The 15th KOOK-TAPU Joint Seminar on Knots and Related Topics and The 17th Graduate Student Workshop on Mathematics

Program of The 15th KOOK-TAPU Joint Seminar on Knots and Related Topics

July 30 (Tue)

9:20–9:30 Opening remarks

(Chair: Sang Youl Lee)

9:30–10:00 **Akio Kawauchi** (OCAMI/Osaka Metropolitan University)
Classifying the surface-knot modules

10:10–10:40 **Seung Yeop Yang** (Kyungpook National University)
Torsion in set-theoretic Yang-Baxter homology of cyclic biquandles

(Chair: Bing Fang)

10:50–11:20 **Jumpei Yasuda** (Osaka University)
Knitted surfaces and their chart descriptions

11:30–12:00 **Zhiqing Yang** (Dalian University of Technology)
Graded knot polynomials

July 31 (Wed)

(Chair: Zhiqing Yang)

9:30–10:00 **Sang Youl Lee** (Pusan National University)
Invariants for dichromatic links using quandle cocycle pairs

10:10–10:40 **Sam Nelson** (Claremont McKenna College)
Psyquandle Brackets

(Chair: Yongju Bae)

10:50–11:20 **Bing Fang** (School of Mathematical Sciences, Dalian University of Technology)
Sufficient conditions for amalgamated 3-manifolds to be ∂-irreducible and irreducible

11:30–12:00 **Seiichi Kamada** (Osaka University)
On classification of generalized Alexander quandles

August 1 (Thu)

(Chair: Kodai Wada)

9:30–10:00 **Taizo Kanenobu** (Osaka Metropolitan University)
$H(2)$-moves on links

10:10–10:40 **Jieon Kim** (Pusan National University)
On a pretzel (immersed) surface-links

(Chair: Sam Nelson)

10:50–11:20 **Kodai Wada** (Kobe University)
Fox $\mathbb{Z}$-colorings and twelve equivalence relations on $\mathbb{Z}^m$

11:30–12:00 **Yongju Bae** (Kyungpook National University)
New polynomial invariants of graphs enhanced by connectivity

12:30–12:40 Closing remarks

13:00–17:00 Free discussion

Program of The 17th Graduate Student Workshop on Mathematics

July 30 (Tue)

13:20–13:30 Opening remarks

13:30–14:30 (Chair: Hirotaka Akiyoshi)

Ryoya Kai (Osaka Metropolitan University)
Euler characteristics of quandles

Bogi Kim (Kyungpook National University)
Higher integrability for weak solutions to parabolic multi-phase equations

Yu Ikehara (Osaka Metropolitan University)
The Applications of Riemann-Roch Theorem

Jihyeon Kim (Pusan National University)
Why Nursing Schedule Optimization is Necessary: Solutions Through Linear Constraint Programming

14:45–15:45 (Chair: Akio Kawauchi)

Jiyoung Oh (Kyungpook National University)
An inversion formula of the attenuated Radon transform on a class of specific cones

Haruchika Tsuno (Osaka University)
2-dimensional braids and their chart presentations

Jaejin Choi (Pusan National University)
Regularity for Elliptic Partial Differential Equations Using Moser Iteration

Takuma Seno (Osaka Metropolitan University)
Cohen-Macaulayness of a ring of invariants of a permutation representation for the characteristic $p = 2$.

16:00–17:00 (Chair: Jieon Kim)

Jiyoung Lee (Pusan National University)
Gradient Estimates for Nonlinear Elliptic Obstacle Problems

Zhang Yangyang (Osaka Metropolitan University)
the proof of two kinds of vanishing theorem

Hyungtae Baek (Kyungpook National University)
The functions $\omega_{R,S}(I)$ and $\Omega_S(R)$

Kazuki Sato (Osaka Metropolitan University)
Poisson equations involving the critical Hardy operator

July 31 (Wed)

13:30–14:30 (Chair: Seiichi Kamada)

Hyunwoo Lee (Kyungpook National University)
Improved weight initialization for deep and narrow feedforward neural network

Ryosuke Miki (Osaka University)
Invariant of knotted surface exteriors obtained from crossed modules

Juneho Lee (Pusan National University)
Predicting Ecological Risks of Non-Native Mammal Invasion: A Case Study on Eastern Grey Squirrels

Jinichiro Tanaka (Osaka Metropolitan University)
On cohomology groups of a neighborhood of a compact complex curve with a node

14:45–15:45 (Chair: Jumpei Yasuda)

Qu Mingzhu (Osaka Prefecture University)
Stability criteria for differential equations with discrete and distributed delays

Jan Kim (Pusan National University)
The residual finiteness and the Hopf property in conjugation quandles

Kota Urabe (Osaka Metropolitan University)
Riesz's representation theorem and its applications

Hongdae Yun (Kyungpook National University)
Betti numbers of the Yang-Baxter (co)homology for the HOMFLYPT polynomial

16:00–17:00 (Chair: Seung Yeop Yang)

Ye Du (Pusan National University)
A Bootstrap Argument to Hölder Continuity for Elliptic Equations

Tomoya Inoue (Osaka Metropolitan University)
Weighted quasilinear eigenvalue problems in exterior domains

Sangsoo Lee (Kyungpook National University)
Introduction to the Khovanov-Jacobsson number of a closed surface of genus n

Katsunori Arai (Osaka University)
A new construction of multiple group racks

August 1 (Thu)

12:10–12:30 Awards Ceremony

12:30–12:40 Closing remarks

13:00–17:00 Free discussion

Abstracts of The 15th KOOK-TAPU Joint Seminar on Knots and Related Topics

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Yongju Bae (Kyungpook National University)

New polynomial invariants of graphs enhanced by connectivity

A connected graph G is said to be *k-connected* if it has more than k vertices and remains connected whenever fewer than k vertices are removed. Notice that if G is a k-connected graph, then at least one of G/e and $G-e$ is k-connected for any edge e of G. By using the property of k-connectivity, we will define new polynomial invariants σ_k for each k and studies properties of the invariants. Also, we will show a relationship with other polynomial invariants like Tutte polynomial and discuss about their applications to other research areas, e.g. knot theory.

Bing Fang (School of Mathematical Sciences, Dalian University of Technology)

Sufficient conditions for amalgamated 3-manifolds to be ∂-irreducible and irreducible

Let $M = M_1 \cup_F M_2$ be an amalgamation of two 3-manifolds M_1 and M_2 along a compact connected surface F. In this talk, we first give some sufficient conditions for M to be ∂-irreducible in terms of distances between certain vertex subsets of the curve complex $C(F)$ and the arc complex $A(F)$. Then we introduce the extended curve complex $\widetilde{C}(F)$ of a compact connected surface F. In the case that F is bi-compressible in the amalgamated 3-manifold M and in the case that F is compressible only in one of M_1 and M_2, we give some sufficient conditions in terms of distance between some vertex subsets of $\widetilde{C}(F)$ for M to be irreducible, respectively.

Seiichi Kamada (Osaka University)

On classification of generalized Alexander quandles

Finite Alexander quandles have been classified up to quandle isomorphism by Sam Nelson. Recently, Akihiro Higashitani and Hirotake Kurihara have established a characterization theorem for finite generalized Alexander quandles under certain assumptions. In this talk, we extend their results by characterizing generalized Alexander quandles without assuming finiteness or other restrictive conditions. This is a joint work with Akihiro Higashitani, Jin Kosaka, and Hirotake Kurihara.

Taizo Kanenobu (Osaka Metropolitan University)

$H(2)$-moves on links

We consider an $H(2)$-move between two torus links of type $(2, 2n)$, T_{2n}. We provide some necessary conditions for two links T_{2n} and T_{2m} to be related by a single $H(2)$-move. In particular, we show: (i) T_{2n} is obtained by a single $H(2)$-move from the Hopf link $T_{\pm 2}$ iff $n = \pm 1, \pm 3$. (ii) T_{2n} is obtained by a single $H(2)$-move from the 2-component trivial link T_0 iff $n = 0, \pm 2$.

Akio Kawauchi (Osaka Central Advanced Mathematical Institute, Osaka Metropolitan University)

Classifying the surface-knot modules

The kth module of a surface-knot of a genus g in the 4-sphere is the kth integral homology module of the infinite cyclic covering of the surface-knot complement. The reduced first module is the quotient module of the first module by the finite sub-module defining the torsion linking. In this talk,it is reported that the reduced first module for every genus g is characterized in terms of properties of a finite generated module. As a by-product,a concrete example of the fundamental group of a surface-knot of genus g which is not the fundamental group of any surface-knot of genus $g-1$ is given for every $g > 0$. The torsion part and the torsion-free part of the second module are determined by the reduced first module and a genus-class invariant in the reduced first module.

Jieon Kim (Pusan National University)
On a pretzel (immersed) surface-links

A pretzel link is a special family of classical links in $\mathbb{R}^3$. Pretzel links consist of a finite number of tangles made of two intertwined circular helices. A surface-link is a surface smoothly embedded in 4-space and immersed surface-link is a closed surface smoothly immersed in 4-space with the property of self-transversality. A (immersed) surface-link is represented by some diagrams in $\mathbb{R}^2$, a generalization of a diagram of classical links. In this talk, we generalize a pretzel link to the (immersed) surface-link case. This is a joint work with Sam Nelson.

Sang Youl Lee (Pusan National University)
Invariants for dichromatic links using quandle cocycle pairs

A *dichromatic link* is a smooth imbedding of n circles in the 3-sphere S^3 such that each component is colored by '1' or '2'. An interesting class of dichromatic links is the class of all knots and links in the solid torus $S^1 \times D^2$. So far, many invariants for classical links have been generalized to dichromatic links, and recently diquandle coloring invariants for dichromatic links have been developed. In this talk, I'd like to introduce shadow diquandle coloring invariants for dichromatic links and present a method of constructing invariants for dichromatic links by using quandle 2- and 3-cocycle pairs satisfying certain conditions. Also, some computing examples of the invariant for knots and links in the solid torus are going to be discussed.

Sam Nelson (Claremont McKenna College)
Psyquandle Brackets

Psyquandles are algebraic structures used to define invariants of pseudoknots and singular knots. In this talk we define psyquandle brackets, skein invariants of psyquandle-colored pseduoknots, and categorify them to obtain psyquandle bracket quivers. This is joint work with Natsumi Oyamaguchi (Tokyo University of Science).

Kodai Wada (Kobe University)
Fox $\mathbb{Z}$-colorings and twelve equivalence relations on $\mathbb{Z}^m$

Considering Fox $\mathbb{Z}$-colorings of classical and virtual tangles, we define twelve equivalence relations on $\mathbb{Z}^m$ for an integer $m \geq 2$. We completely characterize these twelve equivalence relations by introducing several invariants of Fox $\mathbb{Z}$-colorings. As an application, we provide the orbit decomposition of $\mathbb{Z}^m$ under the Hurwitz action of the braid(-permutation) group of degree m. We also provide a sufficient condition for a virtual m-braid to be non-classical. This is joint work with Takuji Nakamura, Yasutaka Nakanishi and Shin Satoh.

Seung Yeop Yang (Kyungpook National University)
Torsion in set-theoretic Yang-Baxter homology of cyclic biquandles

The set-theoretic Yang-Baxter homology is a homological framework derived from the set-theoretic solutions of the Yang-Baxter equation, a fundamental equation in the fields of mathematical physics and knot theory. Even with over two decades of extensive research on set-theoretic Yang-Baxter homology and its broad applications to central areas of contemporary mathematics, there are still very few set-theoretic solutions whose homology has been fully calculated. In this talk, we compute the set-theoretic Yang-Baxter homology of cyclic biquandles.

Zhiqing Yang (Dalian University of Technology)
Graded knot polynomials

Most knot polynomial invariants are not polynomial time computable. But after deforming the knot polynomial and dividing it according to certain grading, each component can be polynomial time computable. In this way, knot invariants that were previously very complex can now be calculated with their low-order components. This idea was applied to HOMFLY polynomial by mathematicians such as Jozef H. Przytycki, F. Jaeger, Akio Kawauchi and others. This report generalizes this result, showing that the knot polynomial deformation they give is a special case of the reporter's knot invariant, and discusses more general possibilities.

Jumpei Yasuda (Osaka University)
Knitted surfaces and their chart descriptions

A braided surface was introduced by Rudolph as a surface in a 4-ball obtained from a motion picture consisting of braids. Kamada studied braided surfaces using chart descriptions, which are planar graphs on a 2-disk. In this talk, we define a knitted surface as a generalization of a braided surface by a generalized chart. Here, a knit is a tangle in a cylinder obtained from a braid by splicing for some crossings. As a main result, we show that every properly embedded surface in a 4-ball with a non-empty boundary is ambiently isotopic to a knitted surface. This is a joint work with Inasa Nakamura (Saga University).

Katsunori Arai (Osaka University)

A new construction of multiple group racks

A spatial surface is a compact surface embedded in the 3-sphere. A spatial surface is represented by a diagram of a spatial trivalent graph , which is called a spatial surface diagram. A multiple group rack (MGR) is an algebraic structure corresponding to Reidemeister moves for spatial surface diagrams. In this talk, we give a way to construct MGRs. As an application, we show an example of an MGR with a coloring that does not correspond to any homomorphism from the fundamental group of the complement of a spatial surface to a group.

Hyungtae Baek (Kyungpook National University)

The functions $\omega_{R,S}(I)$ and $\Omega_S(R)$

In 2011, D. F. Anderson and A. Badawi generalized the concept of prime ideals, and in 2020, A. Hamed and A. Malek further extended this using multiplicative sets. For a commutative ring with identity R and a multiplicative subset S of R, we define an *S-n-absorbing ideal* as a generalization. Additionally, we introduce the following functions:

- $\omega_{R,S}(I) = \min\{n \mid I \text{ is an } n\text{-absorbing ideal of } R\}$, and
- $\Omega_S(R) = \{\omega_{R_S}(I) \mid I \text{ is an ideal of } R \text{ disjoint from } S\}$.

In this talk, we examine the condition under which $\Omega_S(R) \subseteq \mathbb{N}$.

Jaejin Choi (Pusan National University)

Regularity for Elliptic Partial Differential Equations Using Moser Iteration

In this talk, we study the regularity of second-order elliptic partial differential equations. This approach was discovered by De Giorgi and John Nash independently for general second-order elliptic and parabolic partial differential equations, in which no differentiability or continuity is assumed of the coefficients in the 1950s. Moser identified a new approach to their basic regularity theory, introducing the technique of Moser iteration and developing it for both elliptic and parabolic problems in the 1960s. Based on this approach, we obtain the boundedness of the supremum of u which is for the weak solution of second-order elliptic partial differential equations.

Ye Du (Pusan National University)

A Bootstrap Argument to Hölder Continuity for Elliptic Equations

In this talk, we explore how bootstrap argument can be applied in regularity theory. The bootstrap argument is a simple yet powerful tool for proving the regularity of nonlinear equations. We also examine the Hölder regularity of solutions, highlighting that the main technique for establishing Hölder estimates is the bootstrap argument. Through this discussion, we aim to demonstrate how bootstrap argument can effectively enhance regularity results in the study of nonlinear equations.

Yu Ikehara (Osaka Metropolitan University)

The Applications of Riemann-Roch Theorem

This is a survey talk about Riemann-Roch theorem. The theorem is a theory that shows the relationships between the genus of a compact Riemann Surface X (a connected complex manifold of dimension 1) and the dimension of the vector space of meromorphic functions on X. In this talk, I will introduce a proof of the Riemann-Roch theorem, using the theory of sheaves and cohomology. Additionally, we will explore some applications of the theorem, such as the result that all compact Riemann Surfaces with genus $g = 0$ are homeomorphic to $\mathbb{P}^1$.

Tomoya Inoue (Osaka Metropolitan University)
Weighted quasilinear eigenvalue problems in exterior domains

Weighted quasilinear eigenvalue problems are the partial differential equations which are expressed with p-Laplace operator Δ_p, weight function K and real number λ. In this talk, we consider the eigenvalue problems in B_1^c which is the complement of the closed unit ball in $\mathbb{R}^N$. According to the paper by Anoop, Drábek, and Sasi (Calc. Var., 2015), we prove that there exists a positive eigenvalue and an eigenfunction which is positive a.e. in B_1^c.

Ryoya Kai (Osaka Metropolitan University)
Euler characteristics of quandles

A quandle is an algebraic system whose axioms correspond to Reidemeister moves. The algebraic structures of quandles can be regarded as a generalization of the point symmetries of symmetric spaces. In this talk, we provide a definition of the Euler characteristics of quandles. This is based on a formula for the Euler characteristics of compact connected Riemannian symmetric spaces in terms of group actions. We also introduce some properties of Euler characteristics similar to topological Euler characteristics. This is joint work with Hiroshi Tamaru.

Bogi Kim (Kyungpook National University)
Higher integrability for weak solutions to parabolic multi-phase equations

In this talk, we deal with a local higher integrability result for the gradient of a weak solution to a parabolic multi-phase equations. For this, we establish parabolic Poincaré type inequalities and reverse Hölder type inequalities for the gradient of a weak solution in each of difference types of intrinsic cylinders.

Jan Kim (Pusan National University)
The residual finiteness and the Hopf property in conjugation quandles

Recall that a group G is *residually finite* if for every $g \in G \setminus \{1\}$, there is a finite group P and an epimorphism $\psi : G \to P$ so that $\psi(g) \neq 1$. Additionally, a group G is said to be *Hopfian* if every epimorphism $G \to G$ is an automorphism. It is well-known that every finitely generated residually finite group is Hopfian. On the other hand, similar to the residual finiteness in groups, we may extend the definition of the residual finiteness to other algebraic structures. One intriguing example of such algebraic structures is "quandles". We investigate whether quandles derived from groups preserve the residual finiteness and the Hopf property. And conversely, we examine what properties the underlying groups possess when the quandles exhibit such properties. In this talk, we specifically address the residual finiteness and the Hopf property of conjugation quandles, which are representative examples of quandles originating from groups.

Jihyeon Kim (Pusan National University)
Why Nursing Schedule Optimization is Necessary: Solutions Through Linear Constraint Programming

In the healthcare industry, effective nursing schedule optimization is critical for ensuring high-quality patient care, improving nurse satisfaction, and enhancing operational efficiency. This presentation explores the necessity of optimizing nursing schedules and presents linear programming as a robust solution to address this challenge. Nursing schedules are often complex due to the need to balance various constraints such as shift coverage, legal working hours, nurse preferences, and skill requirements. Inadequate scheduling can lead to nurse fatigue, decreased job satisfaction, and suboptimal patient care.

Linear programming provides a mathematical approach to model and solve scheduling problems by defining objective functions and constraints. This technique allows for the systematic consideration of multiple factors, resulting in schedules that meet both organizational goals and individual needs. The application of linear programming in nursing schedule optimization not only ensures compliance with regulatory standards but also maximizes resource utilization and minimizes operational costs.

References

[1] Korea Health Industry Development Institute. 2014 Survey of nurses' activity status Korea Health Industry Development Institute; Cheongju,

[2] Park YC, Kwak SS. Policies for manpower and working condition for health-care industry workers. Seoul: Economic, Social & Labor Council; 2015.

[3] Jeon WR, Ko YW, Kim J. A study of nurse scheduling problem using efficient approximation algorithms. J Kor Inst Inform Technol 2016;14(2):159e66. https://doi.org/10.14801/jkiit.2016.14.2.159.

[4] Scott LD, Rogers AE, Hwang W, Zhang Y. Effects of critical care nurses' work hours on vigilance and patients' safety. American Journal of Critical Care. 2006;15(1):30-37. https://doi.org/10.4037/ajcc2006.15.1.30

Hyunwoo Lee (Kyungpook National University)
Improved weight initialization for deep and narrow feedforward neural network

Appropriate weight initialization settings, along with the ReLU activation function, have become cornerstones of modern deep learning, enabling the training and deployment of highly effective and efficient neural network models across diverse areas of artificial intelligence. The problem of "dying ReLU," where ReLU neurons become inactive and yield zero output, presents a significant challenge in the training of deep neural networks with ReLU activation function. Theoretical research and various methods have been introduced to address the problem. However, even with these methods and research, training remains challenging for extremely deep and narrow feedforward networks with ReLU activation function. In this paper, we propose a novel weight initialization method to address this issue. We establish several properties of our initial weight matrix and demonstrate how these properties enable the effective propagation of signal vectors. Through a series of experiments and comparisons with existing methods, we demonstrate the effectiveness of the novel initialization method.

Jiyoung Lee (Pusan National University)
Gradient Estimates for Nonlinear Elliptic Obstacle Problems

We establish Calderón-Zygmund type estimates for obstacle problems of nonlinear elliptic equations in the divergence form of p-Laplacian type. The results were proved by Byun, Cho, and Wang [1] using the maximal operator approach which Caffarelli and Peral introduced. On the other hand, Acerbi and Mingione introduced a different approach which is a so-called maximal function-free approach in [2]. In this talk, based on this approach, we investigate interior gradient estimates for weak solutions of the obstacle problems.

References

[1] Byun, S., Cho, Y., Wang, L. *Calderón-Zygmund theory for nonlinear elliptic problems with irregular obstacles.* J. Funct. Anal. **263**(10) (2012): 3117–3143.

[2] Acerbi, E., Mingione, G. *Gradient estimates for a class of parabolic systems.* Duke Math. J. **136**(2) (2007): 285–320.

Juneho Lee (Pusan National University)
Predicting Ecological Risks of Non-Native Mammal Invasion: A Case Study on Eastern Grey Squirrels

The introduction of non-native species can have significant detrimental effects on local ecosystems, particularly when these species occupy high trophic levels. Direct experimentation with these introductions is impractical and risky. To address this, we developed computational models to predict the potential impacts of introducing certain mammalian species. Our models incorporate variables such as reproductive rates, interspecies interactions, and environmental modifications.

We specifically examined the eastern grey squirrel (Sciurus carolinensis), a versatile species capable of thriving in various environments, including urban areas. This species exhibits high reproductive potential, with litters of 1 to 4 offspring and biannual breeding cycles. Its omnivorous diet, which includes small vertebrates, birds, berries, and fruits, enhances its adaptability to new habitats such as those found in Korea. Furthermore, the eastern grey squirrel is a strong competitor with native squirrel species and is a vector for poxvirus transmission. Its invasive potential has been documented in regions like Japan and Europe.

Our study simulated the illegal introduction of eastern grey squirrels into pet stores within the densely populated and highly trafficked regions of Incheon and Gyeonggi. We used these simulations to project population dynamics over a decade, factoring in initial population sizes and climatic adaptability. The objective of this research is to anticipate the spread of this invasive species and inform management strategies to mitigate ecological impact and preserve native biodiversity.

Sangsoo Lee (Kyungpook National University)
Introduction to the Khovanov-Jacobsson number of a closed surface of genus n

In this survey talk, we will overview the notion of Khovanov-Jacobsson number which is an invariant of surface-knots. Khovanov's theory offers more detailed information than the Jones polynomial, making it an essential tool in knot theory. We will explore how to compute the Khovanov-Jacobsson number using cobordism theory and apply it to calculate the Khovanov-Jacobsson number of a closed surface of genus n.

Ryosuke Miki (Osaka University)
Invariant of knotted surface exteriors obtained from crossed modules

Crossed modules are powerful tool that has good compatibility with homotopy theory. F. Martin defined a homotopy invariant for compact connected manifolds using crossed modules, and he applied this invariant to exteriors of knotted surfaces. For knotted surface exteriors, this invariant is calculated using motion pictures with bands representing the knotted surfaces. In this talk, I will introduce the method for calculating this invariant and provide some examples to illustrate the process.

Jiyoung Oh (Kyungpook National University)
An inversion formula of the attenuated Radon transform on a class of specific cones

The conical Radon transform, particularly useful in the application of a Compton camera, assigns to a given function its surface integral over a set of cone. We study the attenuated conical Radon transform, which is taken into consideration of the attenuation effect on the conical Radon transform suggested in [1]. The n-dimensional attenuated conical Radon transform is defined and the inversion formula is provided by showing that its projection can be expressed in the form of a convolution.

[1] C. Tarpau, J. Cebeiro, M. K. Nguyen, G. Rollet, and L. Dumas. An analytic inversion formula for a Radon transform on a class of cones. Eurasian Journal of Mathematical and Computer Applications, 10(3):73-83, 2022.

Qu Mingzhu (Osaka Prefecture University)
Stability criteria for differential equations with discrete and distributed delays

This study is devoted to the stability analysis of a scalar linear differential equation involving non-delay term, discrete delay term, and distributed delay term. We establish necessary and sufficient conditions guaranteeing the asymptotic stability of the zero solution composed of explicit delay-dependent criteria when the discrete delay and the distributed delay have a special relationship. The proofs of our results are obtained using the root analysis of the associated characteristic equation. This is a joint work with Hideaki Matsunaga.

Kazuki Sato (Osaka Metropolitan University)
Poisson equations involving the critical Hardy operator

In this talk, we are concerned with the following 2-dimensional Poisson problem

$$\text{(H)} \begin{cases} L_\mu u = f & \text{in } B \setminus \{0\}, \\ u = 0 & \text{on } \partial B, \\ \lim\limits_{|x|\to 0} \frac{u(x)}{\Gamma_\mu(x)} = 0, \end{cases}$$

where $B = B_1(0)$; the unit ball in $\mathbb{R}^2$, f is a Hölder continous function. For $a > 1$,

$$L_\mu :- -\Delta + \frac{\mu}{|x|^2(\log \frac{a}{|x|})^2}, \quad \text{with } \mu \geq -\frac{1}{4},$$

is called the critical Hardy operator.

Our aim of in this talk is to provide a new formulation of distribution identity for the solution of (H), and to express the isolated singularities by the Dirac mass.

Note that the equation (H) coincides with the classical Poisson equations when $\mu = 0$. I will proceed with this talk by comparing with $-\Delta$.

Takuma Seno (Osaka Metropolitan University)
Cohen-Macaulayness of a ring of invariants of a permutation representation for the characteristic $p = 2$.

Invariant theory of a finite group is classified into two cases. One is called the modular case and the other is called the nonmodular case. In the nonmodular case, a ring of invariants is always Cohen-Macaulay and there is a well-known characterization of Gorensteinness, which is called Watanabe ' s theorem. Furthermore, we can calculate the Hilbert series of a ring of invariants by Molien ' s theorem. However, in the modular case, the situation is complicated. A ring of invariants is not always Cohen-Macaulay, and the above theorems do not hold in general. In this talk, by considering the Hilbert series of the ring of invariants, we show that if a permutation representation contains an odd permutation but not contains any transposition then, its ring of invariants is not Cohen-Macaulay for the characteristic $p = 2$.

Jinichiro Tanaka (Osaka Metropolitan University)
On cohomology groups of a neighborhood of a compact complex curve with a node

Let C be a compact complex curve holomorphically embedded in a non-singular complex surface S. When the normal line bundle $N_{C/S} := [C]|_C$ is negative (resp. positive), C has a neighborhood (resp. a fundamental system of neighborhoods) with pseudoconvexity (resp. pseudoconcavity) , which is a complex analogue of the convexity (resp. concavity). What if $N_{C/S}$ is flat ? Assume that C has only one node and $N_{C/S}$ is flat. Under the assumption, Koike showed that the analytic structure of a neighborhood of C is determined by some irrational theoretical number condition. In this talk, we construct a compact complex curve C as above which satisfies the assumption and observe cohomology of a neighborhood of C. This is a joint work with Satoshi Ogawa.

Haruchika Tsuno (Osaka University)
2-dimensional braids and their chart presentations

A 2-dimensional braid is a 2-dimensional analogue of a classical braid, introduced by S. Kamada. It is a branched covering surface embedded in a product of two 2-disks, $D^2 \times B^2$, regarded as the D^2-bundle over B^2. The chart of a 2-dimensional braid is a graph drawn on B^2, which allows us to reconstruct the 2-dimensional braid. In this talk, we will introduce the method for constructing a 2-dimensional braid from its chart and present some invariants that can be easily derived from the chart presentation.

Kota Urabe (Osaka Metropolitan University)
Riesz's representation theorem and its applications

In this talk, we show two types of proofs of Riesz's representation theorem, which characterizes the bounded linear functional on Hilbert spaces. An application to the Dirichlet problem of Poisson equation and an introduction of Lax Milgram's theorem are also shown.

Hongdae Yun (Kyungpook National University)
Betti numbers of the Yang-Baxter (co)homology for the HOMFLYPT polynomial

The Yang-Baxter equation plays a crucial role in knot theory, originating from statistical mechanics and quantum group theory. The theory of Yang-Baxter (co)homology, introduced by J. S. Carter, M. Elhamdadi, and M. Saito, is an effective tool in knot theory as cocycle link invariants. Later, Lebed and Przytycki developed the homology theory of general Yang-Baxter operators. In 2020, Przytycki and Wang introduced Yang-Baxter operators corresponding to the HOMFLYPT polynomial. In this talk, we recall the definition of Yang-Baxter cohomology and some basic well-known results. Furthermore, we investigate the Betti numbers for the Yang-Baxter cohomology groups for the HOMFLYPT polynomial. This is joint work with Xiao Wang and Seung Yeop Yang.

Zhang Yangyang (Osaka Metropolitan University)
the proof of two kinds of vanishing theorem

In this presentation we will introduce two kinds of vanishing theorems（nakano vanishing theorem、Akizuki nakano kodaira vanishing theorem）, vanishing theorems play an important role in complex geometry and the very famous kodaira vanishing theorem was derived with help of vansihing theorem and vanishing theorem can also help us to classify complex manifolds. So this time we will focus on the proof of vanishing theorems