Yifei Zhu

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Positions

Southern University of Science and Technology, Shenzhen, Guangdong, China

Tenure-track assistant professor, February 2020 to present

Visiting assistant professor, December 2016 to January 2020

Academy of Mathematics and Systems Science, Chinese Academy of Sciences, Beijing, China

Visiting scholar, October 2016 to January 2017

Northwestern University, Evanston, Illinois, USA

Visiting assistant professor, September 2013 to August 2016

Mentor: Paul Goerss

Education

University of Minnesota, Twin Cities, Minnesota, USA

Ph.D. in Mathematics, June 2013

Advisor: Tyler Lawson

Peking University, Beijing, China

B.S. in Mathematics, July 2007

Research Interests

Interactions of algebraic topology with algebraic geometry and number theory, especially moduli spaces from spectral algebraic geometry in the context of the Langlands program, as well as applications of topology and geometry to interdisciplinary research, including condensed-matter physics and materials science, time series analysis, human–computer interaction, and systems science.

Publications and Preprints

Topological classification for intersection singularities of exceptional surfaces in pseudo-Hermitian systems

First corresponding author, with Hongwei Jia, Ruo-Yang Zhang, Jing Hu, Yixin Xiao, Shuang Zhang, and C. T. Chan.
Accepted for publication by Communications Physics, available at arXiv:2209.03068.

Non-Hermitian swallowtail catastrophe revealing transitions among diverse topological singularities

First corresponding author, with Jing Hu, Ruo-Yang Zhang, Yixiao Wang, Xiaoping Ouyang, Hongwei Jia, and C. T. Chan.
Nature Physics **19** (2023), 1098–1103.
DOI: 10.1038/s41567-023-02048-w

Norm coherence for descent of level structures on formal deformations

Journal of Pure and Applied Algebra **224** (2020), no. 10, 106382, 35 pp.
DOI: 10.1016/j.jpaa.2020.106382

The Hecke algebra action and the Rezk logarithm on Morava E-theory of height 2

Transactions of the American Mathematical Society **373** (2020), no. 5, 3733–3764.
DOI: 10.1090/tran/8032

Semistable models for modular curves and power operations for Morava E-theories of height 2

Advances in Mathematics **354** (2019), 106758, 29 pp.
DOI: 10.1016/j.aim.2019.106758

Morava E-homology of Bousfield–Kuhn functors on odd-dimensional spheres

Proceedings of the American Mathematical Society **146** (2018), no. 1, 449–458.
DOI: 10.1090/proc/13727

The power operation structure on Morava E-theory of height 2 at the prime 3

Algebraic and Geometric Topology **14** (2014), no. 2, 953–977.
DOI: 10.2140/agt.2014.14.953

Research Grants

2024–2027 National Natural Science Foundation of China (NSFC) General Program grant 12371069, *Methods of algebraic topology to study moduli spaces: with applications to homotopy theory, condensed matter physics, and time series analysis*.

2023–2025 Natural Science Foundation of Guangdong Excellent Young Scientists Fund grant 2023A1515030289, *Computations, structures, and applications in unstable chromatic homotopy theory*.

2018–2020 NSFC Young Scientists Fund grant 11701263, *Methods of algebraic geometry and number theory in algebraic topology*.

2018–present Finance Commission of Shenzhen Municipality start-up research grant.

Awards and Fellowships

2020 Fourth Young Faculty Teaching Competition, Second place, Southern University of Science and Technology.

2017–2022 Overseas High-Caliber Personnel (Level C) fellowship, Shenzhen.

2007–2013 Teaching assistantship, University of Minnesota.

2007 Outstanding Graduating Student award, Peking University.

2005–2006 Outstanding Student award, School of Mathematical Sciences, Peking University.

Conference Presentations

Topological time series analysis with applications

The 21st Annual Meeting of China Society for Industrial and Applied Mathematics, Kunming, October 2023, scheduled.

Moduli, moduli, moduli

International Workshop on Algebraic Topology, Beijing International Center for Mathematical Research, Peking University, Beijing, July 2023.

Topological invariants for stratified singular moduli spaces of non-Hermitian Hamiltonians with applications to condensed matter physics and photonics

The 9th International Congress of Chinese Mathematicians, jointly hosted by Yau Mathematical Sciences Center, Department of Mathematical Sciences of Tsinghua University, Academy of Mathematics and Systems Science of the Chinese Academy of Sciences, and Yanqi Lake Beijing Institute of Mathematical Sciences and Applications, Nanjing, August 2022, postponed.

Combinatorial cell decomposition and cohomology of compactified moduli for hyperbolic surfaces

2021 National Conference on Algebraic and Geometric Topology, Chinese Academy of Sciences, Beijing, August 2021, postponed.

Genera*lized modular forms in topology*

Conference on Low Dimensional Topology, Shenzhen International Center for Mathematics, Shenzhen, November 2020.

Algebraic topology and arithmetic

Fudan-Guanghua International Forum for Young Scholars, Fudan University, Shanghai, December 2019.

Algebraic topology and arithmetic

2019 Young Mathematician Forum, Beijing International Center for Mathematical Research, Peking University, Beijing, December 2019.

Power operations in elliptic cohomology and related arithmetic topics

Special Session on Algebraic and Geometric Topology, AMS–CMS Joint International Meeting, Fudan University, Shanghai, June 2018.

Toward calculating unstable higher-periodic homotopy types

International Workshop on Algebraic Topology, Southern University of Science and Technology, Shenzhen, June 2018.

Symmetry encoded by norm maps

International Workshop on Loop Spaces, Supersymmetry and Index Theory, Chern Institute of Mathematics, Nankai University, Tianjin, July 2017.

Algebraic geometry of ring spectra and multiplicative invariants for families of manifolds

Workshop on Algebraic and Geometric Topology, Nankai University, Tianjin, June 2017.

Toward calculating unstable higher-periodic homotopy types

AMS Special Session on Homotopy Theory, Sectional Meeting, Bloomington, April 2017, scheduled.

Session on chromatic power operations, with P. Nelson and P. VanKoughnett

Operations in Highly Structured Homology Theories, Banff, May 2016.

Modular equations for Lubin–Tate formal groups at chromatic level 2

AMS Session on Algebraic Geometry, Joint Meetings, Seattle, January 2016.

Power operation calculations in elliptic cohomology

AMS Special Session on Homotopy Theory, Joint Meetings, Baltimore, January 2014.

Conference Organizing

International Workshop on Algebraic Topology (IWoAT) 2023

International conference, 5 days, 80 participants.

Joint organizer with H.J. Kong, G. Li, R. Liu, X.D. Shi, G. Wang, J. Wu, and Z. Xu.

Beijing International Center for Mathematical Research, Peking University, July 24–28, 2023.

IWoAT Summer School on Operads, Spectra, and Multiplicative Structures

International conference, 6 days, 100 participants.

Joint organizer with H.J. Kong, G. Li, J. Li, W. Lin, Y. Lu, X.D. Shi, G. Wang, J. Wu, Z. Xu, and F. Zou.

Yanqi Lake Beijing Institute of Mathematical Sciences and Applications, August 14–19, 2023.

Mini-Workshop on Topology and Arithmetic

Domestic conference, 3 days, 60 participants.

Joint organizer with H. Gao, J. Guo, and T. Liang.

Department of Mathematics and Shenzhen International Center for Mathematics, Southern University of Science and Technology, August 7–9, 2023.

Arithmetic and Topology

International conference, 2 days.

Joint organizer with H. Gao.

Department of Mathematics and Shenzhen International Center for Mathematics, Southern University of Science and Technology, December 16–17, 2022, online.

IWoAT Summer School on Chromatic Homotopy Theory and Higher Algebra

International conference, 12 days, 190 participants.

Joint organizer with H.J. Kong, Z. Lü, P. May, X.D. Shi, G. Wang, J. Wu, and Z. Xu.

Shanghai Center for Mathematical Sciences & School of Mathematical Sciences, Fudan University, and Yanqi Lake Beijing Institute of Mathematical Sciences and Applications, August 15–26, 2022, online.

IWoAT Summer School on Equivariant Homotopy Theory and Junior Researcher Forum

International conference, 12 days, 90 participants.

Joint organizer with A. Beaudry, M. Behrens, D. Isaksen, H.J. Kong, Z. Lü, X.D. Shi, G. Wang, and Z. Xu.

Shanghai Center for Mathematical Sciences, Fudan University, July 19–30, 2021, hybrid.

IWoAT 2020

International conference, 5 days.

Joint organizer with A. Beaudry, M. Behrens, D. Isaksen, H.J. Kong, R. Liu, X.D. Shi, G. Wang, and Z. Xu.

Beijing International Center for Mathematical Research, Peking University, August 17–21, 2020, postponed.

IWoAT Summer School on Higher (Infinity-Categorical) Algebra and Its Applications

International conference, 5 days.

Joint organizer with A. Beaudry, M. Behrens, D. Isaksen, H.J. Kong, Z. Lü, X.D. Shi, G. Wang, and Z. Xu.

Shanghai Center for Mathematical Sciences, Fudan University, August 10–14, 2020, postponed.

IWoAT 2019

International conference, 3 days, 140 participants.

Joint organizer with A. Beaudry, M. Behrens, D. Isaksen, H.J. Kong, Z. Lü, G. Wang, and Z. Xu.

Shanghai Center for Mathematical Sciences, Fudan University, August 19–21, 2019.

IWoAT Summer School on Equivariant Homotopy Theory

International conference, 5 days, 140 participants.

Joint organizer with A. Beaudry, M. Behrens, D. Isaksen, H.J. Kong, Z. Lü, G. Wang, and Z. Xu.

Shanghai Center for Mathematical Sciences, Fudan University, August 13–17, 2019.

Special Session on Algebraic and Geometric Topology, AMS–CMS Joint International Meeting

International conference, 4 days, 50 participants.

Joint organizer with M. Hill, Z. Lü, and J. Ma.

Fudan University, Shanghai, June 11–14, 2018.

IWoAT 2018

International conference, 4 days, 70 participants.

Joint organizer (principal) with A. Beaudry, M. Behrens, Z. Huan, H. Miller, N. Stapleton, G. Wang, and Z. Xu.

Southern University of Science and Technology, Shenzhen, June 6–9, 2018.

Operations in Highly Structured Homology Theories

International conference, 5 days, 40 participants.

Organizer for Session on Chromatic Power Operations.

Banff International Research Station, May 22–27, 2016.

SEMINAR TALKS

Topology of stratified singular moduli spaces for physical systems

Westlake University, November 2022.

Topological time series analysis: with applications to biomedical and speech signal processing

Hangzhou Normal University, November 2022.

Spectral moduli problems and unstable chromatic homotopy theory
Beijing Normal University Topology Seminar, January 2022, online.

A topological classification for intersection singularities of exceptional surfaces in pseudo-Hermitian systems
Beijing Normal University Topology Seminar, January 2022, online.

Algebraic topology and arithmetic
Southern University of Science and Technology, December 2019.

Power operations in elliptic cohomology and semistable models for modular curves
Chinese Academy of Sciences Topology Seminar, November 2018.

Toward calculating unstable higher-periodic homotopy types
Electronic Computational Homotopy Theory Seminar, April 2018, online.

Power operations in elliptic cohomology and moduli of elliptic curves
Nankai University, November 2016.

Toward calculating unstable higher-periodic homotopy types
Chinese Academy of Sciences Topology Seminar, November 2016.

Power operation calculations in elliptic cohomology
Southern University of Science and Technology, October 2016.

Modular equations and Hecke operators for local elliptic spectra
University of Chicago Topology Seminar, January 2016.

Local moduli for elliptic spectra
University of Notre Dame Topology Seminar, January 2016.

Computing power operations for Morava E-theory of height 2 at a prime
University of Rochester Topology Seminar, October 2015.

The Hecke algebra action on Morava E-theory of height 2
University of Illinois Urbana-Champaign Topology Seminar, October 2014.

Finite subgroups of a formal group of height 2 over $\mathbb{F}_9$

University of Louisiana at Lafayette Topology Seminar, March 2014.

A formal group of height 2 over $\mathbb{F}_9$

Northwestern University Topology Seminar, October 2013.

Power operations in height-2 Morava E-theory and its $K(1)$-localization

University of Illinois Urbana-Champaign Topology Seminar, September 2013.

Power operations in an elliptic cohomology theory

University of Minnesota Topology Seminar, April 2013.

Computing power operations in Morava E-theory at height 2 for the prime 3

Wayne State University Topology Seminar, March 2013.

The structure of power operations in Morava E-theory at height 2 for the prime 3

University of Chicago Algebraic Topology Seminar, March 2013.

Computing power operations for Morava E-theory of height 2 at the prime 3

University of Virginia Topology Seminar, February 2013.

Selected Conferences and Workshops

Workshop on New Frontiers of Topology

Tianyuan Mathematics Research Center, Chaishitan, September 9–13, 2023.

Workshop on Arithmetic Topology

Pacific Institute for the Mathematical Sciences, University of British Columbia, Vancouver, June 10–14, 2019.

Arbeitsgemeinschaft: Topological Cyclic Homology

Mathematisches Forschungsinstitut, Oberwolfach, April 1–7, 2018.

West Coast Algebraic Topology Summer School

On connections between algebraic topology and number theory.

University of Oregon, Eugene, August 8–12, 2016.

Operations in Highly Structured Homology Theories

Organizer and speaker, Session on Chromatic Power Operations.

Banff International Research Station, May 22–27, 2016.

Conference on Topology and Geometry

Hausdorff Center for Mathematics, Bonn, August 17–21, 2015, scheduled.

Mid-Atlantic Topology Conference—in honor of Nick Kuhn

University of Virginia, Charlottesville, April 25–26, 2015.

West Coast Algebraic Topology Summer School

University of Washington, Seattle, August 26–28, 2011.

New Contexts in Homotopy Theory—in honor of Peter May

University of Chicago, Chicago, October 16–18, 2009.

SEMINAR ORGANIZING

2020–present Southern University of Science and Technology (SUSTech), Applied and Computational Topology Seminar

2017–present SUSTech, Topology Seminar
Joint organizer with S. Garoufalidis.

2011–2012 University of Minnesota, Student Topology Seminar
Joint organizer with D. Bashkirov, R. Hank, and E. Manlove.

REFEREEING

Chinese Annals of Mathematics. Series B

Frontiers of Mathematics

Geometry & Topology

International Mathematics Research Notices

Journal of the Australian Mathematical Society

Journal of Topology

Peking Mathematical Journal

Transactions of the American Mathematical Society

Reviewing

MathSciNet (five reviews currently published)

zbMATH Open (five reviews currently published)

Committee Work

2023–present Undergraduate education committee
2020–present Mathematics colloquium committee

Teaching Experience

Southern University of Science and Technology

- Courses taught:

MA323	Topology
MAT8021	Algebraic Topology (graduate level)
MA423	Seminar in Geometry and Topology
MA327	Differential Geometry
MAT8024	Differentiable Manifolds (graduate level)
MA107A	Linear Algebra
MA101A	Mathematical Analysis I
MA102A	Mathematical Analysis II
MA301	Functions of Real Variables
MAT8010	Combinatorics (graduate level)
MA215	Probability Theory

- Postdoc mentoring: Pengcheng Li (2021–2023), Shiwo Deng (2021–2023, primary mentor: Fuquan Fang).
- Graduate advising: Jizhang Liu (2019–2021), Yifan Wu (2020–present), Xuecai Ma (2020–present), Weiqiu Liang (2020–2021), Siheng Yi (2021–present), Yuqing Xing (2021 visited, primary advisor: Zhen Huan), Kecheng Shi (2021–2022 visited), Tongtong Liang (2021–2023), Zhiwang Yu (2021–present, primary advisor: Fuquan Fang), Yingxin Li (2022–2023 visited), Jiacheng Liang (2022–present), Qingrui Qu (2022–present), Zhonglin Wu (2022–present, co-advisor: Disheng Xu), Wenhui Yang (2023–present), Zeyang Ding (2023–present), Yunhao Sun (2023–present, co-advisor: Xiaowen Hu), Peng Huang (2023–present, co-advisor: Pengcheng Li).

- Undergraduate advising: Jizhang Liu (2017–2019), Yaxi Zhu (2018–2020), Zican Gao (2018–2019), Tongtong Liang (2019–2021), Ruijun Lin (2019–2021), Wenbo Liao (2019–2021), Jinghao Yu (2019–2021), Xiabing Ruan (2019–2021), Mingjie Wang (2020–2023), Linfeng Xu (2020–2022), Lingfeng Liu (2020–2022), Ruoyu Xu (2020–2022), Shuo Ling (2020–2023), Miaosen Jiao (2020–2023), Zijing Zhu (2020–2023), Yukai Wang (2020–2021), Hongxiang Zhao (2021–2023), Pingyao Feng (2021–present), Rongming Yin (2022–present), Zian Zhao (2022–present), Ziyin Hu (2022–present), Zeyang Ding (2022–2023), Zhichao Wang (2022–present), Jinghua Xi (2022–present), Yangqing Li (2022 visited), Jiacheng Liang (2022 visited), Yuanding Li (2023 visited), Yuhe Qin (2023–present), Xinyi Yu (2023–present), Wenhan Tan (2023–present), Yuzheng Ma (2023–present), Zihan Chen (2023–present).
- Fields Honors Class 2021, co-managing with B. Liu.
- Student recruiting, including design of computer-based standardized tests; undergraduate Linear Algebra standardized tests; graduate Geometry and Topology preliminary written exams.
- Tutorial fellow, Shuli College, currently advising 3 students of Class 2023, 3 students of Class 2022, 3 students of Class 2021, and 3 students of Class 2020. Led a panel discussion on math course study for freshmen of the College in Fall 2018 with three teaching-track faculty members.

Northwestern University

- Courses taught:

  Math 230 Differential Calculus of Multivariable Functions
  Math 234 Multiple Integration and Vector Calculus
  Math 240 Linear Algebra
  Math 300 Foundations of Higher Mathematics
- Regularly served as course coordinator for Math 230—the most-enrolled calculus course with the largest instructor group.
- Served as faculty mentor for Math 230's *Gateway Science Workshop* program for two consecutive terms, with recognition from the Provost.
- Involved in *Math Review Study Tables*—drop-in question and answer / group study sessions run prior to calculus exams in residence halls, initiated and co-sponsored by the Office of Residential Academic Initiatives and the Department of Mathematics.
- Involved in piloting the use of *Crowdmark*—a collaborative online grading and analytics platform, with recognition from the Mathematics Department Chair. Experienced with technology and administrative matters.
- Involved in transitioning common calculus course websites from *Blackboard* to *Canvas*.

University of Minnesota

- Teaching assistant for courses:

  Math 1151 Precalculus II
  Math 1271 Calculus I
  Math 2263 Multivariable Calculus
  Math 8602 Real Analysis

- Teaching assistant training, 2007. One of two (among 15) international math graduate students who were exempted from language classes.