

LEHIGH UNIVERSITY GEOMETRY/TOPOLOGY CONFERENCE, 2007

ABSTRACTS OF TALKS (LISTED IN ALPHABETICAL ORDER)

Name: Djamila Aouada (daouada@ncsu.edu), North Carolina State University

Title: *Geometry of the Placenta II: Topological and geometrical modeling of 3D shapes using a global geodesic Morse function.*

Abstract: We present a novel intrinsic geometric representation of 3D objects. We add the proposed modeling of objects to their topological graphs to ensure full and compact descriptions necessary for retrieval, classification and recognition purposes.

In our approach, we address the challenges due to pose variability, computational complexity and noisy data by intrinsically and simply describing a 3D object by a geodesic based Morse function. We exploit the geometric features carried by the dense set of iso-levels of this function. Using Whitney Easy Embedding theorem, we embed the manifold of the geodesic iso-levels in \mathbb{R}^3 and obtain a single space curve as our geometry descriptor. Furthermore, we represent this curve with turning-angles-based Euclidian invariant signatures.

In order to compare 3D objects and quantify their geometric dissimilarities, we define a new Riemannian metric inspired from manifold information theory.

The: experimental results show that our modeling technique has a high level of discrimination, is robust to noise and resolution, and outperforms classical 3D descriptors.

Name: Tony Bahri (bahri@rider.edu), Rider University

Title: *Piecewise Polynomials and the Equivariant Cohomology of Weighted Projective Spaces*

Abstract: A report of joint work with Matthias Franz and Nigel Ray.

The study of weighted projective spaces is of current interest in topology, algebraic geometry, symplectic geometry and theoretical physics. As toric varieties, weighted projective spaces have a natural torus action. We describe the integral equivariant cohomology ring, with respect to this action, in terms of piecewise polynomial functions on the underlying fan. Unlike the ordinary integral cohomology, this ring distinguishes among weighted projective spaces.

Name: Martin Bendersky (mbenders@hunter.cuny.edu), Hunter College, CUNY

Title: *Stable splitting of moment angle complexes*

Abstract: In joint work with Bahri, Cohen, and Gitler we show that the generalization of the moment angle complex associated to a simplicial complex splits after one suspension.

Name: Jeanne Clelland (Jeanne.Clelland@colorado.edu), University of Colorado

Title: *Backlund transformations and Darboux integrability for nonlinear wave equations*

Abstract: We prove that a second-order Monge-Ampere equation for one function of two variables is connected to the flat wave equation by a Backlund transformation if and only if it is integrable by the method of Darboux at second order. The proof relies on a geometric formulation of a Backlund transformation as a certain type of exterior differential system and its associated differential invariants. This is joint work with Thomas Ivey of The College of Charleston.

Name: Ivko Dimitric (ivko@psu.edu) Penn State University, Fayette

Title: *Hypersurfaces of low-type in spaces of constant curvature*

Abstract: We undertake a comprehensive study of submanifolds of low Chen-type in non-flat real space forms immersed into a suitable (pseudo) Euclidean space of symmetric matrices by projection operators. In particular we classify 2-type hypersurfaces in these spaces and give two sets of necessary conditions for a minimal hypersurface to be of 3-type and for a CMC hypersurface to be mass-symmetric and of 3-type. These conditions are then used to classify such hypersurfaces of dimension $n \leq 5$. For example, the complete minimal hypersurfaces of the unit sphere S^{n+1} which are of 3-type via the immersion by the projectors are the Cartan minimal hypersurface $SO(3)/(Z_2 \times Z_2)$ and the Clifford minimal hypersurface $M_{p,n-p}$ for $n \neq 2p$. An interesting characterization of a horosphere in H^{n+1} is also obtained.

Name: Robert Foote (foote@wabash.edu), Wabash College

Title: *Pendulum Dynamics on Surfaces of Constant Curvature*

Abstract: We investigate the behavior of a pendulum, without gravity, the pivot of which moves with constant speed along a geodesic on a surface of constant curvature. On E^2 , of course, the pendulum rotates with constant angular speed; however, on S^2 and H^2 it oscillates. The pendulum satisfies an ODE similar to that of a pendulum in E^2 subject to a constant gravitational force with some interesting differences: (a) Gaussian curvature and distance along the geodesic play the roles of gravity and time, respectively, and (b) there are two stable and two unstable equilibria, instead of one of each. This is joint work with Gregory Galperin and Patrick Coulton.

Name: Tatyana Foth (tfoth@uwo.ca), University of Western Ontario

Title: *Complex submanifolds, connections, and the semiclassical limit.*

Abstract: Let X be an n -dimensional connected compact Kähler manifold ($n > 1$), with an integral Kähler form ω . Let $L \rightarrow X$ be a holomorphic Hermitian line bundle with $c_1(L) = [\omega]$. Let $Y \rightarrow S$ be a complex analytic family of compact complex submanifolds of X . We study asymptotics of curvature of two natural connections in certain line bundles on S .

Name: Daniel Garbin (daniel_garbin@yahoo.com), CUNY Graduate Center

Title: *On the appearance of Eisenstein series through degeneration*

Abstract: Let Γ be a Fuchsian group of the first kind acting on the hyperbolic upper half plane \mathbb{H} , and let $M = \Gamma \backslash \mathbb{H}$ be the associated finite volume hyperbolic Riemann surface. If $\gamma \in \Gamma$ is parabolic, there is an associated (parabolic) Eisenstein series, which, by now, is a classical part of mathematical literature. If $\gamma \in \Gamma$ is hyperbolic, then, following results of Kudla-Millson, there is a corresponding hyperbolic Eisenstein series. In this article, we study the limiting behavior of parabolic and hyperbolic Eisenstein series on a degenerating family of finite volume hyperbolic Riemann surfaces. In particular, we prove the following

result: if $\gamma \in \Gamma$ corresponds to a degenerating hyperbolic element, then a multiple of the associated hyperbolic Eisenstein series converges to a parabolic Eisenstein series on the limit surface. This is a joint work with J. Jorgenson and M. Munn.

Name: Jesus Gonzalez (jesus@math.cinvestav.mx), CINVESTAV.

Title: *Topological complexity of lens spaces*

Abstract: The topological complexity of lens spaces can be used to approach the immersion problem for odd dimensional projective spaces. Following work of Fadell-Husseini (1992) and Farber-Grant (2007), I will describe how to compute the initial stages in such an approach.

Name: Richard Hamilton (hamilton@cpw.math.columbia.edu), Columbia University

Title: *TBA*

Abstract:

Name: R. Andrew Hicks (ahicks@math.drexel.edu), Drexel Univ.

Title: *Exterior Differential Systems for Optical Design*

Abstract: The problem of controlling a single ray bundle has applications to the design of both image formation systems and for illumination systems. Despite being fundamental to both these of these areas, the problem is still not fully understood. I will show how it is naturally framed as an exterior differential system and give some same designs based on these ideas. The problem of controlling multiple ray bundles leads to global problems that appear to be quite hard.

Name: Gerhard Huisken (Gerhard.Huisken@aei.mpg.de), Max Planck Institute

Title: *An isoperimetric concept for the mass in General Relativity*

Abstract:

Name: David Hurtubise (Hurtubise@psu.edu), Penn State Altoona

Title: *Morse-Bott Homology*

Abstract: We construct a chain complex associated to a Morse-Bott function on a finite dimensional compact oriented smooth Riemannian manifold meeting certain transversality assumptions. This Morse-Bott-Smale chain complex reduces to the Morse-Smale-Witten chain complex when the function is Morse-Smale and to the chain complex of smooth singular cubes when the function is constant. Using compactified moduli spaces of time dependent gradient flow lines we prove a continuation theorem asserting that the homology of the Morse-Bott-Smale chain complex is independent of the Morse-Bott function used to define the complex. This proves that the homology of both the Morse-Bott-Smale chain complex and the Morse-Smale-Witten chain complex are isomorphic to the singular homology of the manifold with integer coefficients and gives a new proof of the Morse Homology Theorem.

Name: Thomas Ivey (iveyt@cofc.edu), College of Charleston

Title: *Constructing Hopf Hypersurfaces in the Complex Hyperbolic Plane*

Abstract: Hopf hypersurfaces are real hypersurfaces in a complex space form whose normal vector is related to a principal direction by the complex structure. In complex projective space, and in complex hyperbolic space when the principal curvature is large, Hopf hypersurfaces are locally tubes over complex submanifolds. We give a construction for all Hopf hypersurfaces of small principal curvature in the complex hyperbolic plane, in terms of a surface in a twistor space which is the product of two 3-dimensional spheres. This construction also completes the classification of pseudo-Einstein hypersurfaces. This is joint work with Patrick J. Ryan of McMaster University.

Name: Mark Johnson (mwj3@psu.edu), Penn State Altoona

Title: *Decomposing Diagram Cohomology*

Abstract: In recent joint work with David Blanc and James Turner, the speaker has developed several ways of decomposing the Andre-Quillen cohomology of diagrams in terms of certain types of subdiagrams. This includes constructing two families of spectral sequences, in order to compute cohomology over the full indexing category from information about cohomology of restrictions to subdiagrams. The goal of this talk will be to give an outline of the construction of each type of spectral sequence, in addition to some discussion of the motivation from published work on realizing diagrams of Pi-algebras.

Name: Jonathan Keiter (jkeiter@po-box.esu.edu), East Stroudsburg University

Title: *Views of Normal Surfaces as Tracks in the Vertex-Linking Sphere*

Abstract: Most irreducible 3-manifolds can be triangulated with exactly one vertex. In such a triangulation, the vertex-linking 2-sphere is a normal surface that contains every t-disk. The other normal surfaces can then be views as tracks in this 2-sphere. In the case of a one-vertex triangulation formed from the laying onto the one tetrahedron triangulation of the solid torus, interesting patterns and symmetry can be given to this triangulated 2-sphere and to the tracks of the normal surfaces.

Name: Youngju Kim (ykim@gc.cuny.edu), CUNY

Title: *Geometrically infinite surfaces with discrete length spectra*

Abstract: It is well-known that the length spectrum of a geometrically finite hyperbolic manifold is discrete. We show that geometrically infinite surfaces admits both an infinite dimensional family of quasiconformally distinct hyperbolic structures having a discrete length spectrum, and an infinite dimensional family of quasiconformally distinct structures with a nondiscrete spectrum. This is a joint work with Prof. Ara Basmajian.

Name: Daniel Kling (kling@netcarrier.com), Folded Structures Company

Title: *A Family of Invariants on Manifolds II*

Abstract: We first revisit some results from last year, and give a homology for functions that agrees with the usual set homology for characteristic functions, show this as a generalized Morse Theory, define a Betti number convolution, and construct a one-parameter family of equivalence relations on embedded manifolds that changes continuously from homologous to isometric. The talk will then focus on applying the vocabulary and methodology to name custom properties of embedded objects. This will be illustrated by identifying various structures, textures, morphologies, and configurations of material objects in three-space, with suggested applications to material science, medical imagery, and bioengineering.

Name: Nick Kuhn, University of Virginia

Title: *Models for mapping spaces*

Abstract: Beginning with James' model for the loop space of a suspension, and ending with examples of my favorite Goodwillie towers, I survey 50 years of models for the space of continuous maps between two topological spaces, and similar things. We emphasize how these models lead to stable homotopy decompositions, and thus to computations in both ordinary and generalized homology theories.

Name: Dan Lee (dalee@math.duke.edu), Duke University

Title: *The Riemannian Penrose inequality for dimensions less than 8*

Abstract: The Positive Mass Theorem states that a complete asymptotically flat manifold of nonnegative scalar curvature has nonnegative mass. The Riemannian Penrose inequality provides a sharp lower bound for the mass when black holes are present. More precisely, this lower bound is given in terms of the area of an outermost minimal surface, and equality is achieved only for Schwarzschild metrics. The Riemannian Penrose inequality was first proved in three dimensions in 1997 by G. Huisken and T. Ilmanen for the case of a single black hole. In 1999, H. Bray extended this result to the general case of multiple black holes using a different technique. In this talk we extend Bray's technique to dimensions less than 8. This is joint work with H. Bray.

Name: Michael McCooney (michael.mccooney@fandm.edu), Franklin & Marshall College

Title: *Symmetry groups of non-simply-connected four-manifolds*

Abstract: Let M be a closed, connected, orientable topological four-manifold with $H_1(M)$ nontrivial and free abelian, $b_2(M) \neq 0, 2$, and $\chi(M) \neq 0$. Then the only finite groups which admit homologically trivial, locally linear, effective actions on M are cyclic. The proof uses equivariant cohomology, localization, and a careful study of the first cohomology groups of the (potential) singular set.

Name: Matthew Miller (matthew.miller@bucknell.edu), Bucknell University

Title: *Rational models for configuration spaces of lens spaces*

Abstract: We will begin by discussing geometric computations of Massey products in the universal cover of a configuration space of a three-dimensional lens space. Using the Massey product structure we will then construct rational models for these spaces. Recent work of Sinha and Walter provides a combinatorially rich interpretation of Lie co-algebras that is useful for computing the rational homotopy groups. Time permitting, we will discuss some invariants associated with these Lie co-algebras that seem to illuminate the classification of the Lie co-algebras and the homeomorphism classification of lens spaces.

Name: Stephen F. Miller (sfm15@math.brown.edu), Brown University

Title: *Calculus of Spectra*

Abstract: The "Goodwillie" calculus of functors describes a fairly general homotopy functor as a colimit of n -excisive functors. There is an equivalence between 1-excisive functors and spectra. In the case of endofunctors on Spectra, a 2-excisive functor is equivalent to an equivariant S_2 -spectra (where S_n is the symmetric group on the set of n -elements). We will

discuss these results with a view towards classifying n -excisive endofunctors on Spectra as equivariant S_n -spectra.

Name: Simon P Morgan (morga084@gmail.com), Los Alamos National Laboratory

Title: *Geometry of the Placenta I: Flat norm distance on shape space and its smoothing properties*

Abstract: The rectifiable current flat norm on shapes provides a distance function between shapes. It also comes with a decomposition into a smoothed version of the shapes with constant mean curvature and a swept region. The geometric properties for smoothing and distance functions for statistics on shape space will be discussed along with computational results.

Name: Michael Munn (mikemunn@gmail.com), CUNY - Graduate Center

Title: *Almost equicontinuity and the construction of homotopy maps*

Abstract: In 1994 Perelman published a paper in which he constructed homotopy maps on a manifold, M , with nonnegative Ricci curvature, by constructing a sequence of finer and finer nets bounded by a common map $f : S^k \rightarrow M$. Each net was allowed to bubble out past the previous one in a controlled way. Here we rigorously prove that such a process and other similar sequences of nets produce a continuous homotopy $g : D^{k+1} \rightarrow M$ extending f using almost equicontinuity theory and an Arzela-Ascoli Theorem by Sormani. The technique works on all locally compact Riemannian manifolds and metric spaces

Name: Kei Nakamura (nakamura@math.ucdavis.edu), University of California, Davis

Title: *Fox Re-embedding and Bing Submanifolds*

Abstract: In 1948, Fox showed that every 3-submanifold of the 3-sphere can be re-embedded so that the complement is a union of handlebodies. In 1958, Bing showed that a closed 3-manifold is the 3-sphere if and only if every knot in the manifold can be isotoped to lie within an embedded 3-ball in the manifold. In this talk, we will discuss the common generalization of these two classical theorems in low-dimensional topology.

Name: Peter S. Ozsvath (petero@cpw.math.columbia.edu), Columbia University

Title: *Heegaard Floer homology and knots*

Abstract: Heegaard Floer homology is an invariant for low-dimensional manifolds defined using Heegaard diagrams and holomorphic disks, constructed in joint work with Zoltan Szabo. These constructions can be modified to give an invariant for knots in the three-sphere, knot Floer homology, which has the structure of a bigraded Abelian group whose graded Euler characteristic is the Alexander polynomial. Unlike the Alexander polynomial, however, knot Floer homology contains precise geometric information about the knot: it encodes the knot genus, and also it can be used to determine whether or not the knot is fibered. I will discuss applications of this theory, as well as several recent advances in explicitly calculating these invariants in elementary terms. I will describe joint work with collaborators including Ciprian Manolescu, Sucharit Sarkar, Andras Stipsicz, Zoltan Szabo, and Dylan Thurston.

Name: Pan Peng (ppeng@math.harvard.edu), Harvard University

Title: *On a proof of Labastida-Marino-Ooguri-Vafa conjecture*

Abstract: In this talk, I will present a proof of Labastida-Marino-Ooguri-Vafa (LMOV) conjecture which reveals a deep relation between Chern-Simons gauge theory and topological string theory. I will also discuss some related problems, for example, the relation between LMOV conjecture and volume conjecture.

Name: Jesse Ratzkin (jratzkin@math.uga.edu), University of Georgia

Title: *Rigidity and deformations of constant mean curvature surfaces*

Abstract: Any end of a finite topology, properly embedded, constant mean curvature (CMC) surface has a definite asymptotic structure, and so one can assign asymptotic data to each end of a CMC surface. This asymptotic map motivates the following question: can one deform such a CMC surface while keeping the asymptotic data constant? Alternatively, one can ask for such a surface to be locally rigid. I will discuss local rigidity in the case that the CMC surface has zero genus and is contained in a solid slab. This is joint work with K. Grosse-Brauckmann, N. Korevaar, R. Kusner, and J. Sullivan.

Name: Yongwu Rong (rong@gwu.edu), George Washington University

Title: *Clock moves and a combinatorial homology*

Abstract: This talk is motivated by an attempt to construct the combinatorial Floer homology via clock moves. For each link diagram, we construct graded homology groups using Kauffman's state sum and clock moves for the Alexander polynomial. While these groups are sometimes invariant under Reidemeister moves, they are, unfortunately, not always invariant under these moves. Nonetheless, we have a graded homology theory for link diagrams which yields the Alexander polynomial when taking graded Euler characteristic. This is joint work with Kerry Luse.

Name: Yanir Rubinstein (yanir@mit.edu), MIT

Title: *Some discretizations of geometric evolution equations*

Abstract: We propose the study of certain discretizations of geometric evolution equations as an approach to the study of the existence problem of some elliptic PDEs of a geometric nature as well as a means to obtain interesting dynamics on certain infinite-dimensional spaces. We illustrate the fruitfulness of this approach in the context of the Ricci flow as well as another flow in Kahler geometry. We introduce and study dynamical systems related to the Ricci operator on the space of Kahler metrics that arise as discretizations of these flows. We pose some problems regarding their dynamics and point out a number of applications to well-studied objects such as: canonical metrics, Nadel-type multiplier ideal sheaves, balanced metrics, the Moser-Trudinger-Onofri inequality, energy functionals and the structure of the space of Kahler metrics. For example, we obtain a new sharp inequality strengthening the classical Moser-Trudinger-Onofri inequality on the two-sphere.

Name: Carolyn M. Salafia (salafiadm@aol.com), NYU SOM

Title: *Geometry of the Placenta III: Novel geometric measures of placentas and their branching structure.*

Abstract: The placenta has a branching structure to optimize efficiency of nutrient transfer. Poor placental shape and branching structure can lead to inefficiency of nutrient transfer during pregnancy and can indicate long term health risks. These health risks can come from the nutritional problems during pregnancy or from the fact that bad branching structure in the placenta could indicate a predisposition to bad branching structure in other organs, such as the brain or cardio-vascula system. These issues motivate geometric was of describing shape of the placenta and properties of branching structures.

Name: Bianca Santoro (bsantoro@math.duke.edu), Duke University

Title: *Complete Kähler Ricci-flat metrics on open manifolds*

Abstract: In 1990, Tian and Yau settled the non-compact version of Calabi's Conjecture by proving the existence of complete, Ricci-flat Kähler metrics on smooth, open manifolds that can be compactified by adding a smooth, ample divisor.

We described the asymptotic behavior of the metrics considered by Tian and Yau.

In this talk, we will discuss some existence results, as well as its asymptotic behavior, of complete, Ricci-flat Kähler metrics on an extended class of open Calabi-Yau manifolds. As a corollary, we may provide a wider class of examples of complete, Ricci-flat metrics on open manifolds.

Name: Fernando Schwartz (fernando@math.duke.edu), Duke University

Title: *On the topology of black holes*

Abstract: Interest in constructing new examples of high dimensional black hole spacetimes has increased recently, mostly due to string theory. Despite the fact that event horizons need not be spherical in dimensions greater than four, only one class of examples of nonspherical black holes is known to exist, and it is specific to dimension five –the so-called rotating black rings with horizon topology $S^1 \times S^2$.

An important special case in the construction of spacetimes translates into a problem in Riemannian geometry. Indeed, asymptotically flat Riemannian manifolds with nonnegative scalar curvature are totally geodesic slices of spacetime, and the restriction of the event horizon to the slice is the outermost apparent horizon in the slice.

In this talk we show how to construct slices that have ring apparent horizon. More precisely, for any $n, m \geq 1$, we construct asymptotically flat, scalar flat Riemannian manifolds with smooth outermost apparent horizon which is, topologically, $S^n \times S^{m+1}$.

Name: Christopher W Seaton (seatonc@rhodes.edu), Rhodes College

Title: *Higher Orbifold Euler Characteristics for General Orbifolds*

Abstract: In the literature, three Euler characteristics for orbifolds have received a large amount of attention: the (rational) Euler-Satake characteristic, the Euler characteristic of the underlying space, and the "stringy" orbifold Euler characteristic. For global quotient orbifolds that can be expressed as the quotient of a smooth manifold by the smooth action of a finite group two methods of extending these definitions have been suggested. The first, by Bryan and Fulman, expresses these Euler characteristics as the first three terms of a sequence of Euler characteristics for orbifolds. The second, by Tamanoi, defines an Euler characteristic for each finitely generated group; the three listed correspond to using the free group with one, two, and three generators, respectively.

In this talk, we will introduce definitions of both of these generalizations for general orbifolds and introduce cohomology groups in which the appropriate Euler classes represent these

Euler characteristics. We will discuss relationships between these Euler characteristics and applications, including associated Gauss-Bonnet theorems and different interpretations of indices of vector fields.

Name: Natasa Sesum (natasas@cpw.math.columbia.edu), Columbia University

Title: *Compactness results for the Kähler ricci flow*

Abstract: We consider the Kähler-Ricci flow $\frac{\partial}{\partial t} g_{i\bar{j}} = g_{i\bar{j}} - R_{i\bar{j}}$ on a compact Kähler manifold M with $c_1(M) > 0$, of complex dimension k . We prove the ϵ -regularity lemma for the Kähler-Ricci flow, based on Moser's iteration. Assume that $\int_M |rem|^k dV_t$ and $|ric|$ is uniformly bounded along the flow. Using the ϵ -regularity lemma we derive the compactness result for the Kähler-Ricci flow. Under our assumptions, if $k \geq 3$ in addition, using the compactness result we show that $|rem| \leq C$ holds uniformly along the flow. This means the flow does not develop any singularities at infinity. We use some ideas of Tian to prove the smoothing property in that case.

Name: Thomas Shimkus (shimkust2@scranton.edu), University of Scranton

Title: *New Immersions of Grassmann Manifolds*

Abstract: Let $G_{k,n}$ denote the k -dimensional Grassmann manifold of unoriented k -planes in \mathbb{R}^{n+k} . In 2001 Ken Monks obtained via Groebner bases a simple description of $H^*(G_{2,2^i-3}; \mathbb{Z}_2)$ and used modified Postnikov towers to prove that for

$$i \geq 3,$$

$G_{2,2^i-3}$ immerses in $\mathbb{R}^{2^{i+2}-15}$. I will give a finer modified Postnikov tower argument to prove that for

$$i \geq 3,$$

$G_{2,2^i-3}$ immerses in $\mathbb{R}^{2^{i+2}-17}$. I will also examine possible extensions to immersions of other real flag manifolds.

Name: Yum-Tong Siu (siu@math.harvard.edu), Harvard University

Title: *Multiplier ideal sheaves and their applications to analysis and algebraic geometry*

Abstract: Multiplier ideal sheaves identify the jet directions where estimates for partial differential equations fail. They were first introduced by Joseph J. Kohn to study the complex Neumann problem for weakly pseudoconvex domains and by Alan M. Nadel to study the existence of Kaehler-Einstein metrics for Fano manifolds. The technique of multiplier ideal sheaves injects in a new way methods of algebraic geometry into problems of analysis. It also opens new channels of applying analysis to problems in algebraic geometry, leading to the solution or partial solution of a number of longstanding open problems in algebraic geometry such as the Fujita conjecture, the deformational invariance of plurigenera, and the finite generation of the canonical ring.

Name: Christina Sormani (sormanic@member.ams.org), CUNY Graduate Center

Title: *Conjugate Points on Length Spaces*

Abstract: We describe a variety of distinct extensions on the notion of a conjugate point to complete length spaces: from the one-sided conjugate points introduced in work of Alexander-Bishop, to symmetric conjugate points and ultimate conjugate points developed in work with Shankar. We then prove the Rauch comparison theorem for ultimate conjugate points on compact CBA(1) spaces proving the existence of continuous families of geodesics about geodesics of length less than π in such spaces. This allows us to extend the Long Homotopy Lemma and the Klingenberg Injectivity Radius Estimate to such spaces. Work with Ravi Shankar.

Name: Chan-Ho Suh (suh@math.ucdavis.edu), University of California, Davis

Title: *Menasco normal form and recognizing unknot diagrams*

Abstract: We give a diagrammatic variant of Haken's normal surface theory, which relies only on a knot diagram and not on additional structures such as a triangulation. The variables are normal arcs rather than normal discs. The crucial ingredient is Menasco's crossing bubble technique. We demonstrate an unknot recognition algorithm utilizing these techniques.

Name: Craig J. Sutton (craig.j.sutton@dartmouth.edu), Dartmouth College

Title: *Local rigidity of naturally reductive metrics on simple Lie groups*

Abstract: A long-standing conjecture in Riemannian geometry is that a standard sphere is uniquely determined by the spectrum of its Laplacian. In general, it is expected that the conjecture is also true for any compact symmetric space. We recall that naturally reductive metrics are the ones which in many ways most closely resemble symmetric metrics. For example, geodesic symmetries are volume preserving and every geodesic is an orbit of a one-parameter group of isometries. Thus, if a symmetric metric is not uniquely determined by its spectrum, the naturally reductive metrics would be the most likely source of counterexamples.

Restricting our attention to compact Lie groups, we find that a bi-invariant metric on a compact simple Lie group G is spectrally isolated within the class of left-invariant naturally reductive metrics. In fact, we show that within this class every metric is spectrally isolated. Hence, there are no non-trivial convergent sequences of isospectral invariant naturally reductive metrics on G . In contrast, we note that the literature contains examples of non-trivial isospectral deformations of left-invariant (but not naturally reductive) metrics on classical Lie groups. (This is joint work with Carolyn Gordon.)

Name: Ron Umble (ron.umble@millersville.edu), Millersville University

Title: *Some naturally occurring examples of A-infinity bialgebras*

Abstract: Joint work with Ainhoa Berciano. Let p be an odd prime and $n > 2$. We show that each tensor factor of form $E \otimes \Gamma \in H_*(Z, n; Z_p)$ is an A-infinity bialgebra with non-trivial structure. We give explicit formulas for the structure maps and the quadratic relations among them. Thus $E \otimes \Gamma$ is a naturally occurring example of an A-infinity bialgebra whose structure internal is well-understood.

Name: Valentino Tosatti (tosatti@math.harvard.edu), Harvard University

Title: *The Calabi-Yau equation on symplectic manifolds*

Abstract: We consider the problem of prescribing the volume form of a symplectic form compatible with a given almost-complex structure on a compact symplectic manifold. When the complex structure is integrable, and the manifold is therefore Kaehler, this is the celebrated Calabi conjecture that was solved by Yau 30 years ago. Donaldson has recently conjectured that in dimension 4 the equation is still solvable, and has shown that this would have striking consequences in symplectic topology. In a joint work with Ben Weinkove and Shing-Tung Yau we show that the necessary a priori estimates can be reduced to an integral estimate of a scalar function, and that the conjecture holds under a positive curvature condition.

Name: Damin Wu (dwu@math.ohio-state.edu), Ohio State University

Title: *Kähler-Einstein metrics on general quasi-projective manifolds*

Abstract:
