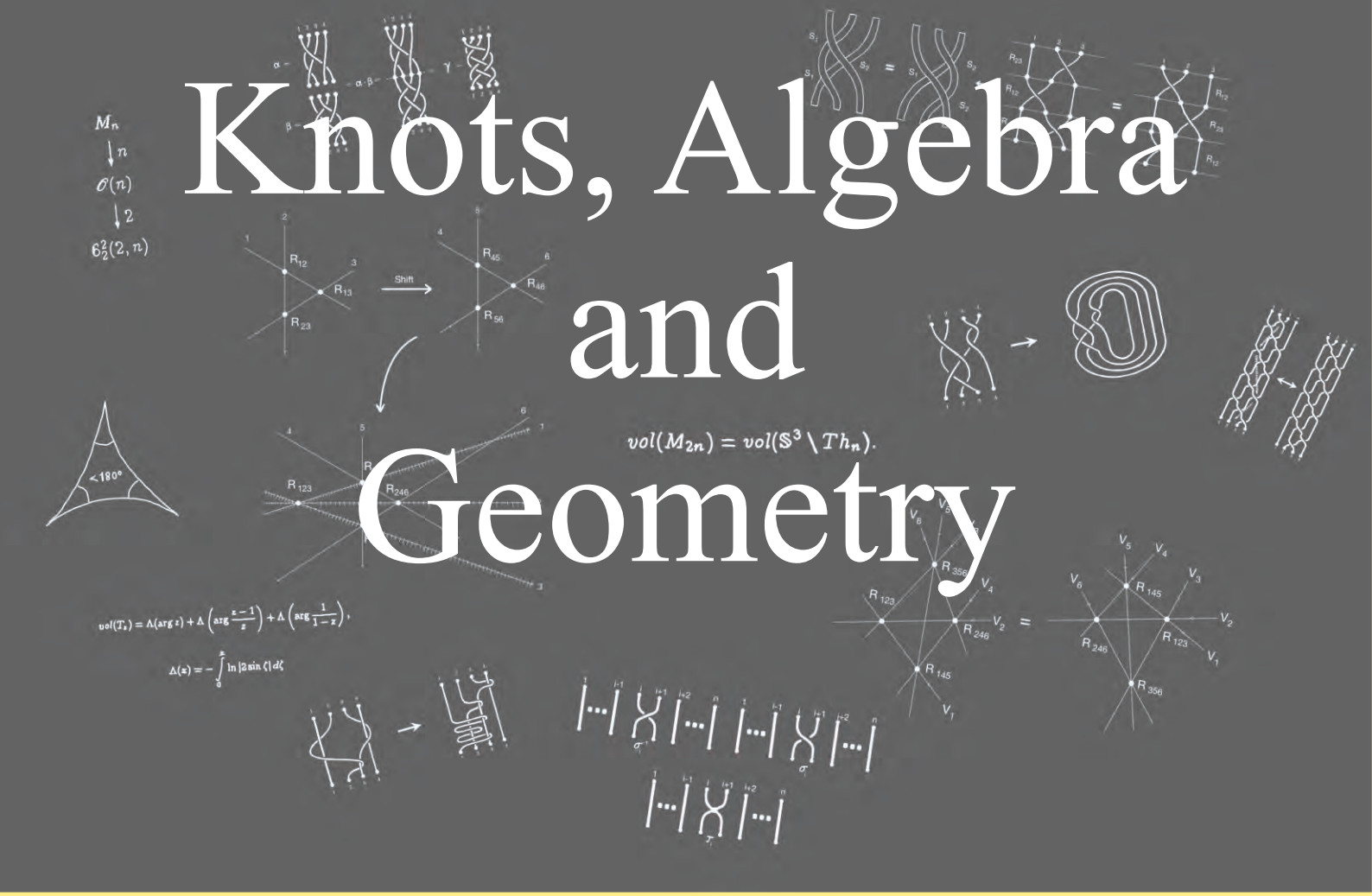
Knots, Algebra and Geometry



Online conference
on the occasion of 60th birthdays of
Valeriy Bardakov and Andrei Vesnin

Program and Abstracts

March 17-19, 2023

KNOTS, ALGEBRA AND GEOMETRY

Online conference on the occasion of 60th birthdays of Valeriy Bardakov and Andrei Vesnin

The online meeting will celebrate Prof. Valeriy Bardakov and Prof. Andrei Vesnin turning 60 this year. The meeting will focus on interactions between topology, geometry and algebra, specifically, from the point of view of low dimensional topology, the topics in which both Valeriy and Andrei have profound contributions.

Key topics include but are not limited to the following:

- Geometric structures on manifolds and orbifolds
- Classical and virtual knots
- Algebraic structures in knot theory
- Applications of the theory of 3-manifolds

ORGANIZERS

Nikolay Abrosimov (Sobolev Institute of Mathematics)

Krishnendu Gongopadhyay (IISER Mohali)

Tatyana Kozlovskaya (Tomsk State University)

Timur Nasybullov (Sobolev Institute of Mathematics)

Madeti Prabhakar (IIT Ropar)

Mahender Singh (IISER Mohali)

Web-page: https://sites.google.com/view/knots-algebra-geometry

Friday, March 17

Schedule of talks according GMT+7 time zone

Zoom: https://us02web.zoom.us/j/83636573209?pwd=c2dwSml4cWpKZVdjb2tSdlpmNXljQT09
Conference ID: 836 3657 3209
Pass code: 752392

10:30 – 11:10	**Akio Kawauchi** *Ribbonness of Kervaire's sphere-link in homotopy 4-sphere and Whitehead aspherical conjecture*
11:20 – 11:50	**Jie Wu** *Homotopy Patterns and Cablings on Braids*
11:50 – 17:20	**Long break**
17:20 – 17:50	**Dmitry Talalaev** *Alternative algebraic structures in low-dimensional topology*
18:00 – 18:40	**Carlo Petronio** *Realizability of Hurwitz branch data with a length-2 partition*

Saturday, March 18

Schedule of talks according GMT+7 time zone

Zoom: https://us02web.zoom.us/j/83636573209?pwd=c2dwSml4cWpKZVdjb2tSdlpmNXljQT09
Conference ID: 836 3657 3209
Pass code: 752392

09:50 – 10:20	**Ualbai Umirbaev** *Representations via differential algebras and equationally Noetherian algebras*
10:30 – 11:10	**Louis H. Kauffman** *Mock Alexander Polynomials*
11:20 – 11:50	**Mohamed Elhamdadi** *Invariants of knots and links from idempotents in quandle rings*
11:50 – 16:40	**Long break**
16:40 – 17:10	**Zoran P. Rakić** *On a model of nonlocal de Sitter Gravity and its solutions*
17:20 – 17:50	**Vladimir Vershinin** *On our joint works with Valerii on braids*
18:00 – 18:40	**Vladimir Turaev** *Quasi-Lie bialgebras of loops in quasi-surfaces*

Sunday, March 19

Schedule of talks according GMT+7 time zone

Zoom: https://us02web.zoom.us/j/83636573209?pwd=c2dwSml4cWpKZVdjb2tSdlpmNXljQT09
Conference ID: 836 3657 3209
Pass code: 752392

10:30 – 11:10	**Seiichi Kamada** *On braid presentation of twisted links and spatial graphs*
11:20 – 11:50	**Manoj Yadav** *Skew Braces*
11:50 – 16:40	**Long break**
16:40 – 17:10	**Paolo Bellingeri** *Groups of cacti and planar braids*
17:20 – 17:50	**Vsevolod Gubarev** *Rota-Baxter groups and braces*
18:00 – 18:40	**Sophia Lambropoulou** *From plat closure to standard closure of braids and back*

ABSTRACTS

Groups of cacti and planar braids

Paolo Bellingeri
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Already known as quasi-braid groups, Henriques and Kamnitzer defined cactus groups in terms of actions on tensor products in cobordism categories. If group presentations are known for these groups, their combinatorial properties and the relationships with braid groups are not yet fully understood.

In this talk we will explore some first results of a combinatorial nature.

Based on joint works with Hugo Chemin & Victoria Lebed and Eddy Godelle & Luis Paris.

Rota-Baxter groups and braces

Vsevolod Gubarev
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We study the connection between recently defined Rota-Baxter groups and skew left braces, generalizations and applications of this connection.

Invariants of knots and links from idempotents in quandle rings

Mohamed Elhamdadi
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We will discuss some new results about idempotents in quandle rings. We will show how idempotents can be used to obtain invariants of knots and links. The results are based on joint works with Brandon Nunez, Mahender Singh and Swain Dipali.

On braid presentation of twisted links and spatial graphs

Seiichi Kamada
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Twisted links are defined by using link diagrams on a plane possibly with virtual crossings and bars modulo a generalization of Reidemeister moves, and they correspond to stable equivalence classes of link in oriented thickenings of surfaces. We discuss Alexander and Markov theorem for twisted links. This is a joint work with Madeti Prabhakar and Komal Negi. And we also introduce Alexander and Markov theorem for spatial graphs. This is bases on a joint research work with V. Lebed during her visit to Osaka as JSPS post-doc fellow.

Mock Alexander Polynomials

Louis H. Kauffman
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This talk will discuss generalizations of the Alexander-Conway polynomial to starred knots (starred regions correspond to holes in a thickened surface), knotoids, virtual knots and knots in thickened surfaces. The Mock Alexander Polynomials can be defined on diagrams whenever the number of faces in the diagram is equal to the number of crossings. Our generalizations use state summations that can be expressed in terms of permanents of matrices associated with the diagrams of the starred entities. These state summations generalize structures in the author's monograph Formal Knot Theory giving state models for the Alexander-Conway polynomial. We will show by examples how the state sums we are using go beyond the determinant formulations of the original Alexander polynomial and will give a number of new examples of computations and formulations of the invariants. We discuss the relationships of skein theory, state sums, classical models and conjectured generalizations of the Fox-Milnor theorem for these invariants.

This talk is joint work with Neslihan Gugumcu.

Ribbonness of Kervaire‘s sphere-link in homotopy 4-sphere and Whitehead aspherical conjecture

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Kervaire's spherical link in homotopy 4-sphere is identified with a ribbon sphere-link in 4-sphere. By developing this idea, Whitehead aspherical conjecture is claimed to be true.

From plat closure to standard closure of braids and back

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Given a knot or link in the form of the plat closure of a braid, we describe an algorithm to obtain a braid representing the same link with the standard closure, and vice-versa. We analyze the three cases of links: in R^3, in handlebodies and in thickened surfaces. We show that the algorithm is quadratic in the number of crossings and loop generators of the braid when passing from plat to standard closure, while it is linear when passing from standard to plat closure. Each type of closure has its advantages. For example the plat closure is most suitable when representing a c.c.o. 3-manifold by its handle decomposition, whilst the standard closure is most suitable when representing a c.c.o. 3-manifold by a surgery description.

This is joint work with Paolo Cavicchioli (U Modena).

Realizability of Hurwitz branch data with a length-2 partition

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To a branched cover $f : \tilde{\Sigma} \to \Sigma$ between closed surfaces one can associate a combinatorial datum given by the surfaces themselves up to homeomorphism, the degree d of f, the number n of branching points of f and the partitions $\left\{\pi_i = \left[d_{ij}\right]_{j=1}^{m_i}\right\}_{i=1}^{n}$ of d given by the local degrees of f at the preimages of the branching points. This datum must satisfy the Riemann-Hurwitz condition plus some extra ones if either $\tilde{\Sigma}$ or Σ or both are non-orientable. A very old question of Hurwitz asks whether a combinatorial datum satisfying the necessary conditions is actually realizable (namely, associated to some existing f) or not (in which case it is called exceptional). The answer is now known in a vast number of cases. In particular, it is always in the affirmative if Σ is orientable and not the sphere. Moreover, the case of a non-orientable Σ can be reduced to the case of an orientable one. And the answer is also affirmative if Σ is the sphere and one of the partitions π_i has length 1. We will concentrate here on the case where Σ is the 3-sphere and one of the partitions π_i has length 2. A complete answer in this case was provided by Pakovich when $\tilde{\Sigma}$ is also the sphere, and we will give a thorough solution for the case of an arbitrary $\tilde{\Sigma}$. Our argument uses Pakovich's statement and an induction on both the genus of $\tilde{\Sigma}$ and the number n of branching points. This is joint work with Filippo Gianni Baroni.

On a model of nonlocal de Sitter Gravity and its solutions

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Despite to all significant gravitational phenomena discovered and predicted by general theory of relativity, it is not a complete theory. One of actual approaches towards more complete theory of gravity is its nonlocal modification.

We consider nonlocal modification of the Einstein theory of gravity in framework of the pseudo-Riemannian geometry. The nonlocal term has the form H(R)F(□)G(R), where H and G are differentiable functions of the scalar curvature R, and F(□) = $\sum_{n=0}^{\infty} f_n \Box^n$ is an analytic function of the d'Alambert operator □.
After consideration of several models of the above-mentioned type, here we deal with H(R) = G(R) = $\sqrt{R - 2\Lambda}$, and where F(□) is an analytic function of the d'Alembert operator □ and also $\Box^{-1}$. Specially, we searching several classes of scaling factors, and we nd some new exact cosmological solutions. We are paid our attention to the scaling factor of the form $a(t) = At^{\frac{2}{3}}e^{\frac{\Lambda}{14}t^2}$, and we test validity of obtained solutions with experimental data and their interpretations.

Alternative algebraic structures in low-dimensional topology

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The field of quantum invariants of knots, which is an example of a very interesting modern cross-disciplinary mathematical theory, was motivated purely by topological problems, but stimulated significant progress in algebra and the theory of integrable systems. In addition to the theory of quantum groups based on the Yang-Baxter equation, the problem of quantum invariants has higher analogues associated with the higher n-simplex equations. In a broader sense, the theory of quantum invariants can be considered as a program for the algebraization of topological invariants. Along this path, a large number of interesting algebraic structures have already emerged, finding their place in algebra, topology and the theory of integrable systems. Such structures include: quandles, racks, braces, rack bialgebras, infinitesimal bialgebras.

In this overview report, I will talk about generalizations of the problem of quantum invariants to higher dimensions, as well as to the listed alternative algebraic structures. Some of the results presented were obtained jointly with V.G. Bardakov.

Quasi-Lie bialgebras of loops in quasi-surfaces

Vladimir Turaev
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A quasi-surface is obtained by gluing a surface Σ to an arbitrary topological space along a mapping of several disjoint subsegments of $\partial\Sigma$ to that space. We define and investigate operations on free homotopy classes of loops in a quasi-surface similar to the standard Lie bracket and Lie cobracket of free homotopy classes of loops in a surface.

Representations via differential algebras and equationally Noetherian algebras

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We show that free algebras of the variety of algebras generated by the Witt algebra W_n, the left-symmetric Witt algebra L_n, and the symplectic Poisson algebra P_n can be described as subalgebras of differential polynomial algebras with respect to appropriately defined products. Using these representations, we prove that W_n, L_n, P_n, and the free algebras of the varieties of algebras generated by these algebras are equationally Noetherian.

This is joint work with A.A. Mikhalev and M. Mustafa

On our joint works with Valerii on braids

Vladimir Vershinin
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The talk is a survey of joint works starting with the paper of 2012 on Brunnian braids and till the last one of 2022 on homotopy braids.

Homotopy Patterns and Cablings on Braids

Jie Wu
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The notion of homotopy pattern was recently introduced by Roman Mikhailov in the Proceedings of the ICM 2022. In this talk, we will give an introduction to the homotopy patterns in group theory proposed by Mikhailov as well as a recent solution of Laurent Bartholdi and Roman Mikhailov to a longstanding dimension problem in group theory using homotopy theory. Moreover, we will give a report of my joint works with Valeriy Bardakov, Volodia Vershinin and others on the topic such as cablings on braids.

Skew Braces

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We'll present some procedures of constructing skew left braces and its applications. Its connection with set-solutions of Yang-Baxter Equation / braided relation will be explained.

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