Keiko Kawamuro

"Diagrammatic left canonical form of braids and applications"

In this talk we focus on geometric/topological aspect of braids. In order to solve the braid word problem in polynomial time, Birman, Ko, and Lee invented the left canonical form of a braid. The original definition of left canonical form is algebraic. I will give its geometric interpretation and application to monoid structure of the braid group. This is joint work with Michele Capovilla-Searle and Rebecca Sorsen.

Yuanyuan Bao

"gl(1|1)-Alexander polynomial for 3-manifolds"

A knot is a smooth embedding of a circle into the 3-sphere. It is known that any closed 3-manifold can be obtained from the 3-sphere by doing Dehn surgeries along knots, and that different surgeries corresponding to the same 3-manifold can be connected by Kirby moves. For a knot invariant (such as polynomial, homology etc), if one can show that it is invariant under Kirby moves, then it gives rise to a 3-manifold invariant. WRT invariant for 3-manifold (Witten, Reshetikhin and Turaev) is defined in this way. The corresponding knot invariant is Jones polynomial, the first quantum invariant for knots. Castantino, Geer and Patureau-Mirand refined WRT's construction. In this talk we explain their idea and report our result on how to construct a 3-manifold invariant from Viro's gl(1|1)-Alexander polynomial. This result is joint work with Noboru Ito.

Andreani Petrou

"Towards knot matrix models for families of twisted hyperbolic knots"

Torus knot matrix models are defined by the superintegrability condition that the averages of characters are equal to the HOMFLY polynomial of torus knots. An alternative manifestation of superintegrability is the complete factorizability of the Harier-Zagier transform -a discrete version of the Laplace transform- of the HOMFLY polynomial. In an attempt to investigate knot matrix models beyond torus knots, I shall explain how skein theory can be used to compute polynomial invariants for some infinite families of twisted hyperbolic knots, via recursive or explicit formulas. It turns out that the derived expressions for their Harer-Zagier transforms are almost factorized rational functions with an intriguing zero locus structure that has traits reminiscent of ADE singularity theory. This talk is based on a project supervised by Prof. Shinobu Hikami.

Yukiko Konishi

“Satake's good basic invariants for finite reflection groups”

Let V be a Euclidean space of dimension n. A finite reflection group G is a finite subgroup of the group of orthogonal transformations which is generated by reflections. It is known that the ring of G-invariant polynomials is generated, as an R-algebra, by n homogeneous, algebraically independent polynomials. Such a set of generators is called a set of basic invariants. The choice of basic invariants is not unique in general. Therefore it may be a natural question to ask if there exists a canonical way to choose a set of basic invariants. In this talk, I explain the notion of "good basic invariants" proposed by Satake in 2020. If time permits, I also explain the relationship with the "flat coordinates" found by Saito-Yano-Sekiguchi in 1980 and the generalization to finite complex reflection groups. This talk is based on the joint work with S. Minabe.

Simona Settepanella

“The Discriminantal arrangement: what an interesting object.”

The discriminantal arrangement has been introduced by Manin and Schechtman in 1989. They defined it as the arrangement $\B(n,k,\A^0)$ which hyperplanes consist of the non-generic parallel translates of the generic arrangement $\A^0$ of n hyperplanes in $\CC^k$. In particular $\B(n,k,\A^0)$ is a generalization of the braid arrangement with which $\B(n,1)=\B(n,1,\A^0)$ coincides. That is the discriminantal arrangement can be regarded as the space of configurations of n hyperplanes in generic position in a k dimensional space. On the other hand Crapo already introduced the discriminantal arrangement in 1985 with the name of \textit{geometry of circuits}. In a more combinatorial setting, he defined it as the matroid $M(n,k, \mathcal{C})$ of circuits of the configuration $\mathcal{C}$ of n generic points in $\RR^k$. The circuits of the matroid $M(n,k, \mathcal{C})$ are the hyperplanes of $\B(n,k,\A^0),$ when $\A^0$ is the arrangement of the hyperplanes in $\RR^k$ orthogonal to the vectors joining the origin with the n points in $\mathcal{C}$. \\
In this talk we will first introduce the discriminantal arrangement from different points of view, then we will illustrate few examples in law dimension and finally we will see few interesting applications and open problems.

Pragnya Das

“The generalization of Sylvester’s And Orchard Problems Via Discriminantal Arrangement.”

In 1989 Manin and Schechtman defined the discriminantal arrangement B(n, k, A) associated to a generic arrangement A of n hyperplanes in a k-dimensional space. In this talk I provide an example of 12 lines with 19 3-points using Pappu’s configuration that elucidates the connection between the well known generalized Sylvester’s and orchard problems and the combinatorics of B(n, k, A). In particular I point out how this connection could be helpful to address those old but still open problems.

Xenia de la Ossa

"Black holes and the arithmetic of Calabi-Yau manifolds"

The main goal of this talk is to explore some questions of common interest for physicists, number theorists and geometers, in the context of Calabi-Yau 3-folds. There are many such relations, however I will focus on the rich structure of black hole solutions of superstrings on a Calabi-Yau manifolds. I will try to give a self contained introduction aimed at a mixed audience of physicists and mathematicians.

The main quantities of interest in the arithmetic context are the numbers of points of the manifold, considered as a variety over a finite field. A mathematician is interested in the computation of these numbers and their dependence on the moduli of the variety. The surprise for a physicist is that the numbers of points over a finite field are also given by expressions that involve the periods of a manifold. These periods determine many aspects of the physical theory, as for example the kinetic terms of the effective Lagrangian as well as the Yukawa couplings, but also properties of black hole solutions. For a mathematician, the number of points determine the zeta function, about which much is known in virtue of the Weil conjectures. I will discuss discuss the appearance of modular groups and modular forms for one parameter families of Calabi-Yau manifolds, arising in relation to the black hole solutions at attractor points.

Yukari Ito

"Resolution of Calabi-Yau singularity and the Orbifold Euler characteristic"

The classification of three dimensional algebraic varieties was finished around 1990 in Algebraic Geometry. At the same time, the orbifolds and the topological invariants appeared in the Superstring theory. Three dimensional Calabi-Yau varieties are good example in both side. Moreover, the Euler characteristics in Superstring theory became important topological invariants of Calabi-Yau singularities. I would like to introduce these history and related results, so-called McKay correspondence.

Maria Stellla Adamo

“On the construction of Wightman fields for 2D CFT with a special representation category.”

Wightman's axiomatic quantum field theory is one of the available approaches to describe Quantum Field Theory (QFT) rigorously. Although such an approach is the most natural, Wightman fields are unbounded operator-valued distributions, thus difficult to investigate. A related one, which instead uses bounded operators, is the algebraic approach, namely Algebraic Quantum Field Theory. In the latter case, one considers instead the relative positions of algebras of bounded operators, i.e., nets of operator algebras.

In my talk, I will present the ideas behind the construction of Wightman fields and the associated operator algebras for a class of 2-dimensional full conformal field theories, namely those arising as extensions of chiral components that admit enough automorphisms among their irreducible representation. If time permits, we will overview our construction for the U(1)-current example.

This talk is based on joint work with L. Giorgetti, Y. Tanimoto, arXiv:2301.12310.

Mayuko Yamashita

“Algebraic topology and physics”

Recently, there has been a growing interest in the relations between algebraic topology and physics. Algebraic topology is used to classify physical systems, and it can be a very powerful tool to analyze physical problems in purely mathematical ways. Also, physically motivated conjectures has lead to many interesting development in homotopy theory. In this talk, I explain these ideas and some of my related works, where we use homotopy theory to study anomalies in string theories.

Nicolas Delporte

“Peeking at quantum gravity with self-overlapping curves”

After a brief overview of the progress in 2d Euclidian quantum gravity achieved within a holographic point of view with JT gravity, we will motivate the study of self-overlapping curves, that is curves that bound an immersed disk in the plane. In particular, we will explore some of their surprising geometrical and combinatorial properties, that we have analysed using analytic and numerical tools.

Slava Lysov

“Tropical geometry and mirror symmetry”

In my talk I will give a brief introduction to tropical geometry, tropical Gromov-Witten invariants and tropical correspondence theorem. I will formulate the tropical mirror correspondence theorem for toric spaces and outline the key steps of its proof.

Makiko Sasada

“Statistical mechanics meets integrable systems”

Abstract. In recent years, there has been growing interest in the studies of integrable systems from a statistical mechanics or probabilistic point of view. In particular, the theory of generalized hydrodynamics developed by physicists suggests that the macroscopic behavior of integrable systems is quite universal. In order to mathematically ground such theories in concrete models, a type of cellular automaton called box-ball system has been extensively studied by probabilists. Such research has successively revealed new connections between probability theory and classical integrable systems. In this talk, I will introduce what kind of problems have been studied and what kind of rigorous results have been obtained, mainly focusing on the case of box-ball system.

Weile Weng

“Random walks in random environments: a mini-introduction and a bit more”

RWRE is a class of simple but powerful models for describing transport process in a highly disordered medium. Early interest in RWRE models begins in the 1970s, and was motivated by problems arising in biology, crystallography and physics. In this pedagogical talk, I will first provide some historical background, and introduce a variety of RWRE models with respect to space, time, and symmetry etc. Then I will discuss the typical research interests and some well-known results in this field. In the end, I will briefly present my own PhD research project, which concerns the quenched functional CLT for random walks in cyclic random environments.

Chihiro Matsui

“Thermalization and relaxation of isolated quantum systems”

Thermalization of isolated quantum systems is one of the most developed topics these days in the field of statistical mechanics. A big achievement has been done for understanding the mechanism of thermalization from the microscopic viewpoint. This is called “eigenstate thermalization hypothesis (ETH)”, which is verified for many generic quantum systems by numerical calculations.

On the other hand, several counterexamples to ETH are known to exist. The famous example is integrable system, which has many conserved quantities to restrict relaxation processes.

In the talk, I will discuss the relaxation state of the XXZ spin chain, which is one of he most well-studied integrable systems, together with the short introduction of quantum mechanics and statistical mechanics.

The talk is based on the published paper J. Phys. A: Math. Theor. 53 134001 (2020).

Silvia Penati

“Novel Mathematical Tools in Quantum Field Theory”

I will review recent progress in the development of new mathematical tools in Quantum Field Theory, which allow to study physical systems beyond the weak coupling approximation. I will make the discussion concrete by focusing on a special corner of QFT, that is the set of supersymmetric Wilson loops in superconformal gauge theories. These are non-local operators that have proved to be accessible by apparently different exact methods: The AdS/CFT correspondence, the conformal bootstrap, quantum integrability and supersymmetric localization. Therefore, they can be used to investigate the consistency of the different methods and perform precision tests of their applicability.

Yolanda Lozano

“Some aspects of duality in String Theory”

We will review the relevance of duality symmetries in String Theory, with special attention to the transformation known as T-duality. We will discuss its role in the generation of new spacetimes where the strings can propagate, some of which are of relevance in the context of the AdS/CFT correspondence and the description of black holes.

Haruna Katayama

“Analogue black holes in superconducting circuits using SNAILs”

Hawking radiation from a real black hole is very weak and difficult to observe. Therefore, analogue black holes have been proposed in various laboratory systems to test Hawking radiation. Among them, superconducting circuits are advantageous for the observation of Hawking radiation in terms of scalability and quantum controllability. In this presentation, we propose an analogue black hole in a travelling wave parametric amplifier Josephson transmission line with superconducting nonlinear asymmetric elements which will enhance the possibility to demonstrate analogue Hawking radiation.

Louise Sutton

"Irreducible Specht modules for symmetric groups and beyond"

In this talk, I will give a brief overview of the representation theory of the symmetric group. Its representations can be constructed from a special family of modules called Specht modules, whose dimensions and bases are known. The irreducible modules arise as certain quotients of Specht modules, whose dimensions are far from being known. One of the fundamental questions in representation theory is to understand these irreducible modules. We can ask a more approachable question: When are these irreducible quotients precisely the corresponding Specht module? I will give a synopsis of past work on this question together with my current research, which generalises this question to other algebras.

Berta Hudak

"(Super)symmetric polynomials and the Pieri rule"

In this talk, we introduce some important symmetric polynomials, in particular Schur polynomials and explain their connection with tableau combinatorics. Then we present the Pieri rule, which expresses a special case of multiplying two Schur polynomials. Finally, we look at supersymmetric (Schur) polynomials and give a simple combinatorial proof for the super Pieri rule.

Laura Escobar

"Partial Permutohedra"

Polytopes, an extension of polygons to arbitrary dimension, have important applications in many areas such as optimization. Classical Greek mathematics recognized the beauty of the platonic solids, which are three-dimensional polytopes. A central problem in the theory of polytopes is to measure families of polytopes, e.g., compute their volume. Partial permutohedra, recently introduced and studied by Heuer and Striker, are polytopes constructed from partial permutations. In this talk I will present results on measuring partial permutohedra. This is joint work with Behrend, Castillo, Chavez, Diaz-Lopez, Harris and Insko.

Remi Avohou

"On ribbon and Brauer Graph algebras"

This talk will review the Brauer configuration algebra. Some results about n-angulation algebra, which generalizes the triangulation algebra will be discussed.
I will present a full formula for the Cartan matrix of the Brauer algebra, allowing us to characterize the Brauer configuration of affine and finite type.

Umida Baltaeva

“Extension of the Tricomi problem for a loaded parabolic-hyperbolic type equation”

The theory of mixed-type equations is one of the principal parts of the general theory of PDEs. The interest for these kinds of equations arise in both theoretical and practical uses of their applications.
I will present the advanced fractional model described with the loaded parabolic-hyperbolic type equation. In this work, we investigate a generalization of the Tricomi problem for a loaded mixed-type equation with the fractional differential operator. The existence and uniqueness of the solution to the problem are proved using the theory of integral equations.

Motoko Kato

“On the center of some Artin groups”

In the study of infinite discrete groups, we often gain insight into the group via a “good” action on a “good” space. In particular, there are strong connections between geometric properties of “non-positive curved spaces”, such as hyperbolic spaces or CAT(0) spaces, and algebraic properties of groups that act on the spaces. In this talk, I would like to talk on Artin groups and their actions on non-positively curved spaces. Artin groups have been widely studied since their introduction by Tits in 1960s. Every Artin group is defined from a finite simple graph, a defining graph, and an associated group presentation. Free abelian groups, free groups and braid groups are examples of Artin groups. There are many open problems on their algebraic properties. In particular, it is conjectured that every Artin group is torsion-free and the center is either infinite cyclic or trivial. There are various partial results that support this conjecture. For example, Charney and Morris-Wright proved this conjecture for Artin groups whose defining graphs are not joins. Their strategy is to study these groups via actions on some complexes called clique-cube complexes, which are CAT(0) spaces. We generalize their result and show that the conjecture holds under relaxed condition for the definition graph. This talk is based on a joint-work with Shin-ichi Oguni (Ehime University).

Mai Katada

“Stable rational cohomology of the IA-automorphism groups of free groups”

The IA-automorphism group IA_n of the free group F_n is a normal subgroup of the automorphism group of F_n, which is an analogue of the Torelli groups of surfaces. We study the rational cohomology of IA_n in a stable range. We also propose a conjectural structure of the stable cohomology of the Torelli groups.

Julie Rowlett

“When can one hear the shape of a flat torus?”

In 1964, Milnor constructed a pair of 16-dimensional flat tori whose Laplace eigenvalues are identical, in spite of the fact that these tori are not isometric. This helped to inspire Kac's famous article `Can one hear the shape of a drum?' If a drum is a 16-dimensional flat torus, the answer is no. However, if two one-dimensional flat tori are isospectral, then they are isometric. So, a natural question is: what is the *highest* dimension in which isospectral flat tori must also be isometric, that is in what dimensions can one hear the shape of a flat torus? We will explore this problem and its resolution and discuss lingering open problems. This talk is based on joint work with Erik Nilsson and Felix Rydell.

Lijie Sun

“From real hyperbolic geometry to complex hyperbolic geometry”

Given a line L and a point p (not on L) in the Euclidean plane, it is well known that there is only one line through p which is parallel to L.
But it will not hold in a hyperbolic plane. Actually, there are exactly three types of geometries: elliptic, Euclidean, hyperbolic geometry with positive,
0, negative curvature respectively. I will briefly introduce the relation of the hyperbolic geometry with physics within my knowledge and present the basic
motivation of my research on complex hyperbolic geometry.

Anjali Shriwastawa

"On the equivalence of two non-Riemannian curvatures in warped product Finsler metrics"

The notion of warped products plays an important roles not only in geometry but also in mathematical physics, especially in general relativity. In fact, many basic solutions of the Einstein field equations, including the Schwarzschild and the Robertson-Walker models, are warped product metrics. In this talk we discuss Buseman-Housdorff volume form and Holmes-Thomson Volume form for the warped product Finsler metrics. With the help of these volume form, we discuss S-curvature and E-curvature for this class of warped product Finsler metrics. Further, we discuss the notion of isotropic S-curvature and isotropic E-curvature are equivalent for this class of metrics.

Misaki Ohta

"On the construction of root lattices and their analogous lattices in high-dimensional Euclidean spaces using quaternions."

By considering group rings of tensor products of complex numbers and quaternions, I construct the lattices with the densest packing F4(D4), E8, and the Barns Wall lattice Λ16.