THE MATHEMATICS OF KNOTS: THEORY AND APPLICATION

CONFERENCE PROGRAM

HEIDELBERG, DEC. 15 - DEC. 19, 2008

MONDAY, Dec. 15

9:00am - 10:00am Louis Kauffman
Title: *Unitary Representations of the Artin Braid Group and the Quantum Algorithms for Jones Polynomials.*

COFFEE

10:45am - 11:45am Heather Dye
Title: *The Arrow Polynomial.*

Abstract: The arrow polynomial is a invariant of virtual links that provides a lower bound on the virtual crossing number. We define the arrow polynomial and the k-degree of a summand of the polynomial. We then prove that the maximal k-degree is a lower bound on the virtual crossing number.

LUNCH

1:30pm - 2:30pm Hugh Morton
Title: *Relations between Homfly and Kauffman satellite invariants.*

Abstract: The general Homfly satellite invariant of a knot is a linear combination of invariants parametrised by a pair of partitions λ and μ, while the Kauffman satellite invariants depend on a single partition λ. This talk gives a relation between the Homfly invariant with $\mu = \lambda$ and the corresponding Kauffman invariant with λ, when the invariants are taken to lie in the ring $\mathbf{Z}_2[v^{\pm 1}, s^{\pm 1}]$ modulo denominators $s^r - s^{-r}$. It is an extension of a result of Rudolph from 1987 dealing with the case where $|\lambda| = 1$, and is joint work with N. Ryder.

2:45pm - 3:45pm Stavros Garoufalidis
Title: *The HOMFLY polynomial of a 3-manifold, the trilogarithm and Painlevé I.*

Abstract: I will discuss a version of the HOMFLY polynomial for a closed 3-manifold and its relation with a special function: the trilogarithm, and a special non-linear ODE: the famous Painlevé I. Technically, this means that we consider perturbative $U(N)$ Chern-Simons theory along a trivial flat connection, and its corresponding cubic graphs. This is joint work with Thang Le and Marcos Marino.

COFFEE

4:15pm - 5:15pm Sergei Chmutov
Title: *Combinatorics of Gauss diagrams and the HOMFLYPT polynomial.*

Abstract: Many link invariants can be expressed in terms of Gauss diagrams. In particular any Vassiliev knot invariant can be expressed in terms of some "subdiagrams" of the Gauss diagram. I'll discuss this approach to invariants coming from the HOMFLYPT polynomial. This approach allows to define HOMFLYPT polynomial for links with ordered components and with a based point on each component. Such definition directly extends to virtual links. Our description generalizes the Gauss diagram formulas for the Conway polynomial obtained earlier jointly with Michael Khoury and Alfred Rossi. This is a joint work with Michael Polyak.

TUESDAY, Dec. 16

9:00am - 10:00am Cameron Gordon
Title: *Exceptional Dehn Filling.*

Abstract: If M is a hyperbolic 3-manifold with cusps, such as the exterior of a hyperbolic knot or link in the 3-sphere, it is rare for M to have two non-hyperbolic Dehn fillings $M(r)$ and $M(s)$ along a given cusp. If this happens, we call $(M; r, s)$ an exceptional pair. We will discuss to what extent, and in what sense, one might expect to be able to classify all exceptional pairs. In particular we shall show that this might be possible when the intersection number between r and s is at least 3. We will indicate the progress that has been made in this direction and identify the problems that remain.

COFFEE

10:45am - 11:45am Vassily Manturov
Title: *Which Khovanov homology theory is the right one?*

Abstract: The talk is devoted to a discussion and comparison of the following versions of Khovanov homology theory: 1) The one by myself, which works for virtual knot theory (plus additional gradings in Khovanov homology), 2) The one by Ozsvath, Rasmussen, and Szabo ("Odd Khovanov homology"), which is connected to Heegaard-Floer and enjoys several important properties and 3) The one by Clark, Morrison, and Walker, which is functorial with sign "+" for cobordisms of 2-surfaces in the 4-space.

GROUP PHOTO

LUNCH

1:30pm - 2:30pm Jacob Rasmussen
Title: *Dehn filling and the Thurston norm.*

Abstract: Suppose Y is a 3-manifold all of whose boundary components are tori (for example, the complement of a link in S^3), and let Z be obtained by Dehn filling one of the components of Y. The Thurston norm on Y gives an upper bound for the Thurston norm on Z. I'll use sutured Floer homology to show that this bound is usually sharp; there are at most a finite number of filling slopes (corresponding to edges of the Thurston polytope) for which the norm drops.

2:45pm - 3:45pm Joan Licata
Title: *Linearized homology for grid number one knots in $L(p, q)$.*

Abstract: Legendrian knots in lens spaces can be described using grid diagrams, and Rasmussen has reformulated the Berge Conjecture as a statement about grid number one knots. We use contact homology for Legendrian knots in S^3 to define an invariant for knots in lens spaces, and we show that this invariant has an elementary combinatorial computation for grid number one knots.

COFFEE

4:15pm - 5:15pm Denis Ilyutko
Title: *Graphs-links, Virtual Links, Kauffman bracket and simplicial presentation of Khovanov homology.*

Abstract: This is joint work with Vassily Manturov. We consider graph-links, which are the quotient set of simple graphs modulo some relations. These relations are the analogous of Reidemeister moves, and the objects form a theory generalizing "virtual links modulo mutations" thus eliciting some unknown aspects of both classical and virtual knot theory. In their article, Traldi and Zulli considered looped graphs obtained from the intersection graphs of the Gauss diagrams. Therefore they constructed a generalization of virtual knot theory. We consider graphs obtained from the intersection graphs of the chord diagrams, corresponding to all virtual links by using a different approach: instead of Gauss diagrams, we consider "rotating circuits" which allow to walk around a diagram of any link in one turn . For graph-links we extend Kauffman bracket to be an invariant of the given set and study properties of it (minimal crossing number etc). For graph-links, we also constuct a generalization of a piece of Khovanov homology which can be represented as a homology of a certain simplicial complex, thus giving rise to "Khovanov homotopy". This leads to a new (topological) point of view on Khovanov homology, which is much more visible on graph-links than on usual (virtual) links.

WEDNESDAY, Dec. 17

9:00am - 10:00am Andrew Ranicki
Title: *Noncommutative localization in algebra and topology.*

Abstract: An introduction to the Cohn noncommutative localization of rings, and some of its applications to knots and links via algebraic K- and L-theory.

COFFEE

10:45am - 11:45am Sylvain Cappell
Title: *The Role of Knot Theory in Transformation Groups.*

NO TALKS THIS AFTERNOON

7:00pm CONFERENCE DINNER at Kulturbrauerei Heidelberg
(Leyergasse 6, 69117 Heidelberg).

THURSDAY, Dec. 18

9:00am - 10:00am Kent Orr
Title: *Surfaces knots and iterated intersection theory.*

Abstract: Scott Carter found curves in oriented surfaces which do not bound disks in any cobounding orientable three manifold. Vladimir Turaev formalized an invariant theory, and constructed tools and new examples for the problem. With V. Turaev, we continue this investigation of immersed surfaces curves and relate this work to the classical knot- slice problem.

COFFEE

10:45am - 11:45am Martin Scharlemann
Title: *Fibered knots and Property 2R.*

Abstract: It is first shown, using sutured manifold theory, that if there are any 2-component counterexamples to the Generalized Property R Conjecture, then any knot of least genus among components of such counterexamples is not a fibered knot. It is interesting to consider even the square knot, which is highly symmetric and fibered. Exploiting remarkable examples of Bob Gompf we argue that the square knot probably is a component of such a counterexample, but not if the Generalized Property R Conjecture is stated in a somewhat weaker form.

LUNCH

1:30pm - 2:30pm De Witt Sumners
Title: *Random Knotting and Viral DNA Packing.*

Abstract: Bacteriophages are viruses that infect bacteria. They pack their double-stranded DNA genomes to near-crystalline density in viral capsids and achieve one of the highest levels of DNA genome condensation found in nature. Despite numerous studies, some essential properties of the packaging geometry of the DNA inside the phage capsid are still unknown. Although viral DNA is linear double-stranded with sticky ends, the linear viral DNA quickly becomes cyclic when removed from the capsid, and for some viral DNA the observed knot probability is an astounding 95%. This talk will discuss comparison of the observed viral knot spectrum with the simulated knot spectrum, concluding that the packing geometry of the DNA inside the capsid is non-random and writhe-directed. Simulations of DNA knotting in confined volumes with and without volume exclusion will be discussed.

2:45pm - 3:45pm Dorothy Buck
Title: *The Topology of DNA-Protein Interactions.*

Abstract: The central axis of the famous DNA double helix is often topologically constrained or even circular. The topology of this axis can influence which proteins interact with the underlying DNA. Subsequently, in all cells there are proteins whose primary function is to change the DNA axis topology – for example converting a torus link into an unknot. Additionally, there are several protein families that change the axis topology as a by-product of their interaction with DNA. This talk will describe typical DNA conformations, and the families of proteins that change these conformations. I'll present a few examples illustrating how Dehn surgery methods have been useful in understanding certain DNA-protein interactions, and discuss the most common topological techniques used to attack these problems.

COFFEE

4:15pm - 5:15pm Daniel Moskovich
Title: *Surgery equivalence classes of knots coloured by metabelian groups*

FRIDAY, Dec. 19

9:00am - 10:00am Sofia Lambropoulou
Title: *Singular knots and Yokonuma-Hecke algebras.*

Abstract: In this talk we introduce a Jones-type invariant for singular knots, using a Markov trace on the Yokonuma-Hecke algebra and the theory of singular braids. Surprisingly, this trace does not normalize directly to yield the invariant, without imposing on it an appropriate condition. (Joint work with Jesus JUYUMAYA,

Univ. Valparaiso, Chile.)

COFFEE

10:45am - 11:45am Jozef Przytycki
Title: *Skein module motivation for Gram determinants of planar curves.*

Abstract: Skein module of links in a 3-manifold is a module of formal linear combinations of links, modulo properly chosen skein relation. In the case of the Kauffman bracket skein relation and the manifold being the product of a surface and the interval the structure of the module is well understood (including the relative case of arcbody). We consider the Gram determinant of the form build on the (relative) Kauffman bracket skein module of the product of a planar surface and the interval. In the case of the disk we get the Lickorish form used to construct Reshetikhin-Turaev-Witten invariants of closed 3-manifolds. In the case of the annulus the form was extensively studied by Rodica Simion and the determinant was computed and factorized by Qi Chen and myself (and by Martin and Saleur). In the case of the disc with two holes the preliminary work was done by Xiaoqi Zhu and myself and even the diagonal case leads to an interesting problem on weighted Catalan numbers (solved by L.Shapiro). We will discuss these and many other related interesting topological and combinatorial questions.

LUNCH

1:30pm - 2:30pm Barbara Jablonska
Title: *Surfaces associated to a knotted space curve.*

Abstract: From any smooth knot K in 3-space, we derive three surfaces with maps to S^2. These represent certain geometric features of the knot diagrams obtained as the orthogonal projections of K in all possible directions. It turns out that these surfaces have the same boundary curves and fold lines on S^2. One can cut them apart and reglue in various different manners obtaining in each case a different compact 2-manifold with a map to S^2. The degrees of these maps yield some interesting results. E.g. in one case the degree is the self-linking number of the initial curve, and the orientation of the manifold prescribes how to compute it from a diagram.

2:45pm - 3:45pm Louis Kauffman
Title: *Extending the Jones Polynomial for Virtual Links.*

COFFEE

4:15pm - 5:15pm Stefan Friedl
Title: *Symplectic 4-manifolds and fibered 3-manifolds.*

Abstract: In 1976 Thurston showed that if N is a fibered 3-manifold, then $S^1 \times N$ is symplectic. We will show that the converse holds, i.e. if N is a 3-manifold such that

$S^1 \times N$ is symplectic, then N is fibered. The key new result is that twisted Alexander polynomials detect fibered 3-manifolds. This is joint work with Stefano Vidussi.