Small exotic 4-manifolds

Anar Ahmadov
Georgia Institute of Technology, USA

Abstract. In this talk we present new examples of symplectic 4-manifolds with same integral cohomology as $S^2 \times S^2$. We also discuss the generalization of these examples to $(2n-1)(S^2 \times S^2)$ for $n > 1$. As an application of these symplectic building blocks we construct

1) An exotic smooth (symplectic) structure on $CP^2\#3(-CP^2)$, $3CP^2\#5(-CP^2)$, and $3CP^2\#7(-CP^2)$.

2) An exotic symplectic structure on $CP^2\#5(-CP^2)$.

3) An infinite family of distinct smooth 4-manifolds homeomorphic but not diffemorphic to $CP^2\#3(-CP^2)$, $3CP^2\#5(-CP^2)$ and $3CP^2\#7(-CP^2)$.

Part of this is joint work with I. Baykur and D. Park.

Knots, graphs and colourablity

Mohammad Azram
International Islamic University, Malaysia

Abstract. A theoretic and diagrammatic relationship between knots and planar graphs has enabled us to visualize, redefine and establish some variational, diagrammatic and illustrative results. It has been shown that the universes, LR-graphs and regions of reduced alternating knots (links) are path connected. Connected universe corresponding to reduced alternating knot (link) is unique. We have redefined the mirror image. It has been established that for reduced alternating knot (linked link), total regions are two more than the total crossings. In case the knot (linked link) is also achiral than total crossings $= 2[total\ black(white)\ regions - 1]$. R^*-move, 2π-twist and π-twist moves enabled us to change connected knot (link) into a reduced form. We have shown that for a un-knot; its bridge number must be one. We have also established that colorability of knot (link) is an ambient isotopy invariant.

Sequence of Riemannian metrics with locally controlled curvature on a closed aspherical 3-manifold

Michel Boileau
Université Paul Sabatier, France

Abstract. We consider sequences of Riemannian metrics on a closed aspherical 3-manifold such that the sectional curvature is locally controlled and the thick part asymptoticaly converges to a hyperbolic 3-manifold. Under some hypothesis the existence of such a sequence implies that the manifold either contains an incompressible torus or is Seifert fibered. Perelman's long term Ricci flow with surgeries allow to apply this result to geometrize aspherical 3-manifolds.

On character varieties, sets of discrete characters, and non-zero degree maps

Steven Boyer
L'Université du Québec à Montréal, Canada

Abstract. In this talk, which reports on work in progress with Michel Boileau, we discuss when a sequence of non-zero degree maps between closed, connected 3-manifolds has a subsequence which converges to a non-zero degree map, and look into what happens when it does not.

Invariants of homology cobordism and link concordance from towers of iterated abelian p-covers

Jae Choon Cha
Information and Communications University, Korea

Abstract. We consider Witt class defect invariants of 3-manifolds extracted from towers of iterated abelian p-covers. We show the invariance under homology cobordism and link concordance.

We discuss the following applications: (1) A construction of rational homology 3-spheres which are not homology cobordant but indistinguishable via known signature invariants. (2) The first proof that the figure eight knot (and certain amphichiral knots) has non-slice Bing double. (3) The existence of "torsion" elements in an arbitrary depth of the Cochran-Orr-Teichner solvable filtration of link concordance.

Some applications of modular forms in topology

Qingtao Chen
University of California at Berkeley, USA

Abstract. In this talk, we will review some interesting applications of modular forms in topology. The modular invariance techniques lead to some cancelation formulas for characteristic forms and consequently imply divisibility results of some characteristic number, e.g. the signature of spin manifolds. We also discuss the odd dimensional analogues, which heuristically study the Chern-Simons transgression on loop space.

Generalizations of gropes

Tim Cochran
Rice University, USA

Abstract. Gropes are 2-complexes that can be viewed as approximations to 2-disks. Immersed gropes encode information about the lower central series and the derived series of the fundamental group of a space. Considering knots or links that bound embedded gropes in 3-space or 4-space gives rich filtrations of knots and links. We describe generalizations of gropes that are related to more exotic commutator series and give different nontrivial filtrations of link concordance. Much of this work is joint with Carol Gee, Shelly Harvey and Connie Leidy.

Topological complexity of 3-manifolds

Pierre Derbez
Université de Provence, France

Abstract. We discuss the following problem: Given two 3-manifolds M and N, is there a way to compare the topology of M and N? To study this question we use degree one maps which allow to define a partial order on the set of closed orientable 3-manifolds, up to homotopy equivalence. In this talk we will study two properties of this partial order:

1. Rigidity: When is a degree one map homotopic to a homeomorphism?
2. Normal form: Give a canonical decomposition of degree one maps.

Stabilizations of Heegaard splittings and incompressible surfaces

Ryan Derby-Talbot
The American University in Cairo, Egypt

Abstract. We give a method for using incompressible surfaces to investigate the question of how many stabilizations are needed to make two Heegaard splittings of a 3-manifold isotopic. In particular, we show that for graph manifolds one stabilization of the higher genus splitting is needed in most cases.

Monotonic simplification algorithms and combinatorics of rectangular diagrams of links

Ivan Dynnikov
Moscow State University, Russia

Abstract. I will speak about a simple method for recognizing the unknot and finding the prime factorization of a link. The method utilizes so called rectangular diagrams of links, also known as grid diagrams and arc-presentations. I will also overview other applications of rectangular diagrams.

My favorite topology problems

Robert Edwards
University of California at Los Angeles, USA

Abstract. Mathematics thrives on problems. These are some of my favorites, which I would love to see solved. They span dimensions from the plane to infinity.

Reverse-engineering families of 4-manifolds

Ronald Fintushel
Michigan State University, USA

Abstract. I will discuss methods of constructing infinite families of homeomorphic but pairwise nondiffeomorphic 4-manifolds.

The volume and Jones polynomial of hyperbolic knots

David Futer
Michigan State University, USA

Abstract. Experimental evidence suggests that hyperbolic knots and links with small volume also have Jones polynomials with small coefficients. In fact, the volume appears to be coarsely determined by the coefficients near the head and tail of the polynomial. I will survey several recent results that prove this is indeed the case for some large families of knots and links.

Volumes of hyperbolic 3-manifolds

David Gabai
Princeton University

Abstract. This is a joint work with Robert Meyerhoff and Peter Milley. We outline a program for determining the low volume closed and cusped hyperbolic 3-manifolds. If successful it will demonstrate a close connection between low volume hyperbolic 3-manifolds and hyperbolic 3-manifolds with low combinatorial/topological complexity, thereby addressing the Thurston, Weeks, Matveev-Fomenko hyperbolic complexity conjecture.

Heegaard Floer theory, Open manifolds and Teichmuller spaces

Siddhartha Gadgil
Indian Institute of Science, India

Abstract. For smooth, open 4-manifolds, we construct an invariant using the Heegaard Floer theory of Ozsvath and Szabo and show that this is sensitive enough to detect exotic $\mathbb{R}^4$'s. In the second part of the lecture, we discuss a method to count holomorphic curves in products of surfaces using Teichmuller theory. The problem of counting curves is closely related to the problem of finding a combinatorial description of Heegaard Floer theory.

Heegaard genus and Dehn filling

Cameron Gordon
University of Texas at Austin, USA

Abstract. (This is joint work with Ken Baker and John Luecke.) The context of the talk is the general question of the behavior of Heegaard genus under two distinct Dehn fillings on a 3-manifold with torus boundary; more specifically we consider the case where one of the fillings is S^3. The result is that there is a function $w(g)$ such that if K is a hyperbolic knot in S^3, and some non-integral Dehn surgery on K gives a non-Haken manifold of Heegaard genus g, then the tunnel number of K is at most $w(g)$. We will also discuss the special case $g = 2$ and its relevance to the conjecture that any Seifert fibered Dehn surgery on a hyperbolic knot in S^3 must be integral.

Classical knot concordance and blanchfield duality

Shelly Harvey
Rice University, USA

Abstract. In 1997, T. Cochran, K. Orr, and P. Teichner defined a filtration F_n on the classical knot concordance group, called the (n)-solvable filtration, that is related to whether a knot bounds an n-stage symmetric grope in the 4-ball. The successive quotients of this filtration are known to be non-trivial at every stage. We show the successive quotients $F_n/F_n + 1$ have infinite rank for every n. The knots that give this generation are closely related to an iterated family of examples first studied by P. Gilmer. To prove our result we use Cheeger-Gromov L^2 rho-invariants associated to the derived series of a knots. This is joint work with T. Cochran and C. Leidy.

Classification of special 2-fold coverings of a S^1-bundle

Claude Hayat-Legrand
Université Paul Sabatier, France

Abstract. (This is joint work with A. Bauval, D. Gonçalves, M.H. Melo.) A special 2-fold covering of a principal S^1-bundle P over a oriented surface is also a S^1-bundle over the same surface with the particularity that its fiber is a square root of the fiber of P. All these special 2-fold coverings are weakly equivalent in the classical sense. It is necessary to add some constraint to get a classification "à la Johnson", corresponding to the particular case where the S^1-bundle is the principal bundle associated to the tangent bundle of the surface.

Complexity for Heegaard splittings

John Hempel
Rice University, USA

Abstract. We introduce a notion of "complexity" for Heegaard Splittings of closed 3-manifolds which arises from the Ozsváth, Szabó. approach to Heegaard Floer homology and discuss how this could be used to simplify such splittings.

Finiteness conditions and PD_r-group covers of PD_n-complexes

Jonathan Hillman
University of Sydney, Australia

Abstract. Gottlieb and Quinn showed that the homotopy fibre of a fibration $p : M \to B$ of a PD_n-complex M over a PD_r-complex B is a PD_{n-r}-complex if and only if it is finitely dominated. When B is aspherical and $p_* = \pi_1(p)$ is an epimorphism the homotopy fibre is the covering space corresponding to $\mathrm{Ker}(p_*)$. We shall show that in this case we may use duality to relax the hypothesis that the fibre be finitely dominated, to requiring merely that it be homotopy equivalent to a complex with finite $[n/2]$-skeleton. In the simplest nontrivial case, when the base is S^1, we can improve this slightly, and our result is then best possible. In particular, we obtain the following 4-dimensional homotopy analogue of the Stallings fibration theorem for 3-manifolds: *if M' is an infinite cyclic covering space of a closed 4-manifold M then M' satisfies Poincaré duality with local coefficients if and only if $\chi(M) = 0$ and $\pi_1(M')$ is finitely generated.* This is joint work with D.H.Kochloukova. Our argument is entirely homological, rather than homotopy-theoretic, and an essential element is her result that certain Novikov extensions of group rings are weakly finite.

A comparison of 3-manifold widths

Diane Hoffoss
University of San Diego, USA

Abstract. We show that the Scharlemann-Thompson width and the Gromov width are comparable for hyperbolic 3-manifolds.

Kleinian groups of small Hausdorff dimension are classical Scottky groups

Yong Hou
Boise State University, USA

Abstract. In this talk we will prove that there exists a positive number λ such that ant k-generated Kleinian groups with limite set of Hausdorff dimension $< \lambda$ are classical Scottky groups.

On braid presentation of surfaces in 4-space and a graphic method to describe them

Seiichi Kamada
Hiroshima University, Japan

Abstract. It is well-known as the Alexander and Markov theorem that every knot in 3-space can be described as a closed braid and such a braid presentation is unique up to Markov-move equivalence. For a knotted surface in 4-space, we have an analogy. Moreover such a braid presentation is describe by a graphic called a chart. We introduce a recent aspect of this.

Reducible and toroidal Dehn fillings with distance 3

Sungmo Kang
University of Texas at Austin, USA

Abstract. If a simple 3-manifold M admits a reducible and a toroidal Dehn fillings, the distance between the filling slopes is known to be bounded by three. In this talk, we classify all simple manifolds which admit a reducible Dehn filling and a toroidal Dehn filling with distance 3.

Enumerating prime links and closed orientable 3-manifolds by characteristic rational invariants

Akio Kawauchi
Osaka City University, Japan

Abstract. Let $\mathbb{L}$ be the set of (unoriented) prime links, and $\mathbb{M}$ the set of the (closed, connected, orientable) 3-manifolds. A *complete invariant* for $\mathbb{L}$ (or $\mathbb{M}$, resp.) is an invariant of $\mathbb{L}$ (or $\mathbb{M}$, respectively) such that the invariants of any two members are equal if and only if they are equal. Further, if we can reconstruct the member itself from some data of the invariant, then we call it a *characteristic* invariant for $\mathbb{L}$ (or $\mathbb{M}$, respectively). In a previous paper [1], the speaker introduced characteristic lattice point invariants for $\mathbb{L}$ and $\mathbb{M}$ to enumerate them (see [3, 4] for some classifications).

In this talk, we explain these characteristic lattice point invariants to obtain some characteristic rational invariants for $\mathbb{L}$ and $\mathbb{M}$, which enable us to construct some two-variable holomorphic functions which theoretically enumerate all the members of $\mathbb{L}$ and $\mathbb{M}$, respectively (see [2]).

References

[1] A. Kawauchi, A tabulation of 3-manifolds via Dehn surgery, Boletin de la Sociedad Matematica Mexicana (3) 10 (2004), 279–304.

[2] A. Kawauchi, Characteristic genera of closed orientable 3-manifolds (revised version), preprint.

[3] A. Kawauchi and I. Tayama, Enumerating prime links by a canonical order, Journal of Knot Theory and Its Ramifications, Vol. 15, No. 2 (2006) 217-237.

[4] A. Kawauchi and I. Tayama, Enumerating 3-manifolds by a canonical order, Proc. of ILDT, World Scientific Publ. (to appear).

Inverse limits of tent maps

James Keesling
University of Florida, USA

Abstract. Inverse limits are important in the study of dynamical systems.

Robert Williams showed that attractors for dynamical systems can be represented as inverse limits of branched manifolds with a single bonding map. It is natural to study and attempt to classify these inverse limits.

This has led to the problem of classifying the inverse limits of the form (I, f_s) where f_s is a member of the tent family, $f_s(x) = \min\{s \cdot x, s \cdot (1-x)\}$ $1 \leq s \leq 2$, and $I = [0, 1]$. It is conjectured that the inverse limits are homeomorphic if and only if $s = t$. This is known as Ingram's Conjecture. Special cases are known, but the general problem remains elusive. One special case stands out. Suppose that f_s and f_t both have periodic turning point. In this case Lois Kailhofer has shown that (I, f_s) is homeomorphic to (I, f_t) if and only if $s = t$.

The proof of Kailhofer's result is complicated, but a shorter and more transparent proof is given by Louis Block, Slagjana Jakimovic, Lois Kailhofer, and James Keesling. The new proof also shows that some power of any homeomorphism is isotopic to a power of the shift map on the inverse limit space.

The techniques developed in the new proof of Kailhofer's theorem suggest an approach to a general solution to Ingram's Conjecture. We will discuss the progress being made using this general approach.

Recent work by Brian Raines and Sonja Štimac has shown that for the class of tent maps with non-recurring turning point Ingram's Conjecture holds. It has been recently shown by Block, Keesling, and Misiurewicz that there are values of s for which the closure of the orbit of the turning point of f_s is an adding machine. This is the simplest case for which the turning point is recurrent, but not periodic. Progress in proving Ingram's Conjecture for this case will be discussed.

Related results by Christoph Bandt, Marcy Barge, Beverly Diamond, Karen Brucks, Henk Bruin, Brian Raines, Chris Good, Sonja Štimac, and others will also be reviewed.

Polynomial splitting of von Neumann rho invariants

Taehee Kim
Konkuk University, Korea

Abstract. In this talk we show that if the connected sum of two knots with coprime Alexander polynomials has vanishing von Neumann rho invariants associated to certain metabelian representations then so do both knots. As an application, we give a new example of infinitely many knots which are linearly independent in the knot concordance group.

A polynomial-time solution to the reducibility problem

Kihyoung Ko
Korea Advanced Institute of Science and Technology, Korea

Abstract. We propose an algorithm for deciding whether a given braid is pseudo-Anosov, reducible, or periodic. The algorithm is based on Garside's weighted decomposition and is polynomial-time in the word-length of an input braid. Moreover, a reduction system of circles can be found completely if the input is a certain type of reducible braids.

Distance of knots and Morimoto's Conjecture on the super additive phenomena of tunnel numbers of knots

Tsuyoshi Kobayashi
Nara Women's University, Japan

Abstract. This is a joint work with Yo'av Rieck. Let K_i $(i = 1, 2)$ be knots in the 3-sphere S^3, and $K_1 \# K_2$ their connected sum. We use the notation $t(\cdot)$ to denote tunnel number of a knot. It is well known that the following inequality holds in general.

$$t(K_1 \# K_2) \leq t(K_1) + t(K_2) + 1.$$

We say that a knot K in a closed orientable manifold M admits a (g, n) position if there exists a genus g Heegaard surface which separates M into handlebodies H_1 and H_2, so that $H_i \cap K$ $(i = 1, 2)$ consists of n arcs that are simultaneously parallel into ∂H_i. It is known that if K_i $(i = 1$ or $2)$ admits a $(t(K_i), 1)$ position then the equality does not hold in the above. Morimoto proved that if K_1 and K_2 are m-small knots then the converse holds, and conjectured that this is true in general (K.Morimoto, Math. Ann., 317(3):489–508, 2000). Morimoto's Conjecture: Given knots $K_1,\ K_2 \subset S^3$, $t(E(K_1 \# K_2)) < t(E(K_1)) + t(E(K_2)) + 1$ if and only if for $i = 1$ or $i = 2$, K_i admits a $(t(K_i), 1)$ position.

In this talk, we describe how to show the existence of conterexamples to this conjecture by making use of 'distance' of knots.

Formulas for the Casson invariant of homology 3-spheres

Sang Youl Lee
Pusan National University, Korea

Abstract. (This is a Joint work with M. Seo.) In this talk, we consider a representation of knots and links in S^3 by integral matrices and then give an explicit formula for the Casson invariant for homology 3-spheres obtained from S^3 by Dehn surgery along the knots and links represented by the integral matrices, in terms of the entries and framings. As applications, we discuss the preimage of the Casson invariant for a given integer and also give formulas for the Casson invariants for some special classes of homology 3-spheres.

Heegaard splittings of amalgamated 3-manifolds and distance in the curve complex

Tao Li
Boston College, USA

Abstract. We study Heegaard splittings of amalgamated 3-manifolds. There is an interesting connection between strongly irreducible Heegaard surfaces of an amalgamated 3-manifold and a certain complexity of the gluing map. We discuss some recent progress in this area.

The Kodaira dimension of symplectic 4-manifolds

Tian-Jun Li
University of Minnesota, USA

Abstract. Various results and questions about symplectic 4-manifolds can be formulated in terms of the notion of the Kodaira dimension. In particular, we will discuss the classification and the geography problems. It is interesting to understand how it behaves under some basic constructions. Time permitting we will discuss the symplectic birational aspect of this notion and speculate how to extend it to higher dimensional manifolds.

Braids and symplectic Reidemeister numbers

Weiping Li
Oklahoma State University, USA

Abstract. We define and study a symplectic Reidemeister number and its zeta function of a symplectic diffeomorphism on representation varieties induced from braid actions. We show that the symplectic zeta function and the symplectic Reidemeister zeta function form the dynamic system point of view are radicals of rational functions for periodic braids.

The geometry of polyhedral surfaces

Feng Luo
Rutgers University, USA

Abstract. Classical differential geometry deals with smooth surfaces and Riemannian metrics. In contrast, a polyhedral surface, such as a tetrahedron, is a surface composed of Euclidean (or spherical, hyperbolic) triangles. This talk discusses the geometry of polyhedral surfaces. We begin by introducing the discrete curvature of polyhedral surfaces, which is an analogous to Gaussian curvature on smooth surfaces. One of the main problems on surface geometry is to understand the relationship between curvature and metric. This relationship will be discussed in detail. It turns out that the cosine law for triangles should be considered as a curvature-metric relation in this setting. We will show you how cosine law implies many rigidity phenomena about the polyhedral surface geometry. Applications to Teichmuller spaces of surfaces will be discussed.

Non orientable surfaces in 3-manifolds

Daniel Matignon
Université de Provence, France

Abstract. (This is a joint work with Nabil Sayari.) By W. Thurston, we know that if M is a hyperbolic 3-manifold with a torus boundary component, then only a finite number of slopes can yield a non-hyperbolic manifold. This talk concerns those slopes which produce a closed non-orientable surface. We discuss about the slopes, the genus of the surface and the distance between such slopes. In particular, we give "optimal" upper bounds for the distance between two slopes which both produce projective planes, or both produce Klein bottles.

All tunnels of all tunnel number 1 knots

Darryl McCullough
University of Oklahoma, USA

Abstract. This is joint work with Sangbum Cho. We present a new theory which describes the collection of all tunnels of all tunnel number 1 knots in the 3-sphere (up to orientation-preserving equivalence in the sense of Heegaard splittings) using the disk complex of the genus-2 handlebody and associated structures. It shows that each knot tunnel is obtained from the tunnel of the trivial knot by a uniquely determined sequence of simple cabling constructions. A cabling construction is determined by a single rational parameter, so there is a corresponding numerical parameterization of all tunnels by sequences of such parameters and some additional data. Up to superficial differences in definition, the final parameter of this sequence is the Scharlemann-Thompson invariant of the tunnel, and the other parameters are the Scharlemann-Thompson invariants of the intermediate tunnels produced by the constructions. The theory extends easily to links, and adapts with little change to allow equivalence of tunnels by homeomorphisms that may be orientation-reversing. We discuss various applications and calculations.

Heegaard splittings and annulus swaps

Yoav Moriah
Technion, Israel

Abstract. The notions of *annulus swap* and *padded* Heegaard splittings are defined. The questions of when Heegaard genus of a knot manifold reduces and when two different Heegaard surfaces become isotopic after a Dehn filling are discussed with examples in Seifert fibered spaces.

A perturbative invariant of 3-manifolds with the first Betti number 1

Tomotada Ohtsuki
Kyoto University, Japan

Abstract. It is known that the perturbative G invariant of rational homology 3-spheres is formulated by the (arithmetic) perturbative expansion of the quantum G invariants of them. In this talk, I explain how to calculate the (arithmetic) perturbative expansion of the quantum $SO(3)$ invariants of 3-manifolds with the first Betti number 1 to formulate the perturbative $SO(3)$ invariant of such 3-manifolds.

Simply connected surfaces of general type with $p_g = 0$ and $K^2 = 2$

Jongil Park
Seoul National University, Korea

Abstract. One of the fundamental problems in the classification of complex surfaces is to find a new family of simply connected surfaces with $p_g = 0$ and $K^2 > 0$. It has been studied intensively by algebraic surface theorists for more than 100 years since Enrique constructed a new surface with $p_g = q = 0$ and $\pi_1 = \mathbf{Z}_2$ in 1894. Although a large number of non-simply connected complex surfaces of general type with $p_g = 0$ and $K^2 > 0$ have been known ([BHPV], Chapter VII), until now the only previously known simply connected, minimal, complex surface of general type with $p_g = 0$ and $K^2 > 0$ was Barlow surface. Barlow surface has $K^2 = 1$. The natural question arises if there is a simply connected surface of general type with $p_g = 0$ and $K^2 \geq 2$.

Recently, I constructed a new simply connected symplectic 4-manifold with $p_g = 0$ (equivalently $b_2^+ = 1$) and $K^2 = 2$ by using a rational blow-down surgery [P]. After this construction, it has been a very intriguing question whether such a symplectic 4-manifold admit a complex structure.

The aim of this talk is to confirm an affirmative answer for the question above. Precisely, we construct a new family of simply connected, minimal, complex surfaces of general type with $p_g = 0$ and $K^2 = 2$ by modifying Park's symplectic 4-manifold in [P]. Our main techniques are a rational blow-down surgery and a $\mathbf{Q}$-Gorenstein smoothing theory. We also construct a family of simply connected, minimal, complex surfaces of general type with $p_g = 0$ and $K^2 = 1$ using the same technique.

In this talk, I'll sketch how to construct such 4-manifolds using a rational blow-down surgery and how to show that such 4-manifolds admit a complex structure using a $\mathbf{Q}$-Gorenstein smoothing theory.

References

[BHPV] W. Barth, K. Hulek, C. Peters, A. Van de Ven, *Compact complex surfaces*, 2nd ed. Springer-Verlag, Berlin, 2004.

[P] J. Park, *Simply connected symplectic 4-manifolds with* $b_2^+ = 1$ *and* $c_1^2 = 2$, Invent. Math. **159** (2005), 657–667.

Polynomial representation for non-compact knots

Madeti Prabhakar
Inidian Institute of Technology Delhi, India

Abstract. In this talk I will discuss the polynomial representation for non-compact knots and elaborate on how to obtain them with a bound on degrees of the defining polynomials, for any knot-type. For this purpose, we use a recent theory of *quasi toric* braid representation of knots. In this talk, I will discuss this idea in detail and provide a method to obtain a degree sequence for a general knot type.

On the boundary slopes of hyperbolic 3-manifolds

Ruifeng Qiu
Dalian University of Technology, China

Abstract. Let M be a hyperbolic 3-manifold, and F be a boundary component of M of genus at least two. For a slope r on F, we denote by $M(r)$ the manifold obtained by attaching a 2-handle to M along R. Natural questions are the following: (1) How many slopes r on F are there so that $M(r)$ is not hyperbolic? (2) Suppose M contains no essential closed surface of genus g. How many slopes r on F are there so that $M(r)$ contains an essential closed surface of genus g? In this talk, we shall introduce some results on this topic.

On distinguishing curve complexes

Kasra Rafi
University of Connecticut, USA

Abstract. We show that, if the curve complexes of a pair of surfaces are quasi-isometric and each has connected Gromov boundary then the two surfaces have equal complexity. This is joint work with Saul Schleimer.

New results about wild Cantor sets

Dušan Repovš
University of Ljubljana, Slovenia

Abstract. We shall present new techniques for constructing wild Cantor sets in R^3 which have some extra properties, for example they are Lipschitz homogeneously embedded, or rigid wild with simply connected complement, and others. We shall also report on new joint work with D. Garity, D. Wright and M. Željko on Bing-Whitehead Cantor sets. We also plan to state several open problems and conjectures concerning wild Cantor sets in $R^{n\geq 3}$.

Khovanov type homologies for graphs

Yongwu Rong
George Washington University, USA

Abstract. In 1999, M. Khovanov introduced a graded homology theory for knots, and proved their graded Euler characteristic is the Jones polynomial. These homology groups turn out to be surprisingly strong invariants and have sparked much attention in low dimensional topology. In this talk, we will discuss several analogous homology theories for graphs, that correspond to the chromatic polynomial (with Laure Helme-Guizon), or the Tutte polynomial (with E. Fanny Jasso-Hernandez), or the Bollobas-Riordan polynomial, or the Penrose polynomial (with Kerry Luse). Connection with other work will be discussed.

On the uniqueness of the decomposition of manifolds, polyhedra and continua into cartesian products

Witold Rosicki
Gdansk University, Poland

Abstract. Generally the uniqueness of the decomposition of topological spaces into Cartesian product does not hold. We have very simple examples. The Cartesian product of a disc with two holes and an interval and the Cartesian product of a torus with one hole and an interval are homeomorphic.

However, the uniqueness of the decomposition holds in some cases. In 1938 K.Borsuk showed that the decomposition of a polyhedron into Cartesian product of 1-dimensional factors is unique.

I will consider the uniqueness of the Cartesian products of 2-polyhedra and present some positive results. In the world of continua such uniqueness results cannot be obtained.

Together with S.Kwasik we considered the Cartesian products of 3-manifolds and n-spheres. If n is even, then the product is unique, if n is odd it is not.

Search the quantum symmetry for topology

Yongbin Ruan
University of Michigan

Abstract. There are many examples where the mathematics from the same root seems to be far apart from each other. We will illustrate such a discontinuous phenomenon using three examples: flop, McKay correspondence and singularities Calabi-Yau correspondence. On the other hand, there is a general principle from physics that the quantum world should be more uniform than classical world. It suggests that there may be a "quantum symmetry" for these disconnected mathematics. In the talk, we will demonstrate such a "quantum symmetry" for quantum cohomology.

Automorphisms of Heegaard splittings of 3-manifolds

Hyam Rubinstein
University of Melbourne, Australia

Abstract. This is joint work with Jesse Johnson (Yale). An automorphism of a Heegaard splitting (M, Σ) of a 3-manifold M is a homeomorphism $\phi : M \to M$ which maps the Heegaard surface Σ to itself. The restriction of ϕ to Σ can be periodic, reducible or pseudo Anosov. We give strong structural results on which 3-manifolds M admit periodic automorphisms and which types of Heegaard splittings Σ admit reducible automorphisms. The latter class is related to open book decompositions.

On the distance between two Seifert surfaces of a knot

Makoto Sakuma
Osaka University, Japan

Abstract. (This is a joint work with with K. Shackleton.) For a knot K in S^3, Kakimizu introduced a simplicial complex whose vertices are all the isotopy classes of minimal genus spanning surfaces for K. In this talk we prove the 1-skeleton of this complex has diameter bounded by a function quadratic in knot genus, whenever K is atoroidal. As an application, we prove the simple connectivity of Kakimizu's complex among all atoroidal genus 1 knots.

The sheet numbers of 2-knots

Shin Satoh
Kobe University, Japan

Abstract. A 2-knot is an embedded 2-sphere in 4-space, and its diagram is a projection image of the 2-knot into 3-space together with crossing information. Such a diagram is regarded as a disjoint union of compact connected surfaces each of which is called a sheet. The sheet number of a 2-knot is defined as the minimal number of sheets for all possible diagrams of the 2-knot. The notion of the sheet number is analogous to the crossing number of a classical knot in 3-space. In this talk, we give a lower bound of the sheet number in several ways (Fox colorings, fundamental quandles, and cocycle invariants), and determine the sheet numbers of the 2-, 3-twist-spun trefoils, and some ribbon 2-knots.

A 3-dimensional reimbedding strategy for the 4-dimensional Schoenflies Conjecture

Martin Scharlemann
University of California at Santa Barbara, USA

Abstract. A proof of the generalized Property R Conjecture in dimension 3 could be useful in proving the Schoenflies Conjecture in dimension 4. Part of the proposed strategy requires a Fox type reimbedding of a 3-dimensional cross-section $M^3 \subset S^3 \times 0 \subset S^4$ in a usefully natural way. For example, if M lies inside a knotted solid torus, a natural reimbedding of M would be to unknot the solid torus in which lies. Sadly, when M lies inside a higher genus knotted handlebody W, there isn't such a natural choice of reimbedding. But for the special case in which W is gotten by tubing together two distant solid tori there is a natural choice: both unknot the tori and straighten the tube. We show how this case alone suffices to prove the genus three, 4-dimensional Schoenflies Conjecture.

The geometry of the disk complex

Saul Schleimer
Rutgers University, USA

Abstract. Masur and Minsky introduced many new techniques in a series of two papers studying the curve complex. Using these we prove that the disk complex is Gromov hyperbolic. We also give an algorithm to compute the distance of a Heegaard splitting up to bounded additive error. This is joint work with Howard Masur.

A presentation for the mapping class group of a non-orientable surface via the complex of curves.

Błażej Szepietowski
Gdańsk University, Poland

Abstract. We study the action of the mapping class group $\mathcal{M}(F)$ on the complex of curves of a non-orientable surface F. We obtain, by using Brown's theorem, a presentation for $\mathcal{M}(F)$ defined in terms of the mapping class groups of the complementary surfaces of collections of curves, provided that F is not sporadic, i.e. the complex of curves of F is simply connected. We also compute a finite presentation for the mapping class group of each sporadic surface.

Dynamics of the modular group action on $SL(2,\mathbb{C})$ characters of the one-holed torus

Ser Peow Tan
National University of Singapore, Singapore

Abstract. The $SL(2,\mathbb{C})$ character variety $\mathcal{X}$ of the one-holed torus T can be identified with $\mathbb{C}^3$. The modular group (as the mapping class group of T) acts naturally on the variety as polynomial automorphisms of $\mathbb{C}^3$. We study the dynamics of this action, in particular,

(1) we describe the largest subset of $\mathcal{X}$ on which the action is properly continuous;

(2) for $\rho \in \mathcal{X}$, we define a closed subset $\varepsilon(\rho)$ of PL, the projective lamination space of T, called the set of end invariants of ρ and show that in many cases, $\varepsilon(\rho)$ is a Cantor set if it contains at least 3 elements and is not all of PL.

An application of normal surface theory to the Thurston norm

Stephan Tillmann
The University of Melbourne, Australia

Abstract. I will describe an application of normal surface theory to the study of the Thurston norm. This is joint work with Daryl Cooper.

Line Bundles, real gerbes, and applications

Shuguang Wang
University of Missouri, USA

Abstract. We investigate geometry of real line bundles and real gerbes, with applications to map spaces and twisted bundles.

Mirror reflections on braids and the higher homotopy groups of the 2-sphere

Jie Wu
National University of Singapore, Singapore

Abstract. We will talk our new progress on the connections between the braid groups and the homotopy groups that: The higher general homotopy groups of the 2-sphere are given by the mirror symmetric elements in certain quotient groups of the Artin braid groups with explicitly given relations.

Homotopy types of homeomorphism groups and spaces of emebddings in 2-manifolds

Tatsuhiko Yagasaki
Kyoto Institute of Technology, Japan

Abstract. In this talk we discuss on homotopy types of homeomorphism groups of non-compact 2-manifolds. Suppose M is a noncompact connected 2-manifold and X is a compact subpolyhedron of M. Let $\mathcal{H}_X(M)$ denote the group of homeomorphisms h of M onto itself with $h|_X = id$ equipped with the compact-open topology. For any subgroup $\mathcal{G}$ of $\mathcal{H}_X(M)$, the symbols $\mathcal{G}_0$ and $\mathcal{G}_1$ denote the connected component and the path component of id_M in $\mathcal{G}$. Let $\mathcal{G}^c = \{h \in \mathcal{G} \mid h \text{ has compact support}\}$ and let $(\mathcal{G}^c)^*_1$ denote the subgroup of $\mathcal{G}^c$ consisting of $h \in \mathcal{G}^c$ which admit a path h_t to id_M in $\mathcal{G}^c$ with a common compact support.

A subset A of a space X is said to be homotopy dense (HD) if there exists a homotopy $\varphi_t : X \to X \ \ (0 \le t \le 1)$ such that $\varphi_0 = id_X$ and $\varphi_t(X) \subset A \ (0 < t \le 1)$. In this case the inclusion $i : A \subset X$ is a homotopy equivalence with the homotopy inverse $\varphi_1 : X \to A$.

Theorem 0.1.

(1) $\mathcal{H}_X(M)_0$ *is a topological* ℓ_2*-manifold.* — *[3]*

(2) $\mathcal{H}_X(M)_0 \simeq \begin{cases} \mathbb{S}^1 & \text{if } (M,X) \cong (\mathbb{R}^2,\emptyset),\ (\mathbb{R}^2,1pt),\ (\mathbb{S}^1\times\mathbb{R}^1,\emptyset),\ (\mathbb{S}^1\times[0,1),\emptyset) \text{ or} \\ & (\mathbb{P}^2\setminus 1pt,\emptyset), \\ * & \text{in all other cases.} \end{cases}$
— *[3]*

(3) $\mathcal{H}^c_X(M)^*_1 \ \subset \ \mathcal{H}_X(M)_0$ *: HD* — *[4]*

Suppose M is a noncompact connected PL 2-manifold. Let $\mathcal{H}^{\mathrm{PL}}_X(M) = \{h \in \mathcal{H}_X(M) \mid h : \text{PL-homeo}\}$.

Theorem 0.2. $\mathcal{H}^{\mathrm{PL,c}}_X(M)^*_1 \ \subset \ \mathcal{H}_X(M)_0$ *: HD* — *[4]*

Suppose μ is a good Radon measure on M with $\mu(\mathrm{Fr}\, X \cup \partial M) = 0$. Let $\mathcal{H}_X(M,\mu) = \{h \in \mathcal{H}_X(M) \mid h \text{ preserves } \mu\}$, $\mathcal{H}_X(M,\mu\text{-reg}) = \{h \in \mathcal{H}_X(M) \mid h \text{ preserves } \mu\text{-null sets}\}$.

Theorem 0.3. — *[6]*

(1) There exists a PL-structure of M *such that* $\mathcal{H}^{\mathrm{PL}}_X(M) \subset \mathcal{H}_X(M,\mu\text{-}reg)$.
$\mathcal{H}^{\mathrm{PL,c}}_X(M)^*_1 \ \subset \ \mathcal{H}_X(M,\mu\text{-}reg)^*_1 \ \subset \ \mathcal{H}_X(M)_0$ *: HD*

(2) (after R. Berlanga) $\mathcal{H}_X(M;\mu)_0$ *is a strong deformation retract of* $\mathcal{H}_X(M)_0$.

We have also studied the groups of Lipschitz homeomorphisms and quasi-conformal homeomorphisms of (noncompact) 2-manifolds ([4], [1]). In [5] we classified homotopy types of the components of spaces of embeddings of compact polyhedra into 2-manifolds.

References

[1] Yagasaki, T., The groups of quasiconformal homeomorphisms on Riemann surfaces, *Proc. Amer. Math. Soc.* 127 (1999) 2727 - 2734.

[2] Yagasaki, T., Spaces of embeddings of compact polyhedra into 2-manifolds, *Topology Appl.*, 108 (2000) 107 - 122.

[3] Yagasaki, T., Homotopy types of homeomorphism groups of noncompact 2-manifolds, *Topology Appl.*, 108 (2000) 123 - 136.

[4] Yagasaki, T., The groups of PL and Lipschitz homeomorphisms of noncompact 2-manifolds, Bulletin of the Polish Academy of Sciences, Mathematics, 51 (2003), 445 - 466.

[5] Yagasaki, T., Homotopy types of the components of spaces of embeddings of compact polyhedra into 2-manifolds, Topology Appl., 153 (2005), 174 - 207.

[6] Yagasaki, T., Groups of measure-preserving homeomorphisms of noncompact 2-manifolds, Topology Appl., 154 (2007), 1521 - 1531.

Solenoid attractors in 4-manifolds

Jiangang Yao
University of California at Berkeley, USA

Abstract. (This is a joint work with Fan Ding and Shicheng Wang.) Morse theory provides a way to get the topological information of manifold by the critical points of a function. Now there is a question in the similar spirit: for a diffeomorphism of a manifold, given the information about its non-wondering set (generalization of periodic points), what can we say about the manifold? Solenoid, which is the nested intersection of solid tori, is a typical type of non-wondering sets. We show that no 4-manifold admits a diffeomorphism whose non-wondering set consists of only solenoids. While in the 3-dimensional case, B. Jiang, Y. Ni and S. Wang showed it could be lens spaces. This problem is also related to Anosov diffeomorphisms and expanding maps in dynamical systems.

Transverse unknots in overtwisted contact structures on 3-sphere

Li Yu
Nanjing University, China

Abstract. It is well known that in a tight contact structure on 3-sphere, two transverse unknots with the same self-linking number are Legendrian isotopic. In this talk, a similar but slightly weaker result is shown to hold in an overtwisted contact structure on 3-sphere. More precisely, two transverse unknots with the same self-linking number in an overtwisted contact structure on 3-sphere are contactomorphic.

Fundamental groups of spaces that not homotopically Hausdorff

Andreas Zastrow
Gdańsk University, Poland

Abstract. In attempts to generalize the classical notion of covering spaces to spaces that are not semilocally simply connected the failure of the property "homotopically Hausdorff" has turned out to be a crucial obstruction. The probably oldest example for a space where this property fails is Griffiths' space from the fifties. The Harmonic Archipelago of Bogley and Sieradski is another example which has the additional nice property that a non-trivial image of it sits in every space that is not homotopically Haussdorff. In a joint research project with Oleg Bogopolski (Novosibirsk) we investigated Fundamental groups of such spaces.

If joint research progress till June suffices, the talk might answer a ten-year old question concerning the fundamental groups of non-homotopically Hausdorff Peano-Continua by Cannon and Conner.

An L^2-Alexander-Conway invariant for knots

Weiping Zhang
Nankai University, China

Abstract. We describe our joint work with Weiping Li on the construction of an L^2-analogue of the Alexander-Conway polynomial for knots, where we make use of the Fuglede-Kadison determinant instead of the usual determinant.

Minimizing lengths of two intersecting simple closedgeodesics

Ying Zhang
Yangzhou University, China

Abstract. We address the problem proposed recently by T. Gauglhofer and H. Parlier on finding out the minimum of the longer of the lengths of a pair of simple closed geodesics on a hyperbolic torus where the hyperbolic torus runs over its moduli space with fixed boundary data and the pair of simple closed geodesics intersect k times for a fixed k.

We have found a new phenomenon that for different types of slope pairs, one minimum may dominate the other for arbitrary boundary data.

On the virtually fiberation of 3-manifolds

Xingru Zhang
The State University of New York at Buffalo, USA

Abstract. We give families of infinitely many closed hyperbolic 3- manifolds which are neither fibred nor semi-fibred, but are virtually fibred. These appear to be the first known such families. For an explicit example, all the 2m-fold ($m > 0$) cyclic branched covers of the 3-sphere branched over the knot 9_{46} (which is the $(1/3, 1/3, -1/3)$-Montesinnos knot) are such closed hyperbolic 3-manifolds. In fact this family contains infinitely many distinct commensurable classes. We find such closed 3-manifolds by first finding new families of virtually fibred cusped hyperbolic 3-manifolds, which are the complements of some Montesinos links in the 3-sphere. This is a joint work with Steven Boyer.

A geometric categorification of representations of $U_{q(sl_2)}$

Hao Zheng
Zhongshan University, China

Abstract. We give a purely geometric categorification of tensor products of $U_{q(sl_2)}$-modules, in the framework of category of perverse sheaves on Grassmannians. The work is motivated in part by a desire to find an alternative interpretation of Khovanov homology.

Homology spheres and cyclic branched coverings of knots

Bruno Zimmermann
Università degli Studi di Trieste, Italy

Abstract. We discuss work in collaboration with Boileau-Paoluzzi and Mecchia-Reni on the following problem: given a homology 3-sphere M (or more generally, a closed orientable 3-manifold), for how many distinct primes p can M be a p-fold cyclic branched covering of knots in the 3-sphere? For a homology sphere M, there are five such primes if and only if M is the 3-sphere, and this result is best possible (this might remain true also for arbitrary 3-manifolds).