The 3rd MMS Workshop for Young Researchers

Date: November 20(Fri), 2026
Venue: Department of Mathematics, Science Bldg. No.3, North Campus, Kyoto University

Time	Representation Theory (Room 127)	Applied Mathematics (Room 110)	Topology (Room 108)	Operator Algebra (Room 152)
9:30–	Reception (Room 109)			
9:55–	Opening (Room 110)			
10:00–11:00	Plenary Talk (Room 110): Miyu Suzuki (Chair: Taisei Shin)			
11:30–12:20	Ilya Dumanski (Chair: Shunsuke Hirota)	Polly Yu (Chair: Pyae Hein Htet)	Daniel Galvin (Chair: Wu Hao)	Timothée Bénard (Chair: Hiroto Nishikawa)
12:20–14:00	Lunch Break			
14:00–14:50	Shunsuke Hirota (Chair: Ilya Dumanski)	Pyae Hein Htet (Chair: Polly Yu)	Wu Hao (Chair: Daniel Galvin)	Hiroto Nishikawa (Chair: Timothée Bénard)
15:10–16:00	Eric Yen-Yo Chen (Chair: Wenda Fang)	Allen Hart (Chair: Masato Hara)	Weizhe Niu (Chair: Yudai Ueda)	Stéphane Dartois (Chair: Hiroro Kamikawa)
16:20–17:10	Wenda Fang (Chair: Eric Yen-Yo Chen)	Masato Hara (Chair: Allen Hart)	Yudai Ueda (Chair: Weizhe Niu)	Hiroro Kamikawa (Chair: Stéphane Dartois)
17:30–19:30	Poster Session & Exchange Meeting (Banquet) at Science Seminar House			

Tea Space: Room 109

Abstracts

Plenary Speaker

Miyu Suzuki (Kyoto University)

Root systems and ADE classification

A root system is a finite set of vectors in Euclidean space that satisfy certain symmetry and integrality conditions. Historically, they were introduced in Lie theory, enabling the classification of semisimple Lie algebras through a simple combinatorial description. However, in a wide range of mathematical fields, not just in Lie theory, it has been observed that root systems appear as the result of classifying various kinds of objects (called ADE classifications). In this talk, I will present several such examples. If time permits, we also discuss a relation between Coxeter systems and root lattices over totally real fields, which is a generalization of well-known classification of root lattices over rational integers. The last part is joint work with Ryotaro Sakamoto and Hiroyoshi Tamori.

Parallel Sessions: Representation Theory

Ilya Dumanski (SLMath Institute)

Perverse coherent sheaves on symplectic singularities

Perverse constructible sheaves are ubiquitous in algebraic geometry and geometric representation theory. Bezrukavnikov introduced their coherent analog, called perverse coherent sheaves. For technical reasons, there are essentially two interesting examples when this notion is well-behaved: the nilpotent cone and the affine Grassmannian. In both these cases, this category is very meaningful and well-studied. We will present a generalization of this construction to an arbitrary symplectic singularity. This may be seen as a step towards building the Kazhdan—Lusztig theory in this setting.

Shunsuke Hirota (Kyoto University)

Introduction to Khovanov Arc Algebras

Khovanov introduced arc algebras in his construction of a categorification of tangle invariants, using a two-dimensional TQFT. In foundational work by Brundan and Stroppel, this algebra and its variants provide a diagrammatic framework for understanding “finite type A characteristic 0 representation theory at cyclotomic level 2”. In particular, arc algebras provide accessible algebraic toy models for learning about Ariki’s categorification theorem, Kazhdan–Lusztig theory and super duality. In this talk, I will revisit and reorganize these classical results from about fifteen years ago, reinterpreting them in light of subsequent developments. Time permitting, I will discuss recent work of the speaker.

Eric Yen-Yo Chen (École Polytechnique Fédérale de Lausanne)

Hamiltonian actions in skein theory

Skein theory assigns to every closed oriented 3-manifold a vector space invariant which can be computed via cutting and pasting, reflecting the fact that it takes part in a 3-dimensional TQFT. In this talk, we motivate and explain progress towards enriching skein theory with boundary conditions which, among other applications, produces new skein-theoretic knot invariants. Our constructions take as input certain Hamiltonian actions and draws inspiration from recent developments in the relative Langlands program and Donaldson-Thomas theory.

Wenda Fang (Kyoto University)

QP-Chiralization of Poisson–Lie Theory

In this talk, I will introduce QP-chiralization, a framework for studying chiral analogues of structures arising in Poisson–Lie theory. I will first explain how classical -matrices give rise to Poisson vertex algebra structures and how the Feigin–Frenkel center can be used to construct integrable hierarchies. I will then reinterpret classical -matrices as Maurer–Cartan elements in the variational QP formalism. Finally, I will discuss some recent progress in joint work with Noriaki Ikeda.

Parallel Sessions: Applied Mathematics

Polly Yu (University of Illinois)

Non-monotonic responses in T-cell activation

T-cell activation can decrease at high antigen dose. Such non-monotonic dose-response curves, where the steady-state output is a non-monotonic function of an input parameter, have commonly been attributed to incoherent feedforward loops. Using combinatorial matrix theory and monotone systems theory, we show that ODE systems can have non-monotonic responses due to a combination of positive and negative feedback loops, without any incoherent feedforward loop. The key observation is that the direction of the response is decided by competing combinations of paths and feedback loops in the influence graph. We illustrate both mechanisms in a model of T-cell activation.

Pyae Hein Htet (Kyoto University)

Fluid dynamics and instabilities in microscale biology

Fluid flows are fundamental to transport and locomotion in biology, from intracellular flows that redistribute cellular constituents to the flows generated by cells as they propel themselves through viscous environments. In this talk, I will discuss how flows and instabilities shape biological systems, with a particular focus on cytoplasmic streaming in Drosophila embryos, the near-wall “hovering” of swimming bacteria, and the elastohydrodynamic buckling underlying double waves in spermatozoa. Across these systems, I use simulations and minimal models to elucidate the simple physical principles which in many cases underlie complex biological phenomena.

Allen Hart (University of Warwick)

Reservoir computing and dynamical systems

A reservoir computer is a kind of recurrent neural network with a reservoir of random features. In this talk we will study the states of the network when it driven by a sequence of observations from a smooth or stochastic dynamical system. In particular we will discuss conditions under which state dynamics become synchronized to and topologically faithful to the source dynamical system. This is a necessary condition for time series forecasting and capturing the behavior around fixed points, and estimating Lyapunov exponents.

Masato Hara (Kyoto University)

Some aspects of dynamical systems learning by reservoir computing

Reservoir computing is a kind of machine learning technique using input-driven dynamical systems. In this presentation, I will talk about learning time series generated by dynamical systems via an Echo State Network (ESN)-type reservoir. I will review some remarkable numerical results demonstrating that ESNs can learn the structure or characteristics of dynamical systems behind teacher time series, including phase space structures, bifurcation structures, and lifetime distributions. I will also introduce mathematical efforts to reveal such capabilities of ESNs.

Parallel Sessions: Topology

Daniel Galvin (University of Texas at Austin)

Non-smoothable surfaces in the 4-sphere

I will describe how to construct topologically locally flat embedded surfaces inside the standard 4-sphere that are not isotopic to any smoothly embedded surface. These surfaces are non-orientable and their exteriors have order two fundamental group. This is joint work with Anthony Conway.

Wu Hao (Kyoto University)

A stable cohomotopy refinement of the $Pin^-(2)$ monopole invariants

The Bauer–Furuta invariant is a stable cohomotopy refinement of the Seiberg–Witten invariant, which can contain more information than the latter. In this talk, we develop an analogous stable cohomotopy refinement of Nakamura's $Pin^-(2)$ monopole invariant, called the $Pin^-(2)$ Bauer–Furuta invariant. We construct it from the $Pin^-(2)$ monopole map and relate it to the original $Pin^-(2)$ monopole invariant. We then establish a connected sum formula for this refined invariant. Finally, we discuss examples, including the Enriques surface and certain elliptic surfaces.

Weizhe Niu (Tsinghua University)

Symmetries of knotted surfaces in 4-manifolds

Which symmetries of an embedded surface extend to symmetries of the ambient 4-manifold? Such symmetries are measured by the extendible mapping class group. In this talk, I will discuss how rim surgery can drastically restrict such symmetries: a single rim surgery leads to an explicit subgroup governed by homological data, while suitably arranged rim surgeries produce infinitely many rigid surfaces in simply-connected 4-manifolds for which no nontrivial symmetry extends. The construction is topological and supported in a 4-ball.

Yudai Ueda (Kyoto University)

On the quandle cocycle invariant of twist roll spun knots

Twist roll spun knot is a 2-knot obtained from 1-knot by combination of twist-spinning and roll-spinning. Quandle cocycle invariants are defined for both 1-knots and 2-knots using an algebraic structure called a quandle and its (co)homology theory. In this talk, we consider generalized Iwakiri–Satoh 2-knots, a class that includes twist roll spun knots. We study their cocycle invariants associated with the tetrahedral quandle. We express these in terms of quandle cocycle invariants of the underlying 1-knots.

Parallel Sessions: Operator Algebra

Timothée Bénard (Université Sorbonne Paris-Nord)

Random walks on homogeneous spaces

I will explain why a random walk on a simple homogeneous space equidistributes toward the Haar measure with an explicit rate, provided the walk is not trapped in a finite invariant set and the driving measure is Zariski-dense with algebraic coefficients. The argument is based on a multislicing theorem which extends Bourgain's projection theorem and presents independent interest. Joint work with Weikun He.

Hiroto Nishikawa (Kyoto University)

Embeddings into the universal Roe algebra

For discrete metric spaces, uniform Roe algebras and quasi-local algebras are C\star-algebras that encode coarse geometric information. Although their definitions are very similar, they need not coincide in general. In this talk, we study their universal versions and show that they have quite different embeddability properties. As a by-product, we also obtain results on embeddings into groupoid C\star-algebras.

Stéphane Dartois (University of Bordeaux)

Injective norm of random tensors and quantum states

In this talk, I will present the results of a collaboration with Benjamin McKenna on the injective norm of large random Gaussian tensors and uniform random quantum states, and describe some of the context underlying this work. The injective norm is a natural generalization to tensors of the operator norm of a matrix and appears in multiple fields. In quantum information, the injective norm is one important measure of genuine multipartite entanglement of quantum states, known as geometric entanglement. In our preprint, we provide a high-probability upper bound on the injective norm of real and complex Gaussian random tensors, which corresponds to a lower bound on the geometric entanglement of random quantum states, and to a bound on the ground-state energy of a particular multispecies spherical spin glass model.

Hiroro Kamikawa (Kyoto University)

The homotopy groups of the equivariant automorphism group of Kirchberg algebras with compact group actions

The homotopy groups of the automorphism group of C-algebras play a crucial role in the classification of C-algebra bundles. Dadarlat described the homotopy groups of the automorphism group of a Kirchberg algebra in terms of KK-theory. In this talk, I will present an equivariant analogue of his result for Kirchberg algebras equipped with compact group actions.

Poster Session

P01 : Taiki Ikeda（Kyoto University）

Weak Solutions to the Weighted Volume-Preserving Mean Curvature Flow

This study investigates a weighted volume-preserving mean curvature flow associated with a positive weight function g, which preserves the weighted volume $\int_E g\,(x)dx$. Based on the weak-solution framework for the volume-preserving mean curvature flow developed by Mugnai, Seis and Spadaro, we construct weak solutions to the weighted volume-preserving mean curvature flow by using a minimizing movement scheme, a time-discrete approximation method developed by Almgren,Taylor and Wang and Luckhaus and Sturzenhecker.

P02 : Kensuke Kanamaru（Kyoto University）

Small and Large Friction Limits for Navier–Stokes Equations with Navier Boundary Condition

We consider the incompressible Navier-Stokes equations in the half-space $\mathbb{R}^n_+ (n \geq 2)$ with the Navier boundary condition involving a nonnegative friction coefficient $\alpha \geq 0$. We investigate the asymptotic behavior of solutions as the friction coefficient tends to zero and infinity. The limit $\alpha \to 0$ corresponds to the perfect slip boundary condition, whereas the limit $\alpha \to \infty$ corresponds formally to the no-slip boundary condition. Using maximal L_p-L_q regularity for the Stokes equations with Navier boundary conditions, we establish estimates that are uniform with respect to the friction coefficient. Based on these estimates, we prove convergence of solutions to the corresponding limiting problems in scaling critical function spaces. In particular, we obtain the convergence rates $O(\alpha)$ as $\alpha \to 0$ and $O((1+\alpha)^{-1})$ as $\alpha \to \infty$. Furthermore, we establish convergence of the velocity, its first- and second-order spatial derivatives, the time derivative, and the pressure gradient, providing a precise description of both limiting processes in the maximal regularity framework.

P03 : Shunichiro Orikasa（Kyoto University）

A Geometric Approach to Codimension 2 Obstructions to Positive Scalar Curvature

The study of obstructions to the existence of metrics with positive scalar curvature (PSC) is a well-established subject in differential geometry. In this poster, we focus on so-called codimension-two obstructions. These obstructions concern codimension-two submanifolds in noncompact manifolds and provide conditions that prevent the existence of complete uniformly positive scalar curvature metrics. Their study was initiated by Gromov–Lawson and has since developed in various directions. We present geometric methods that advance the study of codimension-two obstructions from both qualitative and quantitative perspectives. First, on the qualitative side, we introduce a new approach based on mu-bubbles, which arise as solutions to a geometric variational problem. These hypersurfaces can be used to investigate coarse-geometric properties of the ambient manifold and their interaction with positive scalar curvature. We then discuss a quantitative consequence arising from these obstruction methods: a trade-off between positive scalar curvature and the stable 2-systole, a geometric quantity measuring the size of two-dimensional homology classes. This illustrates how codimension-two topology can impose quantitative constraints on the geometry of manifolds with positive scalar curvature.

P04 ： HAU ChunYin (Kyoto University)

Asymptotically Mittag-Leffler: A Discrete Version of the Gamma Conjecture I

Gamma Conjecture I describes the asymptotic behaviour of the Givental J-function of a Fano manifold, $J(t)$, as $t \to +\infty$. In this poster, we introduce an asymptotic property for the power series coefficients of the J-function, which we call "asymptotically Mittag-Leffler" (aML). This property serves as a discrete analogue to the continuous asymptotics predicted by Gamma Conjecture I. Consequently, it provides an alternative method to verify Gamma Conjecture I using only the coefficients of the J-function. We also describe the structural properties of aML series, including their stability under geometric operations.

P05 ： ZHAN ZHIRUN （Kyoto University）

On stationary flow around a rotating cylinder with free boundary

In this poster I will present some results about the PDE system related to the stationary flow around a rotating cylinder in the presence of a free boundary.

P06 ： Zhijie Ji （Kyoto University）

Tropical Matsusaka and Matsusaka—Ran Criteria

The tropical Schottky problem asks which principally polarized tropical abelian varieties are isomorphic to tropical Jacobian varieties equipped with their canonical principal polarizations. We prove the tropical Matsusaka criterion and the tropical Matsusaka-Ran criterion, which are the main results of this paper, and show that their hypotheses are equivalent. Together with the tropical Poincaré formula proved by Gross-Shokrieh, these results give a geometric solution to the tropical Schottky problem. In particular, we give an affirmative answer to a question posed by Brannetti-Melo-Viviani. Several tools are developed for the proofs of the two criteria. In particular, we establish Hodge-type inequalities for ample tropical Cartier divisors on tropical abelian varieties and prove a splitting criterion for principally polarized tropical abelian varieties.

P07 ： Kenji Fukushi （Kyoto University）

Topological complexity for closed 1-forms

Topological complexity, introduced by Farber, measures the difficulty of motion planning in a topological space. The Lusternik–Schnirelmann category associated with a closed 1-form generalizes the classical Lusternik–Schnirelmann category and is closely related to dynamical systems. Motivated by these concepts, we introduce a version of topological complexity associated with a continuous closed 1-form. This invariant incorporates the behavior of closed 1-forms into motion planning problems. We establish fundamental properties of this invariant, including its dependence only on the cohomology class and its homotopy invariance. Furthermore, we obtain upper and lower bounds in terms of controlled Lusternik–Schnirelmann category and cohomological methods involving local systems. Our results provide a new connection between topological complexity, closed 1-forms, and Lusternik–Schnirelmann theory.

P08：Hiroto Kishi（Kyoto University）

Metastability of Reversible Random Walks in Potential Fields

−The Non-C^2 and Degenerate Cases

We study metastability of reversible random walks on the lattice $N^{-1}\mathbb{Z}^d$ in a potential field$F$, as $N \to \infty$. Previous work on this discrete model assumed that F is of class C^2 and that the relevant saddle points are non-degenerate. We assume only $F \in C^1$ and allow degenerate saddle points: near each saddle point z, in local coordinates y, $F = F(z) - c_1|y_1|^{\alpha_1} + \sum_{i\geq 2} c_i\,|y_i|^{\alpha_i}$ up to higher-order terms, with $c_i > 0$ and $\alpha_i > 1$, where the exponents may differ from direction to direction. In this setting we obtain sharp asymptotics of the capacities between wells: each saddle point z contributes to the subexponential prefactor an explicit constant times $N^{\gamma(z)}$, where $\gamma(z) = \sum_{i\geq 2}(1 - 1/\alpha_i) - (1 - 1/\alpha_1)$. Grouping the wells into clusters according to γ, the capacities between clusters are described by those of a finite graph. We also present ongoing work on the metastable behavior of the process on the corresponding time scales and on the distribution of the saddle point through which the process exits a well.

P09：Kazuhiro Hirao（Kyoto University）

The maximal regularity for a hypoelliptic equation with inhomogeneous boundary data

Maximal regularity is a powerful tool for analyzing linear and non-linear partial differential equations as it provides optimal regularity estimates for solutions. In this poster, we present the maximal regularity estimate for a hypoelliptic equation in the upper half-space with inhomogeneous boundary data. Choosing the L^p-norm in the upper half-space for the solution leads to an anisotropic Besov space for the boundary data. This work is inspired by a recent study on the heat equation.