

Midwest Geometry Conference
MGC 2019
Conference Booklet

Department of Mathematics
Iowa State University

September 6–8, 2019

Plenary conferences

Conformal geometry on 4-manifolds

Sun-Yung Alice Chang
Princeton University

In this talk, I will report on the study of a class of integral conformal invariants on 4-manifolds and applications to the study of topology and diffeomorphism type of a class of 4-manifolds. The key ingredient is the study of the integral of σ_2 of the Schouten tensor which is the part of integrand of the Chern-Gauss-Bonnet formula module the L^2 part of the Weyl curvature. I will also describe the relevance of a 4-th order linear operator (part of the family of GJMS operator) with conformally covariant property in the study of the fully non-linear equation σ_2 under conformal change of metrics.

Isometric embedding via strongly symmetric positive systems

Jeanne Nielsen Clelland
University of Colorado-Boulder

In this talk, I will give an outline of our new proof for the local existence of a smooth isometric embedding of a smooth 3-dimensional Riemannian manifold with nonzero Riemannian curvature tensor into 6-dimensional Euclidean space. Our proof avoids the sophisticated microlocal analysis used in earlier proofs by Bryant-Griffiths-Yang and Nakamura-Maeda; instead, it is based on a new local existence theorem for a class of nonlinear, first-order PDE systems that we call “strongly symmetric positive.” These are a subclass of the symmetric positive systems, which were introduced by Friedrichs in order to study certain PDE systems that do not fall under one of the standard types (elliptic, hyperbolic, and parabolic).

As in earlier proofs, we construct solutions via the Nash-Moser implicit function theorem, which requires showing that the linearization of the isometric embedding PDE system near an approximate embedding has a smooth solution that satisfies “smooth tame estimates.” We accomplish this in two steps:

(1) Show that the approximate embedding can be chosen so that the reduced linearized system becomes strongly symmetric positive after a carefully chosen change of variables.

(2) Show that any such system has local solutions that satisfy smooth tame estimates.

The main advantage of our approach is that step (2) is much more straightforward than similar results for other classes of PDE systems used in prior proofs, while step (1) requires only linear algebra.

This is joint work with Gui-Qiang Chen, Marshall Slemrod, Dehua Wang, and Deane Yang.

Monotonicity formulas and boundary obstacle problems

Donatella Danielli

Purdue University

Obstacle problems play an ubiquitous role in the applied sciences, with applications ranging from linear elasticity to fluid dynamics, from temperature control to financial mathematics. In fact, seemingly different phenomena can be expressed in terms of the same mathematical model of boundary obstacle type. In this talk we will discuss some recent results concerning the regularity of the solution and of its free boundary. In particular, we will highlight the pervasive role played by some families of monotonicity formulas.

Gap and index estimates for Yang-Mills and harmonic map theory

Casey Lynn Kelleher

Princeton University

In this talk we want to discuss joint work with Streets and Gursky on two related questions about the variational structure of the Yang-Mills functional in dimension four. The first is the question of ‘gap’ estimates; i.e., determining an energy threshold below which any solution must be an instanton, hence a minimizer for the Y-M energy. The second question is about non-minimal solutions, and in this case the problem is to estimate the index of a solution. Time permitting, we will also discuss related joint work with Gursky on a gap estimate in harmonic map theory.

Regularity for $C^{1,\alpha}$ interface transmission problems

María Soria-Carro

The University of Texas at Austin

Transmission problems originally arose in elasticity theory, and they are nowadays of great interest due to their many applications in different areas in science, such as electromagnetism, population dynamics and fluid mechanics. Typically, in these problems, there is a fixed interface where solutions may change abruptly, and the primary focus is to study their behavior across this surface. In this talk, we will discuss $C^{1,\alpha}$ boundary regularity for a transmission problem for harmonic functions. This is motivated in part by the classical linear theory established by M. Schechter in 1960. The techniques we use are different since we assume that the geometry of the interface has minimal regularity, thus the standard flattening procedure is not available. Our approach is based on an approximation technique originally developed by L. A. Caffarelli. These results are part of my PhD dissertation, and they are joint work with L. A. Caffarelli and P. R. Stinga.

An infinite-rank summand of the homology cobordism group

Matthew Stoffregen

Massachusetts Institute of Technology

We review involutive Heegaard Floer homology, and then use it to study the homology cobordism group of integer homology three-spheres. In particular, we show that there is a natural infinite-rank summand of this group. This is joint work with Irving Dai, Jen Hom, and Linh Truong.

Short talks

Positive curvature and fundamental group

Elahe Khalili Samani
Syracuse University

A 1960s question of Chern asks if every abelian subgroup of the fundamental group of a Riemannian manifold with positive sectional curvature is cyclic. While this is not true in general, there are some positive results in the presence of symmetry. I will discuss some new structural results along these lines. I will also discuss an application to an infinite family of positively curved Riemannian manifolds.

Cascade feedback linearization

Taylor Klotz
University of Colorado-Boulder

A certain class of control systems exhibit a surprising property that addition of extra differential equations suddenly allow the system to be put into a linearized normal form. This is known as extended dynamic feedback linearization (EDFL). Vassiliou showed that a sufficient condition for a control system with symmetry to be EDFL is another type of linearization known as cascade feedback linearization (CFL), in which the system has two “hidden” linearizable systems. This talk will give an overview of the CFL process as well as some new existence results for CFL systems.

On almost holomorphic mappings

Kirollos Masood

The Ohio State University

A classic result of Liouville tells us that any bounded entire function is constant. And modern complex geometry has allowed us to generalize this result to mappings between suitable complex manifolds. We shall take this principle even further to the realm of almost Hermitian geometry, using what tools and structures remain in the non-integrable case.

Shape optimization of the first Steklov eigenvalue on 2-D domains with a hole

Leoncio Rodríguez Quiñones

Utah State University

We introduce some results in isoperimetric inequalities for the Steklov eigenvalue problem obtained by A. Girouard and I. Polterovich. We also describe a shape derivative approach to provide a candidate for an optimal domain among non-simply connected planar domains with two boundary components. In this talk all domains are assumed to be smooth enough.

A sectional Rogers-Shephard type inequality for product measures

Michael Roysdon

Kent State University

The study of volume of convex bodies is well developed and related to several areas of mathematics and computer science. The question of what happens if volume is replaced by an arbitrary measure on a convex body has not been considered in convex geometry until very recently, mostly because it is hard to believe that difficult geometric results can hold in such generality. However, in 2005, Zvavitch proved that the solution to the Busemann-Petty problem, the signature result in convex geometry, remains exactly the same if volume is replaced by an arbitrary measure with continuous density. Very recently, it was shown that several partial results on the slicing problem, a major open question in the area, can also be extended to arbitrary measures. Significant work has been done to explore the validity of the Brunn-Minkowski inequality for different classes of measures in place of volume. In this context, it was recently discovered that

the Rogers-Shephard inequality, a major tool in the study of non-symmetric convex bodies, which state that, for an arbitrary convex body $K \subset \mathbb{R}^n$,

$$\text{vol}_n(K + (-K)) \leq \binom{2n}{n} \text{vol}_n(K)$$

with equality only when K is an n -dimensional simplex. In this talk, we present a generalization of the Rogers-Shephard inequality to sections of the difference body in the class of measures having radially decreasing densities. In fact, even more is true: such a result hold for a generalization of the difference body, the so-called p -difference body, which allows us to extend the Rogers-Shephard inequality the product measure comprised of p measures having radially decreasing densities.

Divergent operator with degeneracy and related sharp inequality

Liming Sun

Johns Hopkins Univeristy

The differential operator is a divergent operator with degeneracy on the boundary, which is related to the extension operators. The classification results enable us to establish the sharp form for some new discovered inequalities: one is a generalization of Gagliardo-Nirenberg and the other extends a two dimensional inequality due to Beckner for all dimension.

	First Name	Last Name	Home Institution
1	Ankit	Agrawal	Northwestern Univeristy
2	David	Auckly	Kansas State University
3	George	Avalos	University of Nebraska-Lincoln
4	Brenden	Balch	Colorado State University
5	Animesh	Biswas	Iowa State University
6	Ivan	Blank	Kansas State University
7	Austin	Bosgraaf	Wichita State University
8	Caleb	Camrud	Iowa State University
9	Evan	Camrud	Iowa State University
10	Michael	Catanzaro	Iowa State University
11	Sun-Yung Alice	Chang	Princeton University
12	Jeanne	Clelland	University of Colorado, Boulder
13	Donatella	Danielli	Purdue University
14	Erica	de la Canal	The University of Texas at Austin
15	James	Dibble	University of Iowa
16	Hengrong	Du	Purdue University
17	Pelin Guven	Geredeli	Iowa State University
18	Ryad	Ghanam	Virginia Commonwealth University in Qatar
19	Dincer	Guler	Park University
20	Steven	Harding	Iowa State University
21	Palle	Jorgensen	University of Iowa
22	Casey	Kelleher	Princeton University
23	Elahe	Khalili Samani	Syracuse University
24	Thomas	Kindred	University of Nebraska-Lincoln
25	Taylor	Klotz	University of Colorado, Boulder
26	Yueh-Ju	Lin	Wichita State University
27	Steven	Lin	University of Oklahoma
28	Kirollos	Masood	The Ohio State University
29	Jay	Mayfield	Iowa State University
30	Daniel	McGinnis	Iowa State University
31	Nicholas	Meyer	University of Nebraska-Lincoln
32	Shawn	Nevalainen	University of Iowa
33	Xuan Hien	Nguyen	Iowa State University
34	Lee	Przybylski	Iowa State University
35	Leoncio	Rodriguez Quinones	Utah State University
36	Diego	Rojas	Iowa State University
37	Michael	Roysdon	Kent State University
38	Paul	Sacks	Iowa State University
39	Preeti	Sar	Iowa State University
40	Catherine	Searle	Wichita State University
41	Maria	Soria-Carro	The University of Texas at Austin
42	Pablo Raúl	Stinga	Iowa State University
43	Matthew	Stoffregen	Massachusetts Institute of Technology
44	Liming	Sun	Johns Hopkins Univeristy

45	Nyle	Sutton	Iowa State University
46	Mary	Vaughan	Iowa State University
47	Lei	Wang	Chinese Academy of Sciences
48	Ana	Wright	University of Nebraska-Lincoln

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- Department of Mathematics, Iowa State University
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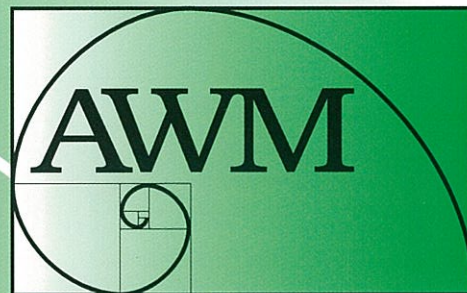
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AWM-MAA Etta Z. Falconer Lecture, given annually at the MAA MathFest.

Mentoring and Community

Mentor Network matches mentors with girls and women interested in a career in mathematics.

AWM Student Chapters support women in mathematics through local events at universities.

AWM encourages women and girls to study and to have active careers in the mathematical sciences, and promotes equal opportunity and the equal treatment of women and girls in the mathematical sciences.

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Awards, Prizes and Grants

Louise Hay Award to a woman with outstanding achievements in math education.

M. Gweneth Humphreys Award to recognize outstanding mentorship.

Essay Contest for K-12 students and undergraduates.

Alice T. Schafer Prize to an undergraduate woman who excels in mathematics.

Ruth I. Michler Memorial Prize to a recently tenured woman for a research semester in the Mathematics Department at Cornell University.

Dissertation Prize for an exceptional dissertation in the mathematical sciences by a woman PhD candidate.

Student Chapter Awards to recognize outstanding achievements in chapter activities among the AWM student chapters.

Research Prizes for early career women

- **AWM-Joan & Joseph Birman Research Prize in Topology and Geometry**
- **AWM-Microsoft Research Prize in Algebra and Number Theory**
- **AWM-Sadosky Research Prize in Analysis**

Travel Grants for women to attend conferences or develop mentoring relationships.

Visit us on the web at <http://www.awm-math.org>

For further information contact: awm@awm-math.org or (703) 934-0163

MGC 2019 Schedule

Friday September 6 – Location: Lagomarcino Hall, Room W0272

12:00 - 4:00: Registration

12:45 - 1:00: Opening

1:00 - 2:00: Alice Chang

2:00 - 2:15: questions & open problems

2:15 - 2:45: coffee break

2:45 - 3:15: Elahe Khalili

3:15 - 3:45: Leoncio Rodriguez Quinones

3:45 - 4:00: short break

4:00 - 4:30: Michael Roysdon

4:30 - 5:00: Liming Sun

Saturday September 7 – Location: Marston Hall, Room 2155

8:00 - 9:00: breakfast provided in Marston Hall

9:00 - 10:00: Donatella Danielli

10:00- 10:15: questions & open problems

10:15 - 10:45: coffee break

10:45 - 11:45: Matthew Stoffregen

11:45 - 12:00: questions & open problems

12:00 - 2:00: lunch provided in Marston Hall – Women’s Networking Meeting

2:00 - 3:00: María Soria-Carro

3:00 - 3:15: questions & open problems

3:15 - 3:45: coffee break

3:45 - 4:45: Jeanne Clelland

4:45 - 5:00: questions & open problems

Sunday September 8 – Location: Marston Hall, Room 2155

8:00 - 9:00: breakfast provided in Marston Hall

9:00 - 9:30: Kirollos Masood

9:30 - 10:00: Taylor Klotz

10:00 - 10:30: coffee break

10:30 - 11:30: Casey Kelleher

11:30 - 11:45: questions & open problems

11:45: end of the conference