Xu Gao

Dr. Xu Gao

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Experience

2023–Present **Postdoctoral**, *School of Mathematical Sciences, Tongji University*, Shanghai, China

Fall 2024 **Visiting Scholar**, *Department of Mathematics, University of Pennsylvania*, Philadelphia, USA

Education

2016–2023 **Ph.D.**, *Mathematics Department, University of California, Santa Cruz*, USA
Advisors: Prof. Chongying Dong & Prof. Junecue Suh

2012–2015 **M.S.**, *Chern Institute of Mathematics, Nankai University*, Tianjin, China
Advisor: Prof. Chengming Bai

2008–2012 **B.S.**, *School of Mathematical Sciences, Nankai University*, Tianjin, China

Research Interests & Selected Publications

My research lies at the intersection of algebra, geometry, and mathematical physics, with a particular focus on topics where category theory and geometry intertwine. My main results are categorized by theme as follows:

Algebro-geometric Study of VOA Conformal Blocks

This is my primary research area. I focus on using modern algebraic geometry tools to study the geometric representation theory of Vertex Operator Algebras (VOAs) on algebraic curves and their degenerations (e.g., nodal curves, orbicurves). My current goals are to establish factorization theorems in vast generality and to develop an algebro-geometric theory of vertex tensor categories.

- **Xu Gao**, Jianqi Liu and Yiyi Zhu, *Twisted restricted conformal blocks of vertex operator algebras I: g-twisted correlation functions and fusion rules*, **Journal of Algebra** 675 (2025), pp. 59–132.
- **Xu Gao**, Jianqi Liu and Yiyi Zhu, *Twisted restricted conformal blocks of vertex operator algebras II: twisted restricted conformal blocks on totally ramified orbicurves*, `arXiv:2403.00545`.
- **Xu Gao**, Jianqi Liu, *Applications of the factorization theorem and fusion rings of vertex operator algebras*, `arXiv:2508.01294`.
- **Xu Gao**, Yiyi Zhu, *Twisted and untwisted universal enveloping algebras for permutation orbifolds*, `(submitted)`.
- **Xu Gao**, Angela Gibney, Daniel Krashen, and Jianqi Liu, *On the strong identity condition for almost-canonically seminormed rings*, `to be submitted`.

Tensor Triangular Geometry and Algebraic Topology

Applying tensor triangular geometry to study geometric invariants of stable homotopy categories in algebraic topology and representation theory.

- **Xu Gao**, Ang Li, *The stable Picard group of finite Adams Hopf algebroids with an application to the $\mathbb{R}$-motivic Steenrod subalgebra $\mathcal{A}^{\mathbb{R}}(1)$*, **Journal of Pure and Applied Algebra** 228 (2024), no. 11, 107732.
- **Xu Gao**, *Stratification for finite groupoids*, available on webpage.

Bruhat-Tits Buildings and p-adic Representation Theory

This study involves combinatorial structures in non-Archimedean geometry and their applications to p-adic group representation theory. It also serves as a foundation for research in arithmetic conformal field theory.

- **Xu Gao**, *Simplicial distance in Bruhat-Tits buildings of split classical type*, **Ph.D. Dissertation**, University of California, Santa Cruz (2023).

Rota-Baxter Operators and Pre-Lie Algebras (Early Work)

Research on Rota-Baxter operators, pre-Lie algebra structures, and deformation theory conducted during my Master's studies.

- Chengming Bai, **Xu Gao**, Ming Liu, and Naihuan Jing, *Rota-Baxter Operators on Witt and Virasoro Algebras*, **Journal of Geometry and Physics** 108 (2016), pp. 1–20.
- **Xu Gao**, *Extensions and Non-abelian Cohomology of Pre-Lie Algebras*, **Master's Thesis**, Nankai University (2015).

Teaching Experience

Extensive experience in independent instruction and teaching assistance abroad. Competent in teaching courses ranging from undergraduate general education (Calculus/Linear Algebra) to advanced major courses (Number Theory/Algebra).

Instructor

- **University of California, Santa Cruz** — Santa Cruz, USA
  MATH 110: Introduction to Number Theory — 2022.09 – 2023.06
  Served as the sole instructor for three consecutive quarters. Responsibility includes syllabus design, lecturing, creating homework and exams, and final grading. Complete teaching materials are available on my website (`gausyu.top/Teaching/`).

Teaching Assistant

- **University of California, Santa Cruz** — Santa Cruz, USA
  Core Courses and Advanced Courses — 2016.09 – 2022.08
  Assisted in teaching core undergraduate mathematics courses and advanced courses for six years, serving over a thousand students. Courses covered include:
  - **Calculus Series**: MATH 11A (Calculus with Applications), MATH 19A/B (Calculus for Science, Engineering, and Mathematics), MATH 22 (Calculus of Several Variables);

- **Algebra Series**: MATH 21 (Linear Algebra), MATH 117 (Advanced Linear Algebra), MATH 111 (Algebra);
- **Advanced Courses**: MATH 100 (Introduction to Proof and Problem Solving), MATH 110 (Introduction to Number Theory).

Academic Activities

(Selected List)

Conference Talks

- **19th National Conference on Lie Theory** — Guangdong Univ. of Tech., Guangzhou
  Orbifold Theory of VOAs via Algebro-geometric Conformal Blocks — 2025.11
- **AMS 2025 Summer Research Institute in Algebraic Geometry** — Fort Collins, CO, USA
  Monoidal Structure on Representations of VOAs via Algebrogeometric Conformal Blocks — 2025.07
- **2025 International Conference on Representation Theory** — Jimei University, Xiamen
  Strong Identity Condition for Almost Canonically Seminormed Rings — 2025.06
- **18th National Conference on Lie Theory** — Tongji University, Shanghai
  p-adic Representations and Simplicial Distance in Bruhat-Tits Buildings — 2023.07
- **AMS 2023 Spring Western Sectional Meeting** — Fresno, CA, USA
  p-adic Representations and Simplicial Balls in Bruhat-Tits Buildings — 2023.05

Invited Seminars

- **Youth Forum on New Progress in Lie Theory** — Nankai University, Tianjin
  Orbifold Theory of VOAs via Algebro-geometric Conformal Blocks — 2025.12
- **Seminar on Tensor Categories of VOAs** — Shanghai Jiao Tong University
  Ribbon Monoidal Category via Algebrogeometric Conformal Blocks — 2025.05
- **Vertex Operator Algebra Seminar** — Tongji University
  Ribbon Monoidal Category via Conformal Blocks and Strong Identity Condition... — 2025.05
- **Algebra Seminar, Chern Institute of Mathematics** — Nankai University, Tianjin
  Towards a Ribbon Monoidal Category Structure via Conformal Blocks of VOAs 2025.01 *(Co)stratifications in representation theory* — 2025.01
- **Math-Physics Joint Seminar, University of Pennsylvania** — Philadelphia, USA
  Twisted Restricted Conformal Blocks of Vertex Operator Algebras — 2024.10
- **Number Theory Seminar, UC San Diego** — San Diego, USA
  p-adic Representations and Simplicial Distance in Bruhat-Tits Buildings — 2023.03
- **Algebra & Number Theory Seminar, University of Arizona** — Tucson, USA
  p-adic Representations and Simplicial Balls in Bruhat-Tits Buildings — 2023.01

Summer Schools & Other Activities

- **AMS 2024 Fall Eastern Sectional Meeting** — Albany, NY, USA
  University at Albany, SUNY — 2024.10
- **MSRI Summer Graduate School: Sparsity of Algebraic Points** — Berkeley, USA
  Mathematical Sciences Research Institute (SLMath) — 2021.06
- **Arizona Winter School: Topology and Arithmetic** — Tucson, USA
  University of Arizona — 2019.03