Program
UF/FSU Topology and Geometry Meeting

Florida State University
February 8 – February 9, 2019

Sponsored by the the De Witt Sumners Endowed Fund.

Program

All talks will be held in Love 101.

Friday February 8th, 2019:

3:00 *Refreshments - room 204*

3:35 Kevin Knudson
Twenty Years of Discrete Morse Theory.

Saturday February 9th, 2019:

9:00 Alex Casella
CR Structures Of Once-Punctured Torus Bundles.

9:30 Michelle Daher
On Macroscopic dimension of non-spin 4-manifolds with residually finite fundamental group.

10:00 Zhe Su
The Riemannian Geometry of the Space of Vector Valued One-Forms.

10:30 *Coffee break - room 204*

11:00 Nikola Milićević
Homological Algebra of Persistence Modules.

11:30 Haibin Hang
Stability of a Multi-Parameter Persistent Homology Approach to Functional and Structural Data.

12:00 *Lunch break - room 204*

2:00 Lacey Johnson
Discrete Morse Theory on Loop Spaces.

2:30 Opal Graham
The Rigidity of Configurations of Points and Spheres.

3:00 Trevor Davila
Decomposition Complexity Growth.

3:30 *Coffee break - room 204*

4:00 Luca Di Cerbo
Punctured spheres in complex hyperbolic surfaces.

4:30 Lorenzo Ruffoni
Complex projective structures with a maximal number of Möbius transformations.

Colloquium Talk

Kevin Knudson, University of Florida
Twenty Years of Discrete Morse Theory.

Since its introduction in the late 1990s, Forman's discrete Morse theory has become an indispensable tool in topology and data analysis. In this talk I will discuss the basic theory, applications, and algorithms, as well as a new stratified version of the theory I have developed in joint work with Bei Wang.

Talks and Abstracts

Alex Casella, Florida State University
CR Structures Of Once-Punctured Torus Bundles.

The Cauchy-Riemann geometry (CR in short) is modelled on the three sphere and the group of its biholomorphic transformations. In 2008 Falbel makes use of ideal triangulations to show that the figure eight knot complement admits a (branched) CR structure. This three manifold belongs to a larger class of important three manifolds that are fiber bundles over the circle, with fiber space the once-punctured torus. In this talk we introduce the audience to these manifolds and show that almost every once-punctured torus bundle admits a (branched) CR structure.

Michelle Daher, University of Florida
On Macroscopic dimension of non-spin 4-manifolds with residually finite fundamental group.

M. Gromov introduced the concept of macroscopic dimension to describe some large scale phenomenon of universal covering of manifolds with positive scalar curvature. He discovered some large scale dimensional deficiency of the universal covering of such manifolds which he formulated in the following: Gromov's Conjecture: The macroscopic dimension of the universal covering $\widetilde{M}$ of a closed n-manifold M with positive scalar curvature satisfies the inequality $dim_{mc}\widetilde{M} \leq n-2$ for the metric on $\widetilde{M}$ lifted from M. In this talk I show that for 4-manifolds with residually finite fundamental group and non-spin universal covering $\widetilde{M}$ the inequality $dim_{mc}\widetilde{M} \leq 3$ implies the inequality $dim_{mc}\widetilde{M} \leq 2$.

Trevor Davila, University of Florida
Decomposition Complexity Growth.

Asymptotic dimension is an invariant of metric spaces and discrete groups introduced by Gromov to study the large-scale geometry of such spaces. However, many groups of interest to geometric group theorists have infinite asymptotic dimension. We define a quasi-isometry invariant of metric spaces called decomposition complexity growth, which generalizes both finite decomposition complexity and asymptotic dimension growth, to aid the classification of dimension-like properties of infinite dimensional spaces. We show that subexponential decomposition complexity growth implies Property A, and that finite decomposition complexity and subexponential dimension growth both imply subexponential decomposition growth. We also show that certain group extensions satisfy subexponential decomposition growth.

Luca Di Cerbo, University of Florida
Punctured spheres in complex hyperbolic surfaces.

In this talk, I will present some recent results concerning punctured spheres in complex hyperbolic surfaces. Among other things, I will show that such surfaces cannot contain properly holomorphically embedded 3-punctured spheres. This is joint work with Stover.

Opal Graham, Florida State University
The Rigidity of Configurations of Points and Spheres.

The rigidity of collections of ideal points and collections of circles in two dimensions is proven by Beardon and Minda using a maximal amount of conformal invariant information. Crane and Short do the same for collections of ideal points and spheres in higher dimensions. In order to uniquely place collections of ideal points in $\mathbb{R}^n_\infty$, the cross ratio of every 4-tuple of points must be known. Similarly, rigidity of a collection of spheres in $\mathbb{R}^n_\infty$ uses the inversive distance between every pair of spheres. When these configurations are additionally required to have an independent subcollection, the amount of necessary conformal invariant information is considerably decreased by way of basic linear algebra in Lorentz space. This talk also points the way to generalize to rigidity of collections of points and spheres together, touches upon the role of independence in rigidity of inversive distance circle packings, and its potential utility in rigidity of projective polyhedra.

Haibin Hang, Florida State University
Stability of a Multi-Parameter Persistent Homology Approach to Functional and Structural Data.

We present a multi-parameter persistent homology approach to functional data on compact topological spaces and structural data treated as compact metric measure spaces. For functional data, we combine sub-level sets and Rips complexes to construct bi-filtered complexes from which we derive homological invariants. We prove a stability theorem for multidimensional persistent homology with respect to a metric in which closeness means that the topology of regions where signals are strong are similar regardless of the global topology of the domains. We construct topological invariants for metric measure spaces by mapping them to functional spaces via centrality functions. For a fixed metric domain, the general stability results imply stability with respect to the Wasserstein metric.

Lacey Johnson, University of Florida
Discrete Morse Theory on Loop Spaces.

My research interests lie in topology with a specific focus on discrete Morse theory in the context of loop spaces. Given a smooth manifold M, its loop space ΩM is the set of closed loops in M based at a fixed point x. This is an infinite-dimensional object, but its topology can be understood using classical smooth Morse theory as demonstrated by J. Milnor. Classical results in Morse theory tell us the loop space of the 2-sphere has the homotopy type of a CW-complex with one cell in each dimension. I will discuss this result from the point of view of discrete Morse theory by constructing a simplicial model for the loop space of the 2-sphere.

Nikola Milicevic, University of Florida
Homological Algebra of Persistence Modules.

In applied topology, one often starts with an increasing family of topological spaces indexed by real numbers. Persistence modules keep track of how the homology of this family varies as we increase the index. These objects are $\mathbb{R}$-graded modules. An equivalent point of view is that they are sheaves over the real line with the poset topology. I will discuss the homological algebra theories with respect to both of these views. These give rise to Universal Coefficient and Kunneth Theorems for persistence modules. Time permitting, I will also discuss applications to data analysis.

Lorenzo Ruffoni, Florida State University
Complex projective structures with a maximal number of Möbius transformations.

As shown by Hurwitz in 1892, the group of holomorphic automorphisms of a compact Riemann surface of genus at least 2 is a finite group, whose order is bounded just in terms of its genus. The surfaces which achieve the bound, and the groups of symmetries thereof, are known to enjoy remarkable geometric and algebraic properties. In this talk we will consider these phenomena for Riemann surfaces endowed with certain geometric structures defined by holomorphic differentials. Among all complex projective structures the most symmetric ones turn out to be precisely the Fuchsian uniformizations of Galois Belyĭ curves. This is a joint work with G. Faraco.

Zhe Su, Florida State University
The Riemannian Geometry of the Space of Vector Valued One-Forms.

In this talk I will introduce a reparametrization invariant metric on the space of vector valued one-forms. The particular choice of metric is motivated by potential future applications in the field of functional data and shape analysis and by connections to the Ebin metric on the space of all Riemannian metrics. The geodesic equation for the space of vector valued one-forms and an explicit formula for the solution to the corresponding initial value problem will be given. We will see that this space is geodesically and metrically incomplete and it has some remarkable totally geodesic subspaces. Also depending on the dimension of the base manifold and the target space, the sectional curvature is either sign-definite or admits both signs.