Colloquium, Academic Year 15-16

Thursdays 4:10 pm in 5211 Stevenson Center, unless otherwise noted
Tea at 3:30 pm in 1425 Stevenson Center
Colloquium Chair (2015-2016): Bruce Hughes

September 10, 2015 (Thursday), 4:10 pm

Groups of homotopy spheres and homotopy groups of spheres

Mike Hill, UCLA
Location: Stevenson 5211
Tea at 3:30 pm in SC 1425. (Contact Person: Anna Marie Bohmann)

September 24, 2015 (Thursday), 4:10 pm

From Mathematics to Cosmology

Marcelo Disconzi, Vanderbilt University
Location: Stevenson 5211
In this talk, I will present the results of a recent paper that has received widespread media coverage. The paper in question was written in collaboration with Robert Scherrer and Thomas Kephart from the Physics department, and grew out of my earlier results on the existence, uniqueness, and causality of Einstein's equations coupled to the Navier-Stokes equations, known as the Einstein-Navier-Stokes system (ENSS). The first part of the talk will be a fairly mathematical discussion of the ENNS. The second part will describe the work with Scherrer and Kephart, where we applied the ENSS to cosmology. The main implication is that the resulting model favors a scenario known as "big rip," where the universe comes to an end in finite time (approximately 22 billion years from now). If time allows, I will say a few words about the press coverage. Tea at 3:30 pm in SC 1425.

October 1, 2015 (Thursday), 4:10 pm

Riemannian Hyperbolization

Pedro Ontaneda, Binghamton
Location: Stevenson 5211
The strict hyperbolization process of R. Charney and M. Davis produces a large and rich class of negatively curved spaces (in the geodesic sense). This process is based on an earlier version introduced by M. Gromov and later studied by M. Davis and T. Januszkiewicz. If M is a manifold its Charney-Davis strict hyperbolization is also a manifold, but the negatively curved metric obtained is far from being Riemannian because it has a large and complicated set of singularities. We show that these singularities can be removed (provided the hyperolization piece is large). Hence the strict hyperbolization process can be done in the Riemannian setting. Tea at 3:30 pm in SC 1425. (Contact Person: Mike Mihalik)

October 8, 2015 (Thursday), 4:10 pm

The interior of dynamical vacuum black holes and the strong cosmic censorship conjecture in general relativity

Mihalis Dafermos, Princeton
Location: Stevenson 5211
I will discuss recent work on the structure of black hole interiors for dynamical vacuum spacetimes (without any symmetry) and what this means for the question of the nature of generic singularities in general relativity and the celebrated strong cosmic censorship of Penrose. This is joint work with Jonathan Luk (Cambridge). Tea at 3:30 pm in SC 1425. (Contact Person: Marcelo Disconzi)

October 29, 2015 (Thursday), 4:10 pm

Combining Riesz bases in R^d

Shahaf Nitzan, Georgia Tech
Location: Stevenson 5211
Orthonormal bases (ONB) are used throughout mathematics and its applications. However, in many settings such bases are not easy to come by. For example, it is known that even the union of as few as two intervals may not admit an ONB of exponentials. In cases where there is no ONB, the next best option is a Riesz basis (i.e. the image of an ONB under a bounded invertible operator). In this talk I will discuss the following question: Does every finite union of rectangles in R^d, with edges parallel to the axes, admit a Riesz basis of exponentials? In particular, does every finite union of intervals in R admit such a basis? This is joint work with Gady Kozma. Tea at 3:30 pm in SC 1425. (Contact Person: Akram Aldroubi)

November 5, 2015 (Thursday), 4:10 pm

3-manifolds, fibrations and the complex of curves

Yair Minsky, Yale
Location: Stevenson 5211
When a 3-manifold fibers over the circle, it typically does so in infinitely many ways, as organized by Thurston's norm on the homology. This provides us with a kind of laboratory to test hypotheses about the ways in which surfaces can embed into 3-manifolds, and the quantitative relations between topology and hyperbolic geometry. This general observation will serve as an excuse to discuss some of the machinery of complexes of curves on surfaces, and the ways in which they encode a kind of topological decomposition of a 3-manifold into geometrically relevant pieces. Tea at 3:30 pm in SC 1425. (Contact Person: Spencer Dowdall)

November 12, 2015 (Thursday), 4:10 pm

Far beyond the infinite

Hugh Woodin, Harvard
Location: Stevenson 5211
The modern mathematical story of infinity began in the period 1879-84 with a series of papers by Cantor that defined the fundamental framework of the subject. Within 40 years the key ZFC axioms for Set Theory were in place and the stage was set for the detailed development of transfinite mathematics, or so it seemed. However, in a completely unexpected development, Cohen showed in 1963 that even the most basic problem of Set Theory, that of Cantor's Continuum Hypothesis, was not solvable on the basis of the ZFC axioms. The 50 years since Cohen's work has seen a vast development of Cohen's method and the realization that the occurrence of unsolvable problems is ubiquitous in Set Theory. This arguably challenges the very conception of Cantor on which Set Theory is based. Thus a fundamental dilemma has emerged. On the one hand, the discovery, also over the last 50 years, of a rich hierarchy axioms of infinity seems to argue that Cantor's conception is fundamentally sound. But on the other hand, the developments of Cohen's method over this same period seem to strongly suggest there can be no preferred extension of the ZFC axioms to a system of axioms that can escape the ramifications of Cohen's method. But this dilemma was itself based on a misconception and recent discoveries suggest there is a resolution (maybe). Tea at 3:30 pm in SC 1425. (Contact Person: Vaughan Jones)

December 3, 2015 (Thursday), 4:10 pm

Bases formed by translates of one function in the space of p-integrable functions

Thomas Schlumprecht, Texas A&M
Location: Stevenson 5211
We consider subspaces of the space of p-integrable functions on the real number line, which are generated by a sequence of functions which is obtained by shifting in a uniform discrete manner the same function f. In particular we are interested in the question whether or not this space could be the whole space of p-integrable functions, assuming the sequence enjoys some basic properties. This is, in different combinations, joint work with Freeman, Odell, Sari, Zhang and Zsak. Tea at 3:30 pm in SC 1425. (Contact Person: Alex Powell)

January 28, 2016 (Thursday), 4:10 pm

Orthogonal bases and tiling: analysis, number theory and combinatorics

Alex Iosevich, University of Rochester
Location: Stevenson 5211
In 1974 Bent Fuglede conjectured that if Ω is a bounded domain in ${\Bbb R}^d$, then $L^2(\Omega)$ has an orthogonal basis of exponentials if and only if Ω tiles ${\Bbb R}^d$ by translation. Even though this conjecture was disproved by Terrance Tao in 2004 in dimensions 5 and higher, it is continuing to lead researchers to fascinating connections and ideas that involve a variety of areas of modern mathematics. In this talk we will present a sampling of these ideas and connections between them, as well as some recent developments in this fascinating field. Tea at 3:30 pm in SC 1425. (Contact Person: Akram Aldroubi)

February 4, 2016 (Thursday), 4:10 pm

Gradings on Simple Algebras and Beyond

Yuri Bakhturin, Memorial U. of Newfoundland
Location: Stevenson 5211
Gradings by groups on simple algebras, like Lie, Jordan, etc., play an important role for the classification and representation theory of these algebras and in applications. At this time, we have a very good understanding of how the group gradings look like on finite-dimensional associative, Lie and Jordan algebras over algebraically closed fields of characteristic zero. There are a number of nice results in the case of algebraically closed fields of prime characteristic, very few when the field is not algebraically closed. Lie and Jordan superalgebras are another class where the work has just started. Even less explored are gradings on simple infinite-dimensional algebras, even locally finite. But we have good classification results for gradings on simple finitary Lie algebras. It should also be mentioned that gradings on not necessarily simple Lie algebras, even nilpotent algebras, are of interest in Differential Geometry. To deal with so different situations, various methods have been offered, from Classical Ring Theory to Algebraic Groups to Hopf Algebras to Polynomial identity algebras. In this talk I will try to explain some of the ideas and present some recent result of this now large area. Tea at 3:30 pm in SC 1425. (Contact Person: Alexander Olshanskiy)

February 12, 2016 (Friday), 4:10 pm

PRESTRAINED ELASTICITY: FROM SHAPE FORMATION TO MONGE-AMPERE ANOMALIES

Marta Lewicka, University of Pittsburgh
Location: Stevenson 5211
This lecture is concerned with the analysis of thin elastic films exhibiting residual stress at free equilibria. Examples of such structures and their actuations include: plastically strained sheets; specifically engineered swelling or shrinking gels; growing tissues; atomically thin graphene layers, etc. These and other phenomena can be studied through a variational model, pertaining to the non-Euclidean version of nonlinear elasticity, which postulates formation of a target Riemannian metric, resulting in the morphogenesis of the tissue which attains an orientation-preserving configuration closest to being the metric's isometric immersion. In this context, analysis of scaling of the energy minimizers in terms of the film's thickness leads to the rigorous derivation of a hierarchy of limiting theories, differentiated by the embeddability properties of the target metrics and, a-posteriori, by the emergence of isometry constraints with low regularity. This leads to questions of rigidity and flexibility of solutions to the weak formulations of the related PDEs, including the Monge-Ampere equation. In particular, we observe that the set of $C^{1,\alpha}$ solutions to the Monge-Ampere equation is dense in C^0 provided that $\alpha<1/7$, whereas rigidity holds when $\alpha>2/3$. Tea at 3:30 pm in SC 1425. (Contact Person: Gieri Simonett)

February 25, 2016 (Thursday), 4:10 pm

Regularity of manifolds with bounded Ricci curvature and the codimension 4 conjecture

Jeff Cheeger, NYU
Location: Stevenson 5211
Let X^n denote the Gromov-Hausdorff limit of a noncollapsing sequence of Riemannian manifolds with uniformly bounded Ricci curvature. Around 1990, early workers, in particular, Mike Anderson, conjectured that apart from a (possibly empty) closed subset S of (Hausdorff) codimension greater or equal to 4, X^n is a smooth riemannian manifold. The example of limits of scaled down 4-dimensional complete noncompact Ricci flat spaces showed that such a result would be sharp. We will try to explain the statement of the conjecture and some of the ideas in the proof. This is joint work with Aaron Naber. Tea at 3:30 pm in SC 1425. (Contact Person: Marcelo Disconzi)

March 3, 2016 (Thursday), 4:10 pm

The inverse problem of seamount magnetism

Robert L. Parker, UC San Diego
Location: Stevenson 5211
Seamounts are submarine volcanos, and they are usually strongly magnetized. The direction of the magnetization gives information to marine geologists about the location of the oceanic plate at the time of the formation of the seamount. Our task is to discover the mean direction of the magnetization based on measurements of the local magnetic field anomaly at the ocean surface. To be useful, the estimate should be accompanied by a measure of its uncertainty. The earliest model of the internal magnetization was that it was uniform throughout, and a least-squares procedure gave the estimate of direction and uncertainty, but the underlying statistical requirements for least-squares estimation were clearly violated. A more sophisticated treatment puts the magnetization function in a Hilbert space; regularization seeks the model of smallest norm, to avoid outlandish solutions. To bound the uncertainty, further assumptions are needed. If a bound on the 2-norm of the magnetization is supplied, the uncertainty in the mean direction can be found in principle. Unfortunately, for most seamount surveys, the uncertainty so calculated is so large as to render the solutions worthless for geological purposes. Of course, it could be that this is a proper assessment: the data may be too weak to yield scientifically interesting conclusions; or perhaps stronger model assumptions can rectify the situation. The science of paleomagnetism is dependent of the requirement that magnetization of most large geological units is unidirectional, even if the intensity varies widely. If this assumption is introduced for the seamount, informative estimates of the direction can be computed even without a bound on the norm of the model. The mathematics behind all the calculations discussed here is the theory of optimization on finite and infinite dimensional linear vector spaces. Tea at 3:30 pm in SC 1425. (Contact Person: Doug Hardin)

March 17, 2016 (Thursday), 4:10 pm

Categories and cohomology theories

Peter May, University of Chicago
Location: Stevenson 5211
For over fifty years, it has been known that a (small, topological) category C has a classifying space BC, generalizing the classifying space of a group. For over forty years, it has been known that if C has a nice product, then C determines a cohomology theory closely related to BC. For over thirty years, it has been known that if C has two nice products related by distributivity (think of finite sets under disjoint union and cartesian product or finitely generated projective modules over a commutative ring under direct sum and tensor product), then the cohomology theory has cup products, just like ordinary cohomology has. These constructions are central to algebraic topology and its relationship with neighboring fields. I will try to give some idea of how these constructions are made and what they are good for. Time permitting, I will say a little about current work generalizing these constructions to equivariant categories, spaces, and cohomology theories, where everything in sight is acted on by a finite group G. Tea at 3:30 pm in SC 1425. (Contact Person: Anna Marie Bohmann)

April 14, 2016 (Thursday), 4:10 pm

Polygonal Billiards and Dynamics on Moduli Spaces

Alex Eskin, University of Chicago
Location: Stevenson 5211
Billiards in polygons can exhibit some bizarre behavior, some of which can be explained by deep connections to several seemingly unrelated branches of mathematics. These include algebraic geometry (and in particular Hodge theory), Teichmuller theory and ergodic theory on homogeneous spaces. I will attempt to give a gentle introduction to the subject. Tea at 3:30 pm in SC 1425. (Contact Person: Mark Sapir)

April 21, 2016 (Thursday), 4:10 pm

The geometry and dynamics of uniformly periodic recursion relations

Robert Bryant, Duke
Location: Stevenson 5211

When $H(x)$ is a real-valued function of a real variable, the 2-step recursion relation

$$x_{i+1} = H(x_i) - x_{i-1}$$

is said to be *n-periodic* if it is periodic with period n for all initial conditions (x_0, x_1). These *n-periodic* recursion relations and their generalizations for certain values of n turn out to have close connections with interesting problems in both dynamical systems and in the theory of cluster algebras. Tea at 3:30 pm in SC 1425. (Contact Person: Bruce Hughes)

» Past Colloquia