

Kareem Alfarra

kalfarra@uwaterloo.ca • Citizenship: Canada

Research interests

Algebraic geometry, Toric Geometry, (Multigraded) Commutative algebra.

Education

2021 – 2025 **University of Waterloo** – Waterloo, Ontario.
Bachelor of Mathematics in pure mathematics.

2025 – 2026 **University of Toronto** – Toronto, Ontario
MSc in Mathematics
Advisor: Hunter Spink.

Honors and scholarships

- 2024 NSERC Undergraduate Student Research Award (Natural Sciences and Engineering Research Council of Canada)
- 2023 Mathematics Undergraduate Research Award (University of Waterloo)
- 2023 NSERC Undergraduate Student Research Award (Natural Sciences and Engineering Research Council of Canada)
- 2021 University of Waterloo President's Scholarship of Distinction (University of Waterloo)

Research experience

May 2024 – **Model Theory of Difference Fields**
August 2024 Supervisor: Rahim Moosa (University of Waterloo).
Description: A difference field is a field equipped with a distinguished automorphism. We can view difference fields as first-order model-theoretic structures in the language of rings together with an additional symbol for the automorphism. In 1989 Hrushovski showed that if the first-order theory of a difference field is superstable, then the fixed field of the automorphism is either everything or is a finite field. In particular, in characteristic zero, superstable difference fields are just pure algebraically closed fields. It is conjectured that this holds in positive characteristic as well: if a difference field is superstable then the automorphism should be an integer power of Frobenius. The goal of this project is to make further progress on the general case. This research is funded through NSERC Undergraduate Student Research Award by the Natural Sciences and Engineering Research Council of Canada.

January 2024 – April 2024 **Formal Deformations of Commutative Rings**
 Supervisor: Jason Bell (University of Waterloo).
 Description: We aim to answer a question of Etingof on filtered deformations. That is, if we have a finitely generated k -algebra R which is also an integral domain and with $\text{char}(k) \neq 0$, is it true that every filtered deformation on R is a polynomial identity? This research is funded through the Mathematics Undergraduate Research Award by the University of Waterloo.

May 2023 – August 2023 **On Polynomials f Coprime to $\lfloor \alpha f \rfloor$ for $\alpha \in \mathbb{F}((t^{-1}))$ in Function Field $\mathbb{F}_q[t]$**
 Supervisor: Yu-Ru Liu (University of Waterloo).
 A well-known result of G.L. Watson gives the density of integers n with $\gcd(n, \lfloor \theta n \rfloor) = 1$ for any fixed real number θ . Our aim is to find a function field analogue of this result by instead considering $\gcd(f, \lfloor \alpha f \rfloor) = 1$ where $f \in \mathbb{F}_q[t]$, $\alpha \in \mathbb{F}_q((t^{-1}))$, and $\lfloor \alpha f \rfloor$ is the natural projection $\mathbb{F}_q((t^{-1})) \rightarrow \mathbb{F}_q[t]$.
 This research is funded through NSERC Undergraduate Student Research Award by the Natural Sciences and Engineering Research Council of Canada.

Teaching experience

Spring 2026, Fall 2025 **MAT 344 Introduction to Combinatorics (University of Toronto)**
 Teaching assistant, responsible for grading and office hours for students.

Spring 2026 **MAT 136: Calculus II (University of Toronto)**
 Held tutorials and office hours for students in addition to grading assignments.

Fall 2025 **MAT 135: Calculus I (University of Toronto)**
 Held tutorials and office hours for students in addition to grading assignments.

Fall 2025 **Math Learning Centre (University of Toronto)**
 Teaching assistant in the tutorial centre providing individual help and tutoring to students.

Fall 2023 **MATH 145: Advanced Algebra (University of Waterloo)**
 Held review sessions midterm and final exams to help students, one session for each exam.

Fall 2023 **MATH 147: Advanced Calculus I (University of Waterloo)**
 Held review sessions for midterm and final exams, one session per exam.

Winter 2023 **MATH 146: Advanced Linear Algebra I (University of Waterloo)**
 Held review sessions for midterm and final exams, one session per exam.

Presentations

- June 20 2023 On Integers n Coprime to $f(n)$
Canadian Undergraduate Mathematics Conference held at the University of Toronto
- July 14 2022 The Game of Cops and Robbers: How Cops Can Outsmart the Robber
Canadian Undergraduate Mathematics Conference held at Université Laval

Service

- January 2024 – **University of Waterloo (Committee lead for Canadian Undergraduate Mathematics conference 2025)**
Present Lead committee meetings. Contact external organizations to obtain both financial and logistical support. Coordinate efforts between members and supporting organizations to ensure smooth operation.
- May 2023 – **Mathematics Society (Pure mathematics, applied mathematics, combinatorics & optimization representative)**
December 2023, Represent and advocate for the interest of student in pure mathematics, applied mathematics, and combinatorics & optimization. Attend society meetings as well as be a member of any relevant committees, such as executive appointment committee.
May 2024 –
Present
- May 2023 – **Mathematics society board (Mathematics Society representative)**
September Be a representative of Mathematics society on the board. Serve the long term interests of all faculty of mathematics students. Sit on any appropriate committees, such as the SPACE committee.
2023, May 2024
– Present
- May 2023 – **Pure Mathematics Club (Vice president pure mathematics)**
December 2023 Organized professor talks for students with the main focus being different areas in pure mathematics, including algebra and algebraic geometry.