Intelligence of Low Dimensional Topology 2006

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ABSTRACT

GENERAL TALKS

Hirotaka Akiyoshi
(Osaka City University Advanced Mathematical Institute)

Ford domain of a certain hyperbolic 3-manifold whose boundary consists of a pair of once-punctured tori

In 1970's, T. Jorgensen characterized in his famous unfinished paper the combinatorial structures of the Ford domains of quasifuchsian punctured torus groups. In the paper he used the "geometric continuity" method which is roughly the method to characterize all possible changes in combinatorial structure while a group gradually deforms. In this talk, I will explain the Jorgensen's work briefly and then talk about an attempt to study the Ford domains of hyperbolic structures on a manifold, which has a pair of punctured tori as boundary but is not the product of the punctured torus and the interval, by using the geometric continuity method. Some numerical result will also be exhibited which determine the combinatorial structures of the Ford domains of a series of Kleinian groups connecting a simple one and one corresponding to a subgroup of a Kleinian group of finite covolume.

Nafaa Chbili
(Osaka City University Advanced Mathematical Institute and Monastir University)

Toward an equivariant Khovanov homology

In this talk, we shall explain how to construct an equivariant Khovanov homology for symmetric links. This construction is better described in terms of the categorification of the Kauffman bracket skein module of the solid torus.

Thomas Fleming and Akira Yasuhara
(University of California San Diego and Tokyo Gakugei University)

Milnor's Isotopy Invariants and Generalized Link Homotopy

It has long been known that a Milnor invariant with no repeated index is an invariant of link homotopy. We show that Milnor's invariants with repeated indices are invariants not only of isotopy, but also of self C_k-moves. A self C_k-move is a natural generalization of link homotopy based on certain degree k clasper surgeries, which provides a filtration of link homotopy classes.

Hiroshi Goda
(Tokyo University of Agriculture and Technology)

Some estimates of Morse-Novikov number of knots and links

Let L be an oriented link in the 3-sphere S^3. The link L is called *fibred* if there is a fibration $\phi : C_L = S^3 \backslash L \to S^1$ behaving 'nicely' in a neighborhood of L. If L is not fibred, it is still possible to construct a Morse map $f : C_L \to S^1$ behaving nicely in a neighborhood of L; such a map has necessarily a finite number of critical points. The minimal number of critical points of such map is an invariant of the link, called *Morse-Novikov number* of L and denoted by $\mathcal{MN}(L)$. In this talk, we discuss some estimates of $\mathcal{MN}(L)$.

Mikami Hirasawa
(Gakushuin University)

Obtaining string-minizing, length-minimizing braid words for 2-bridge links

Let L be an oriented 2-bridge knot or link. In 1991, Murasugi determined the braid index of L, using Morton-Franks-Williams' inequality and Yamada's algorithm. In this talk,we improve the argument and give a quick algorithm to obtain a minimal index braid word for L. We show that a word thus obtainded is of minimal length among those written in terms of the 'extended set of generators' consisting of the usual generators b_j plus words of the form Wb_jW^{-1}, where $W = b_i b_{i+1} \cdots b_{j-1}$.

Atsushi Ishii
(Osaka University)

Smoothing resolution for the Alexander-Conway polynomial

We introduce a new kind of smoothing such that we obtain a disjoint union of framed circles and a framed path after we smooth all crossings of a $(1, 1)$-tangle diagram. By using such a smoothing, we reconstruct the Alexander–Conway polynomial in a manner similar to the way the Jones polynomial is constructed by using the Kauffman bracket polynomial.

Masahide Iwakiri
(Hiroshima University)

Quandle cocycle invariants of torus links

In this talk, we calculate quandle cocycle invariants of torus links associated with dihedral quandles, which is calculated by S. Asami and S. Satoh when they are torus knots.

Teruhisa Kadokami
(Osaka City University Advanced Mathematical Institute)

Reidemeister torsion and Seifert surgeries on knots in homology 3-spheres

We investigate Reidemeister torsions of the result of Seifert surgeris along knots in homology 3-spheres. To state our results, we raise new concepts which relate with an invariant for Dehn surgery along a knot. Then we have the following theorems: (1) values of Alexander polynomials at roots of unities have informations of singular fibers, (2) our new concepts are characterized by singular fibers in the case of Seifert surgeries.

Naoko Kamada
(Osaka City University)

Miyazawa polynomials of virtual knots and virtual crossing numbers

We made a table of virtual knots whose real crossing numbers are equal or less than 4. The virtual crossing numbers of more than half of virtual knots in the table are determined by use of Miyazawa polynomials.

Seiichi Kamada
(Hiroshima University)

Quandles with good involutions, their homologies and knot invariants

Quandles and their homologies are used to construct invariants of oriented knots or oriented surface knots in 4-space. On the other hand, the knot quandle can be defined to the case where knots or surface knots are not oriented. Here we introduce the notion of a quandle with a good involution, and its homology groups. We use them to construct invariants of unoriented knots and unoriendted, or non-orientable, surface knots in 4-space.

Taizo Kanenobu
(Osaka City University)

Finite type Invariants of order 4 for 2-component links

We express a basis for the space of finite type invariants of order less than or equal to four for two-component links in terms of the Conway polynomial, the linking number, and the HOMFLYPT polynomial. As an application, we give some formulas relating to the Kauffman polynomial.

Yasushi Kasahara
(Kochi University of Technology)

Remarks on the faithfulness of the Jones representations

We consider the linear representations of the mapping class group of an n-punctured 2-sphere, constructed by V. F. R. Jones using Iwahori–Hecke algebras of type A. We show that their faithfulness is equivalent to that of certain related Iwahori–Hecke algebra representation of braid groups. In the case of n=6, we provide a further restriction for the kernel, using our previous result on a related representation of the mapping class group of genus 2. We will also touch upon a possible relation with a fake unknot for the Jones polynomial.

Kenichi Kawagoe
(Kanazawa University)

Limits of the HOMFLY polynomial of the Figure-eight knot.

We consider the volume conjecture by the HOMFLY polynomial insted of the Jones polynomial. As the HOMFLY polynomial has two parameters, the asymptotic behavior of it change from 0 to a certain value according to one parameter. As a corollay, limits of the HOMFLY polynomial derived from quantum groups coincide with those of the Jones polynomial, which is the volume of the Figure-eight knot.

Tomomi Kawamura
(Aoyama Gakuin University)

Various Bennequin inequalities on link invariants

We improve the Bennequin inequalities on the slice euler characteristics and the gordian numbers for links, and on certain integer-valued knot invariants. Furthermore, we estimate the Rasmussen invariants for links extended by Beliakova and Wehrli.

Keiko Kawamuro
(Columbia University)

The algebraic crossing number and the braid index of knots and links

It has been conjectured that the algebraic crossing number of link is uniquely determined in minimal braid representation. This conjecture is true for many classes of knots and links.

The Morton-Franks-Williams inequality gives a lower bound for braid index. And sharpness of the inequality on a knot type implies the truth of the conjecture for the knot type.

We prove that there are infinitely many examples of knots and links on which the inequality is not sharp, but the conjecture is still true in these cases. We also show that if the conjecture is true for K and L, then it is also true for the (p, q)-cable of K and for the connect sum of K and L.

Akio Kawauchi
(Osaka City University)

On the surface-link groups

The set of the fundamental groups of n-dimensional manifold-links in S^{n+2} for $n > 2$ is equal to the set SLG of the fundamental groups of surface-links in S^4. We consider the subset $SLG^r_g(A) \subset SLG$ consisting of the fundamental groups of r-component, total genus g surface-links with $H_2(G) \cong A$. By examining the duality theorems for the integral homology of an infinite cyclic covering of a compact oriented manifold, we show that the set $SLG^r_g(A)$ is a non-empty proper subset of $SLG^r_{g+1}(A)$ for every integer $g \geq 0$ and every abelian group A generated by $2g$ elements. We also determine the set $SLG^r_g(A)$ to which the fundamental group of every classical link belongs, and investigate the set $SLG^r_g(A)$ to which the fundamental group of every virtual link belongs.

Teruaki Kitano and Masaaki Suzuki
(Soka University and Akita University)

On the existence of a surjective homomorphism between knot groups

A partial order on the set of the prime knots can be defined by the existence of a surjective homomorphism between the knot groups. Kitano-Suzuki-Wada showed that if there exists a surjective homomorphism between knot groups, then the twisted Alexander polynomials have some property. As an application, we determined all the partial order in the Rolfsen's knot table. In this talk, we will discuss some further results and observations. 1. The trefoil knot and the figure eight knot are minimal in this partial order. 2. Some pairs in this partial order can be realized by periodic knots and degree one maps. 3. In the Rolfsen's table there exists no surjective homomorphism from a knot group to that of a knot with more crossings. We can observe the same result about alternative knots with up to 11 crossings.

Yuya Koda
(Keio University)

Strongly-cyclic branched coverings and the Alexander polynomial of knots in rational homology spheres

Let K be a knot in a rational homology sphere M. In this talk we correlate the Alexander polynomial of K with a g-word cyclic presentation for the fundamental group of the strongly-cyclic covering of M branched over K. We also give a formula for the order of the first homology group of the strongly-cyclic branched covering. Our method provides an easy way to calculate the Alexander polynomial when $(g, 1)$-decompositions of knots are given.

Sang Youl Lee
(Pusan National University)

Invariants of surface links in $\mathbb{R}^4$ via classical link invariants

For a given invariant of classical links in 3-space $\mathbb{R}^3$ with its values in a commutative ring R, we construct a polynomial $L_D(x, y, z) \in R[x, y, z]$ for a Yoshikawa's surface diagram D of a smoothly imbedded closed surface in 4-space $\mathbb{R}^4$ via a state-sum model and discuss some such examples. In particular, we will show that a certain congruence class of the polynomial $L_D(x, y, z) \in \mathbb{Z}[A^{-1}, A][x, y, z]$ obtained from the Kauffman bracket polynomial is an invariant of surface imbeddings in $\mathbb{R}^4$.

Jean-Baptiste Meilhan
(RIMS, Kyoto University)

Surgery along Brunnian links in 3-manifolds.

We consider surgery moves along $(n+1)$-component Brunnian links in compact connected oriented 3-manifolds, where the framing of the components is in $\{\frac{1}{k}; k \in \mathbb{Z}\}$. We show that no finite type invariant of degree $<2n-2$ can detect such a surgery move.

Yasuyuki Miyazawa
(Yamaguchi University)

The Yamada polynomial for virtual graphs

As an extension of the Yamada polynomial for spatial graphs, we construct a polynomial invariant for virtual graphs whose maximum degrees are less than 4, where a virtual graph means a spatial graph diagram possibly with virtual crossings. Since a virtual link can be regarded as a virtual graph having no vertex, the extended Yamada polynomial works for virtual links. It is known that the Yamada polynomial for a classical knot is derived from the Jones polynomial of 2-paralleled link of the knot. As for a virtual knot, we will show that Yamada's formula above does not always hold.

Hiroko Murai
(Nara Women's University)

On the construction of the finite depth foliations on the 3-manifolds

In this talk, we construct codimension one foliations on $\Sigma^{(n)}(K, 0)$, the n-fold cyclic covering space of $S^3(K, 0)$, where $S^3(K, 0)$ denotes the manifold obtained from S^3 by performing 0-surgery on a knot K. Then we see the relation between the depth of the foliation and "gap", which is introduced in this talk, of the depth of the leaves.

Walter Neumann
(Columbia University)

Complex analytic realization of links (joint work with Anne Pichon)

Let Σ be a 3-manifold which is the link (neighborhood boundary) of a point p in a complex surface V. We ask under what conditions a knot or link $L \subset \Sigma$ can be realized by the zero set of some analytic function germ $f : (V, p) \to (\mathbb{C}, 0)$. When Σ is a homology sphere the question has application to the Casson invariant conjecture. In this case the answer is classical for $\Sigma = S^3$ and is otherwise known only for links in the Poincaré-sphere $\Sigma(2, 3, 5)$ and for knots in $\Sigma(2, 3, 7)$ and $\Sigma(2, 3, 11)$. (With Anne Pichon.)

Ryo Nikkuni
(Kanazawa University)

Achirality of spatial graphs and the Simon invariant

The Simon invariant of spatial complete graphs on 5 vertices (resp. spatial complete bipartite graphs on $3 + 3$ vertices) is an odd integer valued invariant which can be calculated from their regular diagrams, like the linking number. In this talk we show that if a spatial complete graph on 5 vertices (resp. spatial complete bipartite graph on $3 + 3$ vertices) is achiral then its Simon invariant is not congruent to -3 and 3 modulo 8. We also give an example of achiral spatial complete graph on 5 vertices whose Simon invariant is 7, and an example of achiral spatial complete bipartite graph on $3+3$ vertices whose Simon invariant is 9.

Jun O'Hara
(Tokyo Metropolitan University)

The configuration space of a spider

The configuration space of the mechanism of a planar robot is studied. We consider a robot which has n arms such that each arm is of length $1 + 1$ and has a rotational joint in the middle, and that the endpoint of the k-th arm is fixed to $Re^{\frac{2k\pi}{n}i}$. Generically, the configuration space is diffeomorphic to an orientable closed surface. Its genus is given by a topological way and a Morse theoretical way. The homeomorphism types of it when it is singular is also given.

Takuya Sakasai
(Graduate School of Mathematical Sciences, The University of Tokyo)

Higher-order Alexander invariants for homology cobordisms of a surface

The set of homology cobordisms of a surface has a natural monoid structure. We give an application of higher-order Alexander invariants, which originated with Cochran and Harvey, to this monoid by using its Magnus representation.

Makoto Sakuma
(Osaka University)

Epimorphisms between 2-bridge link groups (joint work with Tomotada Ohtsuki and Robert Riley)

We give a systematic construction of epimorphisms among 2-bridge link groups, and show that they are realized by "nice" continuous maps. As an application, we give a sufficient condition for the character variety of a 2-bridge link group to be reducible. As another application, we construct a closed orientable hyperbolic 3-manifold (of π_1- rank 2) which has degree 0 maps to infinitely many hyperbolic 3-manifolds (of π_1-rank 2), inducing epimorphisms among the fundamental groups. This gives a positive answer to a question of Gonzalez-Acuna and Raminez, which asks if there is a hyperbolic counter-example to a question proposed by Reid, Wang and Zhou.

Shin Satoh
(Kobe University)

Sheet numbers and cocycle invariants of surface- knots

Abstract of your talk: A knotted surface in 4-space is called a surface-knot, which is described by a diagram through a projection of 4-space onto 3-space. Such a diagram is regarded as a disjoint union of compact connected surfaces, called sheets. The sheet number of a surface-knot is the minimal number of sheets for all possible diagrams of the knot. We give a lower bound of the sheet number by using the quandle cocycle invariant of a surface-knot, and prove that the sheet numbers of the 2- and 3-twist-spun trefoils are equal to 4 and 5, respectively.

Reiko Shinjo
(Osaka City University Advanced Mathematical Institute)

An infinite sequence of non conjugate 4-braids representing the same knot of braid index 4

We showed the following before:

For any knot represented as a closed n-braid ($n \geq 3$), there exists an infinite sequence of pairwise non conjugate $(n+1)$-braids representing the knot.

Using the same technique, we construct such an infinite sequence of pairwise non conjugate 4-braids for some knots of braid index 4. As a consequence, we verify that M. Hirasawa's candidate of such a sequence of braids is actually an infinite sequence.

Alexander Stoimenow
(Research Institute for Mathematical Sciences Kyoto University)

Mutation and the colored Jones polynomial (joint work with Toshifumi Tanaka)

We show examples of knots with the same polynomial invariants and hyperbolic volume, with variously coinciding 2-cable polynomials and colored Jones polynomials, which are not mutants.

Kokoro Tanaka
(University of Tokyo)

A note on C1-moves

S. Kamada introduced the notion of a chart which is a tool for describing a surface braid, where a chart is an oriented labelled graph in a 2-disk satisfying some conditions. He defined moves for charts, called C-moves, which consist of three classes of moves: a C1-move, a C2-move and a C3-move, and proved that there exists a one-to-one correspondence between the equivalence classes of surface braids and the C-move equivalence classes of charts. J. S. Carter and M. Saito proved that any C1-move can be realized by a finite sequence of seven types of elementary C1-moves, but there are some ambiguous arguments in their proof. The purpose of this talk is to give a pricise proof for their assertion.

Motoo Tange
(Kyoto University)

On the applications of correction term to lens space

Ozsvath and Szabo defined an invariant, correction term for any rational homology sphere. We apply this invariant to lens surgery problem.

Ikuo Tayama
(Osaka City University)

Enumerating $3-$manifolds by a canonical order

This work is a joint work with A. Kawauchi. A well-order (called a *canonical order*) was introduced in the set of links by A. Kawauchi [K] (see also A. Kawauchi and I. Tayama [KT]). This well-order also naturally induces a well-order in the set of exteriors of prime links and eventually induces a well-order in the set of closed connected orientable 3-manifolds.

We assign to every link a lattice point whose length is equal to the minimal crossing number on closed braid forms of the link. We call this number the *length* of the link. We note that a link L is smaller than a link L' in the canonical order if the length of L is smaller than that of L', and for any natural number n there are only finitely many links with lengths up to n. We define the *length* of a prime link exterior as the minimal length of a prime link whose exterior is homeomorphic to the given prime link exterior. Then the *length* of a closed connected orientable $3-$manifold is the minimal length on prime link exteriors realizing the $3-$manifold as the 0 surgery manifold along the prime link.

By the canonical order, we enumerated the prime links with up to length 10 and the exteriors of prime links with up to length 9. We are now enumerating the $3-$manifolds with up to length 9. In this talk, we give our latest result and show an application of our study.

References

[K] A. Kawauchi, A tabulation of 3-manifolds via Dehn surgery, Boletin de la Sociedad Matematica Mexicana (3) 10 (2004), 279–304.

[KI] A. Kawauchi and I. Tayama, Enumerating prime links by a canonical order, Journal of Knot Theory and Its Ramifications Vol. 15, No. 2 (2006) 217–237

Yasuyoshi Tsutsumi
(Osaka Institute of Technology)

The Casson-Walker invariant and some strongly periodic link

Let M be a rational homology 3-sphere. Let K be a null-homologus knot in M. In this talk, we compute the Casson-Walker invarinat of the cyclic covering space of M branched over K.

Yukihiro Tsutsumi
(Sophia University)

Free genus one knots with large Haken numbers

It is shown that for a positive integer g, there is a free genus one knot which admits mutually disjoint and mutually non-equivalent $g+1$ incompressible Seifert surfaces each of genus g. As an application we show that for a positive integer g, the genus two handlebody contains mutually disjoint and mutually non-isotopic $g+1$ separating incompressible surfaces each of genus g.

Yoshikazu Yamaguchi
(Graduate School of Mathematical Science, University of Tokyo)

limit values of the non-abelian twisted Reidemeister torsion associated to knots

The differential coefficient of the abelian Reidemeister torsion of a knot exterior at a bifurcation point of the $SL(2,\mathbb{C})$-representation variety of its knot group corresponds a limit value of the non-abelian twisted Reidemeister torsion of the knot exterior. I would like to explain this relationship. This relation was suggested in math.GT/0510607 by J. Dubois and R. Kashaev at first.

Ryosuke Yamamoto
(Osaka City University)

Overtwisted open books and Stallings twist

We discuss a characterization of "overtwisted open books" on a closed oriented 3-manifold, i.e., open book decompositions corresponding to overtwisted contact structures via the Giroux's one-to-one correspondence. We focus on a simple closed curve on fiber surface of an open book along which one can perform Stallings twist, and see that a given open book is overtwisted if and only if it is equivalent to an open book with Stallings twist up to positive stabilization, i.e., plumbing a positive Hopf band to the fiber surface.

Masayuki Yamasaki
(Okayama University of Science)

Knots and 4-dimensional topological surgery

Let K be a knot in S^3, and $E(K)$ be its exterior. Then $M(K) = \partial(E(K) \times D^2)$ is a 4-manifold whose fundamental group is isomorphic to the knot group of K. Hegenbarth and Repovš showed that topological surgery obstruction theory works for $M(K)$ when K is a torus knot. In this talk, I will show that their argument works for any knot.

Tsukasa Yashiro
(University of Auckland, New Zealand)

Cell-complexes for surface-knots and surface-knot groups

A surface-knot is an embedded closed connected oriented surface in 4-space. A surface diagram is a projected image of a surface-knot into 3-space with crossing information. In this talk we define a cell-complex for a surface diagram as a combinatorial presentation. The index of surface diagram is defined as the rank of the second homology group of the cell-complex. We prove that for a 2-knot with non-trivial knot group and triple point number 4, if its minimal surface diagram has the index 1, and 4 branch points, then the surface-knot group has a presentation of the 2-twist-spun trefoil group.

Kouichi Yasui
(Osaka University)

An exotic rational surface without 1- or 3-handles

Harer-Kas-Kirby conjectured that the Dolgachev surface $E(1)_{2,3}$ requires both 1- and 3-handles in any handle decomposition. In this talk, we construct a smooth 4-manifold, which admits a handle decomposition without 1- or 3-handles and has the same homeomorphism type and Seiberg-Witten invariant as $E(1)_{2,3}$, by using Kirby calculus and rational blow-down. There is a possibility that this is a counter example of their conjecture. But if their conjecture is true, we can distinguish the smooth structures by their respective number of 1-handles.
