Postdoc Workshop VI

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孙浩天
王大洵
吴昊宇
喻淞
张震

Oct. 18-19

C548, Shuangqing

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Postdoc Workshop VI 2025

Date

October 18-19, 2025

Venue

清华大学双清综合楼C548
Room C548, Shuangqing Complex Building, Tsinghua University

Zoom

Meeting ID: TBD
Password: YMSC

Purpose

Promote interaction and communication among postdocs and researchers.

Scientific and Organizing Committee

清华大学丘成桐数学科学中心博士后工作组

Support Fundings

清华大学丘成桐数学科学中心博士后活动经费
Funds for Postdoc Academic Activities, YMSC, Tsinghua University

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Timetable

October 18, Saturday

Time	Welcome to Tsinghua	
9:40 - 9:50	丘成桐 **Shing-Tung Yau**	Opening
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October 19, Sunday

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11:30 - 11:55	李上 **Shang Li**	A variant of Artin–Weil method on birational group law and its applications
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13:55 - 14:20	成枭将 **Xiaojiang Cheng**	Infinitesimal normal functions over locally symmetric varieties
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15:30 - 15:55	**Albert Artiles**	Generalized BCZ-maps are weakly mixing
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List of Abstracts

October 18, Saturday

Flat Space Holography via AdS/BCFT

郝鹏翔   *Pengxiang Hao*

YMSC

We study a new class of AdS/BCFT setups, where the world-volumes of end-of-the-world branes (EOW branes) are given by flat spaces, to explore flat space holography from an AdS bulk. We show that they provide gravity duals of CFTs in the presence of null boundaries. Our holographic calculations lead to many new predictions on entanglement entropy, correlation functions and partition functions for CFTs with null boundaries. By considering a bulk region between two EOW branes, we present an AdS/BCFT explanation that the flat space gravity is dual to a Carrollian CFT (CCFT), including the swing surface calculation of entanglement entropy.

Black hole microstates in the BMN matrix quantum mechanics

Sarthak Duary

YMSC

We compute the Witten index of the Berenstein-Maldacena-Nastase (BMN) matrix quantum mechanics, which counts BPS states weighted by their fermion number (i.e., with signs). Due to the protection from supersymmetry, we compute the index in the weak coupling regime, where the Hilbert space splits into distinct superselection sectors, each associated with a supersymmetric vacuum. At finite N, the BMN matrix quantum mechanics has a finite set of discrete vacua, labeled by an N-dimensional representation of $SU(2)$, which corresponds to a partition of the integer N. Each sector contributes a unitary matrix integral, and the fugacity expansion of the index is expressed in terms of symmetric group characters. In the microcanonical ensemble, the entropy is given by the logarithm of expansion coefficients. For a fixed integer N, we consider its integer partitions, each defining a distinct superselection sector labeled by pairs $\{n_i, N_i\}$, where N_i denotes the dimension of an irreducible representation of $\mathrm{SU}(2)$, and n_i counts its multiplicity i.e., how many times that irrep appears such that $N = \sum_i n_i N_i$. By analyzing the coefficients d_j up to high order-particularly d_{N^2}-we extract the degeneracy, and the entropy. Notably, in the case of a single partition sector, when $n_1 \gg N_1$, the entropy exceeds that of the trivial vacuum sector (defined by $n_1 = N, N_1 = 1$). Since the N^2-scaling of entropy in the trivial vacuum sector is interpreted as evidence for BPS black holes in M-theory asymptotic to the plane-wave geometry, we propose that the enhanced entropy in the single partition sector similarly corresponds to black hole microstates. We further support this interpretation using a saddle-point analysis of the entropy. Moreover, for values of $N \leq 8$, we observe that the entropy is dominated by double-partition sectors-specifically those with relatively large values of n_is satisfying $N = \sum_i n_i N_i$. These too are interpreted as contributing to black hole microstate counts. The growth in index sum with N can be attributed to both the increasing multiplicity of partition types and the structural dominance of higher-order partitions. Finally, we analyze the free energy in the trivial vacuum sector at finite chemical potential using saddle-point analysis. We extract the entropy using Legendre transform of the free energy and verify consistency by comparing it with the convergence behavior of $\frac{\log |d_j|}{N^2}$ with N. This is based on joint work with Chi-Ming Chang and Kangning Liu.

(b)RG-flows in AdS

Bason Davide

YMSC

Monotonic functions along the RG flow in Quantum Field Theory (QFT) play a crucial role in understanding the (im)possibility of phase transitions between two critical phases, i.e. the endpoints of the RG flow where the QFT becomes a Conformal Field Theory (CFT). Famous results, such as the c-theorem in two dimensions and the g-theorem in the presence of defects, identify such functions, but they can only be computed at critical points, not along the entire RG flow. In this presentation, we discuss an extension of some of these theorems to massive QFTs in AdS which, in the conformal limit, reduce to the known results. We present the definition of this function, discuss consistency checks, and detail an exactly solvable example using supersymmetry: $\mathcal{N} = 2$ $SU(2)$ Super Yang–Mills theory in AdS$_4$.

Superluminal Liouville walls in 2d String Theory and space-like singularities

刘思浓   *Sinong Liu*

YMSC

An interesting class of time dependent backgrounds in $1 + 1$ dimensional string theory involves worldsheet Liouville walls which move in (target space) time. When a parameter in such a background exceeds a certain critical value, the speed of the Liouville wall exceeds the speed of light, and there is no usual S-Matrix. We examine such backgrounds in the dual $c = 1$ matrix model from the point of view of fluctuations of the collective field, and determine the nature of the emergent space-time perceived by these fluctuations. We show that so long as the corresponding Liouville wall remains time-like, the emergent space time is conformal to full Minkowski space with a time-like wall. However, for the cases where the Liouville wall is superluminal, the emergent space-time has a *space-like boundary* where the collective field couplings diverge. This appears as a space-like singularity in perturbative collective field theory. We comment on the necessity of incorporating finite N, as well as finite (double-scaled) coupling, effects to understand the behavior of the exact theory near this boundary.

Homotopy theoretical holomorphic invariants of complex manifolds

胡家昊　*Jiahao Hu*

YMSC

In this talk, I will begin by presenting a method for extracting new holomorphic invariants of a complex manifold from its de Rham algebra of complex-valued differential forms. These invariants can be seen as refined versions of the complexified homotopy groups. I will then discuss their potential connections with Hermitian geometry. Specifically: (1) the non-abelian part (refined fundamental group) should be related to a generalization of Higgs bundles; (2) the abelian part (refined higher homotopy) may provide new tools for studying the geometry of holomorphic mappings.

Boundary actions of graph of groups

王大洵　*Daxun Wang*

YMSC

In this talk, we will discuss the actions of the fundamental group of graph of groups on trees and on its associated boundaries. By studying such group actions, we provide a family of new examples of fundamental groups of graph of groups that are C^*-simple.

Rigidity of Polyhedral Surfaces under Edge Length Constraint

张震　*Zhen Zhang*

YMSC

In 1813, Cauchy proved that two combinatorially equivalent polytopes in 3 dimensions with congruent corresponding faces must be congruent. This is known as Cauchy's Rigidity Theorem. For example, if a polytope with 12 regular pentagons being connected in the same way as the regular dodecahedron, then it must be the regular dodecahedron. What if we relax the constraints a little bit? Instead of asking the rigidity problem with congruent corresonding faces, we can ask the same problem with congruent corresponding edges. Then a few examples, such as a cube, immediately become flexible. Should we expect most of the polytopes to stay rigid or become flexible? How can we tell if a polytope is rigid this way?

Spectral Networks and SYZ Fibrations

Mohamed Elmi

YMSC

I will explain my work on fibred products of elliptic surfaces, which are birationally equivalent to a (finite cover) of a Calabi-Yau threefold. I will explain how one may search for special Lagrangian submanifolds by computing certain trajectories on a Riemann sphere with punctures. Finally, I will explain how this leads to an SYZ fibration in a concrete example.

Abelian TQFT gravity, ensemble holography and stabilizer states

Nikolaos Angelinos

YMSC

We construct a model of 3D quantum gravity based on abelian topological quantum field theory (TQFT), by defining the gravitational path-integral as a sum over all 3D topologies with genus-g boundary Σ_g. The path-integral of an abelian TQFT $\mathcal{T}$ on any single topology with boundary Σ_g prepares a stabilizer state. This way, $\mathcal{T}$ partitions all these topologies into finitely many equivalence classes, where each topology within a class is associated with the same stabilizer state. The gravitational path-integral can thus be reframed as a weighted sum over representative topologies. The resulting quantum gravity state can then be expressed as a weighted average of 2D CFT partition functions on Σ_g. This establishes a duality between a weighted sum over bulk topologies and a weighted sum over boundary CFTs. We introduce the "λ-matrix", which relates bulk and boundary weights. We explain how this matrix can be fully determined by the set of topological boundary conditions that the TQFT admits, and we present a systematic procedure to construct this set.

4d Chern-Simons and the Gaudin model

Boujakhrout Youssra

YMSC

In order to include the integrable Gaudin model into the 4d CS/ Integrability correspondence, we study the mixed topological-holomorphic Chern-Simons gauge theory on $\Sigma \times C$ in the presence of line and surface defects extending on both submanifolds.

Eigenfunctions of BC Toda chain

Nikita Belousov

BIMSA

The quantum Toda chain is a model of particles on a line with exponential nearest-neighbor interaction. This model is integrable, even when certain fine-tuned potentials are added at the boundaries. In this talk, I will present the construction of eigenfunctions for the Toda chain with a one-sided interaction of BC-type. The main idea is to study infinite-dimensional solutions of the Yang-Baxter and reflection equations associated with the model.

Detecting Optical Correlations via Local Photon Subtraction

李慧慧   *Huihui Li*

YMSC

Detecting and characterizing correlations are common subjects in quantum information theory, which have recently become increasingly essential in various quantum information tasks. A quantifier of correlations is introduced for two-mode Bosonic states defined as the difference between global and local coherence caused by local photon subtraction. The fundamental properties and physical significance of this quantifier are revealed. Additionally, the amount of correlations is analyzed in the output states resulting from input product states through bilinear interactions. The quantifier of correlations is illustrated using typical two-mode Bosonic states and its effectiveness is compared with other existing measures of correlations, such as entanglement and quantum discord.

October 19, Sunday

Derived Enhancements of T fixed subschemes

Marc Besson

YMSC

One version of the Hikita conjecture relates the structure sheaf of a T-fixed subscheme in an affine Grassmannian slice with the cohomology of an appropriate quiver variety. I will discuss forthcoming work with Liang Shiyixin, which provides a derived enhancement of the coherent side. This is a derived scheme whose classical truncation agrees with the T fixed subscheme in Hikita's conjecture. We prove some basic amplitude and duality results on these derived schemes, which should be interesting from the perspective of symplectic duality.

Wonderful Compactifications & Toric Varieties

Lamarche Alicia Mae

YMSC

Given a complex Lie group G of adjoint type, the wonderful compactification $Y(G)$ (originally described by work of DeConcini-Procesi) is a compactification of G by a divisor with simple normal crossings. These groups are specified by their Dynkin diagrams and corresponding root systems, from which one can construct a toric variety $X(G)$. In this talk, we will discuss ongoing work with Aaron Bertram that aims to succinctly describe the derived category of coherent sheaves of $Y(G)$ and $X(G)$.

Smooth Leaves through Foliation Singularities

Bongiorno Federico

YMSC

We identify a natural class of singularities for algebraic foliations in which leaves through singular points retain smoothness. As an application, we obtain a new proof of the Zariski–Lipman conjecture for klt spaces.

Explicit K-moduli for four families of Fano threefolds

Papazachariou Theodoros Stylianos

YMSC

Over the past decade, K-stability has made the monumental achievement of the construction of moduli spaces of Fano varieties and log Fano pairs. This construction is inherently non-explicit, however, and concrete descriptions must be developed case by case. Recent work has produced explicit K-moduli for about a dozen of the 105 Mori–Mukai families of Fano threefolds. To achieve this, two complementary strategies have emerged; either the direct computation of K-stability invariants or the moduli-continuity method, which compares K-moduli to more accessible compactifications (such as GIT). In this talk I will explain how an application of the moduli-continuity yields new explicit descriptions for four additional families—2.11, 3.3, 3.5, and 3.8—by relating their K-moduli to concrete GIT quotients.

A variant of Artin–Weil method on birational group law and its applications

李上   *Shang Li*

YMSC

Enlarging a birational group law into a group scheme was initiated by Weil for algebraic varieties and was established for more general schemes by Artin in SGA3. This technique plays an important role in algebraic geometry, for instance, in the constructions of Chevalley group schemes and of parahoric group schemes and in the study of Néron models. In this talk, we disscus how to enlarge a rational action by a group scheme on another scheme based on Artin's idea. Moreover, we will present its applications in the study of toroidal embeddings of Chevalley group schemes and in the construction partial compactification of various group schemes in the Bruhat–Tits theory.

Birational compactifications of moduli of some log Calabi-Yau surface pairs

吴昊宇   *Haoyu Wu*

YMSC

The construction of a complete moduli space for Calabi-Yau varieties or more generally log Calabi-Yau pairs has always been a fascinating question. Recently, there has been significant progress in achieving this for two-dimensional boundary polarized Calabi-Yau pairs (X, D), where $D \sim_{\mathbb{Q}} -K_X$ is ample. By varying the coefficients of D, this leads to birational compactifications via K-stability and KSBA theory. The goal of this talk is to compare these compactifications for the specific case of surface pairs constructed from K3 surfaces with an anti-symplectic involution, using wall-crossing techniques.

Infinitesimal normal functions over locally symmetric varieties

成枭将   *Xiaojiang Cheng*

YMSC

Normal functions are certain functions (with values in Jacobians) over the parameter spaces of families of varieties. Infinitesimal normal functions are algebraic obstructions to the existence of normal functions. In this talk, I will talk about some calculations of infinitesimal normal functions and their geometric applications, especially in algebraic cycles.

Quantum cohomology of VGIT and flips

喻淞   *Song Yu*

YMSC

We will discuss a decomposition of quantum cohomology for variations of GIT quotients. The result is based on the technique of Fourier analysis on quantum cohomology developed by Iritani and Koto. We will also discuss the application to the decomposition of quantum cohomology for standard flips in birational geometry. This talk is based on joint work with Zhaoxing Gu and Tony Yue Yu.

Tropical super Gromov-Witten invariants

Benjamin Zhou

YMSC

We show that super Gromov-Witten invariants can be computed using tropical curve counting. When the target is a point, the super invariants are descendant invariants on the moduli space of curves, which can be computed tropically. When the target is a convex, toric variety X, we develop a procedure to compute the tropical Euler class of the SUSY normal bundle $\overline{N}_{n,\beta}$ on $\overline{M}_{0,n}(X, \beta)$, assuming it is locally tropicalizable in the sense of [CG], [CGM]. We define the tropical, genus-0, n-marked super Gromov-Witten invariant of X. This gives a tropical interpretation of super Gromov-Witten invariants of convex, toric varieties. This is joint work with Artan Sheshmani, and Shing-Tung Yau.

Generalized BCZ-maps are weakly mixing

Albert Artiles

YMSC

The BCZ-map can be viewed as a Poincaré section to the horocycle flow on the space of unimodular lattices in $\mathbb{R}^2$. This point of view has been generalized to the study of the statistics of saddle connections of Veech surfaces. We study a version of the Siegel-Veech transform conditioned on these sections and use these results to show that these generalized BCZ-maps are weakly mixing.

Optimal transport paths with capacity induced cost function

孙浩天　*Haotian Sun*

YMSC

Optimal transportation can be characterized using various models. In this talk, we will use transport paths which is defined using rectifiable 1-currents to describe a transportation. In a transportation network, the notion of capacity is often used to characterize the maximum weight that can be transported along a path. Also, transportation that takes place in real life rarely posses infinite capacity, and this makes the assumption on capacity constraints practical and worth studying. We will proceed with various format of capacity constraints and analyze how a transport path looks like.

Network Cross-Validation for Nested Models by Edge-Sampling

陈远星　*Yuanxing Chen*

YMSC

In the network literature, a wide range of statistical models has been proposed to exploit structural patterns in the data. Therefore, model selection between different models is a fundamental problem. However, there remains a lack of systematic theoretical understanding for this problem when comparing across different model classes. In this paper, to address this challenging problem, we propose a penalized edge-sampling cross-validation framework for nested network model selection. By incorporating a model complexity penalty into the evaluation process, our method effectively mitigates the overfitting tendency of cross-validation and adapts to varying model structures. This framework supports comparisons among widely used models, including stochastic block models (SBMs), degree-corrected SBMs (DCBMs), and graphon models, providing the first consistency guarantees for model selection across these settings to our knowledge. Empirical evaluations, including both simulated data and the "Political Books" network, demonstrate that our method yields stable and accurate performance across various scenarios.
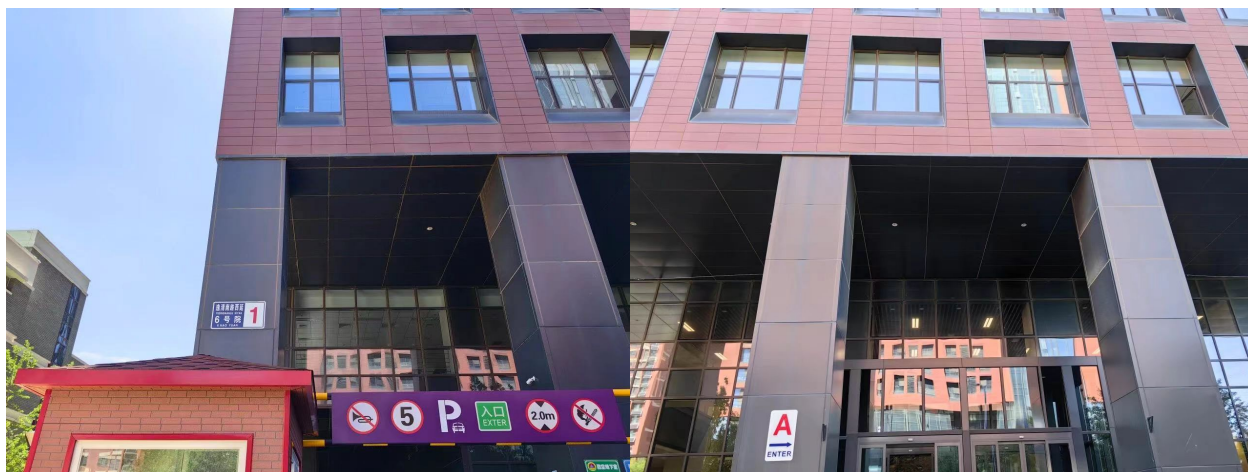
Useful Information

A Guide to Shuangqing Complex Building A

To commute between Jingzhai 静斋 and Shuangqing Building, one can go through the **East Gate** or **Northeast Gate**.

Then follow the red path to the Shuangqing Complex Building A (Yau Mathematics Science Center).

Exterior views of the building.

Address:
双清综合楼A座
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Shuangqing Complex Building A
No. 1, Courtyard 6, West Extension of Yiqing South Road, Haidian District, Beijing
Remarks:
双清公寓马路对面、清华附小（双清校区）西侧
Across the street from Shuangqing Apartments, on the west side of Tsinghua University Primary School (Shuangqing Campus).

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Previous Workshop

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