Title and Abstracts

Research Talks (40 minutes)

Makiko Sasada (The University of Tokyo)

Title: Scaling limits for random processes from the point of view of group cohomology

Abstract: Scaling limits for random walks and stochastic interacting systems have been intensively studied for decades and still remain one of the very major themes of probability theory. I have mainly worked on the diffusive scaling limits in space-time for interacting particle systems, in which I have recently revealed the importance of a group cohomological view and its connection with the Hodge decomposition as well as periodic matrices with collaborators. This structure is expected to be common and effective not only for interacting particle systems but also in the case of one-particle random walks and in homogenization problems. I would like to introduce this connection between the scale limits for random processes and the group cohomology.

Sunggeum Hong (Chosun University)

Title: On the regularity for multilinear pseudo-differential operators

Abstract: In this talk we study a Hörmander type estimates about the multilinear pseudo-differential operators associated with a symbol.

The symbol classes can be classified by the derivative conditions concerning both space and frequency variables.

We firstly introduce known results about these operators when the symbol is independent of the space variable. We nextly extend the derivative conditions of the symbol to more general ones. Especially, we only assume at most the first time of the differentiability of the symbol with respect to the space variable.

Under these weakened conditions, we establish the mapping properties of these multilinear operators on the product Hardy spaces. This is based on the joint work with Yaryong Heo and Chan Woo Yang.

Marie- Françoise Roy (IRMAR Université de Rennes 1)

Title: Elementary recursive complexity results in real algebraic geometry

Abstract: I shall discuss two important results in real algebraic geometry

- quantifier elimination, proving that the projection of a semi-algebraic set is semi-algebraic
- Hilbert 17 th problem, proving that a non negative polynomial is always a sum of squares of rational functions from the point of view of effectivity and complexity.

The two problems look at first sight totally un related at all but it turns out that modern computer algebra techniques play a key role in proving elementary recursive complexity results for both these problems.

Caroline Series (University of Warwick)

Title: Exploring a family of Kleinian groups

Abstract: A Kleinian group is a discrete group of linear fractional transformations (Möbius maps) acting on the Riemann sphere. Given two Möbius maps, how can we tell if the group they generate is discrete? Answering this question leads through Riemann surfaces and Teichmüller theory to some of Thurston's wonderful ideas about hyperbolic 3-manifolds. Also involved are some beautiful computer graphics. I will explain these connections through an example originally introduced by David Mumford and discussed in our book Indra's Pearls (D. Mumford, C. Series and D. Wright, Cambridge University Press 2002).

Dusa McDuff (Columbia University)

Title: An introduction to embedding problems in symplectic geometry

Abstract: This talk will give an elementary introduction to this topic. I will describe the general problem, illustrate its importance, and then explain some classical and recent results."

Hélène Barcelo (MSRI)

Title: Discrete cubical homotopy groups and real Eilenberg-MacLane spaces

Abstract: In this talk we wish to demonstrate how a theory, developed entirely for the purpose of solving problems stemming from search-and-rescue missions, gave rise to one that in turn has applications to fundamental mathematics.

Discrete cubical homotopy theory is a discrete analogue of (singular) simplicial homotopy theory, associating a bigraded sequence of groups to a simplicial complex, capturing some

of its combinatorial structure. The motivation for this construction came initially from the desire to find invariants for dynamic processes that were encoded using (combinatorial) simplicial complexes. The invariants should be topological in nature, but should also be sensitive to the combinatorics encoded in the complex, in particular to the level of connectivity among simplices.
Over the last few years similar notions have arisen from several areas of mathematics (e.g., geometric group theory, coarse geometry, computer science) signaling both the pressing need for such a theory as well as its universal nature. As an illustration, we will provide a real analogue of Brieskorn's result on complex Eilenberg-MacLane spaces associated with Coxeter groups."

Sylvie Paycha (University of Potsdam)
Title: Mathematical reflections on locality
Abstract: Starting from the principle of locality in quantum field theory, which states that an object is influenced directly only by its immediate surroundings, we review some features of the notion of locality arising in physics and mathematics. We encode these in locality relations, given by symmetric binary relations, and locality morphisms, namely maps that factorise on products of pairs in the graph of such locality relations. We shall explain why this factorisation is a key property in the context of renormalisation. This survey talk is based on joint work with Li Guo and Bin Zhang.

Short Talks (15 minutes)

Motoko Kato (University of the Ryukyus)
Title: Acylindrical hyperbolicity of some Artin groups
Abstract: Artin groups, also called Artin-Tits groups, have been widely studied since their introduction by Tits in 1960s. In particular, Artin groups are important examples in geometric group theory. For various non-positively curved or negatively curved properties on discrete groups, Artin groups are interesting targets. In this talk, we treat acylindrical hyperbolicity of Artin groups. Charney and Morris-Wright showed acylindrical hyperbolicity of Artin groups of infinite type associated with graphs that are not joins, by studying clique-cube complexes and the actions on them. By developing their study and formulating some additional discussion, we demonstrate that acylindrical hyperbolicity

holds for more general Artin groups. Indeed, we are able to treat Artin groups of infinite type associated with graphs that are not cones. This talk is based on a joint-work with Shin-ichi Oguni (Ehime University).

Mao Shinoda (Ochanomizu University)
Title: Ergodic optimization and its relation to thermodynamic formalism
Abstract: The main purpose of the ergodic optimization is to describe a maximizing measures, which is an invariant measure attaining maximium of the space average for a given function. In this talk we focus on the interpretation of maximizing measures as a limiting zero temperature version of equilibrium measures.

Yumiko Ohno (Yokohama National University)
Title: Facial achromatic number of triangulations on the sphere
Abstract: A graph consists of a set of vertices and a set of edges. A coloring of a graph is an assigning of colors to the vertices such that any adjacent vertices receive different colors. In particular, a coloring is called complete if every pair of colors appear on some edge. In this talk, we expand complete colorings of graphs to those of graphs embedded on surfaces and consider such colorings of even triangulations on the sphere.

Erika Kuno (Osaka University)
Title: Quasi-isometric embeddings from mapping class groups of nonorientable surfaces
Abstracts: Classifying finitely generated groups by quasi-isometries is a key issue in geometric group theory: two groups are quasi-isometric if, roughly speaking, their word metrics are the same up to linear functions. It is known that the mapping group Mod(N) of a nonorientable surface N is a subgroup of the mapping group Mod(S) of its double covering orientable surface S. We show that the injective homomorphism is a quasi-isometric embedding. This is a joint work with Takuya Katayama.

Xiaodan Zhou (OIST)
Title: Eikonal equations on metric spaces
Abstract: Given an equation $|\nabla u|=1$, how do we solve it? What kind of functions should we call it the solutions to this so-called eikonal equation? In this talk, we will focus on this

simple equation, a special case of the Hamilton-Jacobi equation. The Hamilton-Jacobi equation in general metric spaces recently attracts a great deal of attention because of its broad applications in optimal transport, traffic flow, networks, etc. We will first give a review of basic results of eikonal equation in the Euclidean space and introduce some recent development of this equation on metric spaces.

Natsumi Oyamaguchi (Shumei University)
Title: Region colorings for spatial graphs
Abstract: A Dehn p-coloring for a spatial graph diagram is an assignment of an element(color) of Zp={1,2,⋯,P-1} to each region of the diagram. At each crossing, some coloring condition is satisfied. We give a family of spatial graph invariants and classify the vertex conditions of Dehn colorings. Some examples of spatial graphs can be distinguished by the number of Dehn colorings by selecting an appropriate vertex condition, whereas they cannot be distinguished by the number of Dehn colorings with no vertex condition. This is joint work with Kanako Oshiro(Sophia University).

Eriko Shinkawa (Tohoku University)
Title: Virasoro action on Schur's Q-functions
Abstract: Schur Q-function was introduced by Schur as a symmetric polynomial describing the irreducible index of the projective representation of a symmetric group. A formula for Schur Q-functions is presented which describes the action of the Virasoro operators. This formula follows from the Plücker-like bilinear identity of Q-functions as Pfaffians. There must be an algebra-geometric meaning of these bilinear identities.

Megumi Sano (Hiroshima University)
Title: Harmonic transplantation and its applications to Sobolev embeddings, functional inequalities and PDE
Abstract: The harmonic transplantaion is proposed by Hersch in 1969. It is a generalization of the conformal transplantation and is a powerful tool for the construction of comparison functions or approximate solutions f variational problems.
In this talk, I give different kinds of applications of the harmonic transplantation. Also, I report on my recent results about the embedding, the variational problem and the PDE

via the harmonic transplantation.

Ayako Kubota (Waseda University)
Title: Invariant Hilbert schemes and resolutions of quotient singularities
Abstract: The invariant Hilbert scheme is a moduli space of schemes which aer stable under an action of a reductive algebraic group. By a suitable choice of the parameter, it becomes a candidate for a resolution of singularities of a quotient singularity. In this short talk, I will explain two main problems in the study of the invariant Hilbert scheme from the point of view of birational geometry of singularities.

Ade Irma Suriajaya (Kyushu University)
Title: Goldbach's Conjecture, the Riemann Hypothesis and problems on twin primes in Number Theory, and recent results relating Goldbach and prime pair problems to zeros of L-functions
Abstract: Number Theory has a very long history that dates back thousands of years. The main goal of this study is to understand properties of numbers which essentially can be reduced to understanding prime numbers. Although we have the outstanding Prime Number Theorem, more precise information about the distribution of prime numbers is mostly unknown. For example, it is also not known if there are infinitely many pairs of prime numbers having difference 2, the so-called twin prime pairs. Recent breakthroughs in Analytic Number Theory have succeeded in showing the infinitude of prime pairs with small gaps, which is the contribution of Yitang Zhang, one of this year's Fields medalists, James Maynard, and also Terrence Tao. The 280-year-old Goldbach's conjecture and the Riemann hypothesis which is now over 160 years old are also among the most famous yet important unsolved problems in Analytic Number Theory. The Riemann Hypothesis is a conjecture about the location of zeros of the Riemann zeta function. The importance of this problem not only in Number Theory but also many other areas of Mathematics and even Physics is reflected in many known equivalent statements. In Analytic Number Theory alone, we know the equivalence between the Riemann Hypothesis and many prime distribution related problems. Its equivalence to Goldbach related problems is also known. It is important to note that Goldbach's conjecture itself is an independent problem to the Riemann Hypothesis and neither is stronger than the other. In this talk, I would like to

introduce a few interesting recent results in this direction.

Hyonjung Lee (Kyungpook National University)
Title: Mathematical modeling for COVID-19 transmission dynamics in Korea
Abstract: Mathematical modelling plays a key role in interpreting the epidemiological data on the outbreak of infectious disease. First, mathematical modeling can give us an early warning about the size of the outbreak. Second, we can assess the effect of the control interventions by simulating the various control scenarios to suggest the most effective intervention. In this talk, I'd like to briefly introduce the main results of recent research on the mathematical modeling for COVID-19 transmission dynamics.

Mayuko Yamashita (RIMS, Kyoto University)
Title: Algebraic topology and physics
Abstract: 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.
In this talk, I explain this idea and some of my related works.