tournament.

Panamanian Mathematical Olympiad Member January 2021 – Present

- Wrote a handout and gave a lecture about Circle Geometry in a seminar for high school teachers.
- Organized the shortlist of proposed problems for the 2021 and 2022 Panamanian Mathematical Olympiad.
Reference: Pedro Marrone

Panamanian Training Program Instructor October 2020 – Present

- Served as Panama's Leader at the 2026 International Mathematical Olympiad (IMO).
- Served as Panama's Leader at the 2024 Iberoamerican Mathematical Olympiad.
- Served as Panama's Deputy Leader at the 2023 International Mathematical Olympiad (IMO).
- Currently serve as a math olympiad instructor, mainly in Geometry and Algebra.
- Gave the new students an introductory $\text{\LaTeX}$ course.
- Served as Panama's Deputy Leader at the 2020 Iberoamerican Mathematical Olympiad.
- Served as a jury member at the 2020 Central American and Caribbean Mathematical Olympiad.
Reference: Pedro Marrone

AIPCV Math Olympiad Coach April 2018 – December 2020

- Trained the AIPCV school's team for the first and second rounds of the National Olympiad.
- Wrote a virtual book to train the team.

Work Experience

MIT PRIMES Circle Mentor

MIT, 2023-2025

- Mentored high school students through the material of *The Knot Book* by Colin Adams in 2023 and *Thinking Geometrically: A Survey of Geometries* by Thomas Q. Sibley in 2024 and 2025.
Reference: Marisa Gaetz and Mary Stelow

Undergraduate Assistant for 18.901 Introduction to Topology

MIT, 2023 and 2025

- Graded homework, midterms, and the final exam. Wrote solutions and held office hours.

Undergraduate Math Association Mentor

MIT, 2022

- Provided mentorship to students in introductory real analysis and algebra classes.

Grader for 18.101 Analysis and Manifolds

MIT, 2023

- Graded homework.

Grader for 18.100B Real Analysis

MIT, 2022

- Graded homework and wrote solutions.

Selected Coursework

Algebra

- MATH 7240 Linear Algebraic Groups over Fields (Penn)
- MATH 6020 and MATH 6030 Algebra (Penn)
- 18.725 Algebraic Geometry I and 18.725 Algebraic Geometry II (MIT)
- 18.705 Commutative Algebra (MIT)
- 18.701 Algebra I and 18.702 Algebra II (MIT)

Topology

- MATH 6180 and MATH 6190 Algebraic Topology, Part I (Penn)
- 18.919 Graduate Topology Seminar (MIT)
- 18.905 Algebraic Topology I and 18.906 Algebraic Topology II (MIT)
- 18.904 Seminar in Topology (MIT)

Number Theory

- MATH 6200 and MATH 6210 Algebraic Number Theory (Penn)
- 18.785 Number Theory I and 18.786 Number Theory II (MIT)
- 18.782 Introduction to Arithmetic Geometry (MIT)

Analysis

- MATH 6080 Analysis I and MATH 6090 II (Penn)
- 18.101 Analysis and Manifolds (MIT)
- 18.100B Real Analysis (MIT)

Programming

- 6.100B Introduction to Computational Thinking and Data Science (MIT)
- 6.100A Introduction to Computer Science and Programming in Python (MIT)

Physics

- 8.01 Physics I and 8.02 Physics II (MIT)