Yu Zhao

CONTACT INFORMATION

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RESEARCH INTERESTS

My research interest varies in three different fields: geometric representation theory, especially for representation theory of Yangians, quantum loop/toroidal algebras and cohomological Hall algebras; derived algebraic geometry, especially for derived category and algebraic K-theory of quasi-smooth algebraic stacks; birational geometry, especially for vanishing theory of algebraic varieties.

EMPLOYMENT

Postdocs

Kavli IPMU, University of Tokyo, June 2021-Present

EDUCATION

Massachusetts Institute of Technology

Ph.D. in Mathematics, 2015-2021

- Advisor: Andrei Neguţ

Peking University

B.A. in Mathematics, 2011-2015

RESEARCH GRANT

Grant-in-Aid for Young Scientists (PI, no. 22K13889), "Categorical Representation Theory on an Algebraic Surface", 2022-2025. Japanese Society for the Promotion of Science (JSPS), Japan, 2,860,000 Japanese Yen.

PUBLICATIONS

A Categorical Quantum Toroidal Action on Hilbert Schemes, Journal of the Institute of Mathematics of Jussieu, 1-44. doi:10.1017/S1474748022000585

It constructed a weak categorification of the quantum toroidal algebra action on the Grothendieck group of Hilbert schemes of points of algebraic surfaces.

On the K-Theoretic Hall Algebra of a Surface, IMRN, Issue 6 (2021), pgs. 4445-4486.

It constructed a K-theoretic Hall algebra for the 0-dimension coherent sheaves on an algebraic surface, proved its associativity and gave a shuffle presentation.

Resolution of the Diagonal on the Root Stacks, arXiv:2309.06788.

It gave a new proof of the semi-orthogonal decomposition of coherent sheaves on the root stacks through an explicit resolution of the diagonal.

A Generalized vanishing theorem for Blow-ups of Quasi-smooth Stacks, arXiv:2306.09672.

It described a new methodology of studying enumerative geometry, derived category of coherent sheaves and representation theory through the birational geometry of derived algebraic stacks: we generalized a classical vanishing theorem of algebraic varieties to derived blow-ups of quasi-smooth algebraic stacks. Applications include the virtual

localization theorem, semi-orthogonal decomposition of blow-ups of smooth varieties and weak categorification of quantum loop algebras.

A Note on the Strict Transformation of an Effective Cartier Divisor, arXiv:2304.09475.

It studied the categorical crepant resolutions of algebraic varieties through the strict transform of an effective Cartier divisor.

Derived Blow-ups and Birational Geometry of Nested Quiver Varieties, arXiv:2303.01063.

It studied the general theory of derived blow-ups of quasi-smooth algebraic stacks, and applied to it to a special case, the nested quiver varieties. Particularly, we proved that Neguţ's quadruple moduli space is the derived blow-up of nested quiver varieties along the diagonals.

Moduli Space of Sheaves and Categorified Commutator of Functors, arXiv:2112.12434.

It generalized our construction of the weak categorification of quantum toroidal algebra actions on the Grothendieck group of Hilbert schemes of points on algebraic surfaces to moduli space of stable sheaves. The study of the derived structure of moduli spaces initiated in this paper.

(With Junyao Peng) A Serre Relation in the K-theoretic Hall algebra of surfaces, arXiv:2012.07897.

It is an undergraduate research opportunities program paper. Together with Junyao Peng, we proved a Serre relation for the K-theoretic Hall algebra of any algebraic surface.

The Feigin-Odesskii Wheel Conditions and Sheaves on Surfaces, arXiv:1909.07870.

It generalized the wheel condition of Feigin-Odesskii on the shuffle presentation of quantum loop groups to the K-theoretic Hall algebra of algebraic surfaces.

Invited Talks

Colloquia and conference talks *Hua Luogeng Youth Forum on Mathematics, Chinese Academy of Science, August 2023 (3 talks)*

Derived Blow-ups on Quasi-smooth Stacks and Its Applications, Shanghai Tech University, July 2023 (4 lectures)

Mid-South Algebraic Topology and Geometry Workshop, Huazhong University of Science and Technology, July 2022

NSF FRG Conference: Categorical braid group actions and categorical representation theory, Umass Amherst, June 2021

Seminar talks

Seminar on Pure Mathematics, HKUST, March 2023

RANT Seminar, CUHK, March 2023

Geometry Representation Theory Seminar, Tsinghua University, March 2023

GTM seminar, Kavli IPMU, Nov 2021

EDGE seminar, University of Edinburgh, Dec 2020

Geometric representation theory seminar, National University of Singapore, Dec 2020

GRT at home seminar, Online Zoom, Nov 2020

MS seminar, Kavli IPMU, Oct 2020

Geometry, symmetry and physics seminar, Yale University, Dec 2019

Symmetry and physics seminar, Rutgers University, Oct 2019

Algebraic and discrete math seminar, UC Davis, Oct 2019

Geometric representation seminar, MIT, Sep 2019

Teaching Experience

Recitations led at Massachusetts Institute of Technology:

Spring 2018, Multivariable Calculus (18.02)

Mentoring Activities

Mentoring math research for high school juniors and undergraduate students at MIT

Junyao Peng, A Serre relation in the K-theoretic Hall algebra of surfaces, arXiv:2012.07897

Frank Wang, The integral shuffle algebra and the K-theory of the Hilbert scheme of points in A^2, arXiv:2002.05027, Selected as the Regeneron STS scholar in 2020

Stanley Wang, Connectedness of the moduli space of genus 1 planar tropical curves, arXiv:1901.03795, Selected as the Regeneron STS scholar in 2019

Academic Service

The referee for IMRN and Selecta Mathematica.

References

Prof. Andrei Neguţ ✉ andrei.negut@gmail.com

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Prof. Mingliang Cai (for teaching) ✉ caiml@shanghaitech.edu.cn

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