Speaker: **Aitchison, Iain**
Title: *Canonical flat structures on 3-manifolds*
Authors: Aitchison, Iain
Affiliations: University of Melbourne

Abstract: We discuss natural and canonical deformations between complete, Riemannian metrics of constant curvature, and cone metrics with cone angles an integral multiple of π. We illustrate with Euclidean constructions which shed light on natural geometry of moduli spaces of hyperbolic surfaces of low genus. Other applications will also be discussed, in particular to CAT(0) piecewise Euclidean spines of hyperbolic link complements, which are naturally unions of Euclidean tori.

Speaker: **Bao, Zhiqiang**
Title: *The compressibility of checkerboard surfaces of link diagrams*
Authors: Zhiqiang Bao
Affiliations: Peking University, P. R. China

Abstract: Consider the checkerboard surfaces defined by some link diagrams. When they are not orientable, one considers the boundary surfaces of their small regular neighborhoods. The compressibility problem of these kinds of surfaces in the link complements is studied. We defined normal positions for the compressing discs. This brings up an algorithm to verify compressibility directly from the link diagrams. As an application, the algorithm is applied to diagrams in the knot tables. Examples of both (infinitely many) examples of incompressible and (surprisingly) completely compressible checkerboard surfaces of non-alternating knot diagrams are discovered. The change of compressibility under Reidermeister moves is also studied.

Speaker: **Bestvina, Mladen**
Title: *measured laminations and group theory*
Authors: Bestvina, Mladen
Affiliations: University of Utah

Abstract: I will discuss some of the recent work by Zlil Sela on the Tarski problems. An alternative approach, involving measured laminations on finite complexes, will be described. This is joint work with Mark Feighn.

Speaker: **Bigelow, Stephen**
Title: *Braid groups and symmetric groups*
Authors: Bigelow, Stephen
Affiliations: University of Melbourne

Abstract: Representations of the symmetric group are not well understood when the field has non-zero characteristic. They are closely related to representations of the Hecke algebra when the parameter q is a root of unity. Lawrence has shown how these representations can be defined topologically, as an action of the braid group on the homology of certain configuration spaces. I will use some examples to illustrate how this enables one to "see" why representations become reducible at some roots of unity.

Speaker: **Blanchet, Christian**
Title: *Modular categories and spin structures*
Authors: Blanchet Christian
Affiliations: Universite de Bretagne-Sud

Abstract: We introduce the notion of a spin modular category and explain the role of spin structures in quantum invariants. This is well known for the usual spin structures. We show that for type A modular categories one has to consider spin structures modulo an even integer. We also give a new construction involving complex spin structures.

Speaker: **Boileau, Michel**
Title: *Geometrization of 3-dimensional orbifolds*
Authors: Boileau, Michel
Affiliations: University Paul Sabatier, TOULOUSE, FRANCE

Abstract: Not submitted.

Speaker: **Bonahon, Francis**
Title: *Liouville geodesic currents*
Authors: Francis Bonahon
Affiliations: University of Southern California

Abstract: The "random geodesic" construction associates a geodesic current (= diffused homotopy class of closed curves) to each hyperbolic metric on a surface S. We show that this geodesic current depends differentiably on the metric, in a suitable sense. This is joint work with Yasar Sozen.

Speaker: **Bridson, Martin**
Title: *Curvature, complexity, and mapping tori of free-group automorphisms*
Authors: Martin R. Bridson
Affiliations: Imperial College, London, UK

Abstract: I shall begin with a brief survey of the intimate relationships between various manifestations of non-positive curvature and decision problems in group theory and topology. I shall then explain recent work exploring the outer limits of these relationships, with special emphasis on the mapping tori of free-group automorphisms.

Speaker: **Brittenham, Mark**
Title: *Knots with unique minimal genus Seifert surface and depth of knots*
Authors: Mark Brittenham
Affiliations: University of Nebraska

Abstract: We present a method for generating families of hyperbolic knots with unique minimal genus Seifert surface. These will be used to give examples of families of hyperbolic knots whose exteriors do not admit any taut depth one foliations.

Speaker: **Brown, Robert**
Title: *The Relative Nielsen Number*
Authors: Robert F. Brown
Affiliations: UCLA

Abstract: The need for a homotopy-invariant lower bound for the number of fixed points of maps of pairs arose because of Jiang's proof of the Wecken property for homeomorphisms of surfaces, in order to extend the result from closed surfaces to surfaces with boundary. Schirmer's relative Nielsen number not only furnished the appropriate tool for this purpose but lead to significant developments in just about every aspect of Nielsen theory. This talk will present a sample of these developments, including work (with Kelly) still in progress on the Wecken properties of boundary-preserving maps of surfaces.

Speaker: **Calegari, Danny**
Title: *Bounded cochains on 3-manifolds*
Authors: Danny Calegari
Affiliations: California Institute of Technology

Abstract: We study the large-scale geometry of 3-manifolds whose fundamental groups admit 1-cochains with certain geometric properties, as an intermediate step towards the geometrization conjecture.

An unbounded 1-cochain with bounded coboundary is *weakly uniform* if the coarse level sets are coarsely connected, and *uniform* if the coarse level sets are coarsely connected and coarsely simply connected.

Theorem 1. A 1-cochain on a 3-manifold is weakly uniform iff it is uniform.

This theorem is a coarse analogue of Stallings fibration theorem, and Novikov's theorem about taut foliations; it may also be thought of as a kind of "coarse Scott core theorem".

Theorem 2: If M admits a uniform 1-cochain, then either M is homotopic to a Seifert fibered or solv manifold, or contains a reducing torus, or the fundamental group is word-hyperbolic. Moreover in the last case, there is a precise quasi-isometric model for the universal cover of M, analogous to a singular solv metric, and a dynamical system which conjecturally should produce a hyperbolic structure on M.

This theorem shows that such manifolds M are good generalizations of manifolds which fiber or slither over the circle, and have a similar associated "pseudo Anosov package".

Speaker: **Canary, Richard**
Title: *Deformation theory of hyperbolic 3-manifolds*
Authors: Richard D. Canary
Affiliations: University of Michigan

Abstract: Thurston's Ending Lamination Conjecture provides a conjectural classification of all (marked) hyperbolic 3-manifolds homotopy equivalent to a fixed compact 3-manifold M. This classification is in terms of topological data, the marked homeomorphism type of the manifold, and geometric data, which encodes the asymptotic geometry of the ends of the manifold. Brock, Canary and Minsky recently established this conjecture in the case when M has incompressible boundary. We will discuss the conjecture and some consequences of its proof.

Speaker: **Claude, Hayat**
Title: *TBA.*
Authors: Claude, Hayat
Affiliations: University Toulouse France

Abstract: Not submitted.

Speaker: **Cooper, Daryl**
Title: *The Orbifold Theorem*
Authors: D.Cooper, C. Hodgson, S. Kerckhoff
Affiliations: UCSB

Abstract: We will discuss some aspects of the proof of the orbifold theorem.

Speaker: **Coornaert,**
Title: *Growth of conjugacy classes in Gromov hyperbolic groups*
Authors: Coornaert
Affiliations: IRMA, Strasbourg

Abstract: Let Γ be a group acting properly and cocompactly by isometries on a proper geodesic Gromov-hyperbolic metric space X. For all $t \geq 0$, let $P(t)$ denote the number of conjugacy classes of primitive elements $\gamma \in \Gamma$ whose minimal displacement on X does not exceed t. I will present asymptotic estimates for $P(t)$ as $t \to \infty$ obtained in collaboration with Gerhard Knieper.

Speaker: **Eliashberg, Yakov**
Title: *Topology of Lagrangian embeddings*
Authors: Yakov Eliashberg
Affiliations: Stanford University

Abstract: Topology of Lagrangian embeddings is one of the main subjects of Symplectic topology, which is interconnected with many other themes from Symplectic geometry and related topics. We will discuss some selected results and methods, as well as open problems in this area.

Speaker: **Eudave-Munoz, Mario**
Title: *Incompressible surfaces and (1,1)-knots*
Authors: M. Eudave-Munoz and E. Ramirez-Losada
Affiliations: Instituto de Matematicas, UNAM and CIMAT

Abstract: Let T be a standard torus in S^3. K is a $(1,1)$-knot if K can be positioned so that K intersects T in two points, which divide K into two arcs, and such that each of the arcs is parallel to a simple arc lying on T.

We give a description of all $(1,1)$-knots which contain an essential meridional surface, that is, an incompressible, meridionally incompressible, not ∂-parallel, properly embedded surface in the exterior of a knot K, whose boundary consists of meridians of K.

In particular, we show that for given $g > 0$ and $h > 0$, there are $(1,1)$-knots which contain an essential meridional surface of genus g, and whose boundary has $2h$ components. This contrasts with a result of Gordon and Reid, which shows that $(1,1)$-knots cannot contain "planar" essential meridional surfaces.

Speaker: **Fiedler, Thomas**
Title: *Global Knot Theory*
Authors: Thomas Fiedler
Affiliations: Universite Paul Sabatier ,Toulouse , France

Abstract: Let K be a knot in the product of a surface F with a line . K is called GLOBAL if its projection into F is transverse to some generic vector field on F without critical points of index +1. Global knots generalize closed braids in the solid torus . We construct specific knot invariants of finite type for global knots . These invariants can not be extracted from the Kontsevich integral for knots in a thickened surface . We conjecture that our invariants separate global knots in general and we prove the conjecture in a particular case .

Moreover we use our invariants in order to prove the non-invertibility of certain links in the 3-sphere without making any use of the knot group !

Speaker: **Finashin, Sergey**
Title: *Knotting of Curves in Complex Algebraic Surfaces*
Authors: Sergey Finashin
Affiliations: Middle East Technical University (Ankara)

Abstract: **Theorem.** For any $d > 4$ there exists an infinite family of smooth surfaces, F_i, in CP^2 which are homeomorphic to an algebraic curve, A, of degree d, realize the same homology class as A and have the same as A (i.e., abelian) fundamental group of the complement, $\pi_1(CP^2 - F_i)$, but with the pairs (CP^2, F_i) pairwise smoothly non-equivalent.

Surfaces F_i are obtained from A by an annulus rim surgery. This surgery construction is a modification of the rim surgery used by Fintushel and Stern for similar knotting in the case of trivial fundamental group of the complement.

The annulus rim surgery can be also used for knottings of curves in any complex algebraic surface provided the curves admit certain degenerations.

Speaker: **Frohman, Charles**
Title: *Invariants of 3-manifolds away from roots of unity*
Authors: F. Frohman, J. Kania-Bartoszynska
Affiliations: The University of Iowa

Abstract: An ideal triangulation of a 3-manifold is *efficient* if the only normal tori and spheres are links of the boundary of the manifold. We show that given an efficient triangulation there is an induced linear functional on the Kauffman bracket skein module of the boundary of the three-manifold. The linear functional is obtained by renormalization of the TQFT underlying the Turaev-Viro invariant.

Speaker: **Fujiwara, Koji**
Title: *Quasi-homomorphisms on groups acting on CAT(0) spaces*
Authors: Koji Fujiwara
Affiliations: Tohoku Univ

Abstract: I will discuss quasi-homomorphisms on a group which is acting on a CAT(0) space with rank-1 elements. This is a joint work with Mladen Bestvina.

Speaker: **Furuta, Mikio**
Title: *Geograpy of spin 4-manifolds with $b_1 > 0$*
Authors: FURUTA, Mikio
Affiliations: University of Tokyo

Abstract: It is conjectured that any spin 4-manifold X satisfies the equality $b_2(X)/\sigma(X) \geq 11/8$, where $b_2(X)$ is the second Betti number and $\sigma(X)$ is the signature of X. In this talk I would like to explain the equality could be improved when the intersection form on $H_1(X, \mathbf{Z})$ has some properties.

The main tool is the Seiberg-Witten equation. When the first Betti number $b_1(X)$ is positive, the equation is regarded as a "proper-like" nonlinear map between two Banach bundles over the Jacobian torus. The formal difference of the two Banach bundles is an index of a family of elliptic operators with some symmetry. The outline of the argument is as follows: When the intersection form on $H_1(X, \mathbf{Z})$ is non-trivial, then the index becomes non-trivial. This non-triviality gives a restriction for the existence of the "proper-like" map.

Speaker: **Gabai, David**
Title: *The Smale Conjecture for Hyperbolic 3-Manifolds*
Authors: Gabai, David
Affiliations: Princeton University

Abstract: Not submitted.

Speaker: **Gelca, Razvan**
Title: *On the quantization of the moduli space of flat SU(2)-connections on the torus*
Authors: Razvan Gelca and Alejandro Uribe
Affiliations: Texas Tech University

Abstract: Using the Reshetikhin-Turaev TQFT one can define a quantization of the moduli space of flat SU(2)-connections on the torus. In this particular situation the moduli space admits a covering by the complex plane, so one can perform equivariant Weyl quantization as well. Our main result shows that the two quantizations are unitarily equivalent. The unitary morphism between the Hilbert spaces maps the basis consisting of the core of the solid torus colored by irreducible representations of the quantum group to a basis of odd theta functions.

The proof relies on the computations of the matrices of operators in the two quantizations. One computation is done using cut and paste techniques from TQFT with corners, while the other involves Fourier analysis on the torus. This explains the product-to-sum formula discovered some time ago for the Kauffman bracket on the torus.

Speaker: **Gomez-Larranaga, Jose-Carlos**
Title: *Invariants of the Lusternik-Schnirelmann type for 3-manifolds*
Authors: José-Carlos Gómez-Larrañaga, Francisco González-Acuña, Wolfgang Heil
Affiliations: CIMAT, UNAM, Florida State University

Abstract: The *Lusternik-Schnirelmann category* of a space X, denoted $cat\,(X)$, is defined to be the minimal integer k such that there exists an open covering $\{A_0, \ldots, A_k\}$ of X with each A_i contractible to a point in X. The motivation for introducing this concept was that for a closed differentiable manifold M, $cat\,(M) + 1$ gives a lower bound for the number of critical points of a differentiable real function f on M.

In 1986, M. Clapp and D. Puppe proposed the following generalization: If $\mathcal{A}$ is any class of spaces they replace the condition that $A_j \subset X$ is nulhomotopic by requiring that it factors throught some $A \in \mathcal{A}$ up to homotopy and they obtain the notion of $\mathcal{A}$-*category*. Roughly, they show that

the $\mathcal{A}$-category, under certain conditions, gives new information on the topological structure of the critical set.

In this talk, for a closed 3-manifold M, we relate the $\mathcal{A}$-*cat* (M) with classical 3-manifold theory and give an overview of what is known about these invariants.

Speaker: **Goncalves, Daciberg**
Title: *Braid groups of the Projective plane*
Authors: Daciberg Lima Gonçalves and John Guaschi
Affiliations: University of São Paulo and Université de Toulouse

Abstract: We study the pure braid group short exact sequence described by Fadell and Neuwirth, namely

$$0 \to P_{m-n}(RP^2 - \{x_1, ..., x_n\}) \to P_m(RP^2) \to P_n(RP^2) \to 0$$

and the torsion of the pure Braid groups $P_n(RP^2)$ and of the braid groups $B_n(RP^2)$. The short exact sequence for $n = 2$ and $m = 3$ splits. This was was shown by Burskirk in the 60's. It is an open question the cases where $m > 3$. We show that the sequence does not splits if $m > 3$. For the torsion we show that there is a torsion element of $P_n(RP^2)$ of order k if and only if k is either 2 or 4. Similar there is a torsion element of $B_n(RP^2)$ of order k if and only if k divides either 4n or 4(n-1). Also the only element of order 2 in $B_n(RP^2)$ is the full twist. As a consequence of our result we can show that a k-th root of the full twist exists if and only if k divides either 2n or 2(n-1). For the non-splitting result we use some approach of coincidence theory. For the study of the torsion we use techniques of fibrations more standard in the study of the braids.

Speaker: **Gordon, Cameron**
Title: *Exceptional Dehn surgeries on knots*
Authors: Cameron Gordon and John Luecke
Affiliations: University of Texas at Austin

Abstract: Most Dehn surgeries on most hyperbolic knots in the 3-sphere give hyperbolic 3-manifolds. The fact that the known exceptions are quite special suggests that it may eventually be possible to completely describe all such exceptional surgeries. We will discuss this program and the progress that has been made on it so far.

Speaker: **Hart, Evelyn**
Title: *Nielsen Equivalence on the Figure Eight*
Authors: Evelyn Hart
Affiliations: Colgate University

Abstract: When calculating the Nielsen number of a self-map on the figure eight, there is one step that is not algorithmic. Certain words in the fundamental group must be placed in their orbits under the Reidemeister action. Given two words that appear in the Reidemeister trace, are they in the same orbit? J. Wagner has proven that an algorithm exists for a large class of maps that have remnant. We study extensions to certain maps that do not have remnant.

Speaker: **Harvey, Shelly**
Title: *Higher-Order 3-manifold Invariants with Applications to the Thurston Norm and*

Symplectic 4-manifolds
Authors: Shelly Harvey
Affiliations: UCSD

Abstract: We define an infinite sequence of new invariants, δ_n, of a group G that measure the size of the successive quotients of the derived series of G. In the case that G is the fundamental group of a 3-manifold, we obtain new 3-manifold invariants. These invariants are closely related to the topology of the 3-manifold. They give lower bounds for the Thurston norm which provide better estimates than the bound established by McMullen using the Alexander norm. We also show that the δ_n give obstructions to a 3-manifold fibering over S^1 and to a 3-manifold being Seifert fibered. Moreover, we show that the δ_n give computable algebraic obstructions to a 4-manifold of the form $X \times S^1$ admitting a symplectic structure even when the obstructions given by the Seiberg-Witten invariants fail. There are also applications to the minimal ropelength and genera of knots and links in S^3.

Speaker: **Hayashi, Chuichiro**
Title: *Trivial double-torus knot*
Authors: Chuichiro Hayashi
Affiliations: Japan Women's University

Abstract: A knot K in a closed connected orientable 3-manifold M is called a double-torus knot, if it is in a genus two Heegaard splitting surface H of M. We give a necessary and sufficient condition for a double-torus knot to be the trivial knot in words of meridian disks of genus two handlebodies obtained by splitting M along H.

Speaker: **Heath, Philip**
Title: *Model solvmanifolds for Neilson theory*
Authors: Philip R. Heath and Edward C. Keppelman
Affiliations: Memorial University of Newfoundland, University of Nevada at Reno

Abstract: Existing examples of solvmanifolds (quotients of connected simply connected solvable Lie groups by uniform subgroups), and their maps, seem to be sparse, to say the least. Nilmanifolds (quotients of connected simply connected nilpotent Lie groups by uniform subgroups), on the other hand, are known to be homeomorphic to subgroups of unipotent matrix groups. Furthermore, homotopy classes of self maps of nilmanifolds are also in one-to-one correspondence with the homomorphisms of these subgroups and the Nielsen theory (both ordinary and periodic) is the same as the basic matrix Nielsen theory of tori. Thus this latter class of spaces, serves as models for nilmanifolds and their maps.

In contrast, the construction of and analysis of self maps of solvmanifolds is far more complicated than for nilmanifolds, and there seems to be no corresponding models for solvmanifolds. The purpose of this talk is to give the next best thing, at least as far as Nielsen theory is concerned. Accordingly, we construct a class of solvmanifolds (which we call *models*) and their maps. These models, unlike arbitrary solvmanifolds, exhibit a simple necessary and sufficient condition for the existence of self maps. They not only give a rich source of examples of solvmanifolds, but also serve as paradigms for the Nielsen theory of solvmanifolds in the sense that, for any self map $f : S \to S$ of an arbitrary solvmanifold S, there is an easily constructed (often simpler) solvmanifold S', and an often simpler self map f' of S' that has the same Nielsen theory (ordinary and periodic) as f.

The talk will contain illustrative examples.

Speaker: **Hermiller, Susan**
Title: *Finiteness conditions for groups and monoids*
Authors: Juan Alonso, Susan Hermiller
Affiliations: Swedish Institute of Computer Science, University of Nebraska

Abstract: For a group with homotopical finiteness $\mathcal{F}_n$, there is a $K(\pi, 1)$ whose universal cover admits a group action with finite fundamental domain for the action on the n-skeleton. Squier's property of finite derivation type corresponds to an action up to dimension $n = 3$ in which the fundamental domain consists of "directed" cells. This property can then be applied to monoids as well as groups, and for groups it is equivalent to $\mathcal{F}_3$. In this talk I will discuss a homological analog of the definition of finite derivation type, an extension of this to higher dimensions, and connections to other finiteness conditions.

Speaker: **Hirose, Susumu**
Title: *Diffeomorphisms over surfaces trivially embedded in 4-sphere.*
Authors: Hirose, Susumu
Affiliations: Saga University, Japan

Abstract: A surface in the 4-sphere is *trivially* embedded, if it bounds a 3-dimensional handle body in the 4-sphere. For a surface trivially embedded in the 4-sphere, a diffeomorphism over this surface is extensible if and only if this preserves the Rokhlin quadratic form of this embedded surface.

Speaker: **Hoste, Jim**
Title: *A Formula for the A-polynomial of Twist Knots*
Authors: Jim Hoste and Patrick D. Shanahan
Affiliations: Pitzer College and Loyola Marymount University

Abstract: The fundamental group of a 2-bridge knot has a particularly nice presentation, having only two generators and a single relation. For certain families of 2-bridge knots, such as the torus knots, or the twist knots, the relation takes on an especially simple form. Exploiting this form, we derive a formula for the A-polynomial of twist knots. Our methods extend to at least one other infinite family of (non-torus) 2-bridge knots. From these we determine the associated Newton polygons.

Speaker: **Howards, Hugh**
Title: *Brunnian Circles*
Authors: Hugh Howards
Affiliations: Wake Forest University

Abstract: An n component Brunnian Link is a link of n components ($n \geq 3$)that is not the unlink, but such that if any one component is deleted the remaining $n-1$ components form an unlink.

We give a simple proof that Brunnian links of 3,4, and 5 components cannot be constructed out of perfect circles (ie geometrically round circles). The case $n = 3$ was already known.

Speaker: **Hsiang, Wu-Chung**
Title: *Remarks on Ozsváth-Szabó's Theory*
Authors: Wu-chung Hsiang and Tian-jun Li
Affiliations: Princeton University

Abstract: Let $M^3 = H \bigcup_F H$ be a Heegaard diagram of an oriented 3-dimensional homology 3-sphere M^3, where H's are handlebodies (of genus g) and $F = \partial H$ is the common boundary surface. The meridians of both sides become the α-curves $(\alpha_1, \alpha_2, \ldots, \alpha_g)$ and the β-curves $(\beta_1, \beta_2, \ldots, \beta_g)$

on F. Assume that they intersect transversely. Fix a complex structure of F and it induces a symplectic structure on the g-fold symmetric product $\mathrm{Sym}^g(F)$. The tori $T_\alpha = \alpha_1 \times \alpha_2 \times \cdots \times \alpha_g$ and $T_\beta = \beta_1 \times \beta_2 \times \cdots \times \beta_g$ are Lagrangians of $\mathrm{Sym}^g(T)$. Peter Ozsváth and Zoltán Szaobó have considered the Lagrangian intersection homology theory á la Floer. It turns out that the chain complexes may depend on various choices but the homology groups are the same up to isomorphisms. These are the O-Z invariants of M^3. For the standard S^3, it is isomorphic to $\mathbf{Z}$. (We say that O-Z $= 1$.)

In a very preliminary joint work with T.J. Li, we try to describe O-Z directly from the α-curves and β-curves on F. Particularly, we are experimenting the the following question:

Question: How do we describe the α-curves and β-curves when O-Z $= 1$ (and $g = 2$)?

We also speculate the relative O-Z invariants. We hope that the relative invariants may be used to study the general case (i.e. $g > 2$) for O-Z $= 1$.

Speaker: **Illman, Soren**
Title: *Hilbert's fifth problem and proper actions of Lie groups*
Authors: Soren Illman
Affiliations: University of Cambridge and University of Helsinki

Abstract: Suppose G is a locally euclidean group and M is a locally euclidean space, and let

$$\Phi : G \times M \longrightarrow M \tag{1}$$

be a continuous action of G on M. In his fifth problem Hilbert asks if one then can choose the local coordinates in G and M so that Φ is real analytic.

When $G = M$ and

$$\Phi : G \times G \longrightarrow G \tag{2}$$

is the multiplication in the group G the answer to Hilbert's question is affirmative, as was proved by Gleason, Montgomery and Zippin.

For the question (1) we prove.

Theorem. Let G be a Lie group which acts on a C^1 smooth manifold M by a C^1 smooth proper action. Then there exists a real analytic structure β on M, compatible with the given smooth structure on M, such that the action of G on M_β is real analytic.

Concerning the uniqueness of β in Theorem 1 we have (from a paper by the author and Marja Kankaanrinta).

Theorem. Let M and N be real analytic proper G-manifolds, where G is a linear Lie group. Suppose that M and N are G-equivariantly C^1 diffeomorphic. Then M and N are G-equivariantly real analytically isomorphic.

Speaker: **Jezierski, Jerzy**
Title: *Wecken Type Theorems for Periodic Points*
Authors: Jerzy Jezierski
Affiliations: University of Agriculture, POLAND

Abstract: The classical Wecken theorem claims that any self-map $f : M \to M$ of a compact manifold of dimension ≥ 3 is homotopic to a map having exactly $N(f)$ fixed points where $N(f)$ denotes the Nielsen number. In 1983 Boju Jiang introduced an algebraically computable number $NF_n(f)$ which is an estimate of the cardinality of *n-periodic point set* $\{x \in M; g^n(x) = x\}$ for each g homotopic to f.

We prove that every self-map $f : M \to M$ of a compact PL-manifold of dimension ≥ 3 is homotopic to a map realizing this number i.e. there exists a g homotopic to the given map f and

having exactly $NF_n(f)$ n-periodic points. In particular (for $NF_n(f) = 0$) the map f is homotopic to map with no n-periodic points iff all Nielsen numbers $N(f^k)$, for all k dividing n, disappear.

Speaker: **Jiang, Boju**
Title: *3-Manifolds that admit knotted solenoids as attractors*
Authors: Jiang, Boju; Ni, Yi; Wang, Shicheng
Affiliations: Peking University

Abstract: Motivated by Smale's work in dynamics, the following questions are studied and answered: (1) Which 3-manifolds admit an automorphism whose non-wandering set consists of Smale solenoids? (2) Which 3-manifolds admit an automorphism having a knotted Smale solenoid as attractor? As a consequence of (2), every solenoind that appears as an attractor of a homeomorphism of R^3 is UNknotted.

Speaker: **Jin, Gyo**
Title: *Superbridge index of knots*
Authors: Choon Bae Jeon and Gyo Taek Jin
Affiliations: Korea Advanced Institute of Science and Technology

Abstract: In 1987, Nicolaas Kuiper introduced superbridge index of knots. It is larger than the bridge index for nontrivial knots and harder to compute. We discuss on various upper bounds of superbridge index by other invariants. We also discuss how superbridge index behaves under connected sum of knots.

Speaker: **Kalman, Tamas**
Title: *Fibrations with Legendrian Fibers*
Authors: Tamas Kalman (Tamás Kálmán)
Affiliations: University of California at Berkeley

Abstract: I will consider contact 3–manifolds (M, ξ) that are also total spaces of fibrations with a two-dimensional base F, so that the fibers are Legendrian with respect to ξ. A Legendrian knot K in M then has a front projection to F. I will show how, for a fixed base F with standard constant curvature metric, $M = ST^*F$ (the bundle of cooriented contact elements to F) and K, one can vary the fibration so that the resulting family of projections is a wave propagation. I will also prove that if the fiber is a circle, then M is a covering space of PT^*F, the bundle of contact elements to F.

Speaker: **Kamada, Seiichi**
Title: *Braids and links in dimension four*
Authors: Seiichi Kamada
Affiliations: Hiroshima University

Abstract: Braid theory and knot theory are related to each other via the Alexander and Markov theorem. This situation is generalized into dimension four; namely the theories of 2-dimensional braids and 2-dimensional knots (or knotted surfaces) in 4-space. I will give an introduction to this and discuss some of recent results in this field.

Speaker: **Kania-Bartoszynska, Joanna**
Title: *Knots, characters and integration*
Authors: Charles Frohman, Joanna Kania-Bartoszynska
Affiliations: Boise State University

Abstract: We show how the Turaev's shadow world invariant of links in a cylinder over a compact surface can be extended away from roots of unity. As an application of this invariant we compute integrals of simple closed curves over the character variety of the surface against Goldman's symplectic measure.

Speaker: **Kawauchi, Akio**
Title: *A link group invariant of closed orientable 3-manifold*
Authors: Akio Kawauchi
Affiliations: Osaka City University

Abstract: In this talk, we consider the set $\mathbf{X}$ of integral vectors of finite length as any well-ordered set, although a canonical well-order is in mind. Then for the set $\mathbf{L}$ of (unoriented) types of links in the 3-sphere S^3, we construct a map

$$\sigma : \mathbf{L} \longrightarrow \mathbf{X}$$

which is injective modulo split additions of trivial links. By using this map σ, we can consider $\mathbf{L}$ as a well-ordered set. This well-order of $\mathbf{L}$ leads to the concept of a minimal link type.

Let $\mathbf{L^{sm}}$ be the subset of $\mathbf{L}$ consisting of simple minimal link types. Let $\pi(\mathbf{L^{sm}})$ be the set of isomorphism types of simple minimal link groups. Then we can show that the natural map $\pi : \mathbf{L^{sm}} \to \pi(\mathbf{L^{sm}})$ is bijective. Let $\mathbf{M}$ be the set of unoriented types of closed connected orientable 3-manifolds. Our main theorem is stated as follows:

Theorem. A previously given well-order of $\mathbf{X}$ induces an injective map

$$\mathbf{M} \xrightarrow{\alpha} \mathbf{L^{sm}} \overset{\pi}{\cong} \pi(\mathbf{L^{sm}})$$

such that if we write $\alpha[M] = [L_M]$, then we have $[M] = [\chi(L_M, 0)]$ for the 0-surgery manifold $\chi(L_M, 0)$ of S^3 along the link L_M.

By taking $\mathbf{X}$ with the canonical well-order, several types of closed orientable prime 3-manifolds are ordered and identified with the corresponding simple minimal link types.

The content of this talk is a growing up version of a part of the research announcement *Link corresponding to closed 3-manifold.*

(see http://www.sci.osaka-cu.ac.jp/˜kawauchi/index.htm).

Speaker: **Kelly, Michael**
Title: *Coincidences of maps into the Klein bottle*
Authors: Michael Kelly and Daciberg Gonçalves
Affiliations: Loyola University-New Orleans and Universidade de Sao Paulo

Abstract: For coincidences between pairs of maps from the torus to the torus the Wecken problem has an affirmative solution, and the 1-parameter Wecken problem has a nice solution given in terms of the Nielsen coincidence number of the pair of maps. For surfaces in general any such classification appears to be difficult.

In this talk we consider these problems when the target space is the Klein bottle. We present some partial results for both the Wecken and the 1-parameter Wecken problems, and discuss the methods used. One such result is a surprising non-Wecken result. Namely, there exist pairs of maps

from the torus to the Klein bottle such that the Nielsen coincidence number is zero, but the pair cannot be deformed to be free of coincidence points.

Speaker: **Keppelmann, Edward**
Title: *The Later Years of Helga Schirmer*
Authors: Edward C. Keppelmann
Affiliations: University of Nevada - Reno

Abstract: The work of Helga Schirmer (from approximately 1988 onward) can be broken into the following categories:

1. Nielsen theories for extensions, transversal fixed points, and smoothness issues.
   Let $\bar{f} : \partial M \to \partial M$ be a smooth map on the boundary of a manifold M. How is it that there can be situations where the Nielsen number of the class of smooth extensions to M differs from the Nielsen number of the class of continuous extensions to M?

2. Root theories for iterates and maps of pairs.
   Roots of f^n and their irreducibility are developed. Results depend highly on the periodicity (or lack of it) for the target. A Nielsen root number for maps of pairs, it's computation, and sharpness properties are developed. Results depend highly on whether or not the target belongs to the subspace.

3. Hopf's Absolutgrad and root numbers.
   Uniting Hopf's work of the 1930s, the classical Brouwer degree from 1911, and modern Nielsen theory.

4. The Nielsen theory of bimaps.
   Bimaps are multivalued maps where the images of points consist of either one or two points. A Nielsen number and sharpness results are developed.

5. Periodic points on nonconnected spaces and pairs of spaces.
   The usual Nielsen periodic numbers $NP_n(f)$ and $N\Phi_n(f)$ for the number of periodic points of minimal period n and all $m|n$ are developed in these settings.

6. Coincidence theory of maps with boundary.
   A coincidence number for the setting of $g : (X, \partial X) \to (Y, \partial Y)$ and $f : X \to Y$ is developed. This is a homotopy invariant lower bound on the size of the coincidence set for f (any homotopy) and g (as a map of pairs).

7. Prescribing fixed points and excluding periodic points.
   Situations are developed where data such as a certain homotopy class and prescribed fixed point set can be realized by a map with possibly no periodic points other than fixed points.

8. Triads
   Fixed point theory for triples of spaces and maps and homotopies which respect these is developed in a way which extends relative theory.

In this talk we will highlight some of the great moments of this impressive body of work. We will provide the potential reader of these papers with a pocket guide to the structure of these theories and the types of calculations and observations obtained. In all cases these papers are exceedingly interesting and valuable. They are written with extreme clarity and precision - they are a gift to mathematics which have already planted and no doubt will continue to plant the seeds for numerous exciting future projects.[1]

[1]The set of joint authors on these papers is { Robin Brooks, Robert Brown, Robert Greene, Philip Heath, BoJu Jiang, Cheng Ye You }.

Speaker: **Kerler, Thomas**
Title: *Cyclotomic Integer Expansions of TQFT's*
Authors: Thomas Kerler
Affiliations: The Ohio State University

Abstract: Invariants of 3-manifolds that are part of TQFT's are highly structured, and as such contain information about characteristic surfaces within a 3-manifold. A vast amount of TQFT's are indeed available, such as the Reshetikhin Turaev Theory and others descending from gauge theories. However, very little has been known about the detailed structure of these TQFT that would permit explicit theorems for 3-manifolds. We will give a rather detailed analysis of the Fibonacci TQFT and, from that, develop a more general theory of finite length TQFT. As applications we present concrete results on cut-numbers of 3-manifolds, as well as structural prediction for the Casson Invariants as well as a Torsion extension of the latter. Part of this work is joint with Pat Gilmer.

Speaker: **Ko, Ki**
Title: *Braid group and cryptography*
Authors: Ko, Ki Hyoung
Affiliations: Korea Advanced Institute of Science and Technology

Abstract: Combinatorial groups are familiar to most of topologists. In this talk we explore possibilities of applying combinatorial groups to cryptography and in fact show how to construct public-key encryption schemes and digital signature schemes on the braid groups so that they are based on the feasibilities of the word problem and the decision conjugacy problem and on the infeasibility of the computational conjugacy problem.

Speaker: **Koudriavtseva, Elena**
Title: *Simple curves on surfaces and an analog of a theorem of Magnus*
Authors: Elena Kudryavtseva
Affiliations: Moscow State University

Abstract: (joint work with O. Bogopolski and H. Zieschang)

In 1930 Magnus proved that *if elements u, v of a free group $\mathcal{F}$ have the same normal closures, then u is conjugate to $v^{\pm 1}$*. We know the following two generalizations of this theorem.

1) In 1961 Greendlinger proved that if two subsets $\mathcal{U}$ and $\mathcal{V}$ of a free group $\mathcal{F}$ satisfy some small cancellation conditions and have the same normal closures then there is a bijection $\psi\colon \mathcal{U} \to \mathcal{V}$ such that u is conjugate to $\psi(u)^{\pm 1}$.

2) A group is said to be locally indicable if each of its non-trivial, finitely generated subgroups admits an epimorphism onto the infinite cyclic group. Let $\mathcal{A}$ and $\mathcal{B}$ be two non-trivial locally indicable groups. In 1989 Edjvet proved that if $u, v \in \mathcal{A} * \mathcal{B}$ are cyclically reduced words each of length at least two, and if the normal closures of u and v coincide, then u is a conjugate of $v^{\pm 1}$.

Theorem 1. *Let S be a closed surface and g, h non-trivial elements of $\pi_1(S)$ both containing simple closed two-sided curves γ and χ, resp. If h belongs to the normal closure of g then h is conjugate to g^{ε} or to $(gug^{\eta}u^{-1})^{\varepsilon}$, $\varepsilon, \eta \in \{1, -1\}$; here u is a homotopy class containing a simple closed curve μ which properly intersects γ exactly once.*

Moreover, if h is not conjugate to g^{ε} then $\eta = 1$ if μ is one-sided and $\eta = -1$ elsewise, and χ is homotopic to the boundary of a regular neighbourhood of $\gamma \cup \mu$.

A direct consequence is the following analog of the Magnus' theorem.

Corollary. *Let S be a closed surface and g, h be non-trivial elements of $\pi_1(S)$ both containing simple closed two-sided curves. If the normal closures of g and h coincide then h is conjugate to g or g^{-1}.*

The proof of Theorem 1 is geometrical and uses coverings, intersection numbers of curves, and Brouwer's fixed-point theorem. As a corollary we obtain the following Theorem 2 concerning *normal* automorphisms (an automorphism of a group $\mathcal{G}$ is called normal if it maps each normal subgroup of $\mathcal{G}$ into itself).

Theorem 2. [**?**] *If S is a closed surface different from the torus and the Klein bottle, then every normal automorphism of $\pi_1(S)$ is an inner automorphism.*

Earlier Lubotsky (1980) and Lue (1980) proved that every normal automorphism of a free group of rank at least 2 is an inner automorphism. In 1996 Neshchadim proved that any normal automorphism of the free product of two non-trivial groups is an inner automorphism.

Remark that Theorem 1 and Corollary admit some analogs for non-simple curves satisfying additional assumptions.

Speaker: **Lackenby, Marc**
Title: *Heegaard splittings, the virtually Haken conjecture and Property tau*
Authors: Marc Lackenby
Affiliations: Oxford University

Abstract: I will outline the interaction of three seemingly disparate topics: Heegaard splittings, the virtually Haken conjecture and Property tau. The latter is concept due to Lubotzky and Zimmer, that is defined in terms of eigenvalues of the Laplacian, graph theory or representation theory, and is related to Property T. I will formulate a conjecture about Heegaard splittings, and will show how this and a conjecture of Lubotzky and Sarnak about Property tau implies the virtually Haken conjecture for hyperbolic 3-manifolds. I will also show that the positive virtual b_1 conjecture has equivalent formulations in terms of Heegaard splittings, and in terms of the behavior of the Laplacian.

Speaker: **Lei, Fengchun**
Title: *General complete curve systems in boundary of 3-manifolds*
Authors: Fengchun Lei, Xunbo Yin
Affiliations: Harbin Institute of Technology

Abstract: It is a well known theorem that a 3-manifold M with a Heegaard diagram $(V; J_1, \cdots, J_n)$ is a homotopy 3-sphere if and only if there exists an embedding of V in S^3 so that $J_1, \cdots, J_n$ bound n pairwise disjoint surfaces $S_1, \cdots, S_n$ in $W = \overline{S^3 - V}$. We may assume $S_1, \cdots, S_n$ are incompressible in W. But in general, we cannot assume that they are boundary incompressible, since boundary compressions may yield surfaces with more than one boundary component. We describe a version of above theorem in which the involved surfaces are incompressible and boundary incompressible in the corresponding manifold.

Speaker: **Li, Tian-Jun**
Title: *Space of symplectic forms*
Authors: Tian-Jun Li and Ai-Ko Liu
Affiliations: Princeton University

Abstract: Let M be a closed oriented smooth $4-$manifold admitting symplectic structures. We study the number of of equivalence classes of symplectic canonical classes on M. If M has $b^+ = 1$, we prove there is a unique equivalence class. This result, together with results of Taubes and Witten, implies that the this number is finite for any M. We also study which second cohomology class on M is represented by symplectic forms. In particular, if M is minimal and has $b^+ = 1$, we show that every class of positive square has symplectic representatives.

Speaker: **Li, Weiping**
Title: *Casson invariant is a homotopy invariant*
Authors: Weiping Li and Hyam Rubinstein
Affiliations: Oklahoma State University

Abstract: We use Waldhausen's degree-1 map techniques related to Heegaard decomposition to show that the Casson invariant of integral homology 3-spheres invariant under the orientation-preserving homotopy equivalent maps. The methods used in the proof are degree-1 map, perturbations, orientation comparison and normal bundles.

Speaker: **Lin, Xiao-Song**
Title: *Knot adjacency, genus and essential tori*
Authors: Effie Kalfagianni and Xiao-Song Lin
Affiliations: Michigan State University and UC Riverside

Abstract: A knot K is called n-adjacent to another knot K', if K admits a projection containing n "generalized crossings" such that changing any $0 < m \leq n$ of them yields a projection of K'. We apply techniques and results from the theory of sutured 3-manifolds, Dehn surgery and the theory of 3-manifold mapping class groups to answer the question of the extent to which non-isotopic knots can be adjacent to each other. A consequence of A consequence of our main result is that if K is n-adjacent to K' for all $n \in \mathbf{N}$, then K and K' are isotopic. This provides a partial verification of the conjecture of V. Vassiliev that the finite type knot invariants distinguish all knots.

Speaker: **Marathe, Kishore**
Title: *Level in Chern-Simons Theory*
Authors: Marathe, Kishore B.
Affiliations: CUNY, USA and MPI-MIS, Germany

Abstract: The Chern-Simons theory is parametrized by a real number k called the level of the theory. In many applications one is required to restrict the level to take integral values. Formulas involving level usually consider only the positive integral values. We discuss the significance of level in different applications of the Chern-Simons theory and extend the formulas with positive integral values of k to negative integral values of k. The shift in k by the dual Coxeter number of the gauge group must also be taken into account for negative k. In Witten's derivation of the skein relations for the family of two variable Jones polynomials by using topological quantum field theory, the negative values of the level k (suitably shifted by the dual Coxeter number of SU(n)) give the missing half of this family which contains the skein relation characterizing the original single variable Jones polynomials.

Speaker: **Marzantowicz, Waclaw**
Title: *Homotopy dynamics for three dimensional nil and solvmanifolds*
Authors: Jerzy Jezierski and Waclaw Marzantowicz
Affiliations: Univ. of Agriculture, Warsaw; A. Mickiewicz University of Pozna

Abstract: Let $f : X \to X$ be a map of a compact manifold. We say that $m \in \mathbf{n}$ is a homotopy minimal period if it is a minimal period for every map $g \simeq f$. Since a small perturbation of f is homotopic to it, the set of all homotopy minimal periods reflects the rigid part of dynamics. Recently, a general description of this set has been given for tori, compact nilmanifolds and completely solvable solvmanifolds. They make use of topological tools as the Wecken theorem for periodic points, Anosov theorem, and also of combinatorial and algebraic number theory arguments. If the dimension of such a manifold is 3 then we give a complete list of all sets of homotopy minimal periods due the classification of all homomorphisms of its fundamental group. As a byproduct of the consideration we get a Šarkovskii type theorem for maps of these three manifolds.

Speaker: **Matsuda, Hiroshi**
Title: *Genus one knots which admit (1,1)-decompositions*
Authors: Matsuda, Hiroshi
Affiliations: University of Tokyo

Abstract: We show that genus one knots which admit (1,1)-decompositions in S^3 are characterized by a triple of integers.

Speaker: **Matveev, Sergei**
Title: *Extended complexity of 3-manifolds*
Authors: Sergei Matveev
Affiliations: Chelyabinsk State University

Abstract: Any compact 3-manifold M has a complexity $c(M)$, which is a nonnegative integer number and which is defined as the number of true vertices of a minimal almost simple spine P of M. The complexity has many good properties. In particular, it behave well with respect to cutting M along surfaces. Namely, if M_F is obtained from M by cutting along an incompressible surface $F \subset M$, then $c(M_F) \leq c(M)$. However, this useful property has a shortcoming: the inequality is not strong. So we cannot use it for inductive proofs. We improve that by defining extended complexity $\bar{c}(M)$. It is not a number anymore, but a finite tuple of nonnegative integers. The tuples are considered in lexicographical ordering. We prove that if F is essential, then $\bar{c}(M_F) < \bar{c}(M)$. We apply the extended complexity for proving the algorithmic classification theorem for Haken 3-manifolds.

Speaker: **Mijatovic, Aleksandar**
Title: *Bounds on Pachner moves for non-fibred Haken 3-manifolds*
Authors: Aleksandar Mijatovic
Affiliations: University of Cambridge

Abstract: It has been known for some time that any triangulation of a given 3-manifold M can be transformed into any other triangulation of M by a finite sequence of Pachner moves. It is also known that the existence of a computable upper bound on the length of this sequence is equivalent to an algorithmic solution of the recognition problem for M among all 3-manifolds.

In this talk I will outline a string of results that lead to an explicit upper bound on the number of Pachner moves required to connect any two triangulations of M. The bound is in terms of the number of 3-simplices contained in the triangulations. The assumption on M is that it is Haken and that none of the simple pieces of its JSJ-decomposition are homeomorphic to surface bundles or surface semi-bundles.

Speaker: **Millett, Kenneth**
Title: *Polygonal Knot Space*
Authors: Kenneth Millett
Affiliations: Univesity of California

Abstract: Polygonal knot space is the smooth manifold of embeddings of n-sided polygons in three-space. Specific spaces are required to respect additional structure such as the number or length of edges, bounds on the angles between adjacent edges, bounds on the distance between non-adjacent edges, etc. Methods and results pertaining to the space of equilateral knots and its position in the space of polygonal knots will be presented. An associated focus will be the physical characteristics of equilateral knots such as their optimal energy, ropelength or thickness, diameter, or convex hull volume.

Speaker: **Morimoto, Kanji**
Title: *On Hoidn's inequality*
Authors: Kanji Morimoto
Affiliations: Konan University

Abstract: Let K be a knot in the 3-sphere S^3 and $g_1(K)$ the 1-bridge genus of K. Concerning the additivity of the 1-bridge genus under connected sum, P. Hoidn showed that $g_1(K_1\#K_2) \geq g_1(K_1) + g_1(K_2)$ if both K_1 and K_2 are small. In this talk we generalize the result. In fact we show that $g_1(K_1\#K_2) \geq g_1(K_1) + g_1(K_2)$ if both K_1 and K_2 are meridionally small. In addition, we discuss the best possibility on the inequality.

Speaker: **Mostovoy, Jacob**
Title: *On groups of knots*
Authors: J.Mostovoy, T.Stanford
Affiliations: UNAM, (Cuernavaca,Mexico), NMSU (Las Cruces, US).

Abstract: We show that certain classes of local moves on knot diagrams give rise to groups similar to Gusarov groups of knots.

Speaker: **Murakami, Jun**
Title: *On the relation of the volume of the tetrahedron and the quantum 6j-symbol*
Authors: Jun Murakami
Affiliations: Waseda University

Abstract: A formula for the volume of hyperbolic and elliptic tetrahedron is obtained from the quantum 6j-symbol. Kashaev conjectured that certain asymptotics of some quantum invariants of a hyperbolic knot related to the hyperbolic volume of the knot complement. Such quantum invariants turned out to be specializations of colored Jones polynomials, and then his conjecture suggests that there should be some relation between su_2 invariants and volumes. Applying this idea to the quantum 6j-symbol, a closed formula for the volume of tetrahedra is obtained, which is a sum of 16 terms of dilogarithm functions.

A closed formula for such volumes is already given by Cho-Kim in 1999. However, our formula is symmetric with respect to the edges of the tetrahedron in its presentation, and I would like to introduce here.

Speaker: **Norbury, Paul**
Title: *Minimal spheres of arbitrarily high Morse index.*
Authors: Hass, Norbury and Rubinstein.
Affiliations: University of Melbourne

Abstract: We construct a smooth Riemannian metric on any 3-manifold with the property that there are genus zero embedded minimal surfaces of arbitrarily high index.

Speaker: **Oh, Seungsang**
Title: *Dehn fillings and Small surfaces*
Authors: Sangyop Lee, Seungsang Oh, Masakazu Teragaito
Affiliations: Chonbuk National University, Korea

Abstract: This is an expository talk, in which we give a summary of some of our recent work on Dehn fillings. We investigate the distance between two Dehn fillings on a hyperbolic 3-manifold that yields 3-manifolds containing essential small surfaces.

Speaker: **Park, Jongil**
Title: *A note on exotic smooth structures of 4-manifolds*
Authors: Park, Jongil
Affiliations: Konkuk University, Korea

Abstract: Due to an application of gauge theory to smooth 4-manifolds, it has been known that some topological 4-manifolds do not admit a smooth structure and some smooth 4-manifolds, for example elliptic surfaces, admit an exotic smooth structure.

In this talk we survey known results on exotic smooth structures of 4-manifolds. And then we conclude that most known simply connected, closed, irreducible, smooth 4-manifolds with b_2^+ large enough admit infinitely many distinct exotic smooth structures. Explicitly, for each known simply connected, closed, irreducible, smooth 4-manifold with b_2^+ large enough, we present a family of infinitely many, both symplectic and non-symplectic, 4-manifolds which are homeomorphic, but not diffeomorphic, to a given 4-manifold.

Speaker: **Porti, Joan**
Title: *Finite actions with fixed points on S^3*
Authors: M. Boileau, B. Leeb, J. Porti
Affiliations: U. Toulouse, U. Tuebingen, U. A. Barcelona

Abstract: We give a proof that finite smooth actions on S^3 that have fixed points and preserve the orientation are standard. This illustrates an important case of the orbifold theorem

Speaker: **Qiu, Ruifeng**
Title: *Handle additions on a small hyperbolic 3-manifold*
Authors: Qiu, Ruifeng and Wang, Shicheng
Affiliations: Jilin University and Peking University

Abstract: We will provide a small hyperbolic 3-manifold M such that for every $g > 1$, there are infinitely many isotopy classes of separating curves r on ∂M such that the manifold obtained by doing a handle addition on M along r contains an essential closed surface of genus g.

Speaker: **Roberts, Justin**
Title: *Rozansky-Witten theory*
Authors: Justin Roberts
Affiliations: UC San Diego

Abstract: In 1996 Rozansky and Witten described a new family of $(2 + 1)$-dimensional topological quantum field theories, quite different from the now familiar Chern-Simons theories. Instead of starting from a compact Lie group, one starts with a hyperkähler manifold X^{4n}; the partition function (a topological invariant) for a closed 3-manifold M is then expressed as an integral over the space of all maps from M to X. Further analysis shows that these invariants amount to evaluations of the universal finite-type invariant of Le, Murakami and Ohtsuki, using weight systems derived purely from the hyperkähler manifold X.

I will explain the geometrical origin of these weight systems and then describe (joint work with Simon Willerton and Justin Sawon) a precise analogy between hyperkähler manifolds and Lie algebras, the connections with Vassiliev theory, and the rigorous construction of the TQFT arising from X. The flavour of the theory is appealingly algebro-geometrical: whereas constructions of Chern-Simons theory start from the category of representations of a quantum group, Rozansky-Witten theory turns out to be based on the derived category of coherent sheaves on X.

Speaker: **Roushon, S.**
Title: *Topology of 3-manifolds and a class of groups*
Authors: S. K. Roushon
Affiliations: Tata Institute of Fundamental Research, India.

Abstract: In this lecture we introduce a new class of groups which we call *adorable groups*. In short they are eventually perfect groups. We prove some basic results on these groups and state two conjectures. There is a direct application of one of the conjectures to the Betti number conjecture.

Speaker: **Rubinstein, Joachim**
Title: *Ideal triangulations, angle and hyperbolic structures on 3-manifolds*
Authors: Ensil Kang and J.H. Rubinstein
Affiliations: University of Melbourne

Abstract: M. Lackenby recently introduced a theory of taut ideal triangulations, coming from Gabai's taut foliations. Our main result is that for an irreducible atoroidal 3-manifold with tori boundary components, any taut ideal triangulation admits a space of angles structures, where all angles are strictly positive. This is the first step in an attempt (similar to Casson's) to reprove the existence of complete hyperbolic metrics of finite volume on such manifolds. A key part of the result is an analysis of the space of singular or embedded spun normal surfaces in ideal triangulations. In particular, a canonical basis for this space is constructed and it is shown that there is a nice boundary map from spun normal surfaces to homology classes of loops in the boundary tori, which has image of finite index.

Speaker: **Saito, Masahico**
Title: *Generalizations of quandle cocycle invariants*
Authors: Masahico Saito
Affiliations: University of South Florida

Abstract: Cohomology theories of quandles, that are analogues of cohomology theories of groups and other algebraic systems, have been developed. State-sum invariants called quandle cocycle invariants were defined for knots and knotted surfaces, using quandle colorings and cocycles of a quandle cohomology theory, and applications to non-invertibility and triple point numbers of knotted surfaces were given. Recently, quandle cohomology and extension theories have been generalized to the cases where quandles act on the coefficient groups. After a brief review on quandle cocycle invariants and these recent developments, corresponding generalizations of cocycle knot invariants will be discussed. Another direction of recent developments is to generalize quandles to biquandles, mainly for the study of virtual knots. A cohomology theory for set-theoretic Yang-Baxter equations is defined from this context, and corresponding cocycle state-sum invariants will be discussed.

Speaker: **Saveliev, Peter**
Title: *Higher order Nielsen numbers*
Authors: Peter Saveliev
Affiliations: Marshall University

Abstract: Suppose X, Y are smooth manifolds, $f, g : X \to Y$ are maps. Then the Coincidence Problem studies the coincidence set $C = \{x : f(x) = g(x)\}$ and $m = \dim X - \dim Y$ is called the codimension of the problem. For a map $f : X \to Z$ and a submanifold Y of Z, the Preimage Problem studies the preimage set $C = \{x : f(x) \in Y\}$, $m = \dim X + \dim Y - \dim Z$. In case of codimension 0, the Nielsen number is the lower estimate of the number of points in C changing under homotopies of f, g, and for an arbitrary codimension, of the number of components of C. In

this talk I will consider an approach to the calculation of other topological characteristics of C. The goal will be to estimate the bordism groups $\Omega_*(C)$. In comparison to the classical theory the Nielsen equivalence of the points of C is replaced with an equivalence of singular submanifolds of C. We consider topologically and algebraically essential classes and define higher order Nielsen numbers.

Speaker: **Sawon, Justin**
Title: *Rozansky-Witten theory*
Authors: Sawon, Justin
Affiliations: New College, Oxford

Abstract: In 1996 Rozansky and Witten announced a new construction of finite-type invariants of three-manifolds. The invariant comes from the partition function of a topological sigma model, and hence is written as a path integral involving the space of maps from the three-manifold to a hyperkaehler manifold.

In this talk I will discuss the associated 3-dimensional topological quantum field theory. This is joint work with Justin Roberts and Simon Willerton.

Speaker: **Sedgwick, Eric**
Title: *Weakly reducible Heegaard splittings of manifolds with boundary.*
Authors: Yoav Moriah, Eric Sedgwick
Affiliations: Technion, DePaul University

Abstract: Casson and Gordon demonstrated that if a closed manifold possesses a weakly reducible Heegaard splitting then that splitting is either reducible or the manifold contains an essential surface. We investigate the extent to which this theorem extends to manifolds with boundary.

Speaker: **Shin, Satoh**
Title: *Triple point numbers of surface-knots*
Authors: Shin Satoh (joint work with Akiko Shima)
Affiliations: Department of Mathematics, Chiba University

Abstract: The diagrammatic theory of knotted surfaces in 4-space started with Yajima's work in the 1960's. He showed that if a knotted sphere has a projection into 3-space without triple points then it is a ribbon sphere. In the 1980's Giller developed the diagrammatic theory further and Roseman gave seven fundamental moves those are analogous to the Reidemeister moves. More recently, Kamada developed the braid form of a knotted surface following Viro and Rudolph. A series of works due to Carter and Saito in the 1990's are among the most important foundations of the theory.

The triple point number of a knotted surface is the minimal number of triple points among all projections of the surface. This notion is an analogue of the crossing number of a classical knot. There were no examples of non-ribbon spheres whose triple point numbers were concretely determined. We prove that Zeeman's 2- and 3-twist-spun trefoils have the triple point numbers 4 and 6 respectively. Furthermore, infinitely many examples of knotted spheres with triple point number 4 and 6 can be constructed. In the proof we use the quandle cocycle invariants defined by Carter, Jelsovsky, Kamada, Langford, and Saito in 1999.

Speaker: **Storm, Peter**
Title: *Minimal volume hyperbolic metrics on acylindrical 3-manifolds*
Authors: Peter Storm
Affiliations: U. of Michigan

Abstract: Thurston's Geometrization theorem implies that an acylindrical hyperbolic manifold M admits a unique hyperbolic metric whose convex core has totally geodesic boundary. We show that this is the most efficient hyperbolic metric on M, in the sense that it is the hyperbolic metric whose convex core has least possible volume.

The result above follows from an extension of work of Besson, Courtois and Gallot into the setting of Alexandrov spaces with lower bounds on curvature. This extension also has implications for volumes of hyperbolic cone manifolds.

Speaker: **Taniyama, Kouki**
Title: *A large complete graph in a space contains a link with large link invariant*
Authors: Minori Shirai and Kouki Taniyama
Affiliations: Waseda University

Abstract: Let k be a non-negative integer. Then any embedding of the complete graph on $6 \cdot 2^k$ vertices into a three-space contains a two-component link whose absolute value of the linking number is greater than or equal to 2^k. Let j be a non-negative integer. Then any embedding of the complete graph on $48 \cdot 2^j$ vertices into a three-space contains a knot whose absolute value of the second coefficient of the Conway polynomial is greater than or equal to 2^{2j}.

Speaker: **Teragaito, Masakazu**
Title: *Dehn surgeries creating Klein bottles and genera of knots*
Authors: Kazuhiro Ichihara and Masakazu Teragaito
Affiliations: Hiroshima University

Abstract: We study the creation of Klein bottles by surgery on knots in the 3-sphere. For non-cabled knots, it is known that the slope corresponding to such surgery is an integer. We give an upper bound for the slopes yielding Klein bottles in terms of the genera of knots.

Speaker: **Touraev, Vladimir**
Title: *Homological estimates for the Thurston norm*
Authors: Vladimir Turaev
Affiliations: CNRS - Louis Pasteur University, Strasbourg, France

Abstract: We establish a new homological lower bound for the Thurston norm on the 1-cohomology of a 3-manifold. This generalizes previous results of C. McMullen and S. Harvey.

Speaker: **Verchinine, Vladimir**
Title: *Semigroup of three-page embeddings of singular knots*
Authors: Vladimir Verchinine
Affiliations: Université Montpellier II, France; Sobolev Institute of Mathematics, Novosibirsk, Russia

Abstract: This is a joint work with V. Kurlin. We develop the Dynnikov method of three-page embeddings for *links with singularities* of the following type: with possible double points of intersection in general position. Let SK be a semi-group with 15 generators from the alphabet

$\mathbf{A} = \{a_i, b_i, c_i, d_i, x_i,\ i \in \mathbf{Z}_3\}$ and 84 relations:

(1) $a_i = a_{i+1}d_{i-1}, \quad b_i = a_{i-1}c_{i+1}, \quad c_i = b_{i-1}c_{i+1}, \quad d_i = a_{i+1}c_{i-1},$
(2) $x_i = d_{i+1}x_{i-1}b_{i+1},$
(3) $d_1d_2d_3 = 1,$
(4) $b_id_i = d_ib_i = 1,$
(5) $d_ix_id_i = a_i(d_ix_id_i)c_i, \quad b_ix_ib_i = a_i(b_ix_ib_i)c_i,$
(6) $x_i(d_{i+1}d_id_{i-1}) = (d_{i+1}d_id_{i-1})x_i,$
(7) $(d_ic_i)w = w(d_ic_i),$ where $w \in \{c_{i+1}, x_{i+1}, b_id_{i+1}d_i\},$
(8) $(a_ib_i)w = w(a_ib_i),$ where $w \in \{a_{i+1}, b_{i+1}, c_{i+1}, x_{i+1}, b_id_{i+1}d_i\},$
(9) $t_iw = wt_i,$ where $t_i = b_{i+1}d_{i-1}d_{i+1}b_{i-1}, w \in \{a_i, b_i, c_i, x_i, b_{i-1}d_id_{i-1}\},$
(10) $(d_ix_ib_i)w = w(d_ix_ib_i),$ where $w \in \{a_{i+1}, b_{i+1}, c_{i+1}, x_{i+1}, b_id_{i+1}d_i\}.$

Theorem 1. *Every singular knot can be represented by an element of the semi-group SK. Two singular knots are ambient isotopic if and only if the corresponding elements of SK are equal. An arbitrary element of SK corresponds to a singular knot if and only if this element is central, i.e. it commutes with every element of SK.*

Speaker: **Wang, Bai-Ling**
Title: *Gluing theorem, Seiberg-Witten invariants and Casson-Walker invariants*
Authors: Alan Carey, Matilde Marcolli and Bai-Ling Wang (speaker)
Affiliations: Max-Planck-Institute for Mathematics, Bonn

Abstract: Gluing theorem for both 3-dimensional and 4-dimensional Seiberg-Witten monopoles will be established. We then discuss its application to the Seiberg-Witten invariants for 4-manifolds and confirm the equivalence of Seiberg-Witten invariants and the Casson-Walker invariants for any rational homology 3-sphere.

Speaker: **Wong, Peter**
Title: *Coincidence theory for infra-solvmanifolds*
Authors: Daciberg Goncalves and Peter Wong
Affiliations: Bates College

Abstract: Let $f, g : X \to Y$ be maps between two closed oriented n-manifolds. When Y is an infra-solvmanifold, necessary and sufficient conditions are given for the equality between the Nielsen number $N(f, g)$ and the Reidemeister number $R(f, g)$. The proof makes use of certain residual property of virtually polycyclic groups and the following factorization result: let π be a finitely generated torsion-free virtually polycyclic group. For any finitely generated group G, there exists a finitely generated torsion-free virtually polycyclic group $\bar{G}$ and an epimorphism $\epsilon : G \to \bar{G}$ such that for any homomorphism $\varphi : G \to \pi$, there exists $\bar{\varphi} : \bar{G} \to \pi$ such that $\varphi = \bar{\varphi} \circ \epsilon$.

Speaker: **Yan, Min**
Title: *Set-theoretical Yang-Baxter equation and the corresponding knot invariant*
Authors: Min Yan, Jiang-Hua Lu, Yong-Chang Zhu
Affiliations: Hong Kong U of Sci and Tech, U of Arizona

Abstract: We give a general construction of solutions for the set-theoretical Yang-Baxter equation. The construction generalizes the known constructions and includes essentially all the solutions. It is based on the classification of positive Hopf algebras and the quasi-triangular structures on such algebras. The Hopf algebra background enables us to conclude that the braid representations induced by set-theoretical solutions are essentially equivalent to those of the conjugate types.

Speaker: **Yang, Zhiqing**
Title: *A construction of p-adic group action on Menger compacta*
Authors: zhiqing yang
Affiliations: Student

Abstract: A generalized version of the Hilbert 5th problem, called the Hilbert-Smith conjecture, asserts that among all locally compact groups only Lie group can act effectively on manifolds. It follows from the work of Newman and Smith that it is equivalent to the special case when the topological group is the p-adic integers group $\widehat{Z}_p = \varprojlim \{Z/p^n Z, \phi_n\}$. Although no effective actions of p-adic group on manifolds has yet been constructed, there do exist p-adic group actions on Menger manifolds. We give a new construction of p-adic group action on Menger compacta.

Speaker: **Yang, Su-win**
Title: *Zero-anomaly of perturbative Chern-Simons theory for knot invariant*
Authors: Su-win Yang
Affiliations: National Taiwan University

Abstract: Following the works of Bar-Natan, Bott and Taubes, Altschuler and Freidel, we know how to use the uni-trivalent graphs and their configuration space integrals to get the beautiful and natural Universal Vassiliev knot invariant in the infinite dimensional algebra of chord diagram (or uni-trivalent grapgs). But, there still have some defect. A correction term coming from the integrals over the space of totally concentrated uni-trivalent graphs should be considered; this is called the anomaly of the perturbative Chern-Simons theory.

We believe the anomaly being equal to zero. We show that, under a vanishing conjecture of the graph homology theory, the anomaly is zero. We shall mention the case of oreder 3 in details. For the case of order 5, the vanishing conjecture can be checked directly.

Speaker: **Zhao, Xuezhi**
Title: *On the minimal number of components of fixed point sets*
Authors: Zhao, Xuezhi
Affiliations: Capital Normal Univ., P.R.CHINA

Abstract: Nielsen number $N(f)$ serves as a lower bound for the number of fixed points of self maps in the homotopy class of the given map $f\colon X \to X$. It is also a lower bound for the number of components of fixed point sets of all such maps. But, in general, the relative Nielsen number $N(f; X, A)$ is not a lower bound for the number of components of fixed point set of the maps in the relative homotopy class of $f\colon (X, A) \to (X, A)$.

In this paper, we introduce a new relative homotopy invariant $N^C(f; X, A)$, which is a lower bound for the number of components of fixed point set of the maps in the relative homotopy class of $f\colon (X, A) \to (X, A)$. Some properties of $N^C(f; X, A)$ will be given, which are very similar to those of $N^C(f; X, A)$.

Speaker: **Zhong, Jianyuan**
Title: *On the Kauffman Skein Modules*
Authors: Zhong, Jianyuan K.
Affiliations: Louisiana Tech University

Abstract: Let k be a subring of the field of rational functions in , s which contains and s . Let M be a compact oriented 3-manifold, and let K(M) denote the Kauffman skein module of M over k. Then K(M) is the k-module freely generated by isotopy classes of framed links in M modulo the Kauffman skein relations. In the case of k= Q(, s), the field of rational functions in , s, we give a basis for the

Kauffman skein module of the solid torus and a basis for the relative Kauffman skein module of the solid torus with two points on the boundary. We then show that K(S S) is freely generated by the empty link, i.e., K(S S)

Speaker: **Zuk, Andrzej**
Title: *Automata groups*
Authors: Zuk, Andrzej
Affiliations: ENS Lyon, France

Abstract: Not submitted.