Research Statement

Rui Xiong

In this statement, I will review my research work and present my future plan. The full and updated information can be found in my personal website.

Generality

My research area is mainly about algebraic geometry and algebraic combinatorics.

In general, I put my special interests on varieties which could be combinatorially understood, e.g. flag varieties, Grassmannians, toric varieties, quiver varieties, etc. They and their certain subvarieties are typically parametrized by certain combinatorial structures, and people believe their geometric information can be read from the diagrams via combinatorics. For instance, intersection numbers, Gromov–Witten invariants, Euler characteristic, Hodge polynomials, etc.

I am deeply influenced by geometric representation theory, especially those from the study of (affine) Hecke algebras. So I paid particular attention to homogeneous varieties including flag varieties and Grassmannians. They are varieties admitting a torus action with discrete fixed points where we can apply localization theorem. The tool I used most frequently is the affine Hecke algebras (and its variant). It builds the connection to representation theory and brings combinatorics into the picture.

In the future, I will not be restricted to them. I will extend my research including twisted flag varieties, affine flag varieties, elliptic cohomology and quiver varieties.

Seminars

Besides my TA job in University of Ottawa, I gave many lectures and organized many seminars. The details could be found on my personal website.

- Toric Varieties and its Applications 2022

  The main purpose is to understand the proof of Read's conjecture by Huh. I wrote up an 8-lecture note (for $\approx$ 16 weeks), unfortunately, we stopped after the 6th week.

- Geometric Representation Thery Seminar, 2023 and 2024

  I was co-organizing an online seminar on double affine Hecke algebras. My task is to present Macdonald polynomials, ending with a discussion of Haiman theory. We continue in the new academic year. The topic for this year is affine Springer fibers.

- Affine Weyl Groups 2024

  The main purpose is to present the preliminary knowledge of my undergoing joint work with Neil J.Y. Fan, Peter L. Guo and Changjian Su.

- PKU Algebra and Combinatorics Experience

  I attended the REU program in Peking university as a mentor. With two undergraduate students, we worked out a new combinatorial model of key polynomials.

Published Papers

Around 2022, we found an equivariant log-concavity phenomenon in symmetric algebras and exterior algebras.
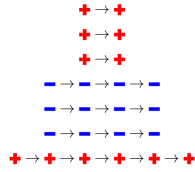
Journal of Algebra, Volume 657, November 2024, 379-401.
Equivariant log-concavity and equivariant Kähler packages
Tao Gui and Rui Xiong

Actually, we proved in the paper that some extra structure exists.

In the following paper, we found a surprising automorphism in the quantum cohomology of Springer resolutions. As an application, we provide a presentation of the quantum cohomology of Springer resolutions.
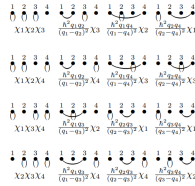
Advances in Mathematics, Volume 442, April 2024, 109577.
Automorphisms of the Quantum Cohomology of the Springer Resolution and Applications
Changzheng Li, Changjian Su and Rui Xiong

We mention in our proof, the Schubert calculus of stable basis, an $\hbar$-deformation of classical Schubert classes, plays an important role.
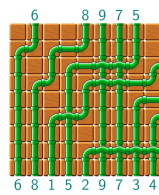
Preprints

I have many preprints concerning on various topics. They are all expected to be published in good journals.
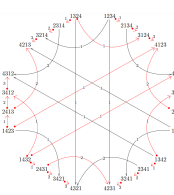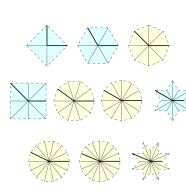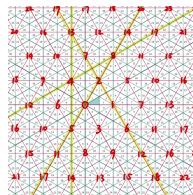
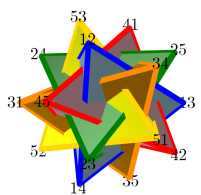| Chern classes of varieties	Chern classes of varieties	Schubert puzzles	Generalized cohomology	affine flag varieties	motivic decomposition
[2211.06802]	[2309.00467]	[2402.04500]	[2303.02409]	[2312.03965]	[2404.07314]

Two of them have received positive opinions by good journals.