2025 Kunming Tianyuan Conference

"Theories and Computations in Mathematical Physics and Topology"

Tianyuan Mathematics Research Center

2025.09.14--2025.09.20

Invited Speakers:

Honghao Gao（Tsinghua U.）　　Jingbang Guo（Fudan U.）

Ruizhi Huang（CAS）　　Qiongling Li（Nankai U.）

Yi Liu（Peking U.）　　XiaoLin Danny Shi（U. Washington Seattle）

Cheng Shu（Westlake U.）　　Zhe Sun（USTC）

Shicheng Wang（Peking U.）　　Zhongzi Wang（Peking U.）

Longting Wu（Southern U. Sci. Tech.）　　Weiwei Wu（Zhejiang U.）

Xiaolei Wu（Fudan U.）　　Tianyu Yuan（Ningbo EITech）

Shuo Zhang（CAS）

会议信息

"Theory and Computation in Mathematical Physics and Topology" Conference will be held from September 15 to September 19, 2025, at the Kunming Tianyuan Mathematics Research Center. The aim of this conference is to advance research and development in mathematical physics and topology within China, explore cutting-edge theories and computational techniques in these fields, facilitate the exchange of the latest domestic and international research progress and trends, promote connections and integration across different branches of mathematics, and provide a platform for experts and young scholars to learn, communicate, and collaborate.

There is no registration fee for the conference. The organizers will arrange the lodging and meals during the conference. We ask participants to arrange your own budget for other expenses.

Scientific Panel

Yi Liu（Peking University） Yongbin Ruan（Zhejiang University） Zhouli Xu（UCLA）

Organization committee

Hana Jia Kong（Zhejiang University）Yi Liu（Peking University）
Yongbin Ruan（Zhejiang University）Weiwei Wu（Zhejiang University）
Zhouli Xu（UCLA）

Sponsor

Chinese Academy of Science
Tianyuan Mathematics Research Center

Contact

Hana Jia Kong，hana.jia.kong@gmail.com, 15116968099

Schedule

2025 Sept. 15, Monday

9:00-9:50	Yi Liu	Hempel pairs and Turaev Viro invariants
10:00-10:50	Honghao Gao	Legendrian knots, Possion variety and quantization
Tea Break		
11:10-12:00	Weiwei Wu	C^0-closedness of Symp_0(X)
Lunch		
Afternoon	Group Discussion	

2025, September 16, Tuesday

9:00-9:50	Shicheng Wang	Chirality of Commensurability Classes of Geometric 3-Manifolds
10:00-10:50	Longting Wu	Poincaré polynomials of moduli spaces of 1-dimensional sheaves on the projective plane
Tea Break		
11:10-12:00	Tianyu Yuan	Morse theory, Floer homology, and Hecke algebra
Lunch		
Afternoon	Group Discussion	

2025, September 17， Wednesday

9:00-9:50	Qiongling Li	Higgs bundles over non-compact surfaces
10:00-10:50	Xiaolei Wu	Embedding groups into acyclic groups
Tea Break		
11:10-12:00	Zhongzi Wang	Some results on cobordism between 3-manifolds with constraints on H_1
Lunch		
Afternoon	Group Discussion	

2025, September 18， Thursday

9:00-9:50	XiaoLin Danny Shi	Periodicities of higher real K-theories
10:00-10:50	Ruizhi Huang	Algebraic topology of 24 dimensional string manifolds
Tea Break		
11:10-12:00	Jingbang Guo	On the q-de Rham Operators
Lunch		
Afternoon	Group Discussion	

2025, September 19， Friday

9:00-9:50	Zhe Sun	Exponential volumes of moduli spaces of hyperbolic surfaces
10:00-10:50	Shuo Zhang	Composed Dehn twist exact sequence through A infinity n-modules
Tea Break		
11:10-12:00	Cheng Shu	The tame Deligne-Simpson problem
Lunch		
Afternoon	Group Discussion	

Talks

2025, September 15 (Monday)

Hempel pairs and Turaev Viro invariants

Yi Liu (Peking University)

Abstract: Hempel pairs are periodic surface bundles with profinitely isomorphic fundamental groups. In this talk, I will discuss whether Turaev--Viro invariants distinguish such pairs. I will explain some motivation of this work and discuss further questions.

Legendrian knots, Possion variety and quantization

Honghao Gao (Tsinghua University)

Abstract: Legendrian knots lie in the overlap of low dimensional topology and contact topology. One of the most robust invariant for Legendrian knots is the Chekanov dg algebra, an invariant defined via Floer theory. In this talk, we will discuss a possion structure on the variety of points of the non-commutative dg algebra. The definition comes from symplectic field theory. Further, the possion structure leads to a quantization of the algebra. This is a joint work with Casals, Ng, Shen, Weng and Zalsow.

C^0-closedness of Symp_0(X)

Weiwei Wu (Zhejiang University)

Abstract: The C^0 topology of the symplectomorphism groups has lots of mysterious basic questions. The famous symplectic rigidity theorem says that, given any symplectic manifold X, the symplectomorphism group Symp(X) is closed in Diff(X) with respect the the C^0 topology. The question of whether Ham(X) is C^0-closed in Symp_0(X) is the content of the famous C^0 flux conjecture. However, the relation between Symp(X) and Symp_0(X) is largely unexplored. Using Floer theory, Jannaud proved that iterations of a Dehn twist cannot lie in the closure of Symp_0(X) for some Liouville domains.

In this talk, we will present a proof of the closedness of Symp_0(X) in Symp(X) when X is a log Calabi-Yau surface of type D, in the sense of Li-Li-Wu. For these symplectic manifolds, it was previously known that Symp_h(X) is a subset of Diff_0(X). The key to our approach is to apply the techniques of J-holomorphic foliations and inflations to obtain necessary C^0-estimates. This is a joint work with Marcelo Atallah and Cheuk-Yu Mak.

2025, September 16 (Tuesday)

Chirality of Commensurability Classes of Geometric 3-Manifolds

Shicheng Wang (Peking University)

Abstract: A manifold is said to be *achiral (or chiral)* if it does (or does not) admit an orientation-reversing homeomorphism. Chirality is a fundamental phenomenon in three-dimensional space. Two manifolds are called *commensurable* if they share a common finite-sheeted covering. A commensurability class of manifolds is said to be *achiral* if it contains an achiral manifold.

We will report on recent work by Tian Ye, Yin Hang, and Wang Zhongzi concerning the chirality of commensurability classes of geometric 3-manifolds. This research demonstrates that, on one hand, the chirality of a manifold is often rooted in its commensurability class or its geometry; on the other hand, the study of chirality of commensurability classes often reveals deeper connections to algebra and number theory.

Poincaré polynomials of moduli spaces of 1-dimensional sheaves on the projective plane

Longting Wu (Southern University of Science and Technology)

Abstract: The geometry of moduli spaces of one-dimensional sheaves on the projective plane has attracted a lot of study recently. In this talk, I will give a new calculation of the Betti numbers of the moduli spaces of one-dimensional sheaves on the projective plane using Gromov-Witten invariants of local P^2 and local curves. The new calculation is based on the refined sheaves/GW correspondence established by Bousseau and all genus local/relative correspondence given by Bousseau-Fan-Guo-Wu. It can be used to prove the divisibility property of Poincaré polynomials of moduli spaces of one-dimensional sheaves on projective plane conjectured by Choi-van Garrel-Katz-Takahashi, and can also be used to determine the leading Betti numbers. Some conjectures concerning the higher range Betti numbers will be proposed if time permits. This is based on a joint work with Shuai Guo and Miguel Moreira.

Morse theory, Floer homology, and Hecke algebra

Tianyu Yuan (Eastern Institute of Technology)

Abstract: Given a smooth manifold and tuples of basepoints, we define a Morse-type A infinity-algebra, called the based multiloop algebra, as a graded generalization of the braid skein algebra due to Morton-Samuelson. For example, when the braid skein algebra is the Type A double affine Hecke algebra (DAHA). The A infinity-operations couple Morse gradient trees on a based loop space with

Chas-Sullivan type string operations. We show that, after a certain base change, it is equivalent to the wrapped higher-dimensional Heegaard Floer A infinity-algebra of disjoint cotangent fibers. This is joint work with Ko Honda, Roman Krutowski, and Yin Tian.

2025, September 17 (Wednesday)

Title: Higgs bundles over non-compact surfaces

Qiongling Li (Nankai University)

Abstract: The non-abelian Hodge correspondence establishes a homeomorphism between the character variety of a surface group and the moduli space of polystable Higgs bundles over a compact Riemann surface. A central step in this correspondence is solving the Hitchin equation to find a harmonic metric. In this talk, I will present new results on the existence and uniqueness of harmonic metrics for Higgs bundles over non-compact surfaces, extending the classical theory beyond the compact setting.

Embedding groups into acyclic groups

Xiaolei Wu (Fudan University)

Abstract: We first discuss various embedding results for groups in the literature. Then we talk about how could one embed a group of type F_n into an acyclic group of type F_n. The embedding we have uses the labelled Thompson group which goes back to Thompson's Splinter group in the 1980s. We explain how one can show that the labeled Thompson groups are always acyclic. This also allows us to build acyclic groups of type F_n but not F_{n+1} for any n. If time permited, I will also discuss related results in the simple setting using the

twisted Brin--Thompson groups. This is based on a joint work with Martin Palmer.

Some results on cobordism between 3-manifolds with constraints on H_1

Zhongzi Wang (Peking University)

Abstract: We call two closed oriented connected 3-manifolds Y_1 and Y_2 are H_1-injective cobordant if there exists a compact oriented 4-manifold W such that $\partial W=Y_1\cup -Y_2$ (where $-Y$ is the orientation reversal of Y) and the inclusion maps $Y_i\to W$ induces injections on H_1.

If Y is the boundary of a compact oriented 4-manifold W such that the inclusion map $Y\to W$ is injective on H_1, then we say Y is H_1-injective null-cobordant.

We proved that the lens spaces $L(p,1)$ where p is a prime number are not H_1-injective null-cobordant. We also proved that all 3-manifolds with $H_1=0$, $\mathbb{Z}$ or $\mathbb{Z}^2$ are H_1-injective null-cobordant.

This is a joint work with Jianfeng Lin.

2025, September 18 (Thursday)

Periodicities of higher real K-theories

XiaoLin Danny Shi (University of Washington at Seattle)

Abstract: Historically, topological K-theory and its Bott periodicity have been very useful in solving key problems in algebraic and geometric topology. In this talk, we will explore the periodicities of higher real K-theories and their roles in several contexts, including Hill--Hopkins--Ravenel's solution of the Kervaire invariant one problem. We will prove periodicity theorems for higher real K-theories at the prime 2 and show how these results feed into equivariant computations. We will then use these periodicities to measure the complexity of the RO(G)-graded homotopy groups of Lubin--Tate theories and to compute their equivariant slice spectral sequences. This is joint work with Zhipeng Duan, Mike Hill, Guchuan Li, Yutao Liu, Guozhen Wang, and Zhouli Xu

Algebraic topology of 24 dimensional string manifolds

Ruizhi Huang (Chinese Academy of Sciences)

Abstract: String structures can be viewed as a lift of spin structures, and play a fundamental role in both mathematics and theoretical physics. In particular, they are deeply connected to the Atiyah-Singer index theory. Beyond their physical relevance, there has been enduring interest in the geometry and topology of string manifolds. Among them, 24-dimensional string manifolds exhibit especially rich and intriguing structure.

In this talk, we will explore the algebraic-topological aspects of 24-dimensional string manifolds, drawing on work by Hirzebruch, Ochanine, Landweber-Stong, Wall, Mahowald-Hopkins, Chen-Han, as well as recent joint work of mine with Fei Han.

On the q-de Rham Operators

Jingbang Guo (Fudan University)

Abstract: The q-de Rham operators, which deform the ordinary algebraic de Rham operators, are important tools to understand cohomology theories in the p-adic settings.

In this talk, the theory of prismatic cohomology will be briefly reviewed through particular Hopf algebroids, whose dual algebras can be regarded as algebras of q-de Rham operators, providing a perspective to both classification and computation. In particular, for certain polynomial rings, explicit complexes formed with q-de Rham operators can be written down for computation.

Through the motivic style filtrations relating prismatic cohomology and topological cyclic homology, and the cyclotomic trace relating topological cyclic homology and algebraic K-theory, the q-de Rham operators become potential tools to understand the algebraic K-theory of certain rings.

2025, September 19 (Friday)

Exponential volumes of moduli spaces of hyperbolic surfaces

Zhe Sun (University of Science and Technology of China)

Abstract: Mirzakhani found a remarkable recursive formula for the volumes of the moduli spaces of the hyperbolic surfaces with geodesic boundary, and the recursive formula plays very important role in several areas of mathematics: topological recursion, random hyperbolic surfaces etc. We consider some more

general moduli spaces M_S(K,L) where the hyperbolic surfaces would have crown ends and horocycle decorations at each ideal points. But the volume of the space M_S(K,L) is infinite when S has the crown ends. To fix this problem, we introduce the exponential volume form given by the volume form multiplied by the exponent of a canonical function on M_S(K,L).

We show that the exponential volume is finite. And we prove the recursion formulas for the exponential volumes, generalising Mirzakhani's recursions for the volumes of moduli spaces of hyperbolic surfaces. We expect the exponential volumes are relevant to the open string theory. This is a joint work with Alexander Goncharov.

Composed Dehn twist exact sequence through A infinity n-modules

Shuo Zhang (Chinese Academy of Sciences)

Abstract: We prove the quilted Floer cochain complexes form A infinity n-modules over the Fukaya category of Lagrangian correspondences. Then we prove that when we restrict the input to mapping cones of product Lagrangians and graphs, the resulting bar-type complex can be identified with bar complex from ordinary Floer theory. As an application we use a family version of quilt unfolding argument to prove two long exact sequences conjectured by Seidel that relates the Lagrangian Floer cohomology of a collection of (possibly intersecting) Lagrangian spheres and the fixed point Floer cohomology of composition of Dehn twists along them.

The tame Deligne-Simpson problem

Cheng Shu (Westlake University)

Abstract: We solve the long-standing problem of Deligne-Simpson: given conjugacy classes $(C_j)_{1\le j\le k}$ of invertible matrices of rank n, do

there exist $A_j\in C_j$ such that (1) $A_1\cdots A_k=\Id$ and (2) there is no nontrivial proper subspace of $\mathbb{C}^n$ that is preserved by every A_j? A conjectural necessary and sufficient condition on $(C_j)_j$ in terms of certain Kac-Moody root systems was proposed by Crawley-Boevey, and the sufficiency statement was later proved in his joint work with Shaw. Our main result proves the necessity statement and the method is a combination of nonabelian Hodge theory and variation of stability conditions.

Local Information

The Tianyuan Mathematics International Exchange Center was established in July 2023. It is an institution dedicated to mathematics and interdisciplinary sciences, jointly organized and constructed by the Tianyuan Fund of the National Natural Science Foundation of China and the National Development and Reform Commission. The center is hosted by the Academy of Mathematics and Systems Science, Chinese Academy of Sciences.

The center is located within the national first-class public welfare forest area of the Chaishitan Reservoir in Yiliang County, Kunming City, Yunnan Province. Surrounded by mountains on three sides and facing water on the other, the center boasts a beautiful environment, picturesque scenery, and a pleasant climate. It sits at an altitude of 1,700 meters and is approximately 90 kilometers from Kunming Changshui International Airport, with a driving time of about 1.5 hours. It is also 30 kilometers from the Stone Forest Scenic Area and 20 kilometers from the Jiuxiang Scenic Area. The total land area of the center is about 27,000 square meters, with a green area of approximately 19,000 square meters and a total construction area of about 6,000 square meters. The center consists of three two-story main buildings: a research building, an expert building, and a support building.

The expert building has 56 dormitory rooms, including:

- 44 single-bed rooms (1.5-meter bed),
- 11 standard twin-bed rooms (1.2-meter beds),
- 1 barrier-free single-bed room (1.2-meter bed).

All rooms are equipped with private bathrooms and shower facilities. The building has four staircases and two elevators, and the inner courtyard features a meditation pavilion. Additional facilities include public restrooms, linen rooms, and laundry rooms. The second-floor common休息 area is equipped with a self-service coffee machine, and a self-service laundry room with washer-dryer combos is located in the southwest corner of the second floor.

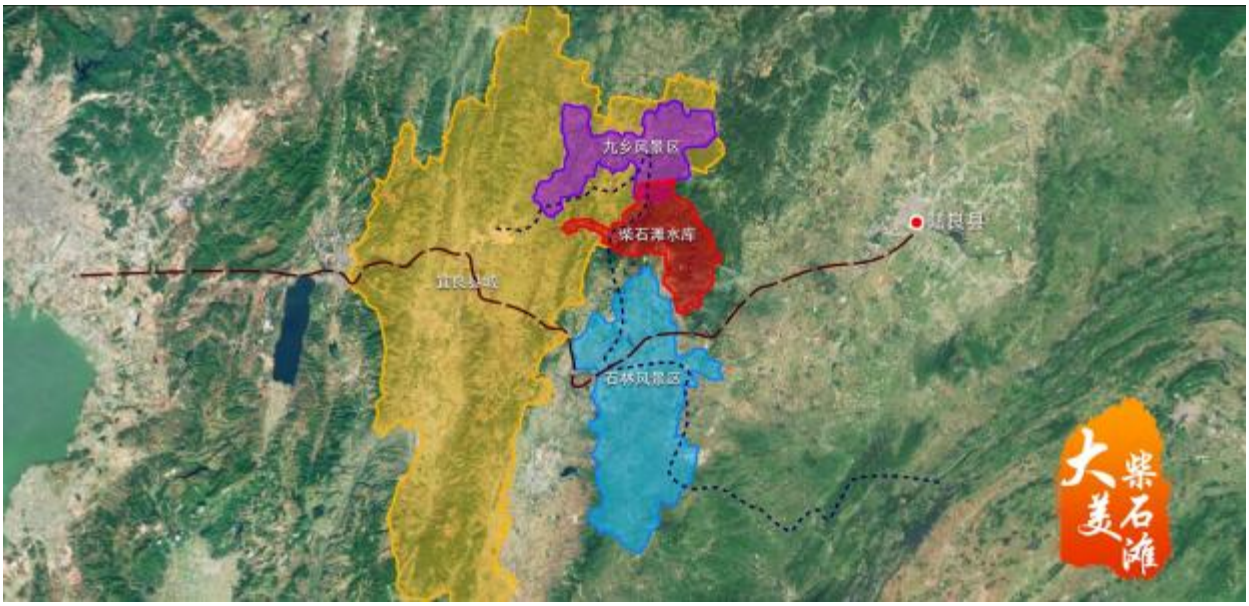
The research building features:

- A large auditorium with a high-definition LED screen and pull-up/down blackboards, accommodating up to 100 people;
- One medium-sized conference room (80 square meters) with a high-definition LED screen;
- Four small conference rooms (35 square meters each), each equipped with a micro-distance high-definition projector and a blackboard;
- 21 seminar/workshop rooms (20 square meters each);
- One library reading room;
- One café.

The support building includes:

- An activity room (Staff Home Gym) on the first floor, approximately 50 square meters;
- Seven dormitory rooms (for center management and service staff), each about 20 square meters;
- A second-floor dining hall (approximately 200 square meters) that provides meals for visitors, capable of seating 60 people simultaneously.

The center is enclosed by a perimeter wall and is equipped with a guard room, a fire water reservoir and pump room, a reclaimed water treatment station, and security surveillance systems.

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