Spring 2015

- **February 5**

  Speaker: Ivan Izmestiev (Freie Universität Berlin)

  Title: Variational properties of the discrete Hilbert-Einstein functional

  Abstract: The discrete Hilbert-Einstein functional (also known as Regge action) for a 3-manifold glued from euclidean simplices is the sum of edge lengths multiplied with angular defects at the edges. There is an analog for hyperbolic cone-manifolds; a discrete total mean curvature term appears if the manifold has a non-empty boundary. Variational properties of this functional are similar to those of its smooth counterpart. In particular, critical points correspond to vanishing angular defects, i.e. to metrics of constant curvature. We give a survey on isometric embeddings and rigidity results that can be obtained by studying the second derivative of the discrete Hilbert-Einstein and speak about possible future developments.

- **February 12**

  Speaker: James Dibble (Rutgers University)

  Title: Totally geodesic maps into manifolds with no focal points

  Abstract: A classical result of Eells-Sampson is that every homotopy class of maps between compact Riemannian manifolds, where the target has non-positive sectional curvature, contains an energy-minimizing harmonic representative. They proved this by inventing the harmonic map heat flow, the first geometric flow defined on manifolds. Their work was refined by Hartman, who proved the monotonicity of certain distance functions under the flow and used this to deduce that that the space of harmonic maps in each homotopy class is path-connected and that energy is constant on it. Applying an identity that dates to the work of Bochner, Eells-Sampson also proved that, when the domain has non-negative Ricci curvature, all harmonic maps are totally geodesic.

  It will be shown that, for domains with non-negative Ricci curvature, the results of Eells-Sampson, along with certain qualitative consequences of Hartman's results, generalize to energy-minimizing maps into manifolds with no focal points. These are manifolds whose universal covers satisfy a simple synthetic condition: For each point and each maximal geodesic, there is a unique geodesic connecting them that intersects the latter perpendicularly. By contrast with previous approaches, the proof uses neither a geometric flow nor the Bochner identity for harmonic maps.

- **February 19**

  Colloquium at **4:30pm**

  Speaker: **Jonathan Williams** (University of Georgia)

  Title: A new approach to general smooth 4-manifolds

  Abstract: Some consider smooth 4-manifolds to be a mature field, which typically means its approachable yet nontrivial problems have become scarce. This is mainly due to a lack of tools. In this talk I will present a new way to depict any smooth, closed oriented 4-manifold that opens the doors to two of the most successful tools from 3-manifolds: pseudoholomorphic curves and discrete groups.

- **February 26**

  Speaker: Eric Swartz (Western Australia)

  Title: Generalized quadrangles with symmetry

  Abstract: A generalized quadrangle is a point-line incidence geometry Q such that (1) any two points lie on at most one line, and (2) given a line l and a point P not incident with l, P is collinear with a unique point of l. Generalized quadrangles are a specific type of generalized polygon, which were first introduced by Tit s in 1959 as geometries associated to classical groups. It is natural, then, to ask the question: if one starts with the abstract definition of a generalized quadrangle, which ones are highly symmetric? I will discuss the background of this question, leading to the following recent work:

  An antiflag of a generalized quadrangle is a non-incident point-line pair (P, l), and we say that the generalized quadrangle Q is antiflag-transitive if the group of collineations (automorphisms that send points to points and lines to lines) is transitive on the set of all antiflags. We prove that if a finite, thick generalized quadrangle Q is antiflag-transitive, then Q is one of the following: the unique generalized quadrangle of order (3,5), a classical generalized quadrangle, or a dual of one of these.

  This is joint work with John Bamberg and Cai-Heng Li, and this talk will assume no prior knowledge of finite geometry.

  Colloquium at **4:30pm**

  Speaker: **Niels Martin Moeller** (Princeton University)

  Title: Gluing of Geometric PDEs - Obstructions vs. Constructions for Minimal Surfaces & Mean Curvature Flow Solitons

  Abstract: For geometric nonlinear PDEs, where no easy superposition principle holds, examples of (global, geometrically/topologically interesting) solutions can be hard to come about. In certain situations, for example for 2-surfaces satisfying an equation of mean curvature type, one can generally “fuse” two or more such surfaces satisfying the PDE, as long as certain global obstructions are respected - at the cost (or benefit) of increasing the genus significantly. The key to success in such a gluing procedure is to understand the obstructions from a more local perspective, and to allow sufficiently large geometric deformations to take place. In the talk I will introduce some of the basic ideas and techniques (and pictures) in the gluing of minimal 2-surfaces in a 3-manifold. Then I will explain two recent applications, one to the study of solitons with genus in the singularity theory for mean curvature flow (rigorous construction of Ilmanen's conjectured “planosphere” self-shrinkers), and another to the non-compactness of moduli spaces of finite total curvature minimal surfaces (a problem posed by Ros & Hoffman-Meeks). Some of this work is joint w/ Steve Kleene and/or Nicos Kapouleas.

- **March 5**

Speaker: Ross Geoghegan (Binghamton University)

Title: A theorem about extensions of groups

- **March 12**

- **March 19**

  Speaker: Matt Zaremsky (Binghamton University)

  Title:The Σ-invariants of Thompson's group F, via Morse theory

  Abstract: In a paper published in 2010, Bieri, Geoghegan and Kochloukova computed the Σ-invariants (also called Bieri-Neumann-Strebel-Renz invariants) of Thompson's group F. In recent joint work with Stefan Witzel, we recomputed these using the action of F on a certain CAT(0) cube complex called the Stein-Farley complex. The main tool is a version of discrete Morse theory. I will explain what all of these words mean over the course of the talk, and it should be accessible to non-experts.

- **March 26**

  Speaker: Matt Zaremsky (Binghamton University)

  Title: The Σ-invariants of the generalized Thompson's groups F_n

  Abstract: Building off the first talk, I will shift from F to a family of groups F_n, of which F is F_2. Using the action of F_n on a CAT(0) cube complex, I was recently able to compute all the Σ-invariants of all the F_n. In this talk I will focus on the aspects of the Σ-invariants that only come up when $n>2$, and will highlight a new technique, building off work of Belk and Forrest, for proving higher connectivity properties of certain complexes. This talk will still be accessible to non-experts, though it will help to have gone to the first talk.

- **April 2**

  Speaker: Jim Belk (Bard College)

  Title: Rearrangement Groups of Fractals

  Abstract: The definition of Thompson's group F depends crucially on the self-similar structure of the unit interval. In this talk, I will describe a family of Thompson-like groups that act on a variety of self-similar structures. Each of these groups has an associated CAT(0) cubical complex, analogous to the Farley complexes for F, T, and V. By analyzing descending links on these complexes, I will show that some of these groups have type F_∞. This is joint work with Bradley Forrest.

- **April 9** no seminar.

- **April 16**

  Speaker: Stefan Witzel (Bielefeld University)

  Title: Arithmetic groups, finiteness properties, and homology

  Abstract: The group $SL_2(F_p[t,t^{-1}])$ is finitely generated but not finitely presented. In fact, it has a finite-index subgroup G with $H_2(G,F_p)$ infinite (this and more was shown by Stuhler). I will talk about results of the same kind for related groups.

- **April 22** at **3:30pm** in **WH 309**

  Speaker: Ralf Spatzier (University of Michigan)

  Title: Higher Rank Rigidity and Positive Curvature

  Abstract: I will review rigidity and non-rigidity results about “higher rank” in Riemannian geometry. Specifically we consider “higher rank” spaces in which subobjects of extremal curvature are plentiful. I will emphasize recent joint work with Schmidt and Shankar on Riemannian manifolds of higher spherical rank where every geodesic c has a perpendicular parallel field making sectional curvature 1 with c, and the sectional curvature is bounded below by 1.

- **April 23**

  Hilton Memorial Lecture at **3pm** in **Science II, Room 140.**

  Speaker: Ralf Spatzier (University of Michigan)

  Title: Higher Rank in Geometry and Dynamics - How isometric and hyperbolic behavior force rigidity

  Abstract: Higher rank phenomena have led to surprising rigidity results in group theory, geometry and dynamics. Examples start with Margulis superrigidity theorem for lattices in higher rank semisimple Lie groups, followed by the classification of nonpositively curved Riemannian manifolds with lots of flats. In recent years similar phenomena have been found in dynamics, in particular in the classification of hyperbolic actions on tori and nilmanifolds of higher rank Abelian groups and their measure rigidity.

- **April 30**

  Dean's Lecture in Geometry and Topology.
  Speaker: **Karsten Grove** (Notre Dame University)

  Title: Symmetry and Positive Curvature

  Abstract: Although constituting a vast extension of ancient Spherical Geometry, the beautiful class of positively curved (Riemannian) spaces is like the “Tip of the Iceberg” among all (Riemannian) spaces. Accordingly, non-symmetric positively curved spaces are known only in a few sporadic dimensions, and yet only a few obstructions to their existence are known.

In this talk, we will describe the current state of affair of the subject including tools and methods, with emphasis on the impact symmetries have had on the development during the last few decades.

- **May 7**

  Speaker: Boris Kalinin (Pennsylvania State University)

  Title: Smooth rigidity and classification for hyperbolic systems and actions

  Abstract: Hyperbolic actions of $\mathbb{Z}^k$ and $\mathbb{R}^k$ extend the classical notion of Anosov diffeomorphisms and flows, which are hyperbolic actions of $\mathbb{Z}$ and $\mathbb{R}$. In contrast to the rank one case, higher rank hyperbolic actions exhibit various rigidity properties. I will focus on the problem of smooth classification, that is finding a smooth conjugacy to an algebraic model. I will give an overview of this area and compare it with the rank one case, where the natural problem is either topological classification or smooth classification under extra assumptions.