ABSTRACTS

Speaker: **Sergey Matveev**
Title: Complexity theory of 3-manifolds and its tabulation.

Abstract: We short describe the definition of complexity and we give as an example of application the table of closed irreducible orientable 3-manifolds of complexity ≤ 13.
The concept of complexity turned out to be useful both for algorithmic recognition of manifolds and for their efficient tabulation.
Def. Let Q be a class of geometric objects. By *complexity function* on Q we mean a map c: $Q \to \mathbb{N} \cup \{0\}$ to the set of non-negative integers.
Desirable properties of complexity: *naturalness*: c agrees with complexity in non-formal meaning of the expression, and c is decreased under *simplification* moves: *finiteness*: the number of objects having a fixed complexity is *finite*.
Complexity of 3-manifolds c: $M \to \mathbb{N} \cup \{0\}$ has the following properties: a) c is additive: $c(M_1 \# M_2) = c(M_1) + c(M_2)$; b) finiteness property; c) $c(M)$ is easy to estimate.
The table shows the number of 3-manifolds depending on the complexity.

c	0	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
N(c)	3	2	4	7	14	31	74	175	436	1154	3078	8421	23448	66197	103041

Our table was created in three steps. Firstly, we have enumerated all manifolds of complexity ≤13. More precisely, we have enumerated their special spines with ≤13 real vertices. The obtained list contained many duplicates. Finally, we have removed all duplicates.
The ``inner'' language of our algorithm and of our computer program is based on the theory of special spines, but of course our program understands also many other popular combinatorial ways of describing the manifolds (for example, surgery presentation and singular triangulation) automatically translating them to the language of special spines.
This is a joint work with V.V. Tarkaev.

Speaker: **Krishnendu Gongopadhyay**
Title: On some decomposition of singular braid groups.

Abstract: Let SB_n be the singular braid group generated by braid generators σ_i and singular braid generators τ_i, $1 \leq i \leq n-1$. Let ST_n denote the group that is the kernel of the homomorphism that maps, for each i, σ_i to the cyclic permutation $(i, i+1)$ and τ_i to 1. In this paper we investigate the group ST_3. We obtain a presentation for ST_3. We prove that ST_3 is isomorphic to the singular pure braid group SP_3 on 3 strands. We also prove that the group ST_3 is semi-direct product of a subgroup H and an infinite cyclic group, where the subgroup H is an HNN-extension of $Z^2 * Z^2$.
This is a joint work with Tatyana Kozlovskaya and Oleg Mamonov.

Speaker: **Aleksandr Mednykh**
Title: The enumeration of coverings of closed orientable Euclidean manifolds.

There are only 10 Euclidean forms, that is flat closed three dimensional manifolds: six are orientable and four are non- orientable. The aim of this paper is to describe all types of n- fold coverings over the orientable Euclidean manifolds G_3 and G_5, and calculate the numbers of non-equivalent coverings of each type. The manifolds G_3 and G_5 are uniquely determined among other forms by their homology groups $H_1(G_3) = Z_3 \times Z$ and $H_1(G_5) = Z$.
We classify subgroups in the fundamental groups $\pi_1(G_3)$ and $\pi_1(G_5)$ up to isomorphism. Given index n, we calculate the numbers of subgroups and the numbers of conjugacy classes of subgroups for each isomorphism type and provide the Dirichlet generating functions for the above sequences. This is a joint work with Grigory Chelnokov.

Speaker: **Rama Mishra**
Title: On state-sum representations of quantum link invariants.

Many quantum link invariants can be calculated as state-sums over the *partarc graph PK* (Jones, Turaev: *Extended Yang-Baxter operator*). Garoufalidis and Loebl define a bichromatic digraph *GK* and calculate the colored Jones polynomial as a state-sum on this graph. Our goal is to understand the relation $PK \leftrightarrow GK$ and corresponding state-sums, also understand the cancellation of non-zero terms of state-sums and calculate the state-sum formulas for the colored Jones polynomial of the family of weaving links, starting with $(3, m) = ((\sigma_1 \sigma_2^{-1})^m)$ (braid closure) and 2 test Volume Conjecture.

Speaker: **Timur Nasybullov**
Title: General constructions of biquandles and their symmetries.

Abstract: Biquandles are algebraic objects with two binary operations whose axioms encode the generalized Reidemeister moves for virtual knots and links. These objects are widely used for constructing invariants for virtual knots and links. This application makes the study of such algebraic systems extremely important. During the talk, we are going to speak about recent joint results with V. Bardakov and M. Singh on new constructions of biquandles. We will introduce the new ways of how biquandles can be constructed from groups, quandles, and other biquandles. In addition, we will discuss the automorphism groups of biquandles which are obtained using these constructions.

Speaker: **Mahender Singh**
Title: Quandle cohomology, extensions and automorphisms.

Abstract: The talk will discuss some recent results about a new relationship between cohomology, extensions and automorphisms of quandles. Viewing the construction of the conjugation, the core and the generalised Alexander quandle of a group as an adjoint functor of some appropriate functor from the category of quandles to the category of groups, it turns out that these functors map extensions of groups to extensions of quandles. If term permits, we will also discuss some natural group homomorphisms from the second cohomology of a group to the second cohomology of its core and conjugation quandles. The results are obtained in a joint work with Valeriy Bardakov.

Speaker: **Andrei Vesnin**
Title: An unknotting invariant for welded knots.

Abstract: We study a local twist move on welded knots that is an analog of the virtualization move on virtual knots. Since this move is unknotting operation, we define an invariant, unknotting twist number, for welded knots. We relate an unknotting twist number with warping degree and welded unknotting number, and establish a low bound on the twisted unknotting number using Alexander quandle coloring. We also study the Gordian distance between welded knots by twist move. This is a joint work with K. Kaur, A. Gill, and M. Prabhakar, see arXiv:2008.03479.

Speaker: **Madeti Prabhakar**
Title: Variations of writhes under a local move in virtual knots.

Abstract: For $n \neq 0$, n-writhes $J_n(K)$ are integer valued virtual knot invariants defines by Satoh and Taniguchi using the index values of crossings in a virtual knot K. $J_n(K)$ are non trivial virtual knot invariants and there importance becomes immediate from the fact that they are involved in coefficients of some important polynomial invariants of virtual knots. Therefore it becomes necessary to study the change in behavior of $J_n(K)$ under local moves in order to predict the variations of polynomial invariants. In this talk we investigate the behavior of $J_n(K)$ under a local move in virtual knot diagrams called arc shift move defined in one of our earlier works. We found that under arc shift move, $J_n(K)$ behaves quite random in the sense that its value may increase as well as decrease by any random non zero integer. More precisely we show that for any non zero integers n, N there exists virtual knot VK_n^N with arc shift number one satisfying $J_n(VK_n^N)=N$. As a consequence we also observe that there exists infinitely many virtual knots which can be distinguished using n-writhe $J_n(K)$ while odd writhe $J(K)$ fails to do so.

Speaker: **Mikhail Neshchadim**
Title: On λ-homomorphic skew braces.

Abstract: 1. For a skew left brace $(G,\cdot,\circ)$, the map $\lambda : (G,\circ) \to Aut(G,\cdot)$, $a \to \lambda_a$, where $\lambda_a(b) = a^{-1} \cdot (a \circ b)$ for all $a, b \in G$, is a group homomorphism. Then λ can also be viewed as a map from (G,·) to Aut(G,·), which, in general, may not be a homomorphism. We study skew left braces $(G, \cdot, \circ)$ for which $\lambda : (G, \cdot) \to Aut(G, \cdot)$ is a homomorphism. Such skew left braces will be called λ-homomorphic [2].
2. We introduce symmetric homology of groups and compute exterior and symmetric (co)homologies of some finite groups [3]. We also compare the classical, exterior and symmetric (co)homologies. Finally, we derive restriction and corestriction homomorphisms for exterior cohomology.
1. V.G. Bardakov, M.V. Neshchadim, M.K. Yadav, Computing skew left braces of small orders. Internat. J. Algebra Appl., https://doi.org/10.1142/S0218196720500216.
2. V.G. Bardakov, M.V. Neshchadim, M.K. Yadav, On λ-homomorphic skew braces. arXiv:2004.05555v1 [math.RA] 12 Apr 2020
3. V.G. Bardakov, M.V. Neshchadim, M. Singh, Exterior and symmetric (co)homology of groups. International Journal of Algebra and Computation. 2020.

Speaker: **Amrendra Gill**
Title: Gordian complexes of knots and virtual knots given by region crossing changes and arc shift moves.

Abstract: Gordian complex of knots was first defined by *M Hirasawa* and *Y. Uchida* using crossing change as local move in classical knots. An extension of the concept to virtual knots was done by *S. Horiuchi et al*. using v−move and forbidden moves. In this talk we discuss Gordian complexes of knots and virtual knots defined using region crossing changes and arc shift move respectively. Gordian complex is a simplicial complex where vertices are knot isotopy classes. Two vertices have an edge between them if the distance between corresponding knots(virtual knots) by region crossing change(arc shift move) is one. Any set of $n + 1$ vertices $\{K_0, K_1, ..., K_n\}$ forms an n−simplex iff distance between any two distinct members of the family is one. We show the existence of an arbitrarily high dimensional simplex in both the Gordian complexes. We prove the re- sults by showing the existence of an infinite family of knots(virtual knots) $K_n(VK_n)$ for $n = 1, 2, . . .$, such that any pair of distinct knots have distance one. This is a joint work with M. Prabhakar and A. Vesnin.

Speaker: **Tatyana Kozlovskaya**
Title: On 3-strand singular pure braid group.

Abstract: We study the singular pure braid group SP_n for $n=2, 3$. We find generators, defining relations and the algebraical structure of these groups. In particular, we prove that SP_3 is a semi-direct product $SP_3 = V_3 \rtimes \mathbb{Z}$, where V_3 is an HNN-extension with base group $\mathbb{Z}^2 * \mathbb{Z}^2$ and cyclic associated subgroups. We prove that the center $Z(SP_3)$ of SP_3 is a direct factor in SP_3. The results are obtained in a joint work with V. G. Bardakov.

Speaker: **Manpreet Singh**
Title: A generalization of Gauss diagrams.

Abstract: Gauss diagrams were introduced by M. Polyak and O. Viro to study Vassiliev invariants. To each oriented classical link, one can associate a Gauss diagram. However, not every Gauss diagram is a Gauss diagram of some classical link. In 1996, L. Kauffman introduced virtual links as a generalization of classical link theory. It is known that there is a one-to-one correspondence between Gauss diagrams and virtual links. S. Kim studied virtual knot groups and their peripheral structure defined by L. Kauffman using Gauss diagrams. In this talk, we will first associate groups to virtual links using a representa- tion of virtual braid groups and will show that these groups are an extension of virtual link groups defined by L. Kauffman. Then we will define marked Gauss diagrams as a generalization of Gauss diagrams. We will associate a group and a peripheral structure to each marked Gauss diagram and will discuss some results obtained in joint work with Valeriy Bardakov and Mikhail Neshchadim.

Speaker: **Nikolay Abrosimov**
Title: On volumes of hyperbolic cone manifolds $7_3^2(\alpha,\beta)$ and $5_2(\alpha)$.

Abstract: We present explicit formula for the volume of hyperbolic cone manifolds 7_3^2 (α,β). The proof is based on the background given in the paper of D. Derevnin, A. Mednykh and M. Mulazzani (2004).
We obtain exact formula for the volume of hyperbolic cone manifolds $5_2(\alpha)$. First, we derive the relation between the complex length of the singular geodesic and conical angle α in the form of Cotangent rule. Then by making use of *A*-polynomial of the knot 5_2 and Schlafli differential equation we prove the volume formula.
This is a joint work with A. Mednykh.

Speaker: **Abhishek Mukherjee**
Title: Discreteness of subgroups by test maps in higher dimesion.

Abstract: Let $\boldsymbol{H}_{\mathbb{F}}^n$ denote the *n*-dimensional $\mathbb{F}$ -hyperbolic space, where $\mathbb{F} = \mathbb{R}$, $\mathbb{C}$ or $\mathbb{H}$ and let *U(n,1;* $\mathbb{F}$*)* be the linear group that acts by the isometries of $\boldsymbol{H}_{\mathbb{F}}^n$. We define that a subgroup *G* of *U(n,1;* $\mathbb{F}$*)* is called *Zariski dense* if it does not fix a point on $\boldsymbol{H}_{\mathbb{F}}^n \cup \partial \boldsymbol{H}_{\mathbb{F}}^n$ and neither it preserves a totally geodesic subspace of $\boldsymbol{H}_{\mathbb{F}}^n$. With motivation from our previous work on determining the discreteness of a zariski-dense subgroup of *SL(2,* $\mathbb{H}$*)* by using a test map not necessarily belongs to the given subgroup we aimed to prove that a Zariski dense subgroup *G* of *U(n,1;* $\mathbb{F}$*)* is discrete if for every loxodromic element $g \in G$, the two generator subgroup <*f*, *g*> is discrete, where f$\in$ U(n,1; $\mathbb{F}$) is a certain element which is not necessarily from *G*. This is based on the joint work with Dr. Krishnendu Gongopadhyay.

Speaker: **Bao Vuong**
Title: On hyperelliptic Euclidean 3-manifolds.

Abstract: A orientable Euclidean manifold which is also called flat 3-dimensional manifolds or just Euclidean 3-forms. Up to homeomorphism, there are six of them. The first one is the three-dimensional torus. In 1972, R. H. Fox showed that the 3-torus is not a double branched covering of the 3- sphere. So, it is not a hyperelliptic manifold. We show that all the remaining Euclidean 3-forms are hyperelliptic manifolds. This work is in collaboration with Alexander Mednykh.

Speaker: **Neha Nanda**
Title: Virtual twins and doodles.

Study of certain isotopy classes of a finite collection of immersed circles with- out triple or higher intersections on closed oriented surfaces can be thought of as a planar analogue of virtual knot theory where the genus zero case corresponds to classical knot theory. Alexander and Markov theorems for the genus zero case are known, the role of groups is played by twin groups, a class of right-angled Coxeter groups with only far com- mutativity relations. In the talk, Alexander and Markov theorems for higher genus case, where the role of groups is played by a new class of groups called virtual twin groups, will be discussed. Furthermore, recent work on structural aspects of these groups will be addressed. This work is in collaboration with Mahender Singh and Tushar Naik.

Speaker: **Andrey Egorov**
Title: Hyperbolic volumes of fullerenes.

Abstract: We observe that fullerene graphs are one-skeletons of polyhedra, which can be realized with all dihedral angles equal to $\pi/2$ in hyperbolic 3-dimensional space. One of the most important invariants of such polyhedra is volume. It is known that some topological indices of graphs of chemical compounds serve as strong descriptors and correlate with chemical properties. In this talk we discuss the correlation of hyperbolic volume of fullerenes with few important topological indexes and show that hyperbolic volume also can serve as a chemical descriptor. We discuss upper and lower bounds for the volume of fullerenes and few conjectures on the structure of fullerenes with minimal volume.