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 B 「グラフィクスとカンドル理論の観点からの４次元トポロジーの研究」（課題番号 19H01788、研究代表者 鎌田聖一氏（大阪大学））と科学研究費補助金 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 基盤研究 A 「結び目と３次元多様体の量子トポロジー」（課題番号 16H02145、研究代表者 大槻知忠（京都大学））（繰越）と科学研究費補助金 挑戦的萌芽研究「ゲージ理論に関連する結び目と３次元多様体の不変量と量子トポロジー」（課題番号 16K13754、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：２０２１年 5月１９日 (水)〜 5月２１日 (金)
ホームページ：http://www.kurims.kyoto-u.ac.jp/~ildt/

この研究集会は、オンライン会議システム Zoom を用いて、オンラインで開催します。参加される方は、5 月 7 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。オンライン会議の視聴のために「ネット環境（wifi など）」と「パソコン」が必要です。Zoom の映像配信の通信量は、1 時間あたり 200MB〜300MB 程度の見込みです。（スマホでも、参加自体は可能ですが、講演スライドの文字を読むのは困難とおもわれ、また、通信量もかかるとおもわれることに、ご注意ください。）参加登録方法と参加方法について、詳細は、研究集会ホームページ（上記 URL）をご覧ください。

5月１９日 (水)

13:15〜13:45　河内 明夫 (大阪市立大学数学研究所)
Smooth homotopy 4-sphere

14:00〜14:30　村尾 智 (早稲田大学)
On invariants for handlebody-knots and spatial surfaces

14:45〜15:15　吉田 純 (理化学研究所革新知能統合センター)
On Khovanov homology and Vassiliev theory

5月２０日 (木)

10:30〜11:00　軽尾 浩晃 (京都大学数理解析研究所 / 日本学術振興会特別研究員 DC)
Degenerations of skein algebras and pants decomposition

11:15〜11:45　Julien Korinman (Waseda University / JSPS Research Fellow)
Stated skein algebras

13:15〜13:45　飯田 暢生 (東京大学大学院数理科学研究科), 谷口 正樹 (理化学研究所 iTEHMS)
Seiberg-Witten Floer homotopy and contact structure

14:00〜14:30　村上 順 (早稲田大学)
On quantum character varieties of knots

5月21日 (金)

10:30〜11:00　田神 慶士 (水産大学校)
Annulus presentation and dualizable pattern

11:15〜11:45　和田 康載 (神戸大学大学院理学研究科)
Combinatorial approach to Milnor invariants of welded links

13:15〜13:45　David Leturcq (RIMS, Kyoto University / JSPS Research Fellow)
Knot invariants from diagram counts

14:00〜14:30　渡邉 忠之 (京都大学理学研究科)
Trivalent graphs and diffeomorphisms of some 4-manifolds

組織委員： 河内明夫、河野俊丈、金信泰造、鎌田聖一、大槻知忠
世話人：大槻知忠 (京大 数理研)、秋吉宏尚 (大阪市立大 理学研究科)
協力スタッフ：石川勝巳、石橋典、軽尾浩晃、清水達郎、湯淺亘

Intelligence of Low-dimensional Topology

May 19–21, 2021

This is an online conference whose live streaming is distributed from RIMS, Kyoto University.

Program

May 19 (Wed)

13:15–13:45 Akio Kawauchi (Osaka City Advanced Mathematical Institute)
Smooth homotopy 4-sphere

14:00–14:30 Tomo Murao (Waseda University)
On invariants for handlebody-knots and spatial surfaces

14:45–15:15 Jun Yoshida (RIKEN AIP)
On Khovanov homology and Vassiliev theory

May 20 (Thu)

10:30–11:00 Hiroaki Karuo (RIMS, Kyoto University / JSPS Research Fellow DC)
Degenerations of skein algebras and pants decomposition

11:15–11:45 Julien Korinman (Waseda University / JSPS Research Fellow)
Stated skein algebras

13:15–13:45 Nobuo Iida (The Universitiy of Tokyo), Masaki Taniguchi (RIKEN iTHEMS)
Seiberg-Witten Floer homotopy and contact structure

14:00–14:30 Jun Murakami (Waseda University)
On quantum character varieties of knots

May 21 (Fri)

10:30–11:00 Keiji Tagami (National Fisheries University)
Annulus presentation and dualizable pattern

11:15–11:45 Kodai Wada (Department of Mathematics, Kobe University)
Combinatorial approach to Milnor invariants of welded links

13:15–13:45 David Leturcq (RIMS, Kyoto University / JSPS Research Fellow)
Knot invariants from diagram counts

14:00–14:30 Tadayuki Watanabe (Department of Mathematics, Kyoto University)
Trivalent graphs and diffeomorphisms of some 4-manifolds

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Abstract

Nobuo Iida (The Universitiy of Tokyo), Masaki Taniguchi (RIKEN iTHEMS)
Seiberg-Witten Floer homotopy and contact structure

The contact invariants in monopole/Heegaard Floer theory have been used as effective tools to study 3 dimensional contact topology. Studying symplectic fillings of contact 3-manifolds is a typical problem for which such techniques can be used. We constructed a homotopical refinement of these invariants using Manolescu's idea of Seiberg-Witten Floer homotopy theory. We will explain developments around this invariant and some applications on topology of symplectic fillings, obstruction to codimension 0 embedding, sliceness of knots, exotic pairs of 4-manifolds with boudary, and so on. This is a joint work with Mukherjee Anubhav (Georgia Tech).

Hiroaki Karuo (RIMS, Kyoto University / JSPS Research Fellow DC)
Degenerations of skein algebras and pants decomposition

For a surface with an ideal triangulation, Bonahon and Wong showed that the skein algebra of the surface can be embedded into a quantum torus, where a quantum torus is a non-commutative algebra with nice properties, e.g. it is a Noetherian domain. From their result, a natural question arises. Can we embed the skein algebra of a closed surface into a quantum torus? The problem is still open since their proof uses an ideal triangulation essentially and any closed surfaces have no ideal triangulations. In this talk, we will give an embedding of a "degeneration" of the skein algebra of a closed surface into a quantum torus. This is joint work with Thang T. Q. Le (Georgia Institute of Technology).

Akio Kawauchi (Osaka City Advanced Mathematical Institute)
Smooth homotopy 4-sphere

It is explained how every smooth homotopy 4-sphere is diffeomorphic to the 4-sphere.

Julien Korinman (Waseda University / JSPS Research Fellow)
Stated skein algebras

Skein algebras of surfaces have been introduced in the 80's by Przyticky and Turaev as a tool to study Topological Quantum Field Theories. They are deformation quantization of character varieties and appear in TQFTs through their finite dimensional representations at roots of unity. Despite the apparent simplicity of their definition, the representation theory of these algebras is far from being understood. In this talk, I will present a recent generalization of skein algebras, made by Bonahon-Wong and Le, named stated skein

algebras. Those are algebras associated to marked surfaces, that is surfaces with parameterized arcs in their boundary, which behave well for the operation of gluing two such arcs. They permit to cut surfaces into elementary pieces (like triangles) and considerably simplify the study of skein algebras. I will present recent progress made in the study of these algebras and their representations.

David Leturcq (RIMS, Kyoto University / JSPS Research Fellow)
Knot invariants from diagram counts

Knot invariants defined from diagram counts are studied since the 90s, following the seminal works from Witten, Bar-Natan, and others. These invariants can be defined as linear combinations of integrals on some manifolds called configuration spaces. An element of such a configuration space is a choice of pairwise distinct points on the knot and in the space. We will give a "dual" interpretation in terms of (signed) counts of diagrams with some vertices on the knots, and some constraints on the edges (given by objets called "propagators"). We will focus on the simplest high-dimensional version of these invariants, first introduced by Bott, Cattaneo, and Rossi. We give a more flexible definition, and explain how this allow to compute such invariants, and to connect them to Alexander polynomial(s). On the remaining time, we will present some insights on generalizations of such constructions, most of them are still open.

Jun Murakami (Waseda University)
On quantum character varieties of knots

Quantum character varieties of knots are considered to be constructed from the skein modules of the knot complements. In this talk, we start with the skein algebras of punctured disks, apply the theory of Habiro's bottom tangles to describe the braid group action, and then, to get the quantum character variety of the knot complement, pick up the invariant part of the action of the braid representing the knot. The actions of braids are given by matrices and the quantum character variety is given by relations that the determinants of certain matrices are equal to 0. This method works well for both classical and quantum cases. This is a joint work with Roland van der Veen.

Tomo Murao (Waseda University)
On invariants for handlebody-knots and spatial surfaces

A handlebody-knot is a handlebody embedded in the 3-sphere. The study of genus 1 handlebody-knots is exactly that of classical knots. In this talk, we introduce an invariant for handlebody-knots, called the f-twisted Alexander invariant, derived from an extension of a multiple conjugation quandle, where a multiple conjugation quandle is an algebra whose axioms are motivated from Reidemeister moves for handlebody-knots. Furthermore, as an application, we demonstrate that our invariant detects 4-move equivalence classes of handlebody-knots. Finally, as long as time permits, we will also discuss an invariant for spatial surfaces, which are compact surfaces embedded in the 3-sphere and can be regarded as a generalization of handlebody-knots.

Keiji Tagami (National Fisheries University)
Annulus presentation and dualizable pattern

The 0-trace of a knot is the 4-manifold obtained from the 4-ball by attaching a 2-handle along the knot with 0-framing. There are some techniques to construct distinct knots with the same 0-trace, for example, Gompf-Miyazaki's dualizable patterns and Abe-Jong-Omae-Takeuchi's annulus presentations. Miller-Piccirillo gave a correspondence between dualizable patterns and Abe-Jong-Omae-Takeuchi's annulus presentations. In this talk, we explain a naturality of Miller-Piccirillo's correspondence. Moreover, if time permits, we introduce an extension of dualizable pattern, which is called "r-dualizable pattern", and its properties.

Kodai Wada (Department of Mathematics, Kobe University)
Combinatorial approach to Milnor invariants of welded links

In the 1950s, J. Milnor defined a family of invariants for classical links in the 3-sphere. In 1997, R. Fenn, R. Rimanyi, and C. Rourke introduced the notion of welded links, which is a generalization of classical links. In this talk, we explain how to extend Milnor's invariants to welded links in a combinatorial way. This is a joint work with Haruko Miyazawa and Akira Yasuhara.

Tadayuki Watanabe (Department of Mathematics, Kyoto University)
Trivalent graphs and diffeomorphisms of some 4-manifolds

I will explain a geometric method to construct families of diffeomorphisms of manifolds by using a higher dimensional analogue of Goussarov-Habiro's trivalent graph surgery in 3-dimension. This would produce lots of potentially nontrivial families of diffeomorphisms of manifolds. In particular, our construction gives nontrivial diffeomorphisms of $D^3 \times S^1$ pointwise fixing the boundary. We will also discuss relation to (part of) those of $D^3 \times S^1$ given by Budney and Gabai.

Jun Yoshida (RIKEN AIP)
On Khovanov homology and Vassiliev theory

Khovanov homology is a categorification of Jones polynomial. As Jones polynomial comes from the representation theory of the quantum $sl(2)$, it can be seen as a kind of a categorified quantum invariant. Hence, it is reasonably expected that there is a solid relation between Khovanov homology and Vassiliev type invariants. To attempt this problem, in this talk, I revisit Khovanov homology in view of Vassiliev theory. Although Vassiliev theory is nowadays mainly understood combinatorially, e.g. using chord diagrams, Vassiliev's original work is involved with the study of the cohomology of the knot space. I will show that Khovanov homology gives rise to a "local system" on the knot space. Furthermore, from this viewpoint, the crossing-change morphism can be seen as a wall-crossing in a more straightforward manner. I will also discuss categorified versions of FI and 4T relations. The talk is based on joint work with N. Ito.