研究集会　Intelligence of Low-dimensional Topology

京都大学数理解析研究所 RIMS 共同研究（公開型）として、また、トポロジープロジェクトの一環として、標記の研究集会を開催いたします。また、この研究集会は科学研究費補助金 基盤研究 A 「３次元双曲多様体上の量子トポロジー」（課題番号 21H04428、研究代表者 大槻知忠（京都大学））と科学研究費補助金 挑戦的研究（萌芽）「ゲージ理論に関連する３次元双曲多様体の不変量」（課題番号 19K21830、研究代表者 大槻知忠（京都大学））の援助をうけています。

日程：２０２４年 5月２２日 (水)〜 5月２４日 (金)
場所：京都大学 数理解析研究所 420 大講演室
アクセス：https://www.kurims.kyoto-u.ac.jp/ja/access-01.html
研究集会ホームページ：https://www.kurims.kyoto-u.ac.jp/~ildt/

この研究集会は、ハイブリッド型（対面とオンライン (Zoom) の併用）で開催することを計画しています。参加者数を事前に把握するために、参加される方（対面もオンラインも）は、5 月 8 日までに、参加登録をお願いします。参加登録の際に「配信映像を録画・録音しないこと」のご同意をお願いします。参加登録方法について、研究集会ホームページ（上記 URL）をご覧ください。

5月２２日 (水)

13:40〜14:20　小沢 誠 (駒澤大学総合教育研究部自然科学部門)
Forbidden complexes for the 3-sphere

14:40〜15:20　久保田 肇 (京都大学)
Grid homology and the connected sum of knots

15:40〜16:20　Andras Juhasz (University of Oxford) (online)
The unknotting number, hard unknot diagrams, and reinforcement learning

5月23日 (木)

10:30〜11:10　和田 康載 (神戸大学)
The orbit classification of $\mathbb{Z}^m$ by the m-braid group

11:30〜12:10　木村 直記 (東京理科大学)
Classical invariants and rack coloring invariants of Legendrian knots

13:40〜14:20　Sebastian Baader (University of Bern)
Minimal topological cobordisms between even strand torus knots

14:40〜15:20　村上 順 (早稲田大学)
On complexified tetrahedron for double twist knots

15:40〜　Problem Session

5月24日 (金)

10:30〜11:10　吉岡 玲音 (東京大学大学院数理科学研究科)
Non-trivial geometric cycles of the space of long embeddings detected by 2-loop graphs

11:30〜12:10　姫野 圭佑 (広島大学先進理工系科学研究科)
Hyperbolic knots whose Upsilon invariants are convex

13:40〜14:20　片田 舞 (九州大学)
The first homology of the IA-automorphism groups of free groups with coefficients in spaces of Jacobi diagrams

14:40〜15:20　Renaud Detcherry (Université de Bourgogne) (online)
On the volume conjecture for Turaev-Viro invariants of 3-manifolds

組織委員：秋吉宏尚、大槻知忠、鎌田聖一、鎌田直子、河野俊丈
世話人：大槻知忠 (京大 数理研)、渡邉忠之 (京大 理学研究科)

Intelligence of Low-dimensional Topology

May 22–24, 2024

This conference is planned to be held at

Room 420, RIMS, Kyoto University,

whose live streaming is distributed online.

Program

May 22 (Wed)

13:40–14:20 Makoto Ozawa (Department of Natural Sciences, Faculty of Arts and Sciences, Komazawa University)
Forbidden complexes for the 3-sphere

14:40–15:20 Hajime Kubota (Kyoto University)
Grid homology and the connected sum of knots

15:40–16:20 Andras Juhasz (University of Oxford) (online)
The unknotting number, hard unknot diagrams, and reinforcement learning

May 23 (Thu)

10:30–11:10 Kodai Wada (Kobe University)
The orbit classification of $\mathbb{Z}^m$ by the m-braid group

11:30–12:10 Naoki Kimura (Tokyo University of Science)
Classical invariants and rack coloring invariants of Legendrian knots

13:40–14:20 Sebastian Baader (University of Bern)
Minimal topological cobordisms between even strand torus knots

14:40–15:20 Jun Murakami (Waseda University)
On complexified tetrahedron for double twist knots

15:40– Problem Session

May 24 (Fri)

10:30–11:10 Leo Yoshioka (Graduate School of Mathematical Sciences, The University of Tokyo)
Non-trivial geometric cycles of the space of long embeddings detected by 2-loop graphs

11:30–12:10 Keisuke Himeno (Graduate School of Advanced Science and Engineering, Hiroshima University)
Hyperbolic knots whose Upsilon invariants are convex

13:40–14:20 Mai Katada (Kyushu University)
The first homology of the IA-automorphism groups of free groups with coefficients in spaces of Jacobi diagrams

14:40–15:20 Renaud Detcherry (Université de Bourgogne) (online)
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Abstract

Sebastian Baader (University of Bern)

Minimal topological cobordisms between even strand torus knots

We determine minimal topological cobordisms between most even- and two-strand torus knots. The Euler characteristic of these cobordisms is given by the difference of the signature invariant. As an application, we show that the signature invariant of even-strand torus knots is minimal among all additive to pological concordance invariants that share the same normalisation.

Renaud Detcherry (Université de Bourgogne) (online)

On the volume conjecture for Turaev-Viro invariants of 3-manifolds

This talk will be a review on the recent advances on the Chen-Yang volume conjecture. This conjecture asserts that the Turaev-Viro invariants of a 3-manifold (possibly with boundary) grow exponentially, and the exponential growth rate should be its simplicial volume. We will explain how this conjecture can be connected to Kashaev-Murakami-Murakami's volume conjecture for colored Jones polynomials, and we will review the different cases that are known. Finally, we will explain some structural results about the exponential growth rate: that it is subadditive under cutting along tori, decreases under Dehn filling, and is bounded by a universal constant times the volume. Finally, we will discuss applications to the AMU conjecture about the detection of pseudo-Anosov mapping classes by quantum representations.

Keisuke Himeno (Graduate School of Advanced Science and Engineering, Hiroshima University)

Hyperbolic knots whose Upsilon invariants are convex

For a knot in 3-sphere, the Upsilon invariant is a concordance invariant derived from knot Floer homology theory. The invariant is a continuous piecewise linear function on [0,2]. Borodzik and Hedden gave a question asking for which knots the Upsilon invariant is a convex function. It is known that the Upsilon invariant of any L-space knot, and a Floer thin knot after taking its mirror image, if necessary, as well, is convex. Also, we can make infinitely many knots whose Upsilon invariants are convex by the connected sum operation. In this talk, we give infinitely many mutually non-concordant hyperbolic knots which provide new answers to Borodzik and Hedden's question.

Andras Juhasz (University of Oxford) (online)
The unknotting number, hard unknot diagrams, and reinforcement learning

We will discuss recent work on using reinforcement learning to study additivity of the unknotting number. As a byproduct, we have obtained many new hard unknot diagrams. This is joint work with Taylor Applebaum, Sam Blackwell, Alex Davies, Thomas Edlich, Marc Lackenby, Nenad Tomasev, and Daniel Zheng.

Mai Katada (Kyushu University)
The first homology of the IA-automorphism groups of free groups with coefficients in spaces of Jacobi diagrams

The Kontsevich invariant takes values in the spaces of Jacobi diagrams. We have an action of the automorphism group $\mathrm{Aut}(F_n)$ of the free group F_n on the space $A_d(n)$ of Jacobi diagrams of degree d on n-component oriented arcs. The IA-automorphism group IA_n of F_n is a normal subgroup of $\mathrm{Aut}(F_n)$. The rational homology of IA_n has been studied but the only case that is completely determined is the first homology. To the best of our knowledge, there is no literature which studies the homology of IA_n with non-trivial coefficients. In this talk, we study the first homology of IA_n with coefficients in $A_2(n)$.

Naoki Kimura (Tokyo University of Science)
Classical invariants and rack coloring invariants of Legendrian knots

Legendrian knots are defined when the ambient 3-manifold is equipped with a contact structure. Legendrian knots are classified up to Legendrian isotopy and Legendrian isotopy classes are finer than knot types. In this talk, we present several invariants of Legendrian knots, including the classical invariants (the Thurston-Bennequin number and the rotation number) and rack coloring invariants.

Hajime Kubota (Kyoto University)
Grid homology and the connected sum of knots

Grid homology is a combinatorial reconstruction of the knot Floer homology. It is an interesting problem whether the known results of knot Floer homology can be shown in the framework of grid homology. In this talk, we will work with the minus flavor of grid homology and show a Künneth formula for the knot Floer homology of connected sums in a combinatorial way. In addition, we will give a combinatorial proof of the additivity of some knot Floer invariants.

Jun Murakami (Waseda University)
On complexified tetrahedron for double twist knots

The shape of a generalized hyperbolic tetrahedron is determined by the data assigned to the edges, the dihedral angles and/or the edge lengths. By complexifying such data, we introduce a complexified tetrahedron. The complement of a double twist knot is decomposed into a union of two congruent complexified tetrahedra, whose edges correspond to some elements of the fundamental group of the knot complement. We propose a way to prove the volume conjecture for double twist knot by using this decomposition.

Makoto Ozawa (Department of Natural Sciences, Faculty of Arts and Sciences, Komazawa University)

Forbidden complexes for the 3-sphere

A simplicial complex is said to be *critical* (or *forbidden*) for the 3-sphere S^3 if it cannot be embedded in S^3 but after removing any one point, it can be embedded.

We show that if a multibranched surface cannot be embedded in S^3, it contains a critical complex which is a union of a multibranched surface and a (possibly empty) graph. We exhibit all critical complexes for S^3 which are contained in $K_5 \times S^1$ and $K_{3,3} \times S^1$ families. We also classify all critical complexes for S^3 which can be decomposed into $G \times S^1$ and H, where G and H are graphs.

In spite of the above property, there exist complexes which cannot be embedded in S^3, but they do not contain any critical complexes. From the property of those examples, we define an equivalence relation on all simplicial complexes $\mathcal{C}$ and a partially ordered set of complexes $(\mathcal{C}/\sim; \subsetneqq)$, and refine the definition of critical. According to the refined definition of critical, we show that if a complex X cannot be embedded in S^3, then there exists $[X'] \subsetneqq [X]$ such that $[X']$ is critical for $[S^3]$.

This is a joint work with Mario Eudave-Muñoz. A preprint is available at arXiv:2403.18279.

Kodai Wada (Kobe University)

The orbit classification of $\mathbb{Z}^m$ by the m-braid group

For an integer $m \geq 2$, the set $\mathbb{Z}^m$ has a natural action of the m-braid group B_m corresponding to Fox colorings for m-braids. In this talk, we provide the orbit classification of $\mathbb{Z}^m$ under the action of B_m by introducing three kinds of invariants of Fox colorings. As an application, we also provide the orbit classification under a natural action of the braid-permutation group BP_m defined by Fenn, Rimányi and Rourke, which corresponds to Fox colorings for virtual braids. This is a joint work with Takuji Nakamura (University of Yamanashi), Yasutaka Nakanishi (Kobe University) and Shin Satoh (Kobe University).

Leo Yoshioka (Graduate School of Mathematical Sciences, The University of Tokyo)

Non-trivial geometric cycles of the space of long embeddings detected by 2-loop graphs

Long embeddings are higher-dimensional analogs of long knots. A certain periodicity motivates us to study cycles of the space of long embeddings in addition to single long embeddings. In 2017, Fresse, Turchin and Willwacher completed a deep homotopy theoretical approach that computes, if the codimension is at least 3, the rational homology of this space using a combinatorial object called graph homology. In this talk, we systematically give geometric cycles of the space of long embeddings associated with 2-loop graphs in their graph homology. We also establish a pairing argument of the cycles with geometric cocycles called configuration space integrals. As an application, we show some of the geometric cycles are non-trivial, even if the codimension is 2. Our results generalize results for 1-loop graphs developed by Bott, Cattaneo, Rossi, Sakai and Watanabe.