Kush Singhal

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EDUCATION:

PhD in Mathematics, Harvard University 2022 - *ongoing*

Advisor: Mark Kisin

Bachelor of Science, University of Hong Kong, HK 2018-2022

Major Mathematics (Intensive)

PAPERS:

- Near-miss Identities and Spinor Genus Classification of Ternary Quadratic Forms with Congruence Conditions, *pre-print*, Apr. 2021, *arXiv*:2104.08798 [math.NT] (submitted for review).
- The Completed L-function attached to the Weight 2 Polar Harmonic Maass Form $H^*_{N,z}(\tau)$, *pre-print*, Jan. 2022, *arXiv*:2201.03146 [math.NT] (submitted for review)

TALKS:

- Gave a talk on representations by ternary quadratic forms at the Harvard "Trivial Notions" 2022 Seminar.
- Spoke at STAGE Spring 2023 organized by the Department of Mathematics, MIT. The talk was a brief review on the theory of reductive groups. See: https://math.mit.edu/nt/stage.html
- Spoke at STAGE Fall 2022 organized by the Department of Mathematics, MIT. The talk was on an example of descent. See: https://math.mit.edu/nt/old/stage_f22.html
- Invited to give a 15-minute talk at Number Theory Days 2021 organized by the Department of Mathematics, HKU. My short presentation was based on my paper on representations by ternary quadratic forms with congruence conditions. For more see: https://hkumath.hku.hk/~imr/event/HKUdays2021/program.php.

RESEARCH:

Areas of Interest: *Algebraic Number Theory, Arithmetic Geometry, Representation Theory*

Undergraduate Research Fellowship Programme (URFP), University of Hong Kong

Supervised by Dr Jiang-Hua Lu *September 2021 – May 2022*

On the Number of Frieze Patterns Associated to Dynkin Diagrams

It is known that the number of frieze patterns associated to a Dynkin diagram is finite. However, the techniques used to find the number of frieze patterns for each Dynkin diagram was different (except E_7 and E_8, for which we do not know the number of friezes). Thus, the goal of this project is to study the underlying mathematical structure in order to find a unified method that could consider all diagrams at once.

Summer Research Programme (SRP), Graduate School, University of Hong Kong

Supervised by Dr Benjamin Robert Kane *Jun 2021 – July 2021*

The Mellin Transform of a Weight 2 Polar Harmonic Maass Form

- In this project, I analysed the Mellin transform of the weight 2 polar harmonic Maass form $H^*_{N,z}(\tau)$. After suitable regularization, I showed that this Mellin transform was holomorphic on $\mathbb{C}\backslash\{1\}$, satisfied a certain functional equation, and its limit as $z \to i\infty$ (after removing some polylogarithm terms) converged to the L-function attached to the weight 2 harmonic Eisenstein series $E^*_{2,N,i\infty}$. I also found an explicit expression for this latter L-function in terms of the Riemann zeta function.
- Authored "The Completed L-function attached to the Weight 2 Polar Harmonic Maass Form $H^*_{N,z}(\tau)$" based on this project.
- As part of the SRP, I was one of few awarded a conditional offer for HKU's Presidential Fellowship for PhD for successfully completing the SRP with "outstanding performance."

Summer Research Fellowship (SRF), Faculty of Science, University of Hong Kong

Supervised by Dr Benjamin Robert Kane *Jun 2020 – Aug 2020*

Spinor Classification of Lattice Cosets, and Near-miss Identities of Ternary Quadratic Forms

- Using a computer search similar to one conducted by Bringmann and Kane, I found candidates for spinor class number 1 lattice cosets. Then, applying the ideas of Liang Sun, as well as Haensch and Kane, I find with proof the genus, spinor genus, and classes for most of my previously found candidates for spinor class number 1 lattice cosets.
- Crucial techniques involved were the theory of modular forms, and the algebraic theory of *p*-adic quadratic forms.
- Authored "Near-miss Identities and Spinor Genus Classification of Ternary Quadratic Forms with Congruence Conditions" based on this work.
- Was invited to give a short talk about this work during HKU's Number Theory Days 2021.

TEACHING:

2023 Summer Tutorial Program, Harvard *July 2023 – August 2023*

I taught a summer tutorial on the arithmetic theory of quadratic forms. I will design my own lectures as well as write my own lecture notes.

Mentor in Harvard Math's Directed Reading Program *Fall 2022 – ongoing*

I am a mentor in the directed reading program at Harvard. I work with undergraduate students one on one, while they learn about topics outside the usual undergraduate curriculum.

Student Teaching Assistant, Dept. of Mathematics, HKU *October 2020 – April 2022*

I conducted revision classes and Q&A sessions for second year courses, as well as answered queries that students emailed in, for the courses Intro to Mathematical Analysis (Fall 2020), Fundamentals of Mathematics (Spring 2021), and Abstract Linear Algebra (Spring 2022).

ACTIVITIES AND POSITIONS HELD:

Managerial

- Chairman of the Hong Kong University Students' Cricket Club, Session 2020-2021. I also captained the team from 2021 onwards.
- Chairman of the Mathematics Society, SS, HKUSU, Session 2018-2019.

Organizational

- Publicity Secretary of the Hong Kong University Students' Cricket Club, Session 2019-2020. I managed the Instagram handle for the club.
- Member of the Event Management Team, Shun Hing College, HKU (2019-to date).

SELECTED HONOURS AND AWARDS

- B.Sc. Class of 1971 Prize offered by the Faculty of Science, HKU (2020-21), offered to the best third-year student from the physical sciences.
- Wong Yung Chow Prize in Mathematics offered by the Department of Mathematics, Faculty of Science, HKU (2020-21).
- Hong Kong University Alumni Award offered by the Faculty of Science, HKU (2020-21). This award is only offered to one third year undergrad from the Faculty of Science.
- Professor Yung-Chow Wong Scholarship offered by the Department of Mathematics, Faculty of Science, HKU (2019-20)
- Dean's Honours List, Faculty of Science, HKU (2018-19) (2019-20) (2020-21)
- Placed 9th overall in the individual category of the Simon Marais Mathematics Competition, 2019. I was also the best individual entry from Hong Kong.

SKILLS, HOBBIES, AND OTHER INTERESTS:

- *Software*:
  - LaTeX (including the beamer package) (advanced)
  - Python (advanced)

    - C++ (intermediate)
- *Sports*: Cricket (previously captained the HKU student cricket team)
- *Hobbies*: Origami
- *Sound Management*: set up and helped run the technical side of things for a music festival. I also helped mix sound for various performances (intermediate)