East Asian Core Doctoral Forum on Mathematics 2020 *

January 14-17, 2020

The University of Tokyo Kashiwa Campus, Chiba, Japan

Organizers:

Jungkai Chen (National Taiwan University)
Zhijie Chen (Tsinghua University)
Zhuo Chen (Tsinghua University)
Norisuke Ioku (Tohoku University)
Tsuyoshi Kato (Kyoto University)
Yasuyuki Kawahigashi (The University of Tokyo)
Toshitake Kohno (The University of Tokyo)
Motoko Kotani (Tohoku University)
Haizhong Li (Tsinghua University)
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Hunhee Lee (Seoul National University)
Zhi Lü (Fudan University)
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Soonki Hong (Seoul National University)
Jie Liu (Fudan University)
Kazuki Kannaka (The University of Tokyo)
Younng-Jin Kim (Seoul National University)
Pu-Zhao Kow (National Taiwan University)
Ryosuke Nakasato (Tohoku University)
Ikkei Shimizu (Kyoto University)
Tailong Zhou (Tsinghua University)

Venue:

Kavli Institute for the Physics and Mathematics of the Universe,
The University of Tokyo

*This meeting is supported by Grants-in-Aid for Scientific Research "Integrated Development of Operator Algebras" (Y. Kawahigashi, 19H00640) and Kavli IPMU, the University of Tokyo.

Plenary talks

January 14 (Tue) 9:00-10:00

Speaker: Chun-Yen Shen (National Taiwan University)
Title: Exponential sums and additive combinatorics
Abstract: The work of Bourgain-Katz-Tao on the sum-product estimates in prime fields has found many important applications in various areas. In particular, an application of their result solves a difficult exponential sum problem in analytic number theory. The goal of this talk is to introduce the connection between analytic number theory and additive combinatorics, and present our recent results that give nontrivial upper bounds for some certain exponential sums in prime fields.

January 15 (Wed) 9:00-10:00

Speaker: Hunhee Lee (Seoul National University)
Title: Quantum information theory and abstract harmonic analysis
Abstract: We would like to demonstrate a rather new idea of applying abstract harmonic analysis to quantum information theory, which can be applied to the case of Bosonic/Fermionic system and more.

January 16 (Thu) 9:00-10:00

Speaker: Zhiyuan Li (Fudan University)
Title: Geometry of moduli space of K3 surfaces.
Abstract: The study of moduli space of K3 surfaces have received a lot of attentions from different aspects in the past decades. In this talk, I will first given an introduction polarized and lattice polarized K3 surfaces and introduce their moduli spaces. I will explain the important interaction between these moduli spaces and how it applies to the study of geometry of them, such as the intersection theory and binational geometry.

January 17 (Fri) 9:00-10:00

Speaker: Yoshiko Ogata (The University of Tokyo)
Title: Automorphic equivalence within gapped phases in the bulk
Abstract: We develop a new adiabatic theorem for unique gapped ground states which does not require the gap for local Hamiltonians. We instead require a gap in the bulk and a smoothness of expectation values of sub-exponentially localized observables in the unique gapped ground state $\varphi_s(A)$. This requirement is weaker than the requirement of the gap of the local Hamiltonians, since a uniform spectral gap for finite dimensional ground states implies a gap in the bulk for unique gapped ground states, as well as the smoothness. This is a joint work with Alvin Moon.

Parallel talks

January 14 (Tue) 10:30-12:10

Speaker: Duhyeong Kim (Seoul National University)
Title: Efficient Homomorphic Comparison Methods with Optimal Complexity
Abstract: Comparison of two numbers is one of the most frequently used operations, but it has been a challenging task to efficiently compute the comparison function in homomorphic encryption (HE) which basically support addition and multiplication. Recently, Cheon et al. (Asiacrypt 2019) introduced a new approximate representation of the comparison function with a rational function, and showed that this rational function can be evaluated by an iterative algorithm. Due to this iterative feature, their method achieves a logarithmic computational complexity compared to previous polynomial approximation methods; however, the computational complexity is still not optimal, and the algorithm is quite slow for large-bit inputs in HE implementation.
In this work, we propose new comparison methods with *optimal* asymptotic complexity based on composite polynomial approximation. The main idea is to systematically design a constant-degree polynomial f by identifying the *core properties* to make a composite polynomial $f \circ f \circ \cdots \circ f$ get close to the sign function (equivalent to the comparison function) as the number of compositions increases. Utilizing the devised polynomial f, our new comparison algorithms only require $\Theta(\log(1/\epsilon)) + \Theta(\log \alpha)$ computational complexity to obtain an approximate comparison result of $a, b \in [0, 1]$ satisfying $|a - b| \geq \epsilon$ within $2^{-\alpha}$ error.
The asymptotic optimality results in substantial performance enhancement: our comparison algorithm on encrypted 20-bit integers for $\alpha = 20$ takes 1.43 milliseconds in amortized running time, which is 30 times faster than the previous work.

Speaker: Dung Tran The (National Taiwan Normal University)
Title: Long-time existence of solution of elastic curves with clamped boundary conditions
Abstract: In this poster, we study L^2-flow of elastic curves in planar with clamped boundary conditions and two movable endpoints. We provide a proof of existence and uniqueness smooth solution on $[0, \infty) \times [0, 1]$.

Speaker: Wei-Ting Kao (National Taiwan University)
Title: The variation formula of the p-mass on three dimensional compact CR manifolds embedded in C^2
Abstract: In recent years, Cheng, Malchiodi and Yang defined the pseudohermitian mass (abbreviated p-mass) for three dimensional asymptotically flat CR manifolds and proved a positive mass theorem for such CR manifolds. Similarly as in the Riemannian case, the p-mass of a certain blow-up of a compact CR 3-manifold is the first nontrivial coefficient in the expansion of the Green function of its CR conformal Laplacian. We study a family of compact CR 3-manifolds embedded in C^2, described by the level sets of a defining function, and derive the variation formula of the p-mass for this deformation. To obtain this result, we generalize the ambient Graham-Lee connection to the one for arbitrary contact form and obtain the conformal transformation law in this extended theory.

Speaker: Fei Si (Fudan University)
Title: Compactification of Moduli space of degree 6 K3 surfaces
Abstract: Compactification is one of central topic in algebraic geometry. Recently, thanks to the developments in minimal model program, a so called Hassette-Keel program, is proposed to study birational geometry of moduli space of curves and its modular Compactification, it is aimed to study log minimal model of $M_{g,n}$. Later, K.O'Grady and R.Laza proposed the Hassette-Keel-Looijenga program to study moduli space of degree 4 K3 surface. Inspired by these, we study various compactification of moduli space of degree 6 K3 surfaces from VGIT and arithmetic viewpoints. In VGIT side, we find the chambers decomposition for the wall-crossing and identify the birational model of moduli space at the wall, eg, we show when the parameter $t = 2/3$, it is the quotient of chow variety. we also give some explicit birational map when crossing the walls. In arithmetic side, we show Looigenga's Compactification is isomorphic to normalization of moduli space of nodal cubic 4-folds. As application, we show that for certain range, Hassette-Keel-Looijenga program of moduli space of degree 6 K3 surfaces is isomorphic to our VGIT. therefore, we partially verify the prediction from arithmetic. Moreover, we also show some Noether-Lefchetz divisors are extremal in its effective cone. This is joint work with Fancois Greer, Radu Laza, Zhiyuan Li, and Zhiyu Tian.

Speaker: Jie Liu (Fudan University)
Title: On the Constantin-Lax-Majda Model with Convection
Abstract: The well-known Constantin-Lax-Majda (CLM) equation, an important toy model of the 3D Euler equations without convection, can develop finite time singularities. De Gregorio modified the CLM model by adding a convective term, which is known important for fluid dynamics. Presented are two results on the De Gregorio model. The first one is the global well-posedness of such a model for general initial data with non-negative (or non-positive) vorticity which is based on a newly discovered conserved quantity. This verifies the numerical observations for such class of initial data. The second one is an exponential stability result of ground states, which is similar to the recent significant work of Jia, Steward and Sverak, with the zero mean constraint on the initial data being removable. The novelty of the method is the introduction of the new solution space H_{DW} together with a new basis and an effective inner product of H_{DW}.

Speaker: Mayuko Yamashita (Kyoto University)
Title: Spectral convergence in geometric quantizations
Abstract: In this talk, I explain a new approach to problems in geometric quantizations, using the theory of convergence for metric measure spaces. Given a prequantized symplectic manifold, we consider a problem to find relations between quantum Hilbert spaces obtained by different methods of quantizations. For a family of Kähler polarizations converging to a real polarization, we analyze the behavior of the spectrum of $\bar{\partial}$-Laplacians, by regarding it as a family of metric measure spaces and looking at the equivariant pointed measured Gromov-Hausdorff limits. In the case where the real polarization is non-singular or has only toric-type singularities, we show the spectral convergence result of $\bar{\partial}$-Laplacians, as well as the convergence result of quantum Hilbert spaces. This is a joint work with Kota Hattori (Keio University).

January 14 (Tue) 14:00-15:05

Speaker: Kazuhiro Ito (Kyoto University)
Title: On a torsion analogue of the weight-monodromy conjecture and its applications
Abstract: The weight-monodromy conjecture due to P.Deligne states that the weight filtration and the monodromy filtration on the l-adic cohomology of a proper smooth scheme over a local field coincide up to some shift. For a proper smooth scheme over a local field which has good reduction, it is nothing more than the Weil conjecture. In this talk, I will talk about a torsion analogue of the weight-monodromy conjecture. I will prove it for surfaces and for the equal characteristic case. In the equal characteristic case, the proof relies on an ultraproduct variant of Weil II recently established by A.Cadoret. As applications, I will discuss some finiteness properties of the Brauer group and the Chow group of codimension two cycles on a proper smooth scheme over a local field.

Speaker: Shih-Hsin Chen (National Taiwan University)
Title: On synchronization analysis of bidirectionally coupled Kuramoto oscillators
Abstract: In the real world, the phenomena of synchronization has been observed in many fields and considered as one of universal features. Kuramoto model is one of mathematical models that are proposed to investigate various phenomena of synchronization such as physics, biology, neuroscience and networks. In this talk, we consider the Kuramoto model with bidirectional interaction. We shall present theoretical results of phase synchronization for the identical case, and frequency synchronization for the non-identical case. Numerical experiments are contained in this talk to support our main results.

Speaker: Gi-Chan Bae (Sungkyunkwan University)
Title: Quantum BGK model near a global Fermi-Dirac distribution.
Abstract: In this presentation, we consider the existence and asymptotic behavior of the fermionic quantum BGK model, which is a relaxation model of the quantum Boltzmann equation for fermions. More precisely, we establish the existence of unique classical solutions and their exponentially fast stabilization when the initial data starts sufficiently close to a global Fermi-Dirac distribution. A key difficulty unobserved in the study of the classical BGK model is that we must verify that the equilibrium parameters is uniquely determined through a set of nonlinear equations in each iteration step.

Speaker: Kazuki Kannaka (The University of Tokyo)
Title: The multiplicity of discrete spectrum for 3-dimensional Lorentzian manifolds
Abstract: A n-dimensional Lorentzian manifold is a smooth manifold with a nondegenerate, symmetric bilinear tensor of signature $(n-1,1)$. A Lorentzian manifold has an intrinsic differential operator called the Laplacian. The spectral properties of the Laplacian have been much investigated for Riemannian manifolds (e.g. Weyl's law). However, it is not the case for Lorentzian manifolds because of various difficulties (e.g. the Laplacian is not elliptic). In this talk, I want to explain some phenomena for the Laplacian of 3-dimensional Lorentzian manifolds with constant sectional curvature.

January 14 (Tue) 15:25-17:05

Speaker: Yizhou Zhou (Tsinghua University)
Title: Construction of Boundary Conditions for Hyperbolic Relaxation Approximations
Abstract: We intend to develop a program aiming at construction of boundary conditions (BCs) for hyperbolic relaxation systems. Physically, such BCs are not always available. The construction is based on the assumption that the relaxation systems and well-posed BCs for the corresponding equilibrium systems are given. The present talk focuses on the linearized Suliciu model. We obtain strictly dissipative and compatible BCs for the linearized model with different non-characteristic boundaries. Moreover, the effectiveness of the constructed BCs is shown by resorting to formal asymptotic solutions and energy estimates.

Speaker: Yansheng Wu (Ewha Womans University)
Title: Characterization of Ramanujan Cayley graphs via linear codes
Abstract: In this talk, we characterize the connection between linear codes and Ramanujan Cayley graphs. We explicitly determine an equivalence between p-ary t-weight linear codes and Ramanujan Cayley graphs with t distinct restricted eigenvalues. In particular, we get an explicit criterion on the equivalence between two-weight linear codes and Ramanujan strongly regular graphs with explicit parameters. Using this characterization, we construct several families of Ramanujan Cayley graphs with two or three eigenvalues from known linear codes with two or three weights, respectively. This is a joint work with Dr. Jong Yoon Hyun (Konkuk University, Glocal Campus) and Prof. Yoonjin Lee (Ewha Womans University).

Speaker: Ikkei Shimizu (Kyoto University)
Title: Local well-posedness for Schrödinger maps with helicity terms
Abstract: In this talk, we consider the initial-value problem for Schrödinger maps with helicity terms. We prove the local well-posedness in two different settings: the general case and the topologically-free case. In the former case, we establish local well-posedness by applying the energy method of McGahagan with improving her argument. In the later case, we show additional properties for solutions, such as blow-up criterion, quantitative bounds and difference estimates. The key idea is the reduction of the problem to a kind of nonlinear Schrödinger equation, so-called the modified Schrödinger map equation. For its analysis, the treatment for magnetic potentials is required. In this talk, I will begin with the introduction of Schrödinger maps, and mainly discuss the techniques used in the later result.

Speaker: Shuzhe Cai (Tsinghua University)
Title: Strong Convergence to Equilibrium for Bosons
Abstract: In this talk I will introduce a recent joint work with Xuguang Lu on the long time strong convergence to equilibrium for solutions of the spatially homogeneous Boltzmann-Nordheim equation for bosons for the hard sphere model. The case of low temperature is included and we obtain a rate of long time convergence to the Bose-Einstein condensation for all isotropic initial data satisfying only the low temperature condition. Our proof is based on the entropy control, positive lower bound of the entropy, Villani's inequality for the entropy dissipation, a suitable time-dependent convex combination between the solution and a fixed positive function (in order to overcome the lack of positive lower bound), and an iteration technique for proving the condensation in finite time. The convergence rate we obtained is very slow: $O(t^{-\alpha})\,(t\to+\infty)$ with $\frac{1}{160}<\alpha<\frac{1}{152}$, but it is the first result on this direction.

January 15 (Wed) 10:30-12:10

Speaker: Jingning He (Fudan University)
Title: Well-posedness for a Cahn–Hilliard–Navier–Stokes system with singular potential and chemotaxis
Abstract: We consider a class of Cahn–Hilliard–Navier–Stokes system modeling two-phase flows with mass transfer coupled to the process of chemotaxis that has recently been proposed by Lam and Wu (European J. Appl. Math., 29 (2018), 595-644). The system under investigation contains a singular potential with double-well structure that guarantees the order parameter belonging to the physically relevant interval $[-1, 1]$. To the best of our knowledge, all available contributions related to this model in the literature are concerned with a regular approximation of the singular potential. We prove the existence of global weak solutions for both two and three dimensions. Moreover, in the two dimensional case, we obtain some further regularity properties and a continuous dependence result on data, which yields the uniqueness of weak solutions.

Speaker: Tailong Zhou (Tsinghua University)
Title: Shifted Inverse Curvature Flows in Hyperbolic Space
Abstract: We introduce the shifted inverse curvature flows in hyperbolic space. This is a family of hypersurfaces in hyperbolic space expanding by f^{-p} with positive power p for a smooth, symmetric, strictly increasing and 1-homogeneous curvature function f of the shifted principal curvatures with some concavity properties. We study the maximal existence and asymptotical behavior of the flow for horo-convex hypersurfaces. In particular, for $0 < p \leq 1$ we show that the limiting shape of the solution is always round as the maximal existence time is approached. This is in contrast to the asymptotical behavior of the (non-shifted) inverse curvature flow.

Speaker: Yang-Zhi Lin (National Taiwan University)
Title: Closed Range Properties For Kohn Laplacian On Generalized Heisenberg Group
Abstract: In this work, we consider Heisenberg group $\mathbb{H}^n := \mathbb{C}^n \times \mathbb{R}$ with CR structure $T^{1,0}\mathbb{H}^n = span\{\frac{\partial}{\partial z_j} + i\frac{\partial \varphi}{\partial z_j}\frac{\partial}{\partial t} | j = 1, 2, \ldots, n\}$, where $\varphi \in C^\infty(\mathbb{H}^n)$. Under uniformly Y(q) condition, we show that the associated Kohn Laplacian $\Box_b^{(q)}$ has L^2 closed range. As an application of our result, we deduce that the associated Szegő kernel S is a complex Fourier integral operator.

Speaker: Ryosuke Nakasato (Tohoku University)
Title: Global well-posedness and singular limit for the magnetohydrodynamics of the damped wave type in the critical Fourier–Sobolev spaces
Abstract: We study the initial-value problem for the incompressible magnetohydrodynamics of the damped wave type in the n-dimensional Euclidian space ($n \geq 2$). In this talk, we first state the derivation of the magnetohydrodynamics of the damped wave type and we show the results on global well-posedness and singular limit for the magnetohydrodynamics of the damped wave type in the critical Fourier–Sobolev spaces $\widehat{\dot{H}}^{-1}_{\infty}(\mathbb{R}^n)$. This talk is based on a joint work with Tatsuya Matsui (ALPS ALPINE CO. LTD.) and Takayoshi Ogawa (Tohoku University).

Speaker: Seung-Jo Jung (Seoul National University)
Title: Hodge ideal spectrum of isolated hypersurface singularities
Abstract: In this talk, I present a recent result comparing the Hodge ideal spectrum with the Steenbrink spectrum for isolated hypersurface singularities. We find that sufficient conditions for their coincidence and non-coincidence in some cases. This talk is based on a joint work with In-kyun Kim, Youngho Yoon, Morihiko Saito.

Speaker: Chang-Wen Liang (National Central University)
Title: A Full Space-time Solution Algorithm with Nonlinear Preconditioning Technique for Hyperbolic Partial Differential Equation Problems
Abstract: As the computing power of the latest parallel computer systems increases dramatically, the fully coupled space-time solution algorithms for the time-dependent PDEs obtain their popularity recently for temporal domain parallelism. In this space-time algorithm, we solve the resulting large, sparse, nonlinear systems in an all-at-once manner. A robust and efficient nonlinear solver plays an essential role as a critical kernel of the whole solution algorithm. We introduce some nonlinear preconditioned Newton algorithm for the space-time formulation of Burgers' equation with shock presented. In that case, the history of the nonlinear residual norm for the classical Newton method suffers from a long stagnation

period due to strong local nonlinearity. To overcome the difficulties, we apply an adaptive nonlinear elimination preconditioning technique to enhance the robustness of the inexact Newton method, in the sense that the number of inexact Newton iterations required to converge is almost independent of both of the time-step and the mesh sizes.

January 15 (Wed) 14:00-15:05

Speaker: Chung-Hsuan Wang (National Cheng Kung University)
Title: Congruence relations and transformation formulas of p-adic hypergeometric functions
Abstract: We introduce new kind of p-adic hypergeometric functions. We show these functions satisfy congruence relations that are similar to Dwork's p-adic hypergeometric functions and p-adic hypergeometric functions of logarithmic type. So they are convergent functions. And we show that there is a transformation formula between our new p-adic hypergeometric functions and p-adic hypergeometric functions of logarithmic type in a particular case.

Speaker: Weike Yu (Fudan University)
Title: Schwarz type lemmas for pseudo-Hermitian manifolds
Abstract: In this talk, we consider some generalized holomorphic maps between pseudo- Hermitian manifolds. These maps include the CR maps and the transversally holomorphic maps. In terms of some sub-Laplacian or Hessian type Bochner formulas, and comparison theorems in the pseudo-Hermitian version, we are able to establish several Schwarz type results for both the CR maps and the transversally holomorphic maps between pseudo-Hermitian manifolds. Finally, we also discuss the CR hyperbolicity problem for pseudo-Hermitian manifolds. This is a joint work with Yuxin Dong and Yibin Ren.

Speaker: Xin Zhao (Tsinghua University)
Title: Natural Vector Method and Its Applications
Abstract: Sequence analysis has become one of the most active and important research areas in bioinformatics as the tools for getting biological sequences increase. However, due to the huge size and high complexity of the data, it will lead to a lot of time to complete sequence analysis if there is no effective algorithm, even becoming an impossible difficult problem to work out. We propose a new method, the natural vector method, which is a whole-genome, non-aligned and non-parametric rapid representation for sequences. It is a very powerful new tool for analyzing evolutionary relationships. Natural vector reflects the distribution of nucleotides or amino acids in gene sequence or protein sequence, which contains the total numbers, the average positions and the high order central moments of nucleotides or amino acids. There is a one-to-one correspondence between any sequence and its natural vector. Comparing with the existing methods, natural vector method has low computational complexity and short computation time, and does not depend on any evolutionary model. This method has been applied to build a variety of databases for classifying new sequences and predicting their properties quickly and precisely, which provides more accurate description of the evolution relationships between species.

Speaker: Nayoung Han (Ewha Womans University)
Title: Cyclic codes over $\mathbb{Z}_4$ using the Frobenius non-chain ring $\mathbb{Z}_4[u]/\langle u^2-1\rangle$
Abstract: We construct infinite families of MDR cyclic codes over $\mathbb{Z}_4$ usnig α-constacyclic codes over the Frobenius non-chain ring R:=$\mathbb{Z}_4[u]/\langle u^2-1\rangle$. We explicitly determine generators of all α-constacyclic codes over R of odd length n, where α is an arbitarary unit of R. Then we obtain MDR cyclic codes over $\mathbb{Z}_4$ of length $2n$ by using a Gray map associated with the unit α from R^n to $\mathbb{Z}_4^{2n}$. This is a joint work with Bohyun Kim, Yoonjin Lee (Ewha Womans University) and Boran Kim (Sungkyunkwan University)

January 15 (Wed) 15:25-16:30

Speaker: Soonki Hong (Seoul National University)
Title: Gibbs measure related to Green functions on metric trees
Abstract: Let $\mathcal{T}$ be a locally finite tree whose geometric boundary has infinitely many points. Suppose that a non-amenable group Γ acts isometrically and geometrically on the tree $\mathcal{T}$.
In this paper, we construct the Gibbs measure on the space of geodesics in $\mathcal{T}$ and observe the properties of Gibbs measure which are important for further studies of random walks and Brownian motion on $\mathcal{T}$.

Speaker: Pu-Zhao Kow (National Taiwan University)
Title: On decay rate of solutions for the stationary Navier-Stokes equation in an exterior domain
Abstract: In this paper [KL19], we consider the asymptotic behavior of an incompressible fluid around a bounded obstacle. By adapting the Schauder's estimate for stationary Navier–Stokes equation to improve the regularity, the problem is solved by using appropriate Carleman estimates. It should be noted that the minimal decaying rate for a general scalar equation is $\exp(-C|x|^{2+})$. However, the structure of the Navier–Stokes is special. Under the assumption for any nontrivial solution to be uniform bounded which is weaker than those in [LUW11], we got the minimal decaying rate is $\exp(-C|x|^{\frac{3}{2}+})$ which is better than the results in general scalar cases.

Reference

[KL19] Pu-Zhao Kow, Ching-Lung Lin, *On decay rate of solutions for the stationary Navier-Stokes equation in an exterior domain*, J. Differential Equations 266 (2019) 3279–3309.
[LUW11] Ching-Lung Lin, Gunther Uhlmann, Jenn-Nan Wang, *Asymptotic behavior of solutions of the stationary Navier-Stokes equations in an exterior domain*, Indiana Univ. Math. J. 60 (6) (2011) 2093–2106.

Speaker: Wei-Chen Chang (National Taiwan University)
Title: Development of Interior Transmission Eigenvalues Problems with Elastic Waves
Abstract: Recently, people are interested in the interior transmission eigenvalues problem (ITEP), they develop many methods in the study of direct and inverse scattering problems for many kinds of waves. We here study the ITEP for the elastic waves. According to the finite element method (FEM), we can change the ITEP for the elastic waves to a general eigenvalue problem (GEP) written in matrix forms. To find the eigenvalues in ITEP is then equivalent to find those in GEP. We aim to propose an efficient numerical algorithm to handle the GEP. In this talk, we focus on the numerical issue from the GEP, for example, how to find more and more eigenvalues and how to compute their corresponding eigenvectors.

Speaker: Il-Seung Jang (Seoul National University)
Title: Flagged Littlewood-Richardson tableaux and branching rule for orthogonal groups
Abstract: We give a new combinatorial formula for the branching rule from the general linear group GL_n to the orthogonal group O_n, which is regarded as a generalization of the Littlewood's restriction formula. This formula is given in terms of Littlewood-Richardson tableaux with certain flag conditions. This can be viewed as an orthogonal analogue of Sundaram's formula in case of symplectic groups.
As an application, we obtain a combinatorial description of the Lusztig t-weight multiplicity $K_{\mu 0}(t)$ of type B_n and D_n with highest weight μ and weight 0.
This is a joint work with Jae-Hoon Kwon (arXiv:1908.11041).

January 16 (Thu) 10:30-12:10

Speaker: Yu Katagiri (Tohoku University)
Title: p-adic entropy defined by a solenoid and p-adic Mahler measures
Abstract: To a dynamical system is attached a non-negative real number called entropy. In 1990, Lind, Schmidt and Ward proved that entropy for a dynamical system induced by the Laurent polynomial algebra over the ring of the rational integers is described by the Mahler measure. In 2009, Deninger introduced p-adic entropy and obtained a p-adic analogue of Lind-Schmidt-Ward's theorem by using p-adic Mahler measures. I will talk about p-adic entropies for two dynamical systems; one is induced by the Laurent polynomial algebra over the ring of the integers of a number field K, and the other is defined by a solenoid.

Speaker: Younng-Jin Kim (Seoul National University)
Title: Theory and Application of Simplicial Harmonic Spaces
Abstract: A harmonic cycle λ, also called a discrete harmonic form, is a solution of the Laplace's equation with the combinatorial Laplace operator obtained from the boundary operators of a simplicial chain complex. By combinatorial Hodge theory, harmonic spaces are isomorphic to homology groups with real coefficients. In particular, if a cell complex has a one dimensional reduced homology, it has a unique harmonic cycle up to scalar multiplication, which we call the standard harmonic cycle. We will present a formula for the standard harmonic cycle λ of a cell complex based on a high-dimensional generalization of cycletrees. Moreover, by using duality, we will define the standard harmonic cocycle λ^* and show intriguing combinatorial properties of λ and λ^* in relation to (dual) spanning trees, (dual) cycletrees, winding numbers $w(\cdot)$ and cutting numbers $c(\cdot)$ in high dimensions. Finally, we will also suggest application methods; an analysis to detect oscillations by using winding number, and cutting number, and a network embedding method, called harmonic mirroring.

Speaker: Qingsheng Zhang (Tsinghua University)
Title: Applications of Statistical Physics Methods to Gromov-Witten Type Theories
Abstract: We introduce some applications of statistical physics methods to Gromov-Witten type theories. We apply the renormalized coupling constants and Virasoro constraints to derive the Itzykson-Zuber Ansatz on the form of the free energy in 2D topological gravity. Its analogues of 1D topological gravity and the Hermitian one-matrix models are treated in the same fashion. We use our results to study special deformation theories due to Zhou and constitutive relations due to Dijkgraaf and Witten. This is a joint work with J.Zhou.

Speaker: Tuowei Chen (Fudan University)
Title: Free boundary problem for one-dimensional compressible Navier-Stokes equations with temperature dependent viscosity and heat conductivity
Abstract: We prove the existence and uniqueness of global strong solution to the free boundary problem in one dimensional compressible Navier-Stokes system for the viscous and heat conducting ideal polytropic gas flow, when the viscosity and heat conductivity depend on temperature in power law of Chapman-Enskog and the data is in the neighborhood of some background solution at initial time. We also study the large time behavior of the solution and obtain its decay property.

Speaker: Jaehun Lee (Seoul National University)
Title: Law of iterated logarithm for symmetric pure-jump processes
Abstract: In this talk, we discuss the liminf and limsup laws of the iterated logarithm for the sample path of symmetric pure-jump Dirichlet form in the metric measure spaces equipped with volume doubling and reverse volume doubling conditions. Also, the law of the iterated logarithm for local time will be established.

Speaker: Xiaobing Sheng (The University of Tokyo)
Title: Thompson's group and it's generalized subgroups.
Abstract: Thompson's group F, T and V were first introduced by Richard Thompson.V has first been further generalized to be a family of finitely presented infinite groups by Higman in the 70's and F, T and V have further been extended to infinite families by Brown and later being generalised by Stein and obtained homology results and simplicity results. Burillo, Cleary, Stein proved the existence of the quasi-isometric embeddings from generalized Thompson's groups F_p, and F_q where p and q are natural number. Motivated by their result, we obtain the analog for T.

January 17 (Fri) 10:30-12:10

Speaker: Kuan-Wei Chen (National Chiao Tung University)
Title: Collective Periodic Solutions in Coupled-cell Systems
Abstract: Many biological clocks are composed by single oscillators. One of the examples is the segmentation clock in interacting cells of zebrafish embryos. The coupled biological oscillators can tick with the same frequency. Thus, how to establish the frequency of a collective oscillation is a key issue in understanding the biological clocks. In general, a population of oscillators with different autonomous frequencies can attain frequency synchronization through coupling. In this lecture, we consider a modified model on somitogenesis of zebrafish proposed by Uriu et al. in 2010. Theoretical analysis on the existence and stability of periodic solutions for coupled-cell system is a nontrivial task. One of the useful theories to study periodic motion is the Hopf bifurcation theorem. Based on the Hopf bifurcation analysis and numerical computations extended from the analysis, we explore how the collective frequency in the coupled-cell systems varies with the coupling strength. In addition, we discuss how the collective frequency of oscillation in the coupled-cell systems is related to the frequencies of isolated individual cells. This is a joint work with Chih-Wen Shih and Kang-Ling Liao.

Speaker: Thanh Son Trinh (Sungkyunkwan University)
Title: Duality and generalized Wasserstein barycenters
Abstract: In this talk, using ideas of Liero, Mielke and Savaré, we establish a Kantorovich duality for generalized Wasserstein distances $W_1^{a,b}$ on a generalized Polish metric space, introduced by Picolli and Rossi in 2014. As a consequence, we get a result of independent interest that $\left(\mathcal{M}(X), W_1^{a,b}\right)$ is a geodesic space for every Polish metric space X. We also prove that $(\mathcal{M}^G(X), W_p^{a,b})$ is isometric isomorphism to $(\mathcal{M}(X/G), W_p^{a,b})$ for isometric actions of a compact group G on a Polish metric space X; and several results of Gromov-Hausdorff convergence and equivariant Gromov-Hausdorff convergence of generalized Wasserstein spaces. Moreover, we show the existence of generalized Wasserstein barycenters for measures with compact supports. We also investigate a dual problem of the barycenter problem via our Kantorovich duality formula for generalized Wasserstein distances $\widetilde{W}_p^{a,b}$, for every $p \geq 1$. Finally, we provide consistency of the barycenters. (This is joint work with Nhan-Phu Chung)

Speaker: Xiao Ren (Fudan University)
Title: A Liouville Theorem for Axi-symmetric Navier-Stokes Equations on $\mathbb{R}^2 \times \mathbb{T}^1$
Abstract: We establish a Liouville theorem for bounded mild ancient solutions to the axi-symmetric incompressible Navier-Stokes equations on $(-\infty, 0] \times (\mathbb{R}^2 \times \mathbb{T}^1)$. This is a step forward to completely solve the conjecture on $(-\infty, 0] \times \mathbb{R}^3$ which was made in (1) to describe the potential singularity structures of the Cauchy problem.

Speaker: Yen-Tsung Chen (National Tsing Hua University)
Title: Integrality of v-adic Multiple Zeta Values
Abstract: In this talk, I will present a recent result on the integrality of v-adic multiple zeta values (MZVs). More precisely, for each index $\mathfrak{s} \in \mathbb{N}^r$ and finite place $v \in A := \mathbb{F}_q[\theta]$, Chang and Mishiba introduce the notion about the v-adic MZV $\zeta_A(\mathfrak{s})_v$ which is a function field analogue of Furusho's p-adic MZVs. By estimating the v-adic valuation of $\zeta_A(\mathfrak{s})_v$, we show that for a fixed index $\mathfrak{s} \in \mathbb{N}^r$, $\zeta_A(\mathfrak{s})_v$ is a v-adic integer for almost all v. This result can be viewed as a function field analogue of the integrality of p-adic MZVs which was proved by Akagi, Hirose and Yasuda.

Speaker: Yasuhiro Oki (The University of Tokyo)
Title: Basic loci of some Shimura varieties for unitary groups in four variables over a ramified prime
Abstract: A Shimura variety is an algebraic varieties over a number field associated to a certain algebraic group over $\mathbb{Q}$. Basic loci are certain closed subsets of mod p reductions of Shimura varieties. It is known that understanding the structures of basic loci is important for number theory. In this talk, we give an explicit description of the structures of basic loci of some Shimura varieties for unitary groups of signature $(2, 2)$ over an odd prime satisfying a ramified condition.

Speaker: Shu Takeuchi (Tohoku University)
Title: The limit of directed graphs via curvature-dimension conditions
Abstract: The following is an important problem in geometric analysis; if a certain condition holds for any space of a convergent sequence (in some sense) of spaces, does the limit space satisfies the same condition? In particular, there have been a lot of works on conditions called curvature-dimension conditions, which is generalized conditions that $\mathrm{Ric}_M \geq K$ and $\dim_M \leq N$ holds in a Riemannian manifold M, by Sturm, Lott-Villani, etc. In this talk, I would like to propose "the limit graph" of a sequence of directed graphs whose weights tends to infinity, by using curvature-dimension conditions. I will also introduce the stability result of curvature-dimension condition with respect to such convergence.