Laboratory of Topology and Dynamics,
Novosibirsk State University

and

Sobolev Institute of Mathematics

VI Russian-Chinese Conference on Knot Theory and Related Topics*

17-21 June 2019, Novosibirsk

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Conference Schedule

Monday, June 17 (Social program for those of guests who already come)

14:30 Excursion to the Central Siberian Geological Museum (http://asknovosibirsk.com/answer/central-siberian-geological-museum/)
We will start at 14:10 from the ground lobby of the Rectors building of NSU (the same building where the hotel of NSU is situated).

16:00 Excursion to the NSU Research and Education Center "Evolution of the Earth" (https://education.nsu.ru/earth_evolution/en/)
We will start at 15:45 from the ground lobby of the Rectors building of NSU (the same building where the hotel of NSU is situated).

17:00 Excursion to the Dome of the Rectors building of NSU.

Tuesday, June 18 (room 212 of the Rectors building of NSU)

09:45–10:00 *Opening of the conference*

Morning session chairman Andrei Vesnin

10:00–10:50 **Louis Kauffman**, *Cobordism of virtual knots and links and the affine index polynomial*

10:50–11:40 **Sofia Lambropoulou**, *Knotoids, braidoids and rail knotoids*

11:40–12:00 *Coffee break (20 minutes)*

12:00–12:50 **Akio Kawauchi**, *Ribbon surface-link and stable-ribbon surface-link*

12:50–14:30 *Lunch break (100 minutes)*

Afternoon session chairman Sofia Lambropoulou

14:30–15:20 **Hongzhu Gao**, *Some remarks on the chord index*

15:20–16:10 **Zhiyun Cheng**, *Region crossing change on surfaces*

16:10–16:30 *Coffee break (20 minutes)*

16:30–17:20 **Jiajun Wang**, *Fundamental group and Heegaard Floer homology*

Wednesday, June 19 (room 212 of the Rectors building of NSU)

Morning session chairman Akio Kawauchi

10:00–10:50 **Fengchun Lei**, *3-submanifolds of* S^3 *which admits complete systems of surfaces*

10:50–11:40 **Sang Youl Lee**, *Biquandle cocycle invariants for surface-links via marked graph diagrams*

11:40–12:00 *Coffee break (20 minutes)*

12:00–12:50 **Valery Bardakov**, *Multi-switches, representations of braids and knot invariants*

12:50–14:30 *Lunch break (100 minutes)*

Afternoon session chairman Fengchun Lei

14:30–15:20 **Andrei Vesnin**, *On the Wiener complexity and the Wiener index of fullerene graphs*

15:20–16:10 **Yongjin Song**, *An infinite family of nongeometric embeddings of braid group into MCG and their homology triviality*

16:10–16:30 *Coffee break (20 minutes)*

16:30–17:20 **Fengling Li**, *A theory of orbit braids*

17:20–18:10 **Nikolay Abrosimov**, *Volume of a compact hyperbolic tetrahedron in terms of its edge matrix*

18:20 *Conference photo (on the stairs in front of the main entrance near the fountain)*

Right after the conference photo, we will walk together to the restaurant for a conference dinner

19:00 **Conference dinner at the restaurant Teplica in Akadempark** *(Nikolaeva str., 12, 3rd floor; all the guests of the Conference are invited)*

Thursday, June 20 (room 212 of the Rectors building of NSU)

Morning session chairman Louis Kauffman

10:00–10:50 **Jiming Ma**, *3-manifold subgroups in certain topologically negatively curved 4-manifold groups*

10:50–11:40 **Sergei Matveev**, *Decompositions of homologically trivial knots in* $F \times I$

11:40–12:00 *Coffee break (20 minutes)*

12:00–12:50 **Vassily Manturov**, *Manifolds of triangulations, braids on manifolds, groups* G_n^k *and* Γ_n^k*, and related groups*

12:50–14:30 *Lunch break (100 minutes)*

Afternoon session chairman Sang Youl Lee

14:30–15:20 **Seongjeong Kim**, *Pure braid group and group* Γ_n^4

15:20–16:10 **Manpreet Singh**, *Residual finiteness of quandles*

16:10–16:30 *Coffee break (20 minutes)*

16:30–17:20 **Zhiqing Yang**, *Non-homogeneous bracket*

17:20 *Closing the Conference*

COBORDISM OF VIRTUAL KNOTS AND LINKS AND THE AFFINE INDEX POLYNOMIAL

LOUIS H. KAUFFMAN

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This talk will discuss the concept of cobordism of virtual knots and links, generalizing cobordism of classical knots and links. We define cobordism of virtual knots and links by adding saddle point moves, births and deaths to the Reidemeister and virtual moves on diagrams with virtual crossings. These definitions also apply to welded knots. The talk will discuss results of Dye, Kaestner and Kauffman and also the author's work on concordance invariance of the Affine Index Polynomial.

KNOTOIDS, BRAIDOIDS AND RAIL KNOTOIDS

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We will first recall the diagrammatic theory of knotoids, introduced by Turaev. We will then review the lifting of planar knotoids in 3-space, by Gugumcu and Kauffman, its importance in applications and its connection to the diagrammatic theory of rail knotoids, which is in turn related to the knot theory of the handlebody of genus 2. Finally, we will present the theory of braidoids, braidoiding algorithms as well as an equivalence relation on the set of braidoids corresponding to equivalence classes of planar knotoids.

RIBBON SURFACE-LINK AND STABLE-RIBBON SURFACE-LINK

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A stable-ribbon surface-link is a surface-link in 4-space such that a connected sum of the surface-link and some number of trivial torus-knots is a ribbon surface-link. A stably trivial surface-link is a surface-link in 4-space such that a connected sum of the surface-link and some number of trivial torus-knots is a trivial surface-link. In this talk, we claim the uniqueness of an orthogonal 2-handle pair on a surface-link, by which it is shown that a stable-ribbon surface-link is a ribbon surface-link as well as a stably trivial surface-link is a trivial surface-link.

References

[1] A. Kawauchi, Ribbonness of a stable-ribbon surface-link, I. A stably trivial surface-link, http://www.sci.osaka-cu.ac.jp/∼kawauchi/
[2] A. Kawauchi, Ribbonness of a stable-ribbon surface-link, II. General case, http://www.sci.osaka-cu.ac.jp/∼kawauchi/
[3] A. Kawauchi, Triviality of a surface-link with meridian-based free fundamental group, http://www.sci.osaka-cu.ac.jp/∼kawauchi/

SOME REMARKS ON THE CHORD INDEX

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We will discuss how to define a chord index via smoothing a real crossing point of a virtual knot diagram. Several polynomial invariants of virtual knots and links can be recovered from this general construction. We also explain how to extend this construction from virtual knots to flat virtual knots.

This is joint work with Zhiyun Cheng and Mengjian Xu.

REGION CROSSING CHANGE ON SURFACES

ZHIYUN CHENG

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Region crossing change is a local operation on link diagrams. It was first proved by Ayaka Shimizu that region crossing change is an unknotting operation on knot diagrams. For links, it turns out that region crossing change on a link diagram is a n unknotting operation if and only if this link is proper. In this talk, I will discuss the effect of region crossing change on link diagrams on surfaces.

FUNDAMENTAL GROUP AND HEEGAARD FLOER HOMOLOGY

JIAJUN WANG

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I will talk about the relation between Heegaard Floer homology and the fundamental groups of three-manifolds.

This is joint work with Matthew Hedden and Xuezhi Zhao.

3-SUBMANIFOLDS OF S^3 WHICH ADMITS COMPLETE SYSTEMS OF SURFACES

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Let M be a compact connected 3-submanifold with one boundary component F, $g(F) = n \geq 1$. If there exists a collection of n pairwise disjoint connected orientable surfaces $\mathcal{S} = \{S_1, \cdots, S_n\}$ properly embedded in M, such that $\partial\mathcal{S} = \{\partial S_1, \cdots, \partial S_n\}$ is a complete curve system on F, we call $\mathcal{S}$ a complete surface system (CSS) for M (or M admits a complete surface system). In the talk, I will introduce some results on 3-submanifolds of S^3 which admits CSS.

This is joint work with Fengling Li and Yan Zhao.

BIQUANDLE COCYCLE INVARIANTS FOR SURFACE-LINKS VIA MARKED GRAPH DIAGRAMS

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In 2001, J. S. Carter, S. Kamada and M. Saito introduced the shadow quandle cocycle invariants for classical links and surface-links (including more general cases) by using the shadow (co)homology theory of quandles, which are generalizations of quandle cocycle invariants introduced by J. S. Carter et al. These invariants for links and surface-links are defined as the state-sums of all Boltzman weights that are evaluations of a given 2- and 3-cocycle at the crossings of link diagrams and triple points of broken surface diagrams modulo Roseman moves, respectively, over all quandle colorings of arcs in link diagrams and sheets in broken surface diagrams together with particularly designed region (shadow) colorings for the complementary regions of the diagrams.

In this talk, Id like to give a gentle introduction to an interpretation of those shadow quandle cocycle invariants for surface-links using biquandles and marked graph diagrams modulo Yoshikawa moves, and discuss some recent progress on the shadow biquandle cocycle invariants for surface-links.

This is a joint work with S. Kamada, A. Kawauchi and J. Kim in part.

MULTI-SWITCHES, REPRESENTATIONS OF BRAIDS AND KNOT INVARIANTS

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A switch on a set X is a bijection $S : X \times X \to X \times X$, that satisfies the set theoretic Yang-Baxter equation. If we have a switch we can define a representation of the braid group B_n by permutations of X^n. If X has an algebraic structure (is a quandle, group, module), then under some extra conditions it is possible to define a representation $B_n \to AutX$. On this way we get the Artin representation $B_n \to Aut(F_n)$, where F_n is a free group of rank n and the Burau representation $B_n \to GL_n(Z[t^{\pm 1}])$. Also, using a switch it is possible to define invariants of knots and links. On this way we get modules of knot, group of knot, quandl of knot. Knot quandle classifies classical knots under week equivalence.

On this talk I introduce multi-switch and virtual multi-switch that generalize switch. Using these definitions we suggest some general approach to construction of representations of virtual braid group VB_n and to definition invariants of virtual knots and links, which generalize some known representations and knot invariants.

This is joint work with Timur Nasybullov.

ON THE WIENER COMPLEXITY AND THE WIENER INDEX OF FULLERENE GRAPHS

ANDREI VESNIN

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Fullerenes are molecules in the form of cage-like polyhedra, consisting solely of carbon atoms. Fullerene graphs are mathematical models of fullerene molecules. The transmission of a vertex v of a graph is the sum of distances from v to all the other vertices. The number of different vertex transmissions is called the Wiener complexity of a graph. Some calculation results on the Wiener complexity and the Wiener index of fullerene graphs of order n? 216 are presented. Structure of graphs with the maximal Wiener complexity or the maximal Wiener index is discussed and formulas for the Wiener index of several families of graphs are obtained.

This is joint work with Andrei Dobrynin. For details see [1].

References

[1] A.A. Dobrynin, A.Yu. Vesnin, On the Wiener complexity and the Wiener index of fullerene graphs, arXiv:1905.01699.

AN INFINITE FAMILY OF NONGEOMETRIC EMBEDDINGS OF BRAID GROUP INTO MCG AND THEIR HOMOLOGY TRIVIALITY

YONGJIN SONG

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The 3-fold branched coverings over a disk with some branch points induce a new nongeometric embedding of braid groups into mapping class groups. Each generator of braid group is mapped to a kind of 1/6 rotation on some part of the surface which turns out to be a product of two Dehn twists. We may consider more general case; n-fold covering for $n > 3$. The n-fold branched coverings over a disk induce a nongeometric embedding in a similar way to the case of 3-fold covering. In the case of n-fold covering, the induced embedding maps each generator of braid group to a product of $n-1$ Dehn twists along $n-1$ consecutive closed curves. We prove that all these new embeddings induce trivial homology homomorphism for any coefficient. We prove this by showing that these embeddings preserve the little 2-cube operad action on the configuration spaces and on the moduli spaces.

A THEORY OF ORBIT BRAIDS

FENGLING LI

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Let M be a connected topological manifold of dimension at least 2 with an effective action of a finite group G. Making use of the orbit configuration space $F_G(M, n), n \geq 2$ of the G-manifold M, we upbuild the theoretical framework of orbit braids in $M \times I$, which enriches the theory of ordinary braids, where the action of G on I is trivial.

This is joint work with Hao Li and Zhi Lü.

VOLUME OF A COMPACT HYPERBOLIC TETRAHEDRON IN TERMS OF ITS EDGE MATRIX

NIKOLAY ABROSIMOV

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A *compact hyperbolic tetrahedron* T is a convex hull of four points in the hyperbolic space $\mathbb{H}^3$. Let us denote the vertices of T by numbers $1, 2, 3$ and 4. Then denote by ℓ_{ij} the length of the edge connecting i-th and j-th vertices. We put θ_{ij} for the dihedral angle along the corresponding edge. It is well known that T is uniquely defined up to isometry either by the set of its dihedral angles or the set of its edge lengths. A *Gram matrix* $G(T)$ of tetrahedron T is defined as $G(T) = \langle -\cos\theta_{ij}\rangle_{i,j=1,2,3,4}$, we assume here that $-\cos\theta_{ii} = 1$. An *edge matrix* $E(T)$ of hyperbolic tetrahedron T is defined as $E(T) = \langle \cosh \ell_{ij}\rangle_{i,j=1,2,3,4}$, where $\ell_{ii} = 0$.

More than 100 years ago Italian matematician G. Sforza found a formula for the volume of a compact hyperbolic tetrahedron T in terms of its Gram matrix (see [1]). The new proof of the Sforza's formula was recently given in [2].

In the present work we present an exact formula for the volume of a compact hyperbolic tetrahedron T in terms of its edge matrix.

Theorem. Let T be a compact hyperbolic tetrahedron given by its edge matrix $E = E(T)$ and $c_{ij} = (-1)^{i+j}E_{ij}$ is ij-cofactor of E. We assume that all the edge lengths are fixed exept ℓ_{34} which is formal variable. Then the volume $V = V(T)$ is given by the formula

$$V = -\frac{1}{2}\int_0^{\ell_{34}} \frac{c_{14}c_{33}(c_{24}c_{34} - c_{23}c_{44}) + c_{13}c_{44}(c_{23}c_{34} - c_{24}c_{33})}{c_{33}c_{44}\det E\sqrt{c_{33}c_{44} - c_{34}^2}}\, t\sinh t\, dt,$$

where cofactors c_{ij} and edge matrix determinant $\det E$ are functions in one variable ℓ_{34} denoted by t.

This is joint work with Vuong Huu Bao.

References

[1] G. Sforza, Ricerche di estensionimetria differenziale negli spazi metrico-projettivi, Memorie Reale Accademia di Scienze, lettere ed arti di Modena, III, VIII (Appendice) (1907), 21–66.

[2] N.V. Abrosimov, A.D. Mednykh, Volumes of polytopes in constant curvature spaces, Fields Institute Communications, 70 (2014), 1–26.

3-MANIFOLD SUBGROUPS IN CERTAIN TOPOLOGICALLY NEGATIVELY CURVED 4-MANIFOLD GROUPS

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For any positive x large enough, it is well-known there are infinitely many hyperbolic 3-manifolds with volume bounded above by x. We show that for a hyperbolic group G, there are only finitely many 3-manifold subgroups in G with volume bounded above. Moreover, if G is the Coxeter group with nerve a flag-no-square triangulation of a 3-dimensional integel homology 3-sphere, in particular if G is the Coxeter group over the famous 120-cell, we also give a lower bound.

DECOMPOSITIONS OF HOMOLOGICALLY TRIVIAL KNOTS IN $F \times I$

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We prove that the summands of such knots represented as a connected sum of prime factors are determined unlikely up to equivalence.

MANIFOLDS OF TRIANGULATIONS, BRAIDS ON MANIFOLDS, GROUPS G_N^K AND Γ_N^K, AND RELATED GROUPS

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In 2015, I defined the groups G_n^k depending on two integer parameters $n > k$ and formulated the following principle: if dynamical systems describing motion of n particle possess a nice codimension 1 property depending exactly on k particles, then these dynamics have invariants valued in G_n^k.

The G_n^k-approach works nicely for the case of Euclidean, hyperbolic and projective spaces but meets serious obstacles when particles move on arbitrary manifolds.

For arbitrary manifold M^n with metric g and an integer number $N >> n$, we shall define *manifolds of triangulations*. They are open manifolds representing certain open subspaces in the configuration space $C(M^n, N)$ where some codimension 2 subset is cut out. This definition is based on the notion of Voronoï tiling and Delaunay triangulation with N vertices.

Besides the metric version of the manifold of triangulations, we shall define topological versions of these manifolds.

The braid groups (metrical and topological) are defined to be fundamental groups of these manifolds. Hence, braid groups are defined for arbitrary manifolds in arbitrary dimensions.

We study homomorphisms of such braid groups to $G_N^{n+2}, \Gamma_N^{n+2}$ and other groups.

It turns out that for dimension 2, the groups Γ_n^4 is closely related to the pentagon relation, Ptolemy varietiy, cluster algebras etc.

In higher dimensions, the groups $\Gamma_n^k, k \geq 5$ are described by using Gale diagrams and have non-trivial abelianisations.

The results are based on my joint work with I.M. Nikonov and can be found in [1].

References

[1] V.O. Manturov, D.A. Fedoseev, S. Kim, I.M. Nikonov, On Groups G_n^k and Γ_n^k: A Study of Manifolds, Dynamics, and Invariants, https://arxiv.org/abs/1905.08049.

PURE BRAID GROUP AND GROUP Γ_N^4

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In this talk we study a group Γ_n^4 corresponding to the motion of points in $\mathbb{R}^2$ from the point of view of Delaunay triangulations. We construct homomorphisms from pure braids on n strands to a product of copies of Γ_n^4. We will also study the group of pure braids in $\mathbb{R}^3$, which is described by a fundamental group of the restricted configuration space of $\mathbb{R}^3$, and define the group homomorphism from the pure braid group in $\mathbb{R}^3$ to Γ_n^4. In the end of this talk we discuss about relations between the restricted configuration space of $\mathbb{R}^3$ and triangulations of the 3-dimensional ball and Pachner moves.

RESIDUAL FINITENESS OF QUANDLES

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Residual finiteness is known to be an important property of groups appearing in combinatorial group theory and low dimensional topology. We investigate residual finiteness of quandles and present some recent observations about residual finiteness of free quandles and link quandles.

COUNTING CONJUGACY CLASSES IN GROUPS WITH CONTRACTING ELEMENTS

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In this talk, we shall discuss a class of statistically convex-cocompact actions with a contracting element. The main result is an asymptotic formula for the number of conjugacy classes, which shares the same formula as the number of closed geodesics on negatively curved compact Riemannian manifolds. As a consequence of the formulae, the transcendental conjugacy growth series is established for all non-elementary relatively hyperbolic groups. The idea of the proof is to understand generic properties of all elements. As a by-product, we showed that an exponentially generic elements in mapping class groups have their Teichmüller axis contained in the principal stratum.

This is joint work with Ilya Gekhtman.

ZEROS OF JONES POLYNOMIALS OF GRAPHS

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Motivated by the Jones polynomial of knots and links, we introduce the Jones polynomial of a graph $G = (V, E)$ with k components as the following specialization of the Tutte polynomial:

$$J_G(t) = (-1)^{|V|-k} t^{|E|-|V|+k} T_G(-t, -t^{-1}).$$

Its basic properties and certain extreme coefficients will be firstly given. Then we prove:
(1) $(-\infty, 0]$ is a zero-free interval of Jones polynomials of connected bridgeless graphs while for any small $\epsilon > 0$ or large $M > 0$, there is a zero of the Jones polynomial of a plane graph in $(0, \epsilon)$, $(1 - \epsilon, 1)$, $(1, 1 + \epsilon)$ or $(M, +\infty)$.
(2) Let $r(G)$ be the maximum moduli of zeros of $J_G(t)$. By applying Sokal's result on zeros of Potts model partition functions and Lucas's theorem, we prove that

$$\frac{q_s - |V| + 1}{|E|} \leq r(G) < 1 + 6.907652\Delta_G$$

for any connected bridgeless and loopless graph $G = (V, E)$ of maximum degree Δ_G with q_s parallel classes.

As a consequence of the upper bound, X.-S. Lin's conjecture holds if the positive checkerboard graph of a connected alternating link has a fixed maximum degree and a sufficiently large number of edges.

This is a joint work with Fengming Dong et al.

References

[1] Fengming Dong, Xian'an Jin, Zeros of Jones polynomials of graphs, The Electronic Journal of Combinatorics, 22 (2015) 3:#P3.23.
[2] Helin Gong, Mengchen Li, Xian'an Jin, Several extreme coefficients of the Tutte polynomial of graphs, arXiv:1705.10023.

NON-HOMOGENEOUS BRACKET

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Classical link invariants satisfies certain homogeneous skein relations. For examples, $v^{-}P(L_{+}) - vP(L_{-}) = zP(L_0)$. While non-homogeneous skein relation $v^{-}H(L_{+}) - vH(L_{-}) = zH(L_0) + x$ defines equivalent link invariant. One can see $H - P = y$ is a constant. We call such an invariant H a trivial non-homogeneous link invariant. In this talk, we discuss a way to introduce nontrivial non-homogeneous link invariant. A special case of this invariant is an oriented version Kauffman bracket.

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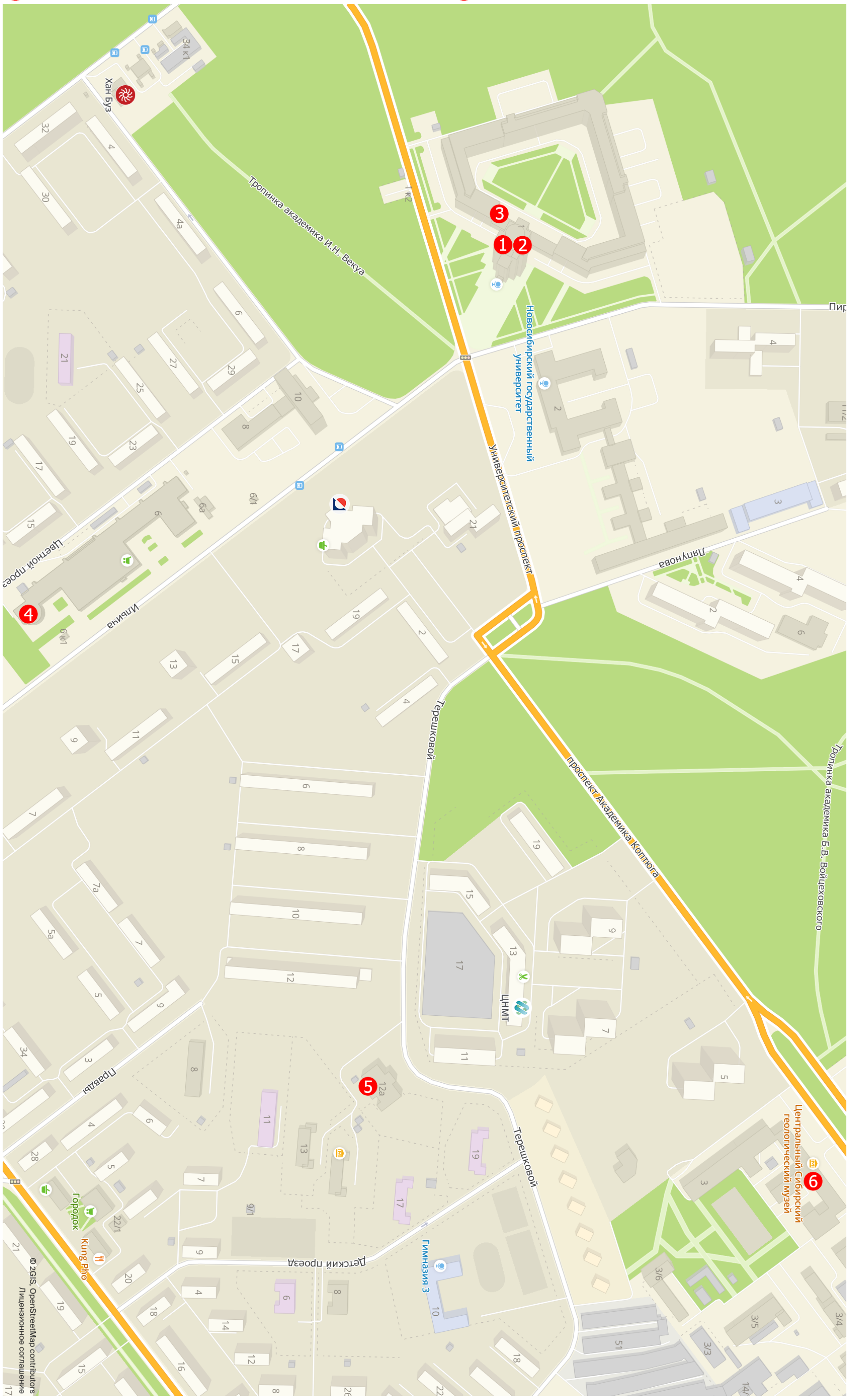
1 Conference hall (room 212)
2 Cafeteria (in the basement)
3 Center "Evolution of the Earth"
4 Restaurant "Pechki-Lavochki"
5 Grill-bar "Peoples"
6 Central Siberian Geological Museum



7 Conference dinner in the Restaurant Teplica (Nikolaeva str. 12, 3rd floor)