KNOTS IN HELLAS 2016

INTERNATIONAL CONFERENCE ON KNOTS, LOW-DIMENSIONAL TOPOLOGY AND APPLICATIONS

Abstracts

INTERNATIONAL OLYMPIC ACADEMY / ANCIENT OLYMPIA / GREECE / **17-23 JULY 2016**

Organized by

National Technical University of Athens

Co-organized by

Hellenic Mathematical Society

REGION OF WESTERN GREECE *full of contrast!*

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European Mathematical Society

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Knots in Hellas 2016

International Conference on Knots, Low-Dimensional Topology and Applications

International Olympic Academy
Ancient Olympia, Greece

July 17–23, 2016

Contents

Summary

The Conference takes place at the International Olympic Academy, Ancient Olympia, Greece, 17-23 July 2016. It is organized by the National Technical University of Athens with the co-organization of the Hellenic Mathematical Society and the Region of Western Greece, with the support of the European Mathematical Society and the National Science Foundation, and under the auspices of the Greek Ministry of Education, Research and Religious Affairs and the Greek Ministry of Culture and Sports.

The goal of this international cross-disciplinary meeting is to give the opportunity to researchers to present cutting-edge research, to enable the exchange of methods and ideas as well as the exploration of fundamental problems in the wide fields of knot theory and low-dimensional topology, from theoretical to applications in sciences like biology and physics, and to provide high quality interactions across fields and generations of researchers, from graduate students to the most senior researchers. The focal topics of the Conference include the wide range of classical and contemporary invariants of knots and links and related topics, such as virtual knots; topological quantum field theory; skein modules and knot algebras; quandles and their homology; braids and orderability of groups; hyperbolic knots and geometric structures of three- and four-dimensional manifolds; physical knots with applications to fluid flows; helicity; topological surgery; DNA enzyme mechanisms; protein structure and function.

The Conference builds on the legacy of the “Knots in Hellas ’98” held at the European Cultural Center of Delphi, Greece.

This Conference also provides a convenient opportunity to celebrate the achievements of Professor Louis H. Kauffman, who reached the age of 70 in February 2015.

Organizing Committees

International Scientific Organizing Committee:
Professor Colin Adams (Williams College, USA)
Professor Cameron McA Gordon (University of Texas at Austin, USA)
Professor Vaughan F.R. Jones (Vanderbilt University, USA)
Professor Louis Kauffman (University of Illinois at Chicago, USA)
Professor Sofia Lambropoulou (National Technical University of Athens, Greece - Chair)
Professor Kenneth Millett (University of California, Santa Barbara, USA)
Professor Jozef Przytycki (George-Washington University, USA)
Professor Renzo Ricca (University Milano-Bicocca, Italy)
Professor Radmila Sazdanovic (North Carolina State University, USA)

Local Organizing Committee:
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Dimitrios Kodokostas (National Technical University of Athens, Greece)
Katerina Ksystra (National Technical University of Athens, Greece)
Sofia Lambropoulou (National Technical University of Athens, Greece - Coordinator)
Petros Stefaneas (National Technical University of Athens, Greece)
Nikos Triantafyllou (National Technical University of Athens, Greece)
Ioannis Diamantis (China Agricultural University)
Konstantinos Karvounis (Universität Zürich, Switzerland)
Haris Lambropoulos (University of Patras, Greece)

Programme overview

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	Wednesday		Thursday			Friday	
07:30 - 08:30	Breakfast						
08:45 - 09:30	**Link invariants** – Bar-Natan		**TQFT** – Garoufalidis			**Nature - Life** – Osheroff	
09:45 - 10:30	**Nature - Physical** – Millett		**Yang-Baxter** – Przytycki			**Nature - Physical** – Sokoloff	
10:30 - 11:00	Coffee break						
11:00 - 11:40	**Categorification** Beliakova	**Virtual** Bardakov	**Nature - Physical** Ricca	**Yang-Baxter** Saito	**TQFT** Blanchet	**Nature - Life** Zechiedrich	**Nature - Physical** Reiter
11:55 - 12:35	**Categorification** Wedrich	**Virtual** Bellingeri	**Nature - Physical** Dennis	**Yang-Baxter** Nosaka	**Categorification** Sulkowski	**Nature - Life** Sulkowska	**Top. spaces** Mikhovich
12:45 - 13:45	Lunch					Farewell Lunch	
15:00 - 15:20	14:00 - 20:00 Excursion: sightseeing at the Kaiafas lake and thermal springs & swimming at the beach of Zaharo		**Nature - Physical** Bode	**Yang-Baxter** Hoste	**TQFT** Murakami	Departures	
15:25 - 15:45			**Nature - Physical** Foster	**Yang-Baxter** Yang			
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16:15 - 16:35				**Yang-Baxter** Wang	**TQFT** Detcherry		
16:35 - 17:00			Coffee break				
17:00 - 17:20			**Nature - Physical** Antoniou	**Yang-Baxter** Nelson	**TQFT** Bloomquist		
17:25 - 17:45			**Nature - Physical** Liu	**Yang-Baxter** Choi	**Nature - Life** Dabrowski-Tumanski		
17:50 - 18:10			**Nature - Physical** Velimirovic	**Yang-Baxter** Mukherjee	**Nature - Life** Price		
18:15 - 18:35			**Skein modules** Kodokostas	**Yang-Baxter** Kim	**Nature - Life** Taylor		
20:00 - 21:00	Dinner		Conference Dinner			Dinner	
21:00 - 23:00			Greek dances - Music & Party				

Detailed programme

Saturday 16 July

16:00 - 21:00	Arrivals

Sunday 17 July

07:30 - 08:30	Breakfast
08:45 - 12:30	Registration
12:45 - 13:45	Lunch
16:00 - 17:10	Arrivals / Registration
	Amphitheatre D. Vikelas
17:15 - 17:45	Welcomes
17:45 - 18:15	Dionyssis Gangas *The International Olympic Academy and the dissemination of the Olympic values*
18:15 - 18:45	Sofia Lambropoulou *Homage to Christos Papakyriakopoulos*
18:50 - 19:35	**Link invariants**: Vaughan F.R. Jones *Knots and links from the Thompson groups*
19:40 - 21:00	Welcome Reception

Monday 18 July

07:30 - 08:30	Breakfast

Plenary talks: Amphitheatre D. Vikelas

08:45 - 09:30	**Virtual Knot Theory**: Louis H. Kauffman *Invariants in Virtual Knot Theory*
09:45 - 10:30	**Geometry of knots and manifolds**: Colin Adams *Multi-crossing number of knots and relations with other invariants*
10:30 - 11:00	Coffee break

Session 1: Amphitheatre D. Vikelas

11:00 - 11:40	**Geometry of knots and manifolds**: Joshua Howie *A characterisation of alternating knot exteriors*
11:55 - 12:35	**Geometry of knots and manifolds**: Effie Kalfagianni *Geometric estimates from knot spanning surfaces*
12:45 - 13:45	Lunch
16:00 - 16:20	**Geometry of knots and manifolds**: Nikolay Abrosimov *Volumes of polyhedra related with links and knots*
16:25 - 16:45	**Geometry of knots and manifolds**: Evgeny Fominykh *Complexity of virtual 3-manifolds*
16:50 - 17:10	**Geometry of knots and manifolds**: Stefanos Gialamas *Determining Vanishing Massey Triple Products in the Complement of a Link with more than two components*
17:15 - 17:35	**Geometry of knots and manifolds**: Catherine Gille *Klein branched covers of spatial trivalent graphs and surgery*
17:35 - 18:00	Coffee break
18:00 - 18:20	**Geometry of knots and manifolds**: Delphine Moussard *Finite type invariants of rational homology 3-spheres*
18:25 - 18:45	**Geometry of knots and manifolds**: Tom Needham *The Geometry of the Shape Space of Framed Loops*
18:50 - 19:10	**Geometry of knots and manifolds**: Joao M. Nogueira *Knot complement with all possible meridional essential surfaces*

Session 2: Conference Hall Otto Szymiczek

11:00 - 11:40	**Invariants of knots in 3-manifolds / Skein modules**: Thang Le *Triangular decomposition of skein algebras and quantum Teichmuller spaces*
11:55 - 12:35	**Invariants of knots in 3-manifolds / Skein modules**: Uwe Kaiser *Skein theory of links in hyperbolic 3-manifolds*
12:45 - 13:45	Lunch
16:00 - 16:40	**Invariants of knots in 3-manifolds / Skein modules**: Hugh Morton *A skein theoretic model for the double affine Hecke algebras*
16:50 - 17:10	**Invariants of knots in 3-manifolds / Skein modules**: Ioannis Diamantis *On the Homflypt skein module of the lens spaces $L(p, 1)$ via braids*
17:15 - 17:35	**Invariants of knots in 3-manifolds / Skein modules**: Boštjan Gabrovšek *Knots in Seifert Fibered Spaces*

17:35 - 18:00 Coffee break

18:00 - 18:20 **Invariants of knots in 3-manifolds / Skein modules**: Enrico Manfredi
Diffeomorphic vs isotopic knots in lens spaces

18:25 - 18:45 **Invariants of knots in 3-manifolds / Skein modules**: Alessia Cattabriga
Representations and invariants of links in lens spaces

Session 3: Conference Room C. Diem

11:00 - 11:40 **Braids**: Jinseok Cho
Cluster algebra on the braids

11:55 - 12:35 **Braids**: Mauro Spera
Geometry of unitary Riemann surface braid group representations and Laughlin-type wave functions

12:45 - 13:45 Lunch

16:00 - 16:40 **Braids**: Vladimir Vershinin
Brunnian and Cohen braids and Lie algebras

16:50 - 17:10 **Braids**: Usman Ali
On the Gröbner-Shirshov basis of 3-braids

17:15 - 17:35 **Braids**: Zaffar Iqbal
Hilbert series of right-angled affine Artin monoids $M(\widetilde{A}_n^{\infty})$

17:35 - 18:00 Coffee break

18:00 - 18:20 **Braids**: Joseph Ricci
Congruence subgroups and low-dimensional representations of the braid group B_3

19:15 - 20:00 Poster session

20:00 - 21:00 Dinner

Tuesday 19 July

07:30 - 08:30 Breakfast

Plenary talks: Amphitheatre D. Vikelas

08:45 - 09:30 **Geometry of knots and manifolds**: Cameron Gordon
Left-orderability and cyclic branched covers of knots

09:45 - 10:30 **Khovanov homology and categorification**: Radmila Sazdanovic
Khovanov homology: an introduction

10:30 - 11:00 Coffee break

11:00 - 11:40 **Knot algebras / Link invariants**: Sofia Lambropoulou
A new skein invariant for classical links from the Yokonuma–Hecke algebras

Session 1: Amphitheatre D. Vikelas

11:55 - 12:35 **4-dimensional topology**: Anthony Bosman
Shake Slice and Shake Concordant Links

12:45 - 13:45 Lunch

16:00 - 16:40 **4-dimensional topology**: Samuel J. Lomonaco
The Geometry of the Fox Free Calculus with Applications to Higher Dimensional Knot Theory

16:50 - 17:10 **4-dimensional topology**: Celeste Damiani
Alexander invariants for ribbon tangles

17:15 - 17:35 **Geometry of knots and manifolds**: Shawn Rafalski
Volume bounds for certain hyperbolic 3-orbifolds

17:35 - 18:00 Coffee break

18:00 - 18:20 **Geometry of knots and manifolds**: António Salgueiro
Actions of 3-manifolds with the same quotient

18:25 - 18:45 **Geometry of knots and manifolds**: Anastasiia Tsvietkova
The number of surfaces of fixed genus in an alternating link complement

18:50 - 19:10 **Geometry of knots and manifolds**: Christine Ruey Shan Lee
The colored Jones polynomial and slopes of pretzel knots

19:15 - 19:35 **Geometry of knots and manifolds**: Byunghee An
Chekanov-Eliashberg DGAs for singular Legendrian knots

Session 2: Conference Hall Otto Szymiczek

11:55 - 12:35 **Knot algebras / Link invariants**: Mikami Hirasawa
Interlacing zeros of Alexander polynomials of links

12:45 - 13:45 Lunch

16:00 - 16:20 **Knot algebras / Link invariants**: Dimos Goundaroulis
A new 2-variable generalization of the Jones polynomial

16:25 - 16:45 **Knot algebras / Link invariants**: Fathi Ben Aribi
Detecting knots with the L^2-Alexander invariant

16:50 - 17:10 **Knot algebras / Link invariants**: Nafaa Chbili
Polynomial invariants of Quasi-Alternating links

17:15 - 17:35 **Knot algebras / Link invariants**: Zhiqing Yang
Multi-skein equation knot invariant

17:35 - 18:00 Coffee break

18:00 - 18:20 **Virtual Knot Theory**: Neslihan Gügümcü
How to estimate the height of a knotoid

18:25 - 18:45 **Knot algebras / Link invariants**: Hwa Jeong Lee
On the arc index of Kanenobu knots

18:50 - 19:10 **Knot algebras / Link invariants**: John Bryden
Abelian quantum knot Invariants

19:15 - 19:35 **Knot algebras / Link invariants**: Alexander Stoimenow
On coefficients and roots of the Alexander-Conway polynomial

Session 3: Conference Room C. Diem

11:55 - 12:35 **Khovanov homology and categorification**: Alexander Shumakovitch
Knot invariants arising from homological operations on Khovanov homology

12:45 - 13:45 Lunch

16:00 - 16:20 **Khovanov homology and categorification**: Dan Scofield
Torsion in Khovanov link homology via chromatic graph cohomology

16:25 - 16:45 **Khovanov homology and categorification**: Marithania Silvero
Studying torsion of extreme Khovanov homology

16:50 - 17:10 **Khovanov homology and categorification**: Hoel Queffelec
HOMFLY-PT and Alexander polynomials from a doubled Schur algebra

17:15 - 17:35 **Khovanov homology and categorification**: Abdul Rauf Nizami
Khovanov Homology of the Braid Link $x_1 x_2 x_1 \cdots$

17:35 - 18:00 Coffee break

18:00 - 18:20 **Braids**: Matthieu Calvez
Towards an algebraic Nielsen-Thurston classification of braids

18:25 - 19:05 **Topological spaces**: Ruth Lawrence
Explicit DGLA models of simple chain complexes and their properties

19:30 - 20:00 Poster session

20:00 - 21:00 Dinner

Wednesday 20 July

07:30 - 08:30 Breakfast

Plenary talks: Amphitheatre D. Vikelas

08:45 - 09:30 **Knot algebras / Link invariants**: Dror Bar-Natan
The brute and the hidden paradise

09:45 - 10:30 **Knots in Nature - Physical Sciences**: Kenneth C. Millett
Random sampling spaces of thick polygons

10:30 - 11:00 Coffee break

Session 1: Amphitheatre D. Vikelas

11:00 - 11:40 **Khovanov homology and categorification**: Anna Beliakova
Quantum Link Homology via Trace Functor

11:55 - 12:35 **Khovanov homology and categorification**: Paul Wedrich
Some differentials on colored Khovanov-Rozansky link homology

Session 2: Conference Hall Otto Szymiczek

11:00 - 11:40 **Virtual Knot Theory**: Valeriy Bardakov
Some representations of virtual braid group

11:55 - 12:35 **Virtual Knot Theory**: Paolo Bellingeri
Local moves for welded knotted objects

12:45 - 13:45 Lunch

14:00 - 20:00 Excursion: sightseeing at the Kaiafas lake and thermal springs & swimming at the beach of Zaharo

20:00 - 21:00 Dinner

Thursday 21 July

07:30 - 08:30 Breakfast

Plenary talks: Amphitheatre D. Vikelas

08:45 - 09:30 **TQFTs and the volume conjecture**: Stavros Garoufalidis
Nahm sums, the Bloch group and quantum topology

09:45 - 10:30 **Distributive structures and Yang-Baxter homology**: Jozef H. Przytycki
Knot Theory: from Fox 3-colorings of links to Yang-Baxter homology

10:30 - 11:00 Coffee break

Session 1: Amphitheatre D. Vikelas

11:00 - 11:40 **Knots in Nature - Physical Sciences**: Renzo L. Ricca
Knots cascade detected by a monotonically decreasing sequence of HOMFLYPT values

11:55 - 12:35 **Knots in Nature - Physical Sciences**: Mark Dennis
Knotted Vortices in Light

12:45 - 13:45 Lunch

15:00 - 15:20 **Knots in Nature - Physical Sciences**: Benjamin Bode
Knotted fields and real algebraic links

15:25 - 15:45 **Knots in Nature - Physical Sciences**: David Foster
Knotted Resonances

15:50 - 16:30 **Knots in Nature - Physical Sciences**: Rafal Komendarczyk
Ropelength, crossing number and finite-type invariants

16:35 - 17:00 Coffee break

17:00 - 17:20 **Knots in Nature - Physical Sciences**: Stathis Antoniou
The dynamics of topological surgery

17:25 - 17:45 **Knots in Nature - Physical Sciences**: Xin Liu
On the derivation of HOMFLYPT as a new invariant of topological fluid mechanics

17:50 - 18:10 **Knots in Nature - Physical Sciences**: Ljubica S. Velimirovic
Infinitesimal bending of knots

18:15 - 18:35 **Invariants of knots in 3-manifolds / Skein modules**: Dimitrios Kodokostas
Algebras of Hecke type on the mixed braid group with two fixed strands

Session 2: Conference Hall Otto Szymiczek

11:00 - 11:40 **Distributive structures and Yang-Baxter homology**: Masahico Saito
Topological quandles and cocycle knot invariants

11:55 - 12:35 **Distributive structures and Yang-Baxter homology**: Takefumi Nosaka
Twisted cohomology pairings of knots

12:45 - 13:45 Lunch

15:00 - 15:20 **Distributive structures and Yang-Baxter homology**: Jim Hoste
Knots with finite n-quandles

15:25 - 15:45 **Distributive structures and Yang-Baxter homology**: Seung Yeop Yang
Annihilation of rack and quandle homology groups of finite quandles

15:50 - 16:10 **Distributive structures and Yang-Baxter homology**: Witold Rosicki
Cocycle invariants of codimension 2 embeddings of manifolds

16:15 - 16:35 **Distributive structures and Yang-Baxter homology**: Xiao Wang
Equivalence of two definitions of set-theoretic Yang-Baxter homology

16:35 - 17:00 Coffee break

17:00 - 17:20 **Distributive structures and Yang-Baxter homology**: Sam Nelson
Biquandle Brackets

17:25 - 17:45 **Distributive structures and Yang-Baxter homology**: Seonmi Choi
On quandle homology groups of finite quandles

17:50 - 18:10 **Distributive structures and Yang-Baxter homology**: Sujoy Mukherjee
The role of associativity in the homology of self-distributive algebraic structures

18:15 - 18:35 **Distributive structures and Yang-Baxter homology**: Byeorhi Kim
On decomposition of finite quandles

Session 3: Conference Room C. Diem

11:00 - 11:40 **TQFTs and the volume conjecture**: Christian Blanchet
Modified trace on quantum sl(2) and logarithmic invariants

11:55 - 12:35 **Khovanov homology and categorification**: Piotr Sulkowski
Knot invariants and BPS states

12:45 - 13:45 Lunch

15:00 - 15:40 **TQFTs and the volume conjecture**: Hitoshi Murakami
Colored Jones polynomial and SL(2;C) representations of a knot group

15:50 - 16:10 **TQFTs and the volume conjecture**: Tian Yang
Volume Conjectures for Reshetikhin-Turaev and Turaev-Viro invariants

16:15 - 16:35 **TQFTs and the volume conjecture**: Renaud Detcherry
Curve operators in TQFT as Toeplitz operators

16:35 - 17:00 Coffee break

17:00 - 17:20 **TQFTs and the volume conjecture**: Wade Bloomquist
Asymptotic Faithfulness of Quantum SU(3) Representations

17:25 - 17:45 **Knots in Nature - Life Sciences**: Pawel Dabrowski-Tumanski
Topology of proteins with complex lasso structure

17:50 - 18:10 **Knots in Nature - Life Sciences**: Candice Price
A Discussion on the Tangle Model: An Application of Topology

18:15 - 18:35 **Knots in Nature - Life Sciences**: Alexander Taylor
Virtual knotting expressed in proteins

20:00 - 21:00 Conference Dinner

21:00 - 23:00 Greek dances - Music & Party

Friday 22 July

07:30 - 08:30 Breakfast

Plenary talks: Amphitheatre D. Vikelas

08:45 - 09:30 **Knots in Nature - Life Sciences**: Neil Osheroff
Recognition of DNA Topology by Topoisomerases

09:45 - 10:30 **Knots in Nature - Physical Sciences**: Dmitry Sokoloff
Classical helicity and higher helicity invariants in astrophysical dynamos

10:30 - 11:00 Coffee break

Session 1: Amphitheatre D. Vikelas

11:00 - 11:40 **Knots in Nature - Life Sciences**: Lynn Zechiedrich
Effect of DNA Supercoiling on DNA Dynamics

11:55 - 12:35 **Knots in Nature - Life Sciences**: Joanna Sulkowska
Entanglement in proteins: knots, slipknots and lassos

Session 2: Conference Hall Otto Szymiczek

11:00 - 11:40 **Knots in Nature - Physical Sciences**: Philipp Reiter
Elastic knots

11:55 - 12:35 **Topological spaces**: Andrey Mikhovich
Schematization, QR-presentations and Conjuring(s)

12:45 - 13:45 Farewell Lunch

20:00 - 21:00 Dinner

Saturday 23 July

07:00 - 12:00 Departures

Abstracts

4-dimensional topology

Anthony Bosman
Rice University, USA

Title: Shake Slice and Shake Concordant Links

In the 1970s Akbulut introduced that idea of a shake slice knot and shake concordance. While this offered a natural generalization of sliceness and concordance of knots, little research has been done on this notion. Recently, Cochran and Ray offered a complete characterization of shake slice and shake concordance in terms of concordance and satellite operators, along with a number of related results. We extend the notion of shake slice and shake concordance to links and offer a characterization in terms of link concordance and the multiinfection of a link by a string link. We also discuss which invariants and properties of concordance generalize to shake concordance and consider possible directions for further work.

Celeste Damiani
Université de Caen Normandie, France
Coauthors: Vincent Florens

Title: Alexander invariants for ribbon tangles

Ribbon tangles are proper embeddings of tori and annuli in the 4-dimensional ball, bounding 3-manifolds with only ribbon singularities. We construct an Alexander invariant for these objects that induces a functorial generalisation of the Alexander polynomial. This functor is an extension of the Alexander functor for usual tangles defined by Bigelow Cattabriga-Florens and studied by Flores-Massuyeau. If considered on braid-like ribbon tangles, this functor coincides with the exterior powers of the Burau-Gassner representation. On one hand, we observe that the action of cobordisms on ribbon tangles endows them with a circuit algebra structure over the operad of cobordisms, and we show that the Alexander invariant commutes with the circuit algebra's composition. On the other hand, ribbon tangles can be represented by welded tangle diagrams: this allows to give a combinatorial description of the Alexander invariant.

Samuel J. Lomonaco
University of Maryland Baltimore County (UMBC), USA

Title: The Geometry of the Fox Free Calculus with Applications to Higher Dimensional Knot Theory

We begin by showing how the Wirtinger presentation of the fundamental group of a knot can be extended to a generalized presentation. This generalized presentation gives a complete cell decomposition of the knot exterior. Moreover, this generized presentation, under generalized Tietze transformations, represents the simple homotopy type of the knot exterior.

Next, we then use the generalized presentation to construct a chain complex (C_*, d_*) for the universal cover of the knot exterior, where all the boundary morphisms d_* are constructed from the Fox free derivative. Finally, we consider applications to 3 and 4 dimensional knot theory.

Braids

Usman Ali
CASPAM, Bahauddin Zakariya University Multan, Pakistan
Coauthors: Anam Riaz

Title: On the Gröbner-Shirshov basis of 3-braids

Direct consequences of the form of Gröbner-Shirshov basis for the positive 3-braids are given. The Garside normal forms, summit words, and the smallest summit word in the centralizers of Artin generators are described. The result is related to a classification of a particular class of links with braid index three. A criterion for braids in the centralizer to be a quasipositive is also given.

Matthieu Calvez
Universidad de Santiago de Chile USACH, Chile
Coauthors: Bert Wiest

Title: Towards an algebraic Nielsen-Thurston classification of braids

We attach to the braid group (more generally to any Garside group) a Gromov-hyperbolic graph on which the group acts by isometries: the *additional length graph*. For braids, this is meant to be an algebraic analog of the curve complex attached to the Mapping Class Group of the punctured disk. We will present positive results and open questions on a conjectured dictionary between Nielsen-Thurston classification and the classification of isometries of the additional length graph as a hyperbolic space.

Jinseok Cho
Pohang Mathematics Institute, POSTECH, South Korea
Coauthors: Christian Zickert (University of Maryland)

Title: Cluster algebra on the braids

We introduce the cluster algebra of the braids proposed by Hikami-Inoue in [1] and show its relationship with the hyperbolic structures of links. Then we give new interpretation of the cluster algebra in terms of the Ptolemy coordinates with respect to certain obstruction class. Using it, the answer to the Hikami-Inoue conjecture is given.

References:
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[2] S. Garoufalidis, M. Goerner, and C. K. Zickert. The Ptolemy field of 3-manifold representations. Algebr. Geom. Topol., 15(1):371–397, 2015.

Zaffar Iqbal
University of Gurat, Pakistan
Coauthors: M. Akram, Univerdity of Gujrat; S. Batool, Univerdity of Gujrat

Title: Hilbert series of right-angled affine Artin monoids $M(\widetilde{A}_n^{\infty})$

In this paper we find the Hilbert series of the right-angled affine Artin monoids $M(\widetilde{A}_n^{\infty})$ of type $\widetilde{A}_n$. It is already proved that the growth rate of all the spherical Artin monoids is bounded above by 4. Here we discuss the behavior of the growth rate of $M(\widetilde{A}_n^{\infty})$. Our computations suggest that the growth rate of $M(\widetilde{A}_n^{\infty})$ is unbounded. Furthermore, the behavior of the growth rates of few other right-angled affine Artin monoids is observed.

Joseph Ricci
University of California Santa Barbara, USA
Coauthors: Zhenghan Wang, University of California Santa Barbara

Title: Congruence subgroups and low-dimensional representations of the braid group B_3

Ng and Schauenburg showed that the kernel of a TQFT representation of $\mathrm{SL}(2,\mathbb{Z})$ is a congruence subgroup. Motivated by their result, we prove that the kernel of a two-dimensional irreducible representation of the braid group B_3 with finite image enjoys a congruence subgroup property. In particular, we show that up to scaling the kernel projects onto a congruence subgroup in $\mathrm{PSL}(2,\mathbb{Z})$. We apply our results to braid group representations coming from the braiding on weakly integral simple objects in modular tensor categories. We also show that our result is not true in general for higher-dimensional representations. Our technique uses classification theorems and the Fricke-Wohlfarht theorem, a deep result in number theory.

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[1] S.-H. Ng and P. Schauenburg, *Congruence Subgroups and Generalized Frobenius-Schur Indicators, Communications in Mathematical Physics, 300 (2010), no. 1, 1-46.*

Mauro Spera
Dipartimento di Matematica e Fisica Niccolo Tartaglia, Universita Cattolica del Sacro Cuore, Italy

Title: Geometry of unitary Riemann surface braid group representations and Laughlin-type wave functions

In this talk, based on our paper [1], we review the geometric construction of the simplest unitary Riemann surface braid group representations by means of stable holomorphic vector bundles over complex tori and the prime form on Riemann surfaces, building on Bellingeri's presentation ([2]). Generalised Laughlin wave functions are then introduced. The genus one case is discussed in some detail also with the help of non-commutative geometric tools and, time permitting, an application of Fourier-Mukai-Nahm techniques will be also given, explaining the emergence of an intriguing Riemann surface braid group duality.

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Vladimir Vershinin
Université de Montpellier, France

Title: Brunnian and Cohen braids and Lie algebras

We present results on Brunnian and Cohen braids and their relations with the other mathematical structures. These results were obtained recently in joint works with V.G. Bardakov, Jingyan Li, R. Mikhailov and Jie Wu.

Distributive structures and Yang-Baxter homology

Seonmi Choi
Kyungpook National University, South Korea
Coauthors: Yongju Bae, Kyungpook National University

Title: On quandle homology groups of finite quandles

A quandle is a set equipped with a binary operation satisfying three quandle axioms. It also can be expressed as a sequence of permutations of the underlying set satisfying certain conditions. In this talk, we will show how one can calculate rack/quandle homology groups of finite quandles by using the properties of corresponding permutations.

Jim Hoste
Pitzer College, Claremont, USA
Coauthors: Patrick D. Shanahan

Title: Knots with finite n-quandles

Associated to every knot is its fundamental quandle Q(K), which Joyce proved is a complete knot invariant. A somewhat more tractable, but less sensitive invariant is the n-quandle, a quotient of Q(K) defined for every natural number n. I will describe these quandles and show that the n-quandle of a knot is isomorphic to the set of cosets of the peripheral subgroup of a certain quotient of the fundamental group of the knot. This characterization proves a conjecture of Przytycki: The n-quandle of a knot is finite if and only if the fundamental group of the n-fold cyclic cover of the 3-sphere branched over the knot is finite. I will outline a program to catalog all finite quandles that appear as n-quandles of some knot or link. Some of this is joint work with Pat Shanahan.

Byeorhi Kim
Kyungpook National University, South Korea
Coauthors: Yongju Bae, Kyungpook National University

Title: On decomposition of finite quandles

In 2008, Ehrman G., Gurpinar A., Thibault M. and Yetter D. showed that every quandle can be decomposed as connected subquandles. In this talk, we will talk about precise conditions for the operation tables which can be quandles. And we also study the inner automorphism groups of such quandles.

Sujoy Mukherjee
The George Washington University, USA
Coauthors: Coauthors:

Title: The role of associativity in the homology of self-distributive algebraic structures

A quandle is an algebraic structure whose axioms correspond to the three Reidemeister moves. A shelf is a magma satisfying the right self-distributivity axiom, which corresponds to the third Reidemeister move. In particular, all quandles are shelves. In the last three decades, two-term (rack), quandle and one-term homology theories were defined and developed to study these structures. We will show that unital shelves have trivial augmented one-term homology groups in all dimensions and their two-term (rack) homology groups are the group of integers in all dimensions. Next, we will apply the results to study the one-term and two-term (rack) homology groups of Laver tables and special families of f-block spindles.

Sam Nelson
Claremont McKenna College, USA
Coauthors: Michael E. Orrison and Veronica Rivera

Title: Biquandle Brackets

We introduce a new class of quantum enhancements we call biquandle brackets, which are customized skein invariants for biquandle colored links. Quantum enhancements of biquandle counting invariants form a class of knot and link invariants that includes biquandle cocycle invariants and skein invariants such as the HOMFLY-PT polynomial as special cases, providing an explicit unification of these apparently unrelated types of invariants. We provide examples demonstrating that the new invariants are not determined by the biquandle counting invariant, the knot quandle, the knot group or the traditional skein invariants.

Takefumi Nosaka
Kyushu University, Japan

Title: Twisted cohomology pairings of knots

The cohomology pairings of manifolds have a long history; including Poincare duality, Goldman Lie algebra and surgery theory. In this talk, I introduce a diagrammatic computation for twisted cohomology pairings of knots. Here, quandle theory plays a key role. Furthermore, I give some applications, e.g, Blanchfield pairings of knots, (twisted) Milnor duality, and bilinear forms on the twisted Alexander modules of links.

Jozef H. Przytycki
George Washington University, USA & University of Gdansk, Poland

Title: Knot Theory: from Fox 3-colorings of links to Yang-Baxter homology

We start from the short introduction to Knot Theory from the historical perspective, starting from Heraclas text (the first century A.D.), mentioning R. Llull (1232-1315), A. Kircher (1602-1680), Leibniz idea of Geometria Situs (1679), and J.B. Listing (student of Gauss) work of 1847. We will spend some time on Ralph H. Fox (1913-1973) elementary introduction to diagram colorings (1956). In the second part of the talk I will describe how Fox work was generalized to distributive colorings (rack and quandle) and eventually in the work of Jones and Turaev to link invariants via Yang-Baxter operators. Here the importance of statistical mechanics to topology will be mentioned. Finally I will describe recent developments which started with Mikhail Khovanov work on categorification of the Jones polynomial. By analogy to Khovanov homology we build homology of distributive structures (including homology of Fox colorings) and generalize it to homology of Yang-Baxter operators. We speculate, with supporting evidence, on co-cycle invariants of knots coming from Yang-Baxter homology. Here the work of Fenn-Rourke-Sanderson (geometric realization of pre-cubic sets of link diagrams) and Carter-Kamada-Saito (co-cycle invariants of links) will be discussed and expanded. No deep knowledge of Knot Theory, homological algebra or statistical mechanics is assumed, I will work from basic principles. Because of this some topics will be only briefly described. But I believe in "Open Talks", that is I hope to discuss and develop above topics in an after-talk discussion over coffee or tea with willing participants.

References: arXiv:1409.7044 [math.GT].

Witold Rosicki
University of Gdansk, Poland

Title: Cocycle invariants of codimension 2 embeddings of manifolds

We consider the classical problem of a position of n-dimensional manifold M^n in R^{n+2}.

We show that we can define the fundamental (n+1)-cycle and the shadow fundamental (n+2)-cycle for a fundamental quandle of knotting $M^n \to R^{n+2}$. In particular, we show that for any fixed quandle, quandle coloring, and shadow quandle coloring of a diagram of M^n embedded in R^{n+2} we have (n+1)- and (n+2)-(co)cycle invariants (i.e.invariant under Roseman moves).

The case n=2 is well known. The case n=3 we can explane in a geometric way. The general case we described in arXiv:1310.3030v1 and an article in Banach Center Publications 103, 2014.

Masahico Saito
University of South Florida, USA
Coauthors: W. Edwin Clark

Title: Topological quandles and cocycle knot invariants

Quandle cocycle invariants have been applied to various properties of knotted surfaces as well as classical and virtual knots. They have been studied mostly with finite quandles. After a review of the invariant, we generalize it to topological quandles. The cocycle invariants have an interpretation as partitions of colorings, using colorings of long knots by quandle abelian extensions associated with cocycles. This interpretation is used for topological quandles. As an example, the generalized invariants are computed for some knots with SO(3). We observe that SO(3) is an abelian extension of the 2-sphere with conjugation quandle structure. Points of the sphere are identified with rotations of constant angle about the corresponding unit vectors. Regular polygons in the sphere, for example, appear as coloring conditions.

Xiao Wang
The George Washington University, USA
Coauthors: Jozef H. Przytycki

Title: Equivalence of two definitions of set-theoretic Yang-Baxter homology

In 2004, Carter, Elhamdadi and Saito defined a homology theory for the set-theoretic Yang-Baxter operator. In 2012, Przytycki defined another homology theory for Yang-Baxter operator which has a nice graphic visualization. We show that they are equivalent in the sense that they give the same homology group.

Seung Yeop Yang
The George Washington University, USA
Coauthors: Jozef H. Przytycki

Title: Annihilation of rack and quandle homology groups of finite quandles

It is a classical result in reduced homology of finite groups that the order of a group annihilates its homology. The first general result for rack and quandle homology in this direction were obtained by Litherland and Nelson, and Etingof and Grana independently. Niebrzydowski and Przytycki proved that the torsion part of the homology of the dihedral quandle of order 3 is annihilated by its order, and they conjectured that for a finite quasigroup quandle (or Latin quandle) the torsion of its homology is annihilated by the order of the quandle. The conjecture is partially proved by Nosaka for finite connected Alexander quandles.

In this talk, we prove the conjecture in full generality. We, moreover, discuss annihilation of rack and quandle homology groups of finite m-almost quasigroup quandles and non-connected dihedral quandles.

Geometry of knots and manifolds

Nikolay Abrosimov
Sobolev Institute of Mathematics, Russia
Coauthors: Alexander Mednykh, Sobolev Institute of Mathematics; Dasha Sokolova, Novosibirsk State University

Title: Volumes of polyhedra related with links and knots

We overview the geometry of knots and links. We consider a geometric structure on knots and links complement. We present fundamental polyhedra related to them. We find trigonometrical and algebraic identities between lengths and angles. We observe a volume calculation for knots and links.

In particular we consider the Hopf link, the figure eight knot 4_1 with a bridge and the link 6_2^2.

Colin Adams
Williams College, USA
Coauthors: Gregory Kehne, Carnegie Mellon University

Title: Multi-crossing number of knots and relations with other invariants

Multi-crossings are crossing with more than two strands passing through them. An übercrossing projection is a projection of a knot with only one multi-crossing. A petal projection is an übercrossing projection with no nested loops. We introduce these ideas and then extend various results about the usual knot projections to these other cases, including a variety of results on hyperbolic volume.

Evgeny Fominykh
Chelyabinsk State University, Russia
Coauthors: V. Turaev and A. Vesnin

Title: Complexity of virtual 3-manifolds

Virtual 3-manifolds were introduced by Matveev in 2009 as a natural generalization of the classical 3-manifolds. In this talk we define the complexity of virtual 3-manifolds and calculate it for virtual 3-manifolds defined by special polyhedra with one or two 2-components. As a corollary, we establish the exact values of complexity for infinite families of hyperbolic 3-manifolds with geodesic boundary.

Stefanos Gialamas
American Community Schools of Athens, Greece

Title: Determining Vanishing Massey Triple Products in the Complement of a Link with more than two components

The purpose of this presentation aims to introduce an algorithm which detects vanishing Massey Triple Products, in the complement of a Link with more than two components. By using the commutator subgroups of the fundamental group of the Link, we construct the Lie algebra associated to the fundamental group. The Cohomology Ring of the Lie algebra is used to define Massey Triple Products. The author's two theorems provide the conditions under which one can determine whether Massey Triple Products vanish. The algorithm is applied to braids and answers partially the question, which closed braids have vanishing Massey Triple Products.

The method requires a presentation of the fundamental group of the complement of the Link satisfying the following condition: The number of generators of the fundamental group of the complement of the Link, equals to the number of generators of the first Homology group of the complement of the Link.

Catherine Gille
IMJ-PRG, Université Paris Diderot, France

Title: Klein branched covers of spatial trivalent graphs and surgery

A Klein branched cover is a cover of the 3-sphere branched over an embedded connected trivalent graph (endowed with some coloring). It can be seen as a generalization of the double branched cover of a knot. We describe completely this family of 3-manifolds in terms of surgery on certain links.

Cameron Gordon
University of Texas at Austin, USA

Title: Left-orderability and cyclic branched covers of knots

For a prime 3-manifold M, it is conceivable that the following three properties are equivalent: (1) $\pi_1(M)$ is left-orderable, (2) M has a co-orientable taut foliation, and (3) M is not a Heegaard Floer L-space. One class of manifolds for which these properties have been investigated are the n-fold cyclic branched covers $\Sigma_n(K)$ of prime knots K. We will survey some of the results in this direction. We will also prove a conjecture of Riley on $SL(2, R)$ representations of 2-bridge knot groups, which implies that if K is a 2-bridge knot with non-zero signature then $\pi_1(\Sigma_n(K))$ is left-orderable for n sufficiently large.

Joshua Howie
University of Melbourne, Australia

Title: A characterisation of alternating knot exteriors

We give a characterisation of alternating knot exteriors based on the presence of a pair of special spanning surfaces. This shows that alternating is a topological property of the knot exterior and not just a property of diagrams, answering an old question of Ralph Fox.

The characterisation leads to a normal surface algorithm which can decide if a knot is alternating, given a triangulation of its exterior as input. In particular, we show that the desired pair of spanning surfaces appear as fundamental solutions in the normal surface solution space.

Effie Kalfagianni
Michigan State University, USA
Coauthors: Stephan Burton, Michigan State University

Title: Geometric estimates from knot spanning surfaces

We discuss bounds on the cusp volume and the length of the meridian of hyperbolic knots in terms of the topology of essential surfaces spanned by the knots. In many cases (e.g. when the knot is “adequate”) these bounds are obtained from knot diagrams. We will also discuss some applications to Dehn surgery.

Christine Ruey Shan Lee
University of Texas at Austin, USA
Coauthors: Roland van der Veen, Leiden University

Title: The colored Jones polynomial and slopes of pretzel knots

The Slope Conjecture [Gar11] and the Strong Slope Conjecture [KT15] relate the growth of the degrees of the colored Jones polynomial to the slopes and Euler characterstics of essential surfaces in the knot complement. In this talk, we present our recent result proving these conjectures for a class of 3-tangle pretzel knots [LvdV16]. In particular, we will discuss how the use of the Hatcher-Oertel algorithm and the corresponding computation of the colored Jones polynomial in the proof suggest a framework for understanding these conjectures for more general knots.

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[LvdV16] Christine Ruey Shan Lee and Roland van der Veen, *Slopes for pretzel knots.* arXiv:1602.04546, 2016.

Delphine Moussard
Université de Bourgogne, France

Title: Finite type invariants of rational homology 3-spheres

We introduce a theory of finite type invariants for rational homology 3-spheres which can be thought as a rational homology version of the Goussarov-Habiro theory for integral homology spheres. For this theory, we describe combinatorially the space of finite type invariants, graded by the degree. This provides a comparison of the Le-Murakami-Ohtsuki invariant and of the Kontsevich-Kuperberg-Thurston invariant, the equivalence of which has been conjectured by Kuperberg and Thurston.

Tom Needham
University of Georgia, USA

Title: The Geometry of the Shape Space of Framed Loops

Moduli spaces of loops in 3-manifolds have been studied from a variety of perspectives. In the smooth category, various authors (Marsden-Weinstein, Brylinski, Millson-Zombro) have shown that these spaces are infinite-dimensional Kähler manifolds. In the PL category, the moduli spaces are known as polygon or linkage spaces, and they serve as one of the primary models used to study random knotting. In this talk we describe the geometry of the moduli space of Euclidean similarity classes of parameterized *framed* loops in $\mathbb{R}^3$. We show that, with respect to a natural Riemannian metric, this space is isometric to an infinite-dimensional complex Grassmannian. Moreover, we show that this space is closely related to the loop spaces mentioned above via symplectic reduction. As an application of this structure, we describe an algorithm for shape matching for framed paths and loops. In this model, shape similarity correlates to geodesic distance in the moduli space—this algorithm is particularly effective because, remarkably, the moduli space admits explicit geodesics. This gives a novel method for distinguishing shapes of oriented trajectories or protein backbones.

Joao M. Nogueira
University of Coimbra, Portugal

Title: Knot complement with all possible meridional essential surfaces

We show the existence of infinitely many knots, both hyperbolic and non-hyperbolic, where each complement contains meridional essential surfaces of simultaneously unbounded genus and number of boundary components. In particular, we construct examples of knot complements each of which having all possible compact surfaces embedded as meridional essential surfaces.

Shawn Rafalski
Fairfield University, USA
Coauthors: Christopher K. Atkinson, University of Minnesota Morris; Jessica Mallepalle, Arcadia University; Joseph Melby, University of Minnesota Morris; Jennifer Vaccaro, Olin College of Engineering

Title: Volume bounds for certain hyperbolic 3-orbifolds

For any finite-volume hyperbolic 3-manifold M containing an embedded incompressible (π_1-injective) surface S, the work of Agol, Storm, and Thurston gives a lower volume bound for M in terms of the Euler characteristic of the guts of the path metric completion of $M - S$. We consider any compact hyperbolic 3-orbifold $\mathcal{O}$ with underlying space the 3-sphere and whose singular set consists of a trivalent graph. In the case that $\mathcal{O}$ contains an embedded incompressible 2-orbifold Σ whose underlying space is the 2-sphere, we use this work to obtain a lower volume bound for $\mathcal{O}$ in terms of the Euler characteristic of Σ. This result is joint work with undergraduate students who took part in the Fairfield University Research Experiences for Undergraduates Program.

António Salgueiro
University of Coimbra, Portugal

Title: Actions of 3-manifolds with the same quotient

Let M be an orientable 3-manifold and G_1 and G_2 be two finite groups that act on M preserving the orientation, with the same quotient $M/G_1 \cong M/G_2$. We discuss when this implies that G_1 and G_2 are conjugated, and give some examples where these groups are not conjugated.

Anastasiia Tsvietkova
University of California, Davis, USA
Coauthors: Joel Hass, Abigail Thompson

Title: The number of surfaces of fixed genus in an alternating link complement

An incompressible surface in a 3-dimensional manifold is, in intuitive terms, a surface which is simplified as much as possible while remaining nontrivial in the manifold. Let our 3-manifold M be the complement of a prime alternating link with n crossings in a 3-sphere. We show that the number of genus-g incompressible surfaces in M is bounded by a polynomial in n. Previous bounds were exponential in n.

Invariants of knots in 3-manifolds / Skein modules

Alessia Cattabriga
University of Bologna, Italy
Coauthors: Enrico Manfredi, Michele Mulazzani, University of Bologna; Lorenzo Rigolli, Ruhr-Universität Bochum

Title: Representations and invariants of links in lens spaces

In the last decades a lot of work on knot theory in lens spaces has been done: different representations were introduced to extend invariants defined for links in the 3-sphere. In this talk we describe the disk diagrams representation and its connections with the other link representations. Moreover, we use it to compute invariants for links in lens spaces, focusing, particularly, on the relation between Alexander polynomial, HOMFLY-PT polynomial and Link Floer Homology.

Ioannis Diamantis
International College Beijing, China Agricultural University, China
Coauthors: Sofia Lambropoulou

Title: On the Homflypt skein module of the lens spaces $L(p,1)$ via braids

In this talk we will present recent results on the Homflypt skein module of the lens spaces $L(p,1)$, $\mathcal{S}\,(L(p,1))$, using braids. We will first present algebraic mixed braid classification of links in any c.c.o. 3-manifold M obtained by rational surgery along a framed link in S^3 and we will focus on the case where $M = L(p,1)$. Then, we will present a new basis, Λ, for the Homflypt skein module of the solid torus ST, $\mathcal{S}\,(\mathrm{ST})$, which topologically is compatible with the handle sliding moves and is appropriate for computing skein modules of arbitrary c.c.o. 3-manifolds. $\mathcal{S}(\mathrm{ST})$ plays an important role in the study of Homflypt skein modules of arbitrary c.c.o. 3-manifolds, since every c.c.o. 3-manifold can be obtained by integral surgery along a framed link in S^3 with unknotted components. The new basis Λ comes from the work of S. Lambropoulou on the generalized Hecke algebra of type B, $\mathrm{H}_{1,n}(q)$. More precisely, we start with the well-known basis Λ' of $\mathcal{S}(\mathrm{ST})$ and an appropriate linear basis Σ_n of the algebra $\mathrm{H}_{1,n}$ and we convert elements in Λ' to sums of elements in Σ_n. Then, using conjugation and the stabilization moves, we convert these elements to sums of elements in Λ by managing gaps in the indices, by ordering the exponents of the looping elements and by eliminating braiding tails in the words. Further, we define total orderings on the sets Λ' and Λ and, using these orderings, we relate the two sets via a block diagonal matrix, where each block is an infinite lower triangular matrix with invertible elements in the diagonal. Using this matrix we prove linear independence of the set Λ.

We will then establish the connection between $\mathcal{S}(\mathrm{ST})$, the Homflypt skein module of the solid torus ST, and $\mathcal{S}(L(p,1))$ and arrive at an infinite system, whose solution corresponds to the computation of $\mathcal{S}(L(p,1))$. We start from the Lambropoulou invariant X for knots and links in ST, the universal analogue of the Homflypt polynomial in ST, and the new basis, Λ, of $\mathcal{S}(\mathrm{ST})$. We will show that $\mathcal{S}(L(p,1))$ is obtained from $\mathcal{S}(\mathrm{ST})$ by considering relations coming from the performance of braid band moves (bbms) on elements in the basis Λ, where the braid band moves are performed on any moving strand of each element in Λ. We do that by proving that the system of equations obtained from diagrams in ST by performing bbm on any moving strand is equivalent to the system obtained if we only consider elements in the basic set Λ. We will then present an augmented set L and prove that the system of equations obtained from elements in Λ by performing bbms on any moving strand is equivalent to the system obtained if we consider elements in the augmented set L and only perform bbms on their first moving strand. Finally, we will present some results toward the solution of the infinite system and prove that this system splits into infinite many self-contained subsystems.

Boštjan Gabrovšek
University of Ljubljana, Faculty of Mathematics and Physics, Slovenia
Coauthors: Enrico Manfredi, Eva Horvat

Title: Knots in Seifert Fibered Spaces

We present arrow diagrams for links in Seifert fibered spaces and provide a complete list of Reidemeister moves for these diagrams. For such diagrams we state the Reidemeister theorem that two links are isotopic if and only if they differ by a finite sequence of planar isotopies and Reidemeister moves.

In the second part we give a Wirtinger-type presentation for the fundamental group of the knot's complement, which can be read directly from the diagram. By abelization we calculate the first homology group and provide a lower bound for the rank.

Lastly, using Fox calculus on the knot group, we define the twisted Alexander polynomials associated with links in Seifert fibered spaces. For the special case of lens spaces, we notably simplify the construction and show that the Alexander polynomial respects a skein realation.

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[1] B. Gabrovšek and E. Horvat, On the Alexander polynomial of links in lens spaces, arXiv:1606.03224 [math.GT] (2016).
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Uwe Kaiser
Boise State University, USA

Title: Skein theory of links in hyperbolic 3-manifolds

We consider a complexity function for unoriented links in a hyperbolic 3-manifold M defined using the length function and the injectivity radius. Collections of free homotopy classes of loops are uniquely represented by unions of geodesics in M. For a given union of prime geodesics we study resolution links of the corresponding immersions. These are all links with the same complexity. The goal is to develop higher order complexities to prove finiteness results for skein resolutions.

Dimitrios Kodokostas
National Technical University of Athens, Greece
Coauthors: Sofia Lambropoulou

Title: Algebras of Hecke type on the mixed braid group with two fixed strands

Mixed links in S^3 consist of two parts, the first encoding a 3-manifold M^3 and the second encoding a link in M^3. For a given manifold M^3 and a link L encoding it, the mixed braid groups $B_{n,m}$ (for a fixed n depending on L, and for an arbitrary m) consist of braids coming from the corresponding mixed links each such braid consists of two sets of strands: the first set forms the identity braid on n (*fixed*) strands, whereas the second set consists of m (*moving*) strands which braid with each other and with the fixed ones. $B_{n,m}$ become groups under concatenation of braids, and it is establieshed that such mixed braid representation in S^3 of the link structure in M^3 holds for closed connected oriented manifolds, for handlebodies and for complements of links in S^3 [HL,La2,LR1].

The mixed-braid setting can be utilized in order to construct homfly-pt type invariants for oriented links in 3-manifolds M^3 whose braid structure is encoded by the groups $B_{1,n}$, like for example the solid torus [La1] and the lens space $L(p,1)$ [DLP,DL1,DL2]. To achieve this, one mimics the original Jones construction of the classical homfly-pt polynomial for the oriented links in S^3 [J], first constructing appropriate algebras over the associated braid groups for the manifold, and then choosing an appropriate "inductive" basis on them so that the construction of an Ocneanu's Markov trace on their union would be possible, which subsequently could be used for the construction of the invariant.

We are currently jointly working with S. Lambropoulou on the mixed braid groups $B_{2,n}$ which are related to links in handlebodies of genus two, in the complement of the 2-unlink and in the connected sums $L(p,1)\#L(q,1)$. As an appropriately related sequence of algebras to carry over the above plan for a knot invariant construction, we have defined for every n the quotient algebra $\mathcal{H}_{2,n}(q)$ of $\mathbb{Z}[q^{\pm}]B_{2,n}$ over the quadratic skein relations $g_i^2 = (q-1)g_i + q \cdot 1, i = 1,2,\ldots,n-1$ of the classical Iwahori-Hecke algebra $\mathcal{H}_n(q)$ for the images g_i of the usual braiding generators σ_i. And we have spotted a basis $\Lambda_n = \Pi_1\Pi_2\cdots\Pi_n\Pi'_1\Pi'_2\cdots\Pi'_n g$ for this algebra, where $g \in \mathcal{H}_n(q)$ and Π_i, Π'_i are finite products of appropriate braids $\tau_i^{\pm 1}, \mathcal{T}_i^{\pm 1}$ or just of $\tau_i^{\pm 1}$ respectively. We have proved that Λ_n is a spanning set of $\mathcal{H}_{2,n}(q)$ and our next goal is to prove that it is also linearly independent.

References:

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Thang Le
Georgia Institute of Technology, USA

Title: Triangular decomposition of skein algebras and quantum Teichmuller spaces

We show how to decompose the Kauffman bracket skein algebra of a surface into elementary blocks corresponding to the triangles in an ideal triangulation of the surface. This gives an easy proof of the existence of the quantum trace map of Bonahon and Wong. We also explain the relation between the Kauffman bracket skein algebra and the quantum Teichmuller space.

Enrico Manfredi
Università di Bologna, Italy

Title: Diffeomorphic vs isotopic knots in lens spaces

Links in lens spaces may be defined to be equivalent by ambient isotopy or by diffeomorphism of pairs. Following the disk diagram description of links in lens spaces given in [2], it is possible to find a set of Reidemeister-type moves on disk diagrams that allows to recognize isotopy-equivalent links. In [1] Bonahon describes the diffeotopy groups of lens spaces, that is to say, non-isotopic diffeomorphisms of lens spaces that generates this finite groups. We will describe the effect of this diffeomorphisms on disk diagrams, providing a set of diffeo-equivalence moves for links in lens spaces. Moreover we investigate how the diffeo-equivalence relates to the lift of the link in the 3-sphere.

References:

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Hugh Morton
University of Liverpool, United Kingdom
Coauthors: Peter Samuelson

Title: A skein theoretic model for the double affine Hecke algebras

We consider oriented braids in the thickened torus $T^2 \times I$, together with a single fixed base string. The based skein $H_n(T^2, *)$ is defined to be $\mathbf{Z}[s^{\pm 1}, q^{\pm 1}]$-linear combinations of n-braids subject to the Homflypt relation $X_+ - X_- = (s - s^{-1})X_0$. In addition a braid string is allowed to cross through the base string at the expense of multiplying by a parameter q.

Composition of braids induces an algebra structure on $H_n(T^2, *)$, generated by the standard braid generators σ_i whose strings remain inside a cylinder away from the base string, along with elements ξ_1 and η_1. These are represented by braids in which the first string follows the curve $(1, 0)$ or $(0, 1)$ respectively in the torus, while all other strings remain vertical. Elements ξ_i and η_i can be defined similarly moving string i only. We show that the resulting elements $\{\sigma_i\}, \{\xi_i\}, \{\eta_i\}$ satisfy the relations of the double affine Hecke algebra $\ddot{H}_n$, as defined by Cherednik.

We discuss how to include closed curves in the thickened torus in the model in an attempt to incorporate our earlier work on the Homflypt skein of T^2 into the setting of the algebras $\ddot{H}_n$.

References:
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[2] H.R. Morton and P. Samuelson, The Homflypt skein algebra of the torus and the elliptic Hall algebra, Duke Math. Journal (to appear).

Khovanov homology and categorification

Anna Beliakova
Universität Zürich

Title: Quantum Link Homology via Trace Functor

In this talk I will define a new triply graded invariant of links in a thickened annulus – the quantum annular link homology. This theory admits an action of the quantum sl(2) which intertwines the action of annular cobordisms. In particular, the braid group action on the n-cables factors through the Jones skein relations. This leads to a new polynomial invariant of closed surfaces knotted in four dimensions. All the results are joint with K. Putyra and S. Wehrli.

Abdul Rauf Nizami
University of Education, Lahore, Pakistan
Coauthors: Mobeen Munir, University of Education; Ammara Usman, University of Education; Tanveer Sohail, University of Science and Technology of China; Dishya Arshad, University of Education

Title: Khovanov Homology of the Braid Link $x_1x_2x_1\cdots$

Khovanov homology was introduced by Mikhail Khovanov as a categorification of the Jones polynomial. Khovanov assigned a bigraded chain complex $C^{i,j}(L)$ to the oriented link diagram L whose differential is graded of bidegree $(1,0)$ and whose homotopy type depends only on the isotopy class of L. The bigraded homology group $H^{i,j}(L)$ of the chain complex $C^{i,j}(L)$ provides an invariant of oriented links, now known as Khovanov homology.

Although computing the Khovanov homology of links is common in literature, no general formulae have been given for all of them. We give the Khovanov homology of the link $x_1x_2x_1\cdots$, which is divided into six classes depending on number of factors. Moreover, we recover the Jones polynomial from the graded Poincaré polynomial of this link.

Hoel Queffelec
CNRS and U. Montpellier, France
Coauthors: Antonio Sartori (Uni Freiburg)

Title: HOMFLY-PT and Alexander polynomials from a doubled Schur algebra

The HOMFLY-PT polynomial is a two-variable knot invariant, that can be specialized to both the Alexander and the Jones polynomials. However, the quantum group based constructions yielding these latter invariants do not lift to the HOMFLY-PT polynomial. Using ideas from Howe duality, we introduce a doubled version of the quantum Schur algebra, which allows us to define in a unified quantum setting the HOMFLY-PT, Reshetikhin-Turaev, and Alexander polynomials.

Radmila Sazdanovic
North Carolina State University, USA

Title: Khovanov homology: an introduction

We introduce Khovanov homology along with a brief overview of developments in low dimensional topology it has inspired and relations to other link homology theories. The main emphasis will be on the role of torsion in Khovanov homology and several open problems.

Dan Scofield
North Carolina State University, USA

Title: Torsion in Khovanov link homology via chromatic graph cohomology

The categorification of the chromatic polynomial by Helme-Guizon and Rong is isomorphic to Khovanov link homology over a range of homological gradings. Motivated by Hochschild homology, we compute torsion in chromatic homology for certain classes of graphs. As a consequence, we offer insight into Z2 torsion of certain classes of knots and links.

Alexander Shumakovitch
The George Washington University, USA
Coauthors: Krzysztof Putyra, ETH Zurich, Switzerland

Title: Knot invariants arising from homological operations on Khovanov homology

There are several homological operations that can be defined between even and odd Khovanov homology theories using the unified homology theory developed by Putyra. This construction works for both reduced and unreduced versions of the Khovanov homology. We discuss these homological operations, compare different versions of them, and show how they can give rise to new knot invariants with interesting properties. This is a joint work with Krzysztof Putyra.

Marithania Silvero
Universidad de Sevilla, Spain
Coauthors: Józef H. Przytycki

Title: Studying torsion of extreme Khovanov homology

In [GMS] we presented a new approach to extreme Khovanov homology in terms of the independence complex obtained from a specific graph constructed from the link diagram. With this point of view, we study the conjecture stating that extreme Khovanov homology has no torsion. Namely, we we conjectured that for any link the previous complex is homotopy equivalent to a wedge of spheres. In particular, this homotopy type would be a link invariant.

In this talk we present some special cases where the conjecture holds, and show how to construct a permutation circle graph whose independence complex has the homotopy type of any given finite wedge of spheres. As consequence of this work we obtain a method for constructing some interesting families of H-thick links with gaps in their extreme Khovanov homology and generalize some results in [CS] and [N-R].

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Piotr Sulkowski
University of Warsaw, Poland & Caltech, USA

Title: Knot invariants and BPS states

Knot theory turns out to be deeply related to quantum field theory and string theory. Such physical perspectives provide a novel interpretation of various known knot invariants and lead to a formulation of new invariants. I will explain how realization of knots in the system of D-branes in string theory results in a formulation of integral BPS invariants, which (physically) count the number of so-called BPS states. I will present how integrality of these invariants leads to surprising statements and predictions in number theory. I will also explain how these BPS invariants are encoded in algebraic curves (certain reformulations of A-polynomials), how quantization of such curves results in quantum BPS invariants, and how an additional refinement of these results gives a glimpse into the realm of knot homologies.

Paul Wedrich
Imperial College London, United Kingdom

Title: Some differentials on colored Khovanov-Rozansky link homology

I will start by introducing the family of colored Khovanov-Rozansky sl(N) and HOMFLY-PT link homologies, which categorify the Reshetikhin-Turaev sl(N) link invariants and their large N limits. The members of this large family of invariants are related through spectral sequences from which additional topological information can be extracted, for example in the form of Rasmussen-type concordance invariants. The focus of this talk is on some new spectral sequences which lead to proofs of physical conjectures about the structure of colored HOMFLY-PT homology. This builds on joint work with David E. V. Rose and earlier work of Jake Rasmussen.

Knot algebras / Link invariants

Fathi Ben Aribi
University of Geneva, Switzerland

Title: Detecting knots with the L^2-Alexander invariant

The L^2-Alexander invariant of a knot is a continuous real function defined by Li and Zhang in 2006 as an infinite-dimensional version of the Alexander polynomial. It contains classical invariants of geometry and topology like the simplicial volume and the genus. Using 3-dimensional topology, we will explain how this invariant detects several knots among the set of all knots.

Dror Bar-Natan
University of Toronto, Canada

Title: The brute and the hidden paradise

There is expected to be a hidden paradise of poly-time computable knot polynomials lying just beyond the Alexander polynomial. I will describe my brute attempts to gain entry.

John Bryden
PMU, Saudi Arabi

Title: Abelian quantum knot Invariants

Abelian quantum knot invariants can be obtained from the linking form of closed orientable 3-manifolds. Recent work has led to the classification of linking forms of closed oriented 3-manifolds in terms of the linking forms of Seifert manifolds with orbit surface S^2 or connected sums of such Seifert manifolds. All such linking forms have been computed explicitly. We show how to construct these abelian quantum knot invariants from the linking form.

Nafaa Chbili
UAEU, United Arab Emirates

Title: Polynomial invariants of Quasi-Alternating links

In this talk, we introduce the class of quasi-alternating links, then we will explain how to use the Jones polynomial and the Brandt-Lickorish-Millet polynomial to introduce new obstruction criteria for a link to be quasi-alternating. As an application, we identify some knots of 12 crossings or less and some links of 9 crossings or less that are not quasi-alternating.

Dimos Goundaroulis
National Technical University of Athens, Greece
Coauthors: Sofia Lambropoulou

Title: A new 2-variable generalization of the Jones polynomial

Since the original construction of the Jones polynomial, the Temperley-Lieb algebra has become a cornerstone of a fruitful interaction between Knot theory and Representation theory. The Temperley-Lieb algebra was introduced by N. Temperley and E. Lieb in a statistical mechanical context in 1971 and was rediscovered by V.F.R. Jones as a knot algebra in 1983. A knot algebra comprises an algebra A, an appropriate representation of the braid group in A and a Markov trace function defined on A. The Temperley-Lieb algebra, the Iwahori-Hecke algebra and the BMW algebra are the most known examples of knot algebras.

In this talk we will present a new 2-variable generalization θ of the Jones polynomial that is derived from the framization of the Temperley-Lieb algebra. The framization of a knot algebra is a relatively new technique that was proposed by J. Juyumaya and S. Lambropoulou and it consists in an extension of a knot algebra via the addition of framing generators which are intrinsically involved in the algebra relations. In this way one obtains a new algebra which is related to framed braids and framed knots. The basic example of framization is the Yokonuma-Hecke algebra which can be regarded as a framization of the Iwahori-Hecke algebra. We will prove the well-definedness of the new invariant θ both algebraically and skein theoretically. The 2-variable invariant θ coincides with the Jones polynomial on knots but is stronger than the Jones polynomial on links, as it can detect more pairs of non-isotopic links.

Mikami Hirasawa
Nagoya Institute of Technology, Japan
Coauthors: Kunio Murasugi

Title: Interlacing zeros of Alexander polynomials of links

We say that a link is bi-stable if the zeros of its Alexander polynomial are either real or complex of modulus one. In this talk, we study such links via interlacing property of the real zeros. Two or more polynomials are said to be interlaced if their real zeros are interlaced. From an interlaced pair of polynomials we can make another interlaced pair. We modify Alexander polynomials so that it is bi-stable if and only if the modified polynomial has only real zeros. As an application of the interlacing property, we show that some arborescent links have bi-stable Alexander polynomials.

Vaughan F.R. Jones
Vanderbilt University, USA

Title: Knots and links from the Thompson groups

In an investigation of the limit Hilbert space for a quantum spin chain we discovered representations of Thompson's groups, which play the role of local scale transformations. By choosing skein theoretic parameters for these representations we found a way to obtain all knots and links, oriented or unoriented, as the coefficients of the "vacuum vector" in the representation. This gives rise to many interesting questions and shows that Thompson's group F is as good at producing knots and links as the braid groups.

Sofia Lambropoulou
National Technical University of Athens, Greece
Coauthors: M. Chlouveraki, J. Juyumaya and K. Karvounis

Title: A new skein invariant for classical links from the Yokonuma–Hecke algebras

We present the construction of a family of new 2-variable polynomial invariants for oriented classical links, Θ_d, where $d \in \mathbb{N}$, defined via a Markov trace on the Yokonuma–Hecke algebra $\mathrm{Y}_{d,n}$ of type A. Yokonuma–Hecke algebras are generalizations of Iwahori–Hecke algebras, and this family contains the Homflypt polynomial, the famous 2-variable invariant for classical links arising from the Iwahori–Hecke algebra of type A. We show that these invariants are topologically equivalent to the Homflypt polynomial on *knots*, but not on *links*, by providing pairs of Homflypt-equivalent links that are distinguished by our invariants. In order to do this, we prove first that our invariants can be defined diagrammatically via a special skein relation involving *only crossings between different components.*

We further generalize this family of invariants to a new 3-variable skein link invariant, Θ, which is stronger than the Homflypt polynomial. Finally, we present a closed formula for this invariant, by W.B.R. Lickorish, which uses a complicated mixture of Homflypt polynomials of sublinks and linking numbers of a given oriented link.

References:
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[4] K. Karvounis, *Enabling computations for link invariants coming from the Yokonuma-Hecke algebras*, to appear in J. Knot Theory and its Ramifications, special issue dedicated to the memory of Slavik Jablan.
[5] L. H. Kauffman, S. Lambropoulou, *New invariants of links and their state sum models*, in preparation.

Hwa Jeong Lee
Daegu Gyeongbuk Institute of Sciences & Technology, South Korea
Coauthors: Hideo Takioka

Title: On the arc index of Kanenobu knots

In this talk, we calculate the Kauffman polynomial $F_{K(p,q)}(a, z)$ of Kanenobu knots $K(p, q)$ with p, q half twists and determine their spans on the variable a completely. As an application, we determine the arc index of infinitely many Kanenobu knots.

Alexander Stoimenow
Gwangju Institute of Science and Technology, School of General Studies, GIST College, South Korea

Title: On coefficients and roots of the Alexander-Conway polynomial

The Alexander polynomial remains one of the most fundamental invariants of knots and links in 3-space. It topological understanding has led a long time ago to the insight what (Laurent) polynomials occur as Alexander polynomial of an arbitrary knot. Ironically, the question to characterize the Alexander polynomials of alternating knots turns out to be far more difficult, even although in general alternating knots are much better understood. Hoste, based on computer verification, made the following conjecture about 10 years ago: If z is a complex root of the Alexander polynomial of an alternating knot, then $\mathrm{Re}(z) > -1$. We discuss some results toward this conjecture, about 2-bridge (rational) knots or links, 3-braid alternating links, and Montesinos knots.

Zhiqing Yang
Dalian University of Technology, China

Title: Multi-skein equation knot invariant

This is a follow-up work of arXiv:1004.2085. The author modifed earlier work to get an easier invariant. It is a generalization of both the HOMFLY and Kauffman two variable polynomials. Different from Yasuyuki Miyazawa's approach, we use a system of skein equations to define the invariant, and give a easy method to solve its word problem. A simplified version of the invariant is a knot polynomial with 3 variables.

Knots in Nature - Life Sciences

Pawel Dabrowski-Tumanski
Faculty of Chemistry and Centre of New Technologies, University of Warsaw, Poland
Coauthors: Wanda Niemyska, Institute of Mathematics, University of Silesia, Katowice, Poland; Joanna I. Sulkowska, Faculty of Chemistry and Centre of New Technologies, University of Warsaw, Poland

Title: Topology of proteins with complex lasso structure

Knotted proteins are well known examples of biological structures, whose analysis requires mathematical tools. However, knots are not the only topologically nontrivial structures found in nature. The world of composite protein arrangements has been vastly expanded by our recent discovery of complex lasso proteins. Complex lasso proteins arise, when the protein backbone forms a covalently closed loop, which can be pierced by (at least one) tail. Although we have described so far one-loop geometries [1,2], most of protein chains have a few closed loops, differently arranged, which creates entirely new complex arrangements in proteins. These arrangements can be topologically classified on the basis of knot theory. In this work we introduce such classification and discuss its role in biology.

References:
[1] P. Dabrowski-Tumanski, W. Niemyska, P. Pasznik, J. I. Sulkowska - LassoProt: server to analyze biopolymers with lassos – Nucleic Acids Res. 2016 Apr 29. pii: gkw308 (2016).
[2] W. Niemyska, P. Dabrowski-Tumanski, M. Kadlof, E. Haglund, P. Sułkowski, J. I. Sulkowska - Complex lasso: new entangled motifs in proteins – Under review.

Neil Osheroff
Vanderbilt University School of Medicine, USA
Coauthors: Rachel E. Ashley

Title: Recognition of DNA Topology by Topoisomerases

The double helical structure, length, and compaction of DNA, along with normal nucleic acid processes, generate a number of topological problems that the cell must be able to resolve in order to survive. Examples are DNA under- and overwinding (negative and positive supercoiling), knotting, and tangling. Levels of DNA supercoiling strongly affect processes such as replication and transcription and DNA knots and tangles must be removed in order to open the double helix and segregate chromosomes during mitosis. Topological issues in DNA are resolved in human and bacterial cells by enzymes called topoisomerases. Type I topoisomerases regulate DNA supercoiling by generating transient single-stranded breaks in the genetic material. Type II topoisomerases regulate DNA supercoiling and remove knots and tangles by generating transient double-stranded breaks in the double helix. This presentation will familiarize the audience with DNA topoisomerases, how they resolve topological issues, and how they discern the geometry of DNA supercoils.

Candice Price
University of San Diego, USA

Title: A Discussion on the Tangle Model: An Application of Topology

The tangle model was developed in the 1980's by professors DeWitt Sumner and Claus Ernst. This model uses the mathematics of tangles to model protein-DNA binding. An n-string tangle is a pair (B, t) where B is a 3-dimensional ball and t is a collection of n non-intersecting curves properly embedded in B. n-string tangles are formed by placing $2n$ points on the boundary of B, and attaching n non-intersecting curves inside B. Tangles, like knots and links, are studied through their diagrams. In the tangle model for DNA site-specific recombination, one is required to solve simultaneous equations for unknown tangles which are summands of observed DNA knots and links. This discussion will give a review of the tangle model including definitions.

Joanna Sulkowska
University of Warsaw, Faculty of Chemistry and Centre of New Technologies, Poland
Coauthors: P. Dabrowski-Tumanski, W. Niemyska, E. Rawdon, A. Stasiak, K. Millett

Title: Entanglement in proteins: knots, slipknots and lassos

Identification of entanglement in proteins is a non-trivial task, which requires probabilistic approach to knot theory and chemical intuition to discover new topological motifs. I will present various motifs that have been identified to date, and summarize the current status of this field. First, to describe structure of proteins with knots and slipknots [1,2], I will introduce their characteristic referred to as the topological fingerprint. Second, I will present a class of proteins with a lasso motif, which we have identified recently [3,4]. Lasso structures arise when a protein backbone forms a covalently closed loop, which is pierced by (at least one) tail. Lasso configurations can also be classified topologically on the basis of knot theory. I will discuss possible biological functions of knots and lassos. All those results indicate that a proper understanding of biology requires tools from knot theory, and knot theory itself can be stimulated by a discovery of exotic structures in biopolymers.

References:
[1] J.I. Sulkowska, E. J. Rawdon, K. C. Millett, J. N. Onuchic, A. Stasiak, Conservation of complex knotting and slipknotting patterns in proteins, Proc. Natl. Acad. Sci (USA), (2012) 109(26): E1715-23.
[2] M. Jamroz, W. Niemyska, E.J. Rawdon, A. Stasiak, K.C. Millett, P. Sułkowski, J.I. Sulkowska, KnotProt: a database of proteins with knots and slipknots, Nucleic Acids Res. (2014), 43: D306-D314.
[3] P. Dabrowski-Tumanski, W. Niemyska, P. Pasznik, J. I. Sulkowska, LassoProt: server to analyze biopolymers with lassos, Nucleic Acids Res. 2016 Apr 29. pii: gkw308 (2016).
[4] W. Niemyska, P. Dabrowski-Tumanski, M. Kadlof, E. Haglund, P. Sułkowski, J. I. Sulkowska - Complex lasso: new entangled motifs in proteins, under review.

Alexander Taylor
University of Bristol, United Kingdom
Coauthors: Keith Alexander, University of Bristol; Mark Dennis, University of Bristol

Title: Virtual knotting expressed in proteins

An important potential application of knot theory in the life sciences is the study of knotting in protein backbone chains; it is well established that knots occur in a small but significant fraction of known proteins, and that they may have important physiological implications for the molecule [1]. Since protein backbones are open curves this analysis depends on inferring the knot type from an average over different possible closures of their termini. We instead identify the open curves as virtual knots, a wider class of topological objects that can more precisely capture their topological character, by interpreting projections of the curve as virtual knotoids [2]. This analysis reveals many virtually knotted proteins, both as reinterpretations of known knotted structures and amongst protein backbones that otherwise appear topologically trivial, but they are surprisingly rare compared to proteins that are unambiguously classically knotted. We discuss what this implies for protein structures by comparison with other compact filamentary chains.

References:
[1] J I Sulkowska, E J Rawdon, K C Millett, J N Onuchic and A Stasiak. Conservation of complex knotting and slipknotting patterns in proteins. *PNAS* **109**, E1715-23 (2012).
[2] N Gügümcü and L H Kauffman. New invariants of knotoids, arXiv:1602.03579.

Lynn Zechiedrich
Baylor College of Medicine, Houston, Texas, USA
Coauthors: Jonathan M. Fogg, Rossitza N. Irobalieva, Muyuan Chen, Steven J. Ludtke, Michael F. Schmid, Sarah A. Harris, and Wah Chiu

Title: Effect of DNA Supercoiling on DNA Dynamics

Despite its importance, much about supercoiled DNA (positively supercoiled DNA, in particular) remains unknown. We utilized state-of-the-art electron cryo-tomography to investigate the 3-dimensional structures of individual purified 336 bp (32 exact turns of the helix) DNA minicircles covering nine different degrees of DNA supercoiling (from σ = -0.190 to +0.085). Minicircles in each supercoiling state adopt a unique and surprisingly wide distribution of three-dimensional conformations, which strongly influence formation of non-B structures (Irobalieva et al. 2015 Nat. Comm. 6, 8440). Gel electrophoretic mobility of the minicircles strongly depends upon salt concentrations, with positively and negatively supercoiled DNA responding vastly differently. Increased monovalent or divalent cations increases minicircle compaction, and thus mobility, of negatively supercoiled minicircles but has no effect on positively supercoiled topoisomers. Glyoxal binding and nuclease Bal-31 cleavage assays reveals increased propensity of exposed DNA bases with increased negative supercoiling. Cleavage assays revealed both the precise superhelical density and the specific DNA sequences at which cleavage occurred. These mapping data support the “cooperative kinking model” of Lionberger et al. 2011 (Nucleic Acids Res. 39, 9820), in which an apical bend on one side of the supercoiled minicircle renders a site 180° away susceptible to the nuclease. Beyond a sharp supercoiling threshold, we also detected exposed bases in positively supercoiled DNA, supporting a model for a sharp transition to P-DNA (Allemand et al. 1998 Proc. Natl. Acad. Sci. U.S.A. 95, 14152). These experiments both inform and are informed by previous single-molecule DNA manipulation experiments and atomistic computer simulations.

Knots in Nature - Physical Sciences

Stathis Antoniou
National Technical University of Athens, Greece
Coauthors: Sofia Lambropoulou

Title: The dynamics of topological surgery

Topological surgery occurs in natural phenomena where a sphere of dimension 0 or 1 is selected, forces are applied and the manifold in which they occur change type. For example, it happens during DNA recombination, when cosmic magnetic lines reconnect, in the formation of tornadoes, in Falaco Solitons, in the cell mitosis and in the formation of black holes. In this talk, we will present new theoretical concepts which enhance the formal definition of topological surgery with the observed dynamics.

Benjamin Bode
University of Bristol, United Kingdom
Coauthors: Mark Dennis, University of Bristol

Title: Knotted fields and real algebraic links

Following work by Brauner and Milnor on links of isolated complex singularities, Akbulut and King showed in 1981 that for every link L there exists a polynomial function $F: \mathbb{R}^4 \to \mathbb{R}^2$ with a weakly isolated singularity at 0 and such that its zero set on any 3-sphere of small radius around 0 is ambient isotopic to L.
We will describe an explicit algorithm that constructs a polynomial function $f: \mathbb{R}^4 \to \mathbb{R}^2$ whose zero set on the unit 3-sphere is ambient isotopic to L for any given link L. Such constructions have applications in the physical sciences, in the study of knotted configurations ('knotted fields') in superfluid dynamics, optics and particle physics.
We show that for certain symmetric links the constructed functions can be arranged to satisfy Akbulut and King's requirements and that the method of construction allows us to give bounds on the degrees of the polynomials in terms of link invariants.

Mark Dennis
University of Bristol, United Kingdom

Title: Knotted Vortices in Light

The possibility that light fields might accommodate knots is a question naturally raised by Kelvin's hypothesis that atoms are knotted vortices in the ether. A natural framework to realise knots in light is as optical vortices, which are nodal lines of intensity naturally occurring in propagating, coherent waves, along which the optical phase is singular and around which the electromagnetic energy circulates. Propagating light fields can be structured using optical holograms to create optical vortex fields with a range of different knot types [1], which can be used to embed knots in other physical systems such as quantum fluids. Natural light scattering from rough surfaces (so called speckle patterns) has a surprisingly complex tangled vortex structure. This will be described using computer simulations of chaotic 3D cavity modes (eigenfunctions)–analogous to Chladni patterns for 2D elastic plates–in which knotted vortices of a wide range of complexity are found [2].

References:
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[2] A J Taylor & M R Dennis "Vortex knots in tangled quantum eigenfunctions" submitted 2016.

David Foster
University of Bristol, United Kingdom

Title: Knotted Resonances

In the 1960's Skyrme proposed a topological model of atomic nuclei, where the solutions are lump-like and belong to the third homotopy group of the three-sphere. This topology stabilises them. The model's energy functional can be understood as an elastic energy functional, and its minima correspond to nuclei. Recently the model has had success at replicating key properties of nuclei. Namely it has replicated the deuteron, diproton and dibaryon [1].

In the talk we will discuss knot-like solutions, which correspond to multiple nuclei anti-nuclei pairs. These solutions are not topologically stabilised, and can hence decay away. We see how different knots decay in different modes, which illuminates the local geometry of the configuration space. We will also discuss how certain knots/links life-time can be increased by a time dependent flow, leading to new nuclear physics predictions.

References:
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Rafal Komendarczyk
Tulane University, USA
Coauthors: Andreas Michaelides

Title: Ropelength, crossing number and finite-type invariants

Ropelength and embedding thickness are related measures of geometric complexity of classical knots and links in the Euclidean space. In their recent work, Freedman and Krushkal posed a question regarding lower bounds for embedding thickness of n-component links in terms of Milnor linking numbers (mu-invariants). In this talk we will show how to obtain such estimates, generalizing the known linking number bound. In the process, we generalize the results of Kravchenko and Polyak on the arrow polynomial formulas of mu-invariants of string links. We also collect several facts about finite type invariants and ropelength/crossing number of knots giving examples of families of knots, where estimates via the finite type invariants outperform the well-known knot–genus estimate.

Xin Liu
Beijing University of Technology, China
Coauthors: Renzo L. Ricca

Title: On the derivation of HOMFLYPT as a new invariant of topological fluid mechanics

By using and extending earlier results (Liu & Ricca 2012), we derive the skein relations of the HOMFLYPT polynomial for ideal fluid knots from helicity, thus providing a rigorous proof that the HOMFLYPT polynomial is a new, powerful invariant of topological fluid mechanics (Liu & Ricca 2015). Since this invariant is a two-variable polynomial, the skein relations are derived from two independent equations expressed in terms of writhe and twist contributions. Writhe is given by addition/subtraction of imaginary local paths, and twist by Dehn's surgery. HOMFLYPT then becomes a function of knot topology and field strength. For illustration we derive explicit expressions for some elementary cases and apply these results to homogeneous vortex tangles.

Kenneth C. Millett
University of California, Santa Barbara, USA
Coauthors: Kyle Chapman, University of Georgia; Laura Plunkett, Holy Names Universit

Title: Random sampling spaces of thick polygons

Open and closed polygons provide an attractive coarse grained model for many molecular structures. The random selection of polygons of a specified thickness is, however, an objective that has not been achievable until very recently. Here, we give an elementary description of the distinct sampling strategies that have been employed, their limitations, and the new algorithms of Chapman and Plunkett that now allow one to randomly sample the spaces of open and closed polygons with specified thickness. We observe that the introduction of even a very modest thickness has an immediate and profound effect on the shape, the size, and the type of knot formed.

Philipp Reiter
University of Duisburg-Essen, Germany
Coauthors: Henryk Gerlach, EPF Lausanne; Heiko von der Mosel, RWTH Aachen University

Title: Elastic knots

In order to investigate the elastic behavior of knotted loops of springy wire, we minimize the classic bending energy regularized by ropelength, i.e., the quotient of length over thickness, in order to penalize self-intersection. Our main objective is to characterize the limit configurations of energy minimizers as the regularization parameter tends to zero, which will be referred to as *elastic knots*.

For every odd $b > 1$ and the respective class of $(2, b)$-torus knots (containing the trefoil) we obtain a complete picture showing that the respective elastic $(2, b)$-torus knot is the twice covered circle.

Renzo L. Ricca
U. Milano-Bicocca, Italy
Coauthors: Xin Liu

Title: Knots cascade detected by a monotonically decreasing sequence of HOMFLYPT values

Due to reconnection or recombination of neighboring strands vortex knots are found to undergo an almost generic cascade process, that tend to reduce topological complexity by stepwise unlinking. Here, by using the HOMFLYPT polynomial recently introduced for fluid knots, we prove that under the assumption that topological complexity decreases by stepwise unlinking this cascade process follows a path detected by a unique, monotonically decreasing sequence of numerical values (Liu & Ricca 2016). This result holds true for any sequence of standardly embedded torus knots T(2, 2n + 1) and torus links T(2, 2n). By this result we demonstrate that the computation of this adapted HOMFLYPT polynomial provides a powerful tool to quantify topological complexity of various physical systems.

Dmitry Sokoloff
Moscow State University and IZMIRAN, Russia

Title: Classical helicity and higher helicity invariants in astrophysical dynamos

Helicity (Gauss invariant) is a quantity which substantially determines magnetic field evolution in many celestial bodies. Self-excitation of large-scale magnetic field (dynamo) is controlled by helicity of vortex lines while nonlinear saturation of dynamo depends on helicity of magnetic lines. Contemporary observational astronomy spent a lot of efforts for observational identification of these helicities. The role of higher helicity invariants in dynamo action remains still not fully clear. We argue here that the higher helicity invariants hardly participate in dynamo saturation however may be important as a factor which determines magnetic field decay.

Ljubica S. Velimirovic
Faculty of Science and Mathematics, University of Nis, Serbia
Coauthors: Louis H. Kauffman, University Illinois Chicago, USA & Marija S. Najdanovic,Faculty of Science and Mathematics, University of Nis, Serbia

Title: Infinitesimal bending of knots

This talk is devoted to a study of the infinitesimal bending of knotted curves. Variations of the Willmore energy, the total curvature, the total torsion, as well as the total normalcy are obtained. Some examples are visualized.

Topological spaces

Ruth Lawrence
Hebrew University, Jerusalem, Israel
Coauthors: Dennis Sullivan, SUNY/CUNY

Title: Explicit DGLA models of simple chain complexes and their properties

About twenty years ago, Kontsevich started building an interesting differential on a free Lie algebra with two odd generators a, b and one even generator e. The differential began $da = -\frac{1}{2}[a,a]$, $db = -\frac{1}{2}[b,b]$, $de = b - a + \frac{1}{2}[e, a+b] + \cdots$ with terms involving Bernoulli numbers. It seemed to be a miracle that the higher order terms could be chosen so that $d^2 = 0$. About fifteen years ago, Sullivan realised that such differentials should exist for abstract reasons related to algebraic topology, an argument which works for any cell complex but does not produce a unique or closed formula in general.

For the interval, the formula is unique and in joint work with Sullivan we showed how it can be interpreted using the formalism of connections, curvature and gauge transformation from differential geometry. In this talk we will discuss the interplay between the algebra and geometry inherent in these constructions including localisation, functorial properties under subdivision (via the Baker-Campbell-Hausdorf formula), reconstruction of the set of points by solving the Maurer-Cartan equations and automorphism groups of the DGLAs. This is a report on work in progress. Parts of this work are joint with Dennis Sullivan and my current/former students Nir Gadish, Itay Griniasty and Matan Seidel.

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[2] N. Gadish, "A free differential Lie algebra model of the 2-cell", *Minor thesis* 2011.
[3] I. Griniasty & R. Lawrence, "Finding points in DGLA model", *Minor thesis* 2013.
[4] M. Seidel, "Automorphism Groups of Simple DGLA models", *Minor thesis* 2015.

Andrey Mikhovich
MSU, Moscow, Russia

Title: Schematization, QR-presentations and Conjuring(s)

We discuss briefly our recent results on schematization technics in two-dimensional homotopy theory answering to the question of Serre, to the Melnikov's conjecture and introducing Infinite Gaschütz theory.

We emphasize the flexibility of the theory by constructing conjuring(s) (the Amitsur-Levitzki identities in pro-p-groups), which play the key role for deformations.

TQFTs and the volume conjecture

Christian Blanchet
IMJ-PRG, Univ Paris Diderot, France
Coauthors: Anna Beliakova, Nathan Geer

Title: Modified trace on quantum sl(2) and logarithmic invariants

This work is motivated by non semisimple TQFTs and logarithmic quantum invariants. When considering quantum sl(2) at a root of unity, the colored Jones invariant of links vanishes when a projective module is used. The idea of logarithmic invariants and non semisimple TQFT is to get information which is killed in the semisimple case because of this phenomenon. A key tool is the notion of modified trace first introduced by Geer and Patureau. Here we consider the restricted quantum sl(2) at a 2p-th root of unity, and construct the modified trace. This allows to define colored Logarithmic invariants for links which are split in negative and positive parts. The positive part is colored by elements in the center of the quantum group, while the negative part which should be non empty, is colored by pairs (P,f) where f is an endomorphism of a projective object P. Following Henning, Kauffman-Radford, Lyubashenko, Kerler-Lyubashenko, we use integral to extend logarithmic invariants for colored links in 3-manifolds and further get TQFT on a category of admissible decorated cobordisms.

Wade Bloomquist
University of California Santa Barbara, USA
Coauthors: Zhenghan Wang, University of California Santa Barbara

Title: Asymptotic Faithfulness of Quantum SU(3) Representations

To any closed orientable surface we can associate a vector space generated by admissible labelings of the spine of the handlebody bounded by the surface. In the particular case where these labelings arise from $SU(3)$ at a fixed level, this vector space is the the $SU(3)_k$ TQFT vector space given by the Reshitiken-Turaev construction. We look to use skein theoretic techniques, originating from the spiders of Kuperberg, to study an action of the mapping class group on this vector space. In particular, we will show that any non-central element of the mapping class group is detected by this representation at a sufficiently high level. This implies the direct sum over all possible levels gives a faithful representation of the mapping class group of any closed orientable surface.

Renaud Detcherry
Michigan State Unversity, USA

Title: Curve operators in TQFT as Toeplitz operators

Reshetikhin-Turaev invariants are invariants of 3-manifolds defined using skein theory, but a famous conjecture of Witten says that their asymptotic can be expressed using geometric invariants like Chern-Simons invariants and Reidemeister torsions. We will explain how to use tools of geometric quantization to represent curve operators in Reshetikhin-Turaev TQFTs as Toeplitz operators and derive from this an asymptotic expansion for some pairings of TQFT vectors. The formula obtained looks similar to the Witten conjecture.

Stavros Garoufalidis
Georgia Institute of Technology, USA
Coauthors: Frank Calegari, Don Zagier

Title: Nahm sums, the Bloch group and quantum topology

I will report on a construction of a number-theory invariant associated to an element of the Bloch group and to a root of unity, and which appears (conjecturally) in the asymptotics of the Kashaev invariant at roots of unity, in the quantum modular form conjecture of Zagier and in the modularity conjecture of Nahm.

Hitoshi Murakami
Tohoku University, Japan
Coauthors: Anh T. Tran

Title: Colored Jones polynomial and SL(2;C) representations of a knot group

We will explain some relations of the colored Jones polynomial of a knot to SL(2;C) representations of its knot group. Especially, we will give an explicit formula to express the Chern-Simons invariants and the twisted Reidemeister torsions of the representations in terms of the colored Jones polynomial for a twice-iterated torus knot.

Tian Yang
Stanford University, USA
Coauthors: Qingtao Chen

Title: Volume Conjectures for Reshetikhin-Turaev and Turaev-Viro invariants

In a joint work with Qingtao Chen, we consider a family of Turaev-Viro type invariants for a 3-manifold M with non-empty boundary, indexed by an integer $r \geqslant 3$, and propose a volume conjecture for hyperbolic M that these invariants grow exponentially at large r with a growth rate the hyperbolic volume of M. The crucial step is the evaluation at the root of unity $\exp(2\pi\sqrt{-1}/r)$ instead of that at the usually considered root $\exp(\pi\sqrt{-1}/r)$. Evaluating at the same root $\exp(2\pi\sqrt{-1}/r)$, we then conjecture that, the original Turaev-Viro invariants and the Reshetikhin-Turaev invariants of a closed hyperbolic 3-manifold M grow exponentially with growth rates respectively the hyperbolic and the complex volume of M. This uncovers a different asymptotic behavior of the values at other roots of unity than that at $\exp(\pi\sqrt{-1}/r)$ predicted by Witten's Asymptotic Expansion Conjecture, which may indicate some different geometric interpretation of the Reshetikhin-Turaev invariants than the $SU(2)$ Chern-Simons theory. Numerical evidences will be provided to support these conjectures.

Virtual Knot Theory

Byunghee An
Institute for Basic Science, Center for Geometry and Physics, South Korea
Coauthors: Youngjin Bae (Institute for Basic Science, Center for Geometry and Physics

Title: Chekanov-Eliashberg DGAs for singular Legendrian knots

The Chekanov-Eliashberg DGA is an invariant of a Legendrian knot L which is a differential graded algebra obtained by counting rigid, punctured holomorphic disks with boundary on the Lagrangian projection of L. In this talk, we extend the Chekanov-Eliashberg DGA to singular Legendrian knots and use to separate some pairs of singular Legendrian knots.

Valeriy Bardakov
Sobolev Institute of Mathematics, Russia

Title: Some representations of virtual braid group

We consider representations of virtual braid groups by automorphisms of some groups. We will construct a representation which generalizes the previously known representations. Using this representation we define a group of virtual links and a group of fused links.

Paolo Bellingeri
University of Normandy, Caen, France
Coauthors: Benjamin Audoux, Jean-Baptiste Meilhan, Emmanuel Wagner

Title: Local moves for welded knotted objects

We consider welded knotted objects (links, string links, braids) under several equivalence relations, such as self-crossing changes, self-virtualizations, sharp, Delta and forbidden moves. We establish several relations between them and for some particular cases we provide a topological interpretation and a complete classification for such quotients.

References:
[1] B. Audoux, P. Bellingeri, J-B. Meilhan and E. Wagner; *On Usual, Virtual and Welded knotted objects up to homotopy, to appear in J. Math. Soc Japan.*
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[3] B. Audoux, P. Bellingeri, J-B. Meilhan and E. Wagner; *On forbidden moves and the Delta move*, arXiv:1510.04237.

Neslihan Gügümcü
National Technical University of Athens, Greece
Coauthors: Louis H. Kauffman

Title: How to estimate the height of a knotoid

A standard 1-1 tangle has its endpoints in a single region of the diagram. A knotoid diagram generalizes the 1-1 tangle and allows the endpoints to be in different regions. This gives rise to a new theory and many new questions. Taking knotoids up to the knotoid equivalence, we can ask how far apart the endpoints need to be in all instances of diagrams for the equivalence class. We call this distance (in terms of crossing the boundaries of regions) the height of the knotoid. In this talk we construct two polynomial invariants of knotoids in analogy to corresponding invariants of virtual knots; the affine index polynomial and the arrow polynomial. We show how the affine index polynomial and the arrow polynomial provide bounds on the height of a classical knotoid.

Louis H. Kauffman
University of Illinois at Chicago, USA

Title: Invariants in Virtual Knot Theory

We review the definition(s) of virtual knot theory and discuss invariants of virtual knots, including the bracket polynomial, the arrow polynomial, the affine index polynomial, parity and the Manturov bracket, quantum invariants of rotational virtual knots and Khovanov homology for virtual knots. We also discuss applications of virtual knot theory to the study of knotoids (joint work with Neslihan Gügümcü). The talk will concentrate on examples and open problems.

Posters

Bruno Aarón Cisneros de la Cruz
CONACyT - UNAM Oaxaca, Mexico
Coauthors: Luis Paris, University of Burgundy; Paolo Bellingeri, University of Normandy

Title: The word problem for Virtual braid groups

We present an implementable solution to the word problem for virtual braid groups.

Amanda R. Curtis
University of California, Santa Barbara, USA

Title: Idempotents for A2

The A2 planar algebra lets you do algebraic computations by manipulating certain diagrams. When applied to a knot diagram, it gives a specialization of the HOMFLY knot invariant. More generally, by replacing strings in the knot by an idempotent in the algebra, one arrives at a "colored HOMFLY" invariant. In the A1 case, the recursively defined Jones-Wenzl idempotents give rise to the colored Jones polynomial. We offer a new construction for the A2 idempotents, called the rainbow construction, which will give rise to a colored HOMLFY invariant, more efficiently than any known recursive formula.

Marcelo Flores
Universidad de Valparaiso, Chile
Coauthors: Jesus Juyumaya, Sofia Lambropoulou

Title: A framization of the Hecke algebra of type B

In this work we introduce a framization (a framization of a knot algebra, consists in adding certain new generators, called framing generators, to the original presentation of the knot algebra together with certain relations among the original generators and these new generators) of the Hecke algebra of type B. For this framization we construct a faithful tensorial representation and two linear bases. We finally construct a Markov trace on these algebras and from this trace we derive isotopy invariants for framed and classical knots and links in the solid torus.

Anne Isabel Gaudreau
McMaster University, Canada

Title: Almost Classical Knots

Some consider virtual knots to be the most natural extension of classical knot theory. Their combinatorial definition indeed allows to extend many invariants to these new objects. However, they fail in general to admit even a checkerboard colouring. Almost classical knots form a subset of virtual knots which enjoy a number of equivalent topological, combinatorial, and algebraic definitions, and for which more classical invariants extend. This presents properties and open problems related to almost classicality of knots and links.

Michal Jablonowski
University of Gdansk, Poland

Title: Braid and flat banded link forms of marked graph diagrams for surface-links

We will discuss two methods for presentation of knotted surfaces in the four space. One visual by defining a long flat form of a banded link for any surface-knot, and examining a number and a position of its Morse's critical points. Second method is by investigating a monoid corresponding to the braid form of marked graph diagrams, where algebraic relations on words will be derived from the topological Yoshikawa moves (which sufficiency was proved by Swenton, Kearton and Kurlin).

Both methods start with the use of transverse cross-sections (by Fox and Milnor) and producing a four-valent graph from the hyperbolic splitting (introduced by Lomonaco, Kawauchi, Shibuya, Suzuki and Kamada) of a knotted surface. We will give examples of given constructions for classes of knotted surfaces, to which the classification problem is still open.

Yevhen (Evgeniy) Kurianovych
University of Minnesota, Twin Cities, USA
Coauthors: Vladimir Bychkov, Michael Kreshchuk, Mikhail Shifman

Title: Non-Abelian moduli and topological defects localized on domain walls

We consider topological defects in a framework of classical field theory. Starting with a simple domain wall, arising from a Z_2 symmetry of a Lagrangian, we show that this model can be extended to support an extra field, which possesses an $O(3)$ symmetry and has a non-zero vacuum expectation value only on the domain wall world volume. In this model we construct a skyrmion - a defect corresponding to a topologically non-trivial mapping of the domain wall plain to the target space. If instead of $O(3)$ an extra field has a Z_2 symmetry, we construct a 1-dimensional domain wall, localized on a 2-dimensional one. Both these defects are relevant to condensed matter physics applications. In all cases we derive a low-energy effective actions which describe motion of a system as a whole, while its internal structure is not changed.

Wanda Niemyska
University of Silesia and University of Warsaw, Poland
Coauthors: Pawel Dabrowski, University of Warsaw; Kenneth Millett, University of California; Joanna I. Sulkowska, University of Warsaw

Title: Minimal surface, Gauss linking number and Homfly polynomial as the tools for studying Lasso structures in proteins

The entanglement in proteins became an important topic of studies in last years, where mathematical tools need to be used. Since knotted structures are already well known [2], complex lasso proteins is our recent discovery [1,3]. Complex lasso proteins arise when the protein backbone forms a covalently closed loop, which can be pierced by (at least one) tail. In our studies we applied minimal surfaces spanned on that loop to determine if complex lasso structure arises in the protein chain. In the poster we want to discuss this method and other possible approaches as well, including Gauss linking number and Homfly polynomial.

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Alessandra Renieri
University of Camerino, Italy
Coauthors: Benvenuti S., Piergallini R.

Title: Homotopic intersection form of a surface and positivity in the mapping class group

Let $S_{g,b}$ be a compact, connected, oriented surface of genus g, with b boundary components ($b \geq 1$), δS. For reasons of simplicity, we will use S instead of $S_{g,b}$. Given $s_0 \in \delta S$, let $\Gamma = \pi_1(S, s_0)$ the fundamental group and let $\pi : (\tilde{S}, \tilde{s_0}) \to (S, s_0)$ the universal covering with the choice of a base point and let $\widetilde{\alpha}$ be the lift of α. We know that There exists a map $\omega : \Gamma \times \Gamma \to \mathbb{Z}[\Gamma]$, $\omega(x, y) = \sum_{P \in x \cap y} e_P g_P \in \mathbb{Z}[\Gamma]$, called *homotopic intersection form* such that:

1. $\omega(y, x) = -\overline{\omega(x, y)} + (y - 1)(x^{-1} - 1)$,
2. $\omega(xy, z) = \omega(x, z) + x\omega(y, z)$,
3. $\omega(x, yz) = \omega(x, y) + \omega(x, z)y^{-1}$,

We know that, taking a diffeomorphism $f : S \to S$ fixing the boundary pointless, f in right-veering if $\omega_1(f_*\alpha, \alpha)$ is odd for any $\alpha \in \pi(S, s_0)$. The concept of right-veering is important in the field of Low dimension Contact Topology (relationship to tight contact structures and open book decompositions). At this stage we are working on the idea of define a kind of gradualness of right-veeringness, using other $\omega_\delta \in \pi(S, s_0)$, $\omega_\delta \neq 1$, and trying to turn simple diffeomorphisms into right-veering, after doing n-positive Dehn twists.

Nancy Scherich
University of California, Santa Barbara, USA

Title: Specializations of the Burau Representation into Lattices

Squier showed that the Burau representation of the braid group fixes a Hermitian form. Using this form, one can show that specializing to certain Salem numbers places the image inside a lattice. While it is unknown whether the image itself is a lattice, there are some interesting results on commensurability of the target lattices.

Ryoto Tange
Kyushu University, Japan
Coauthors: Takahiro Kitayama, University of Tokyo; Masanori Morishita, Kyushu University; Yuji Terashima, Tokyo Institute of Technology

Title: On certain L-functions for deformations of knot group representations

We study the twisted knot module for the universal deformation of an SL(2)-representation of a knot group, and introduce an associated L-function, which may be seen as an analogue of the algebraic p-adic L-function associated to the Selmer module for the universal deformation of a Galois representation. We then investigate two problems proposed by Mazur: Firstly, we show the torsion property of the twisted knot module over the universal deformation ring under certain conditions. Secondly, we verify the simplicity of the zeroes of the L-function by some concrete examples for 2-bridge knots.

Michel Thomé
Paris, France

Title: System of all knots and all links via closed braids

We provide a constructive and theoretical evidence that the remarkable property that all knots and all links, without exception, have a “closed braid” projection (Alexander, 1923) is the only natural and direct path to their classification. We found the general decomposition-parametrization and its left-total order for closed braids. Which, for any given left-irreducible closed braid, gives the immediate right following one and thus builds without forgetting any, in a total order from left to right, all possible distinct successive closed braids by increasing crossings number, through all possible successive strands numbers and all possible successive distributions of both positive and negative crossings, without having also to vary the n-link shown components number (because the components number of a closed braid is a tied variable, dependent only on its crossings distribution and is not a variable for construction of closed braids). The element that origins this left-order is, of course, the smallest irreducible closed braid on the left, the very first closed braid, closed braid single-stranded (ie, without crossing) that is to say the trivial closed braid, i.e. the unknot, the very first 1-link. To avoid the possible build duplicates and even try to build only the knots and links canonical representatives, we define what conditions must meet a closed braid to be a canonical representative “candidate”. For example, it is sufficient that any closed braid contains a left-reducible sub-braid for itself being left-reducible and so, we can then say that: 1- it already has on his left, at least one another equivalent closed braid ”smaller” than herself to this order. And 2- since it is not the smallest of its equivalence class, then it is a duplicate of the canonical representative of this class, 3- and therefore it can not be accepted as a possible canonical representative “candidate” of this class. This condition alone eliminates automatically all closed braids with a single crossing by column because we know in advance that they are reducible. Which requires that any canonical representative “candidate” has at least two crossings by columns. We know that we will get duplicates, at least when closed braids matching torus knots and links will be built, because they are the only n-links having pairs of closed braids projections whose meridians and longitudes commute.

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