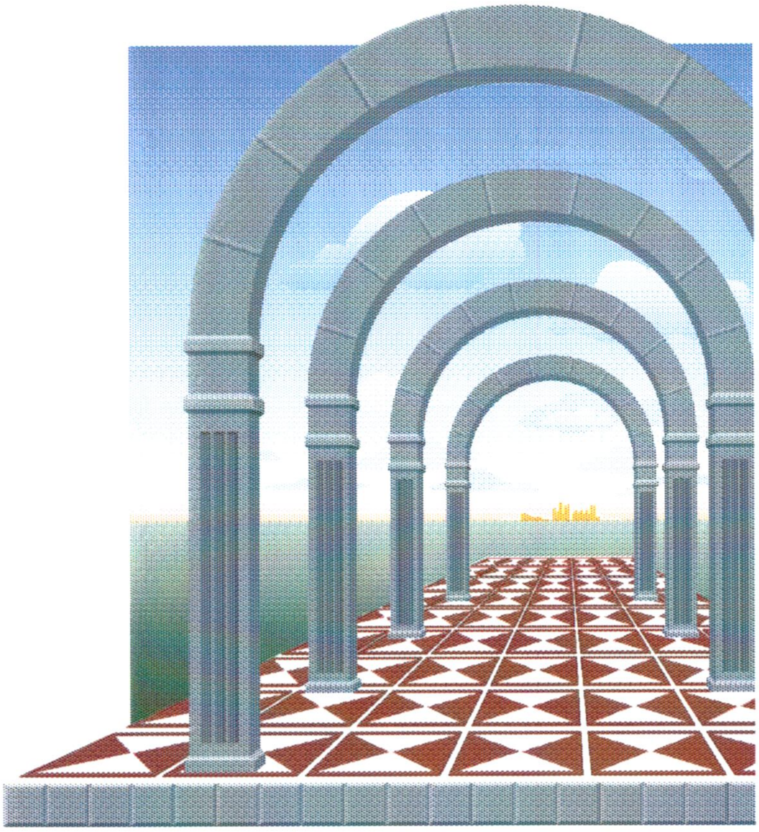
The OLIVER CLUB

1996-1997

Mathematics Department
Cornell University



The OLIVER CLUB

presents

John Hubbard

Cornell University

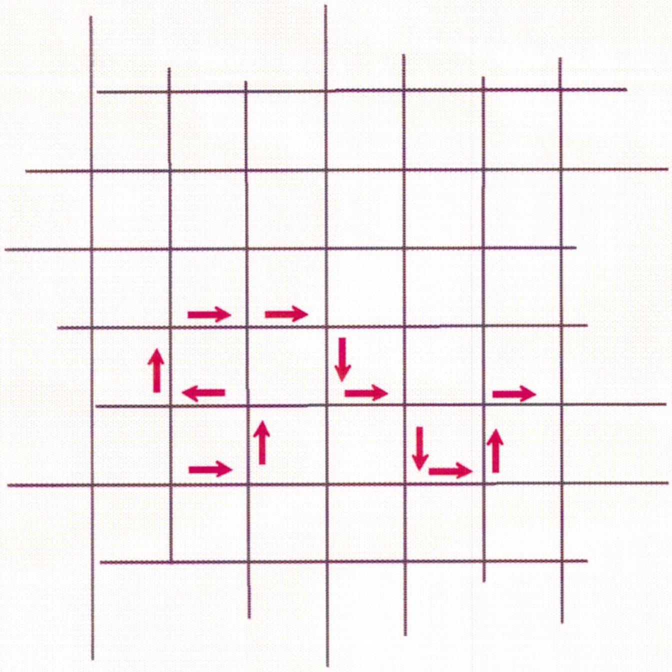
Thursday, Sept. 19
4:15 p.m.
328 White Hall

Compactifications of Rational Maps: a solution of a conjecture of Milnor

Abstract

Most "mappings" f from projective space $\mathbf{P}^n$ to itself are not quite mappings: they have points of indeterminacy. We will construct a compact space X and a mapping $f : X \to \mathbf{P}^n$ (some sort of infinite blow-up space) such that f lifts to $\tilde{f} : X \to X$. In some cases, this space can be described completely: it contains links, solenoids, etc. Milnor conjectured what it could look like for a composition of Henon mappings; we will prove this conjecture.

Refreshments will be served at 3:45
in the math department lounge.



The OLIVER CLUB

presents

Laurent Soloff-Coste

C.N.R.S. Toulouse

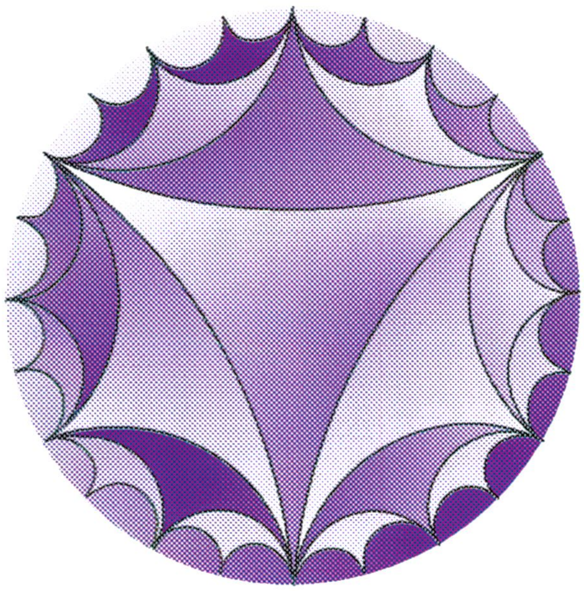
Thursday, Sept. 26
4:15 p.m.
328 White Hall

Random walks and geometry of finitely generated groups

Abstract

What are the possible behaviors of simple random walks on Cayley graphs of groups? How is this question related to the geometry of Cayley graphs and to the algebraic structure of groups? These problems come to life through the early work of Kesten. I will review the progress made in the last decade.

Refreshments will be served at 3:45
in the math department lounge.



The OLIVER CLUB

presents

Jeff Diller

Cornell University

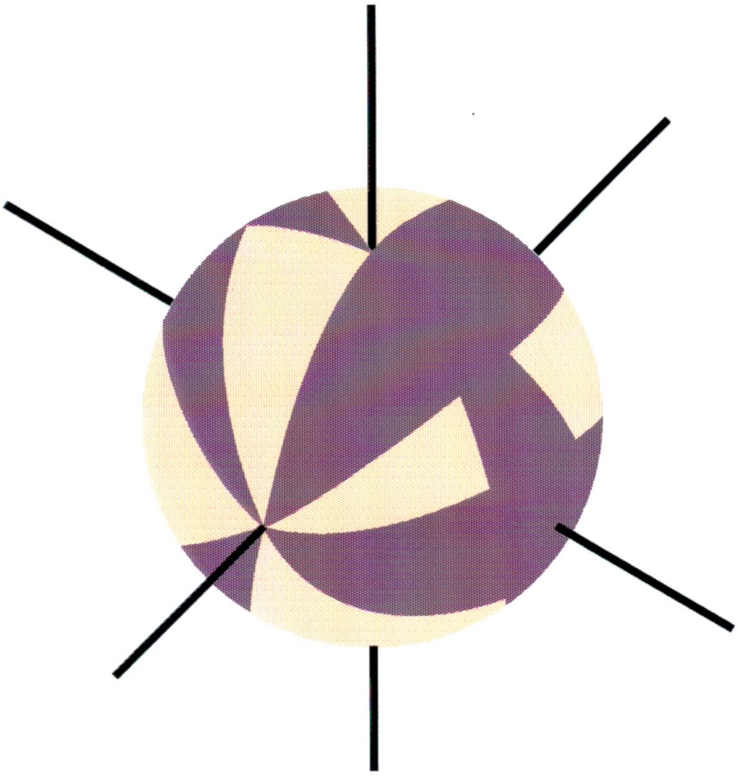
Thursday, October 3
4:15 p.m.
328 White Hall

Complex analysis via hyperbolic geometry

Abstract

A remarkable, and by now classical, result in complex analysis is that most Riemann surfaces admit a unique complete, conformal metric with constant Gauss curvature -1. Beginning with the Schwarz Lemma, a great many results in complex analysis admit very elegant interpretations via the hyperbolic metric. In this talk, we present a (rather skewed) sample of old and new results that proceed from the hyperbolic point of view.

Refreshments will be served at 3:45
in the math department lounge.



The OLIVER CLUB

presents

John Meier

Lafayette College and
Cornell University

Thursday, October 10
4:15 p.m.
328 White Hall

Groups and their graphs; subgroups and their subgraphs

Abstract

A homomorphism from a finitely generated group G to a finite abelian group has finitely generated kernel. If the image group is infinite abelian, however, there may be no finite generating set for the kernel. I will show how to decide whether the kernel is finitely generated by examining its action on the Cayley graph of G. I will then sketch how these techniques apply to questions of finite presentability and beyond, emphasizing concrete examples. I will conclude with a recent result (joint with Meinert and Van Wyk) which contains famous examples due to Stallings (1963), Bieri (1976) and Bestvina and Brady (1995)

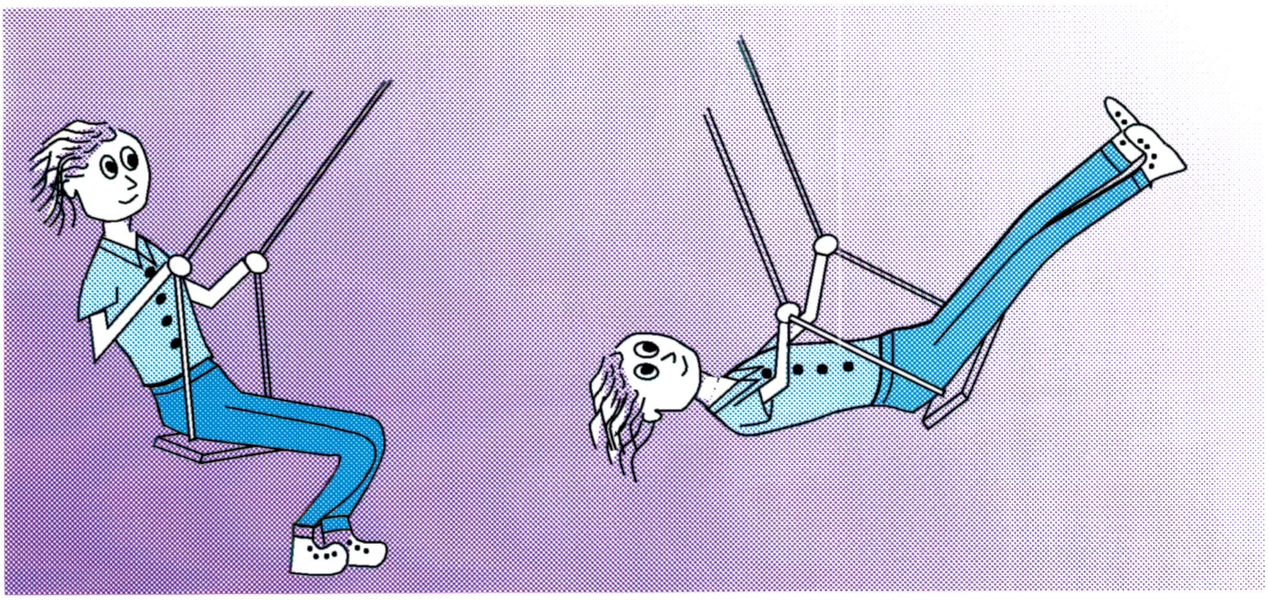
Refreshments will be served at 3:45
in the math department lounge.

The OLIVER CLUB presents

Richard Rand

Cornell University

Thursday, October 24
4:15 p.m.
328 White Hall



The Mathematics of Pumping a Swing

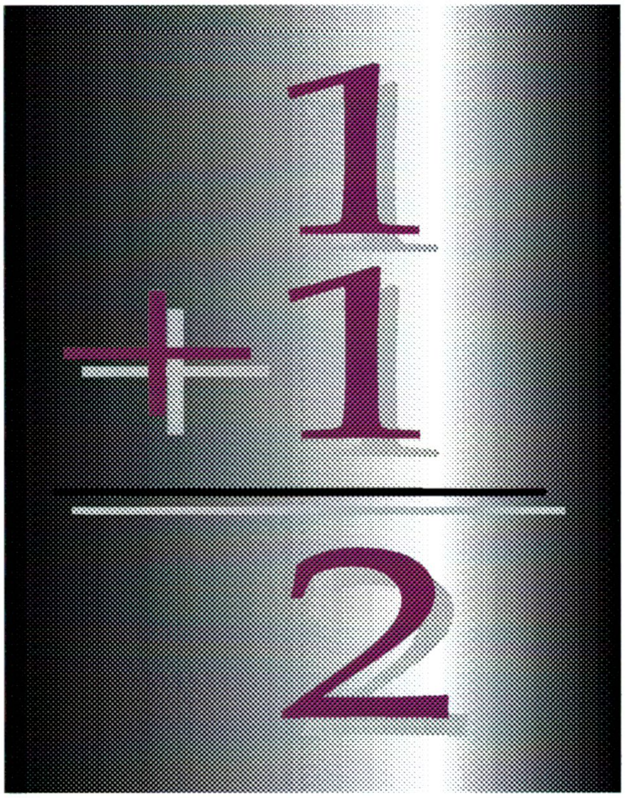
A swing may be modeled as a mathematical pendulum. Then pumping the swing corresponds to making small changes in the pendulum's size or shape so as to produce large motions.

These changes may classified as either being given functions of time (nonautonomous), or as depending upon the state of the pendulum (autonomous), or both.

They may also be classified as either changing the length of the pendulum (as in a person standing on a swing), or as changing the orientation of the person's body (as in a person pumping a swing from a seated position), or both.

In this seminar we will examine some models of pumping a swing.

Refreshments will be served at 3:45
in the math department lounge.



The OLIVER CLUB

presents

Persi Diaconis

Cornell University
and Harvard University

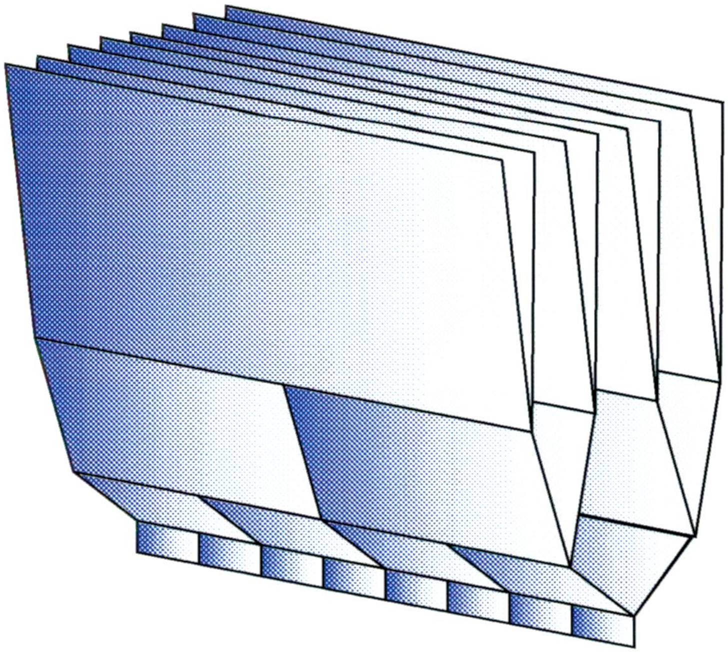
Thursday, October 31
4:15 p.m.
328 White Hall

A Generalization of 1+1=2

Abstract

Naturally occuring problems in statistics (logistic regression), operations research (integer programming) and algebraic geometry (toric varieties) lead to the problem of counting the number of lattice points in a convex set of d-dimensional Euclidean space. I will show how combinatorics and algebra combine to tame some examples that arise in practice. This is joint work with Ron Graham and Bernd Sturmfels.

Refreshments will be served at 3:45
in the math department lounge.



The OLIVER CLUB

presents

Martin Bridson

Oxford University and
Princeton University

Thursday, November 7
4:15 p.m.
328 White Hall

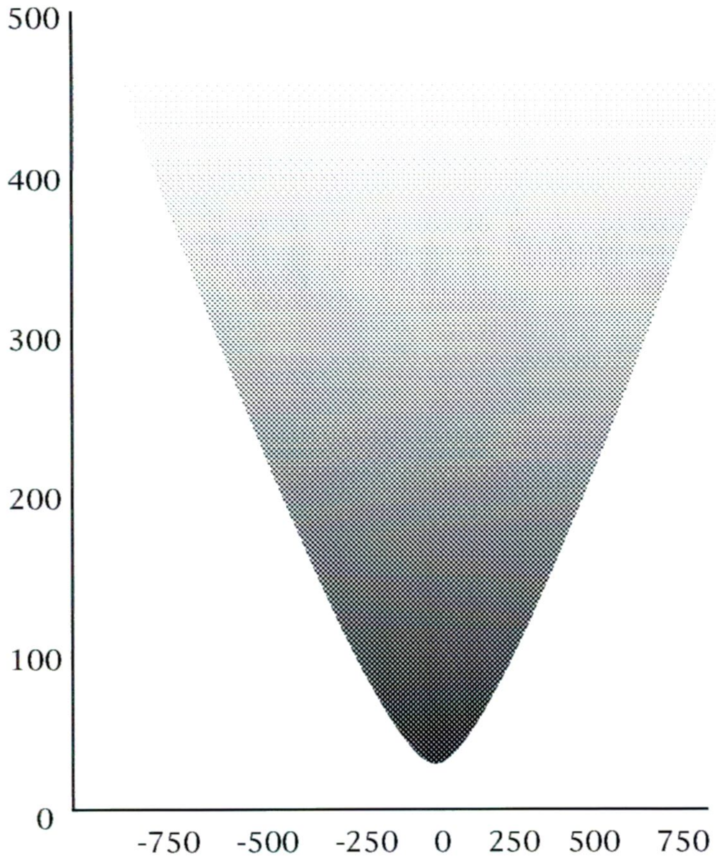
Isoperimetric inequalities in finitely-presented groups

Any wire loop of length λ in Euclidean space bounds a disk of area at most $\lambda^2/4\pi$. In contrast, any loop of length λ in hyperbolic space bounds a disk whose area is bounded above by a linear function of λ. One describes this difference by saying that loops in Euclidean space satisfy a quadratic isoperimetric inequality whereas loops in hyperbolic space satisfy a linear isoperimetric inequality.

More generally, associated to every closed Riemannian manifold one has an isoperimetric function that describes the area of the disks needed to fill loops of length λ in the universal cover of the manifold. Somewhat surprisingly, the asymptotic behavior of this isoperimetric function depends only on the fundamental group of the manifold. Indeed, following Gromov and Dehn, it makes sense to talk about the isoperimetric function of a finitely presented group, and (modulo a natural notion of equivalence) the isoperimetric functions of a closed manifold and of its fundamental group are the same.

From a different point of view, the isoperimetric function of a group can bew thought of as a measure of the complexity of the word problem, i.e. the complexity of the process necessary to determine whether or not a word in the generators of the group represents the identity. In recent years a good deal of effort has gone into determining the isoperimetric functions of various important classes of groups and also into determining which functions actually arise as isoperimetric functions. In this talk I shall give an overview of what is known about isoperimetric inequalities for groups and conclude with some open questions.

Refreshments will be served at 3:45 in the math department lounge.



The OLIVER CLUB

presents

Mark Gross

Çornell University

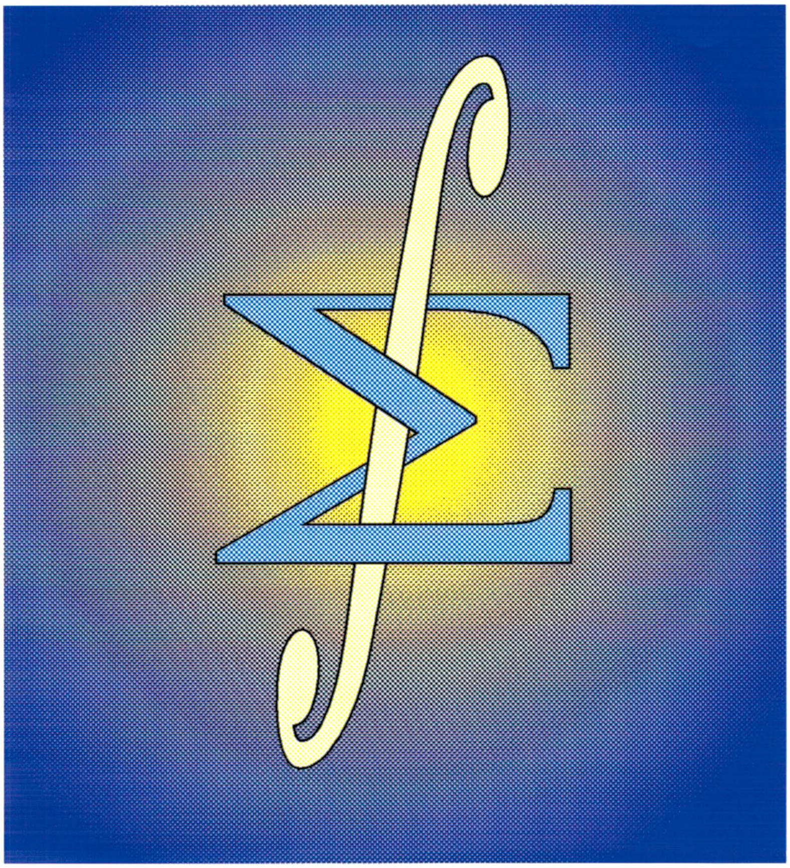
Thursday, November 14
4:15 p.m.
328 White Hall

Mirror Symmetry and Special Lagrangian Submanifolds

Abstract

Mirror smmetry is a prediction coming from string theory in physics that certain seemingly unrelated complex manifolds have very similar properties. The relation between these manifolds has been mysterious for quite some time, but recent work in physics by Strominger, Yau and Zaslow have given an exciting conjecture as to what the precise nature of the relationship between these manifolds should be. In particular, this involves the notion of supersymmetric, or special Lagrangian submanifolds. The latter notion was defined in the eighties by Harvey and Lawson for the study of volume minimizing submanifolds. I will discuss these various concepts, and give some concrete examples of the geometry involved.

Refreshments will be served at 3:45
in the math department lounge.



The OLIVER CLUB

presents

J. Martin Lindsay

Cornell University

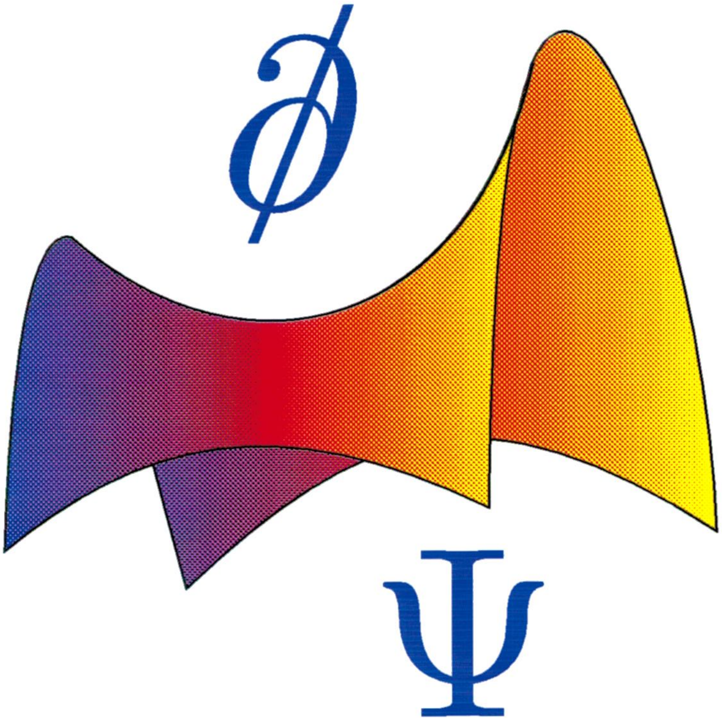
Thursday, November 21
4:15 p.m.
328 White Hall

The Quantisation of Stochastic Analysis

Abstract

Noncommutative probability is an enrichment of probability theory (as laid down by Kolmogorov) which is in the spirit of other parts of contemporary mathematics that have "gone commutative"--topology, measure theory, differential geometry, group theory. It both impinges upon and draws ideas from diverse areas of mathematics. Instances include central limits of canonical variables (p,q) in quantum mechanics, the classification of operator algebras (II-factors) associated with free groups, the characterisation of endomorphisms of Brownian motion, and the evolution of open quantum systems. In this seminar I shall describe stochastic analysis from a noncommutative viewpoint of Brownian motion. The basic tool is an elementary algebra of finite subsets of the real line. The talk is aimed at a general mathematical audience.

Refreshments will be served at 3:45
in the math department lounge.



The OLIVER CLUB

presents

John Morgan

Columbia University

Thursday, Dec. 5
4:15 p.m.
328 White Hall

Seiberg-Witten Invariants for four-dimensional manifolds

Abstract

This talk will be a survey of the current state of the art concerning the Seiberg-Witten invariants and their applications to topological problems. We will discuss Kahler surfaces, where the invariants are completely calculated, symplectic manifolds (Taubes'theorem gives much information), and product formulas for the behavior of the invariants under gluing along 3three-manifolds. This allows one to construct new four-manifolds (irreducible but not symplectic) and to prove that they are indeed new.

Refreshments will be served at 3:45
in the math department lounge.

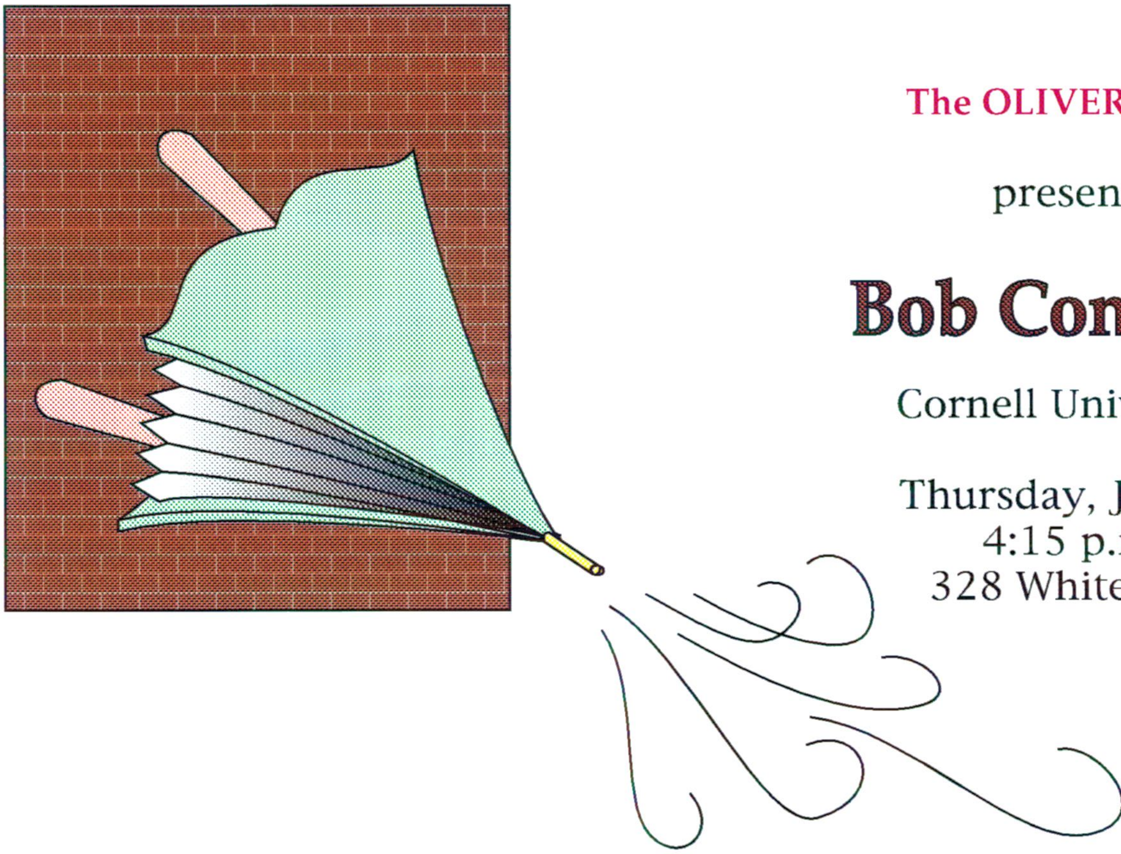
The OLIVER CLUB

presents

Bob Connelly

Cornell University

Thursday, Jan. 30
4:15 p.m.
328 White Hall

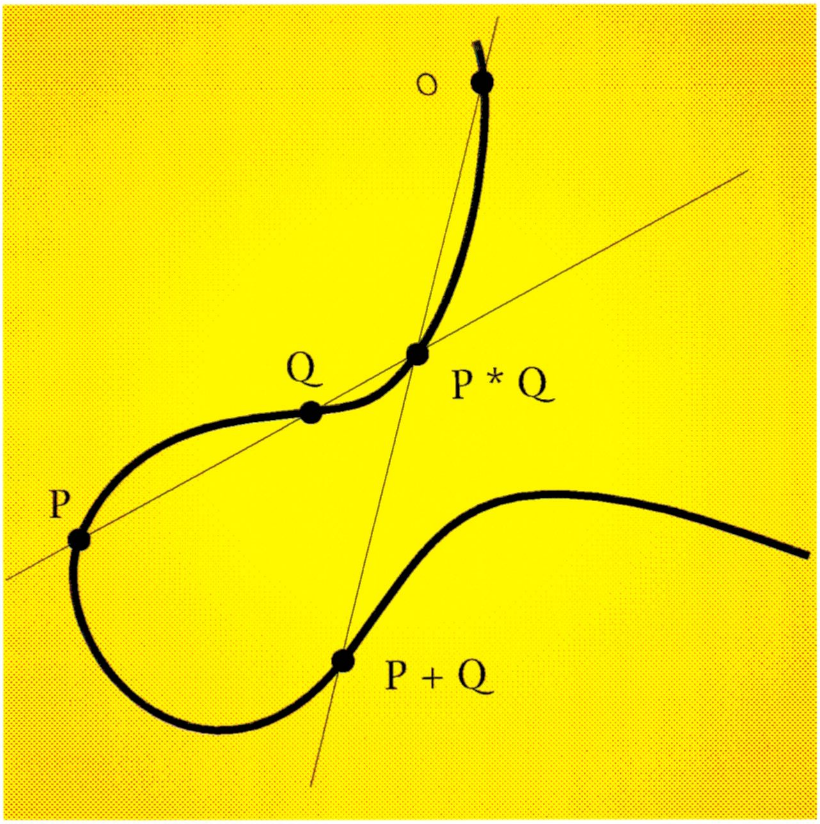


The Bellows Conjecture

Abstract

This is joint work with I. Sabitov and A. Walz. Consider a closed polyhedral surface in three-space that has the property that it can change its shape while keeping all its polygonal faces congruent. Adjacent faces are allowed to rotate along common edges. Mathematically exact flexible surfaces were found by Connelly in 1978. But the question remained as to whether the volume boundedby such surfaces was necessarily constant during the flex. Inother words, is there a mathematically perfect bellows that actually will exhale and inhale as it flexes? For the known examples, the volume did remain constant. Following an idea of Sabitov, but using the theory of places in algebraic geometry (suggested by Steve Chase), we will show that there is no perfect mathematical bellows. All flexible surfaces must flex with constant volume.

Refreshments will be served at 3:45
in the Math Department Lounge.



The OLIVER CLUB

presents

Fred Diamond

Massachusetts Institute
of Technology

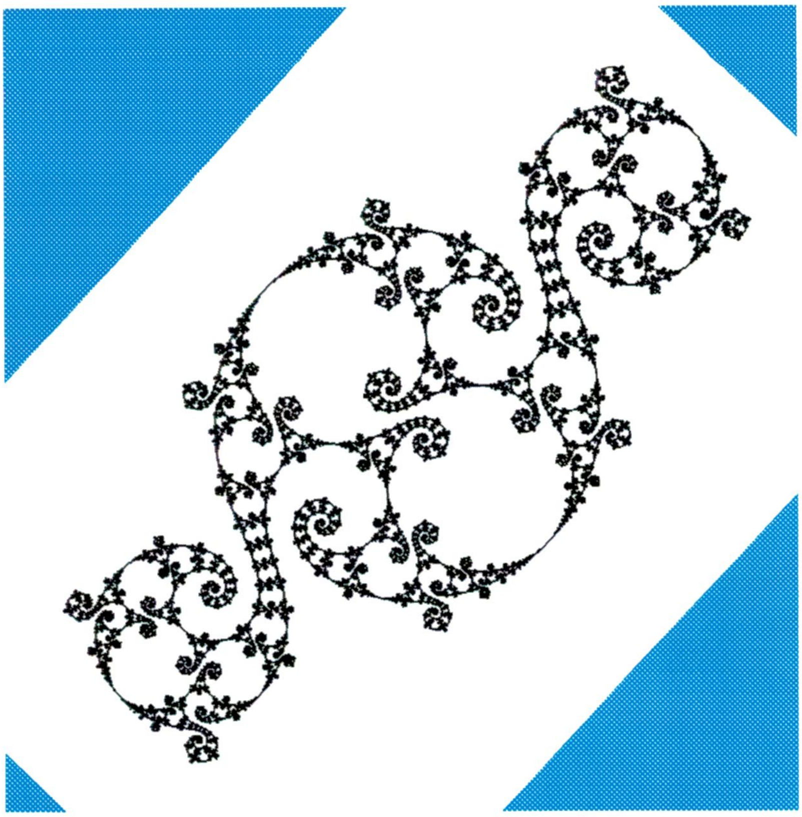
Thursday, Feb. 6
4:15 p.m.
328 White Hall

Modular Forms and Fermat's Last Theorem

Abstract

The theory of modular forms has become an important tool in number theory. These functions can be considered a natural generalization of Dirichlet characters. I'll begin with a discussion of Dirichlet characters and L-series, then explain how modular forms enter the picture. I'll discuss applications to the arithmetic of elliptic curves and Fermat's Last Theorem, and the general principles behind them.

Refreshments will be served at 3:45
in the math department lounge.



The OLIVER CLUB

presents

Cliff Earle

Cornell University

Thursday, Feb. 13
4:15 p.m.
328 White Hall

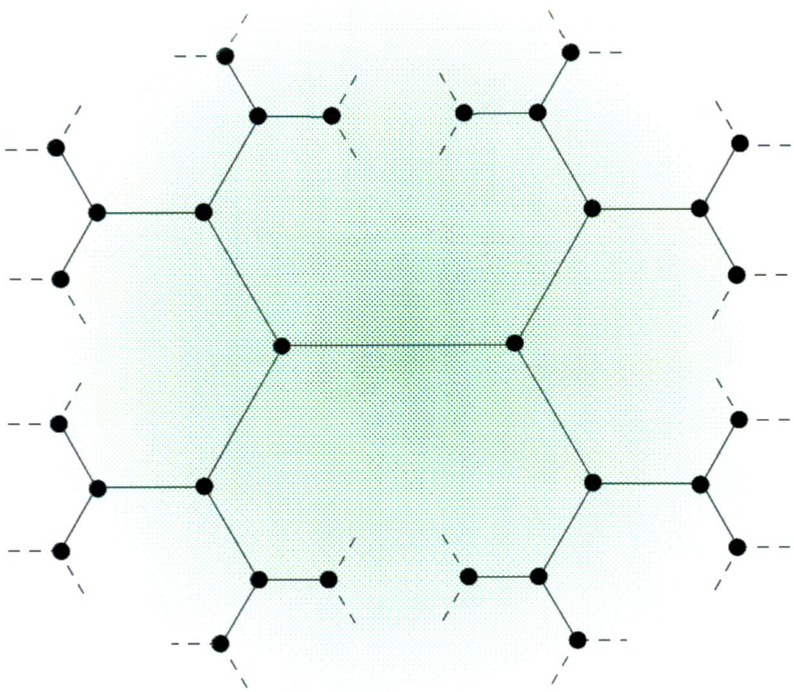
The Teichmüller space of a closed set in the plane

Abstract

If a family of rational maps or Kleinian groups depends on some complex parameters, the Julia set of the map or the limit set of the group (the figure shows such a limit set) will vary with the parameters. The way these sets vary captures useful information about the variation of the maps or groups. For this reason a theory of "holomorphic motions" of subsets of the plane has developed in recent years. It is closely linked to the theory of quasi-conformal maps and Teichmuller spaces.

The Teichmuller space T(E) of a closed set E in the plane is a universal parameter space for holomorphic motions of E. We shall describe T(E) and its tangent space at the basepoint. This tangent space can be interpreted as the set of infinitesimal holomorphic motions of E and has explicit descriptions as a set of vector fields on E.

Refreshments will be served at 3:45
in the math department lounge.



The OLIVER CLUB

presents

Allen Moy

University of Michigan
Ann Arbor

Thursday, Feb.20
4:15 p.m.
328 White Hall

Some Geometric Techniques in Representation Theory

Abstract

The representation theory of p-adic groups is intimately connected to number theory. But increasingly geometric techniques are being used to study them.

In this talk I will discuss some of these geometric methods. In addition to the philosophy of the orbit method, I will illustrate the use of the geometry of the Bruhat-Tits building and the notion of unstable orbits (in the sense of Mumford) in a representation of a complex reductive group.

My talk will start at an elementary level with examples such as the Heisenberg group and SL(2) over real, finite and p-adic fields. I will then proceed to the more sophisticated techniques as time permits.

Refreshments will be served at 3:45
in the math department lounge.

The OLIVER CLUB

presents

Mike Stillman

Cornell University

Thursday, Feb.27
4:15
328 White Hall

Computer algebra using Macaulay II

Abstract

Macaulay II is a specialized computer algebra system that Dan Grayson and I have been developing for the last several years. This system is designed for researchers in algebraic geometry, commutative algebra, and related fields. However, since Macaulay II deals with polynomials in several variables, and matrices of such polynomials, it is often useful in many other fields as well (people in combinatorics, physics, topology, vision and other fields have been using Macaulay II).

The purpose of this talk is two fold. The first is to describe some of the useful tools of computational algebra and algebraic geometry, and the second goal is to provide an overview to Macaulay II, so that you will be able to determine when this system may help you in your own research (especially since there is a resident expert here!) We will accomplish both by describing some specific problems and examples, and seeing how they may be computed in Macaulay II.

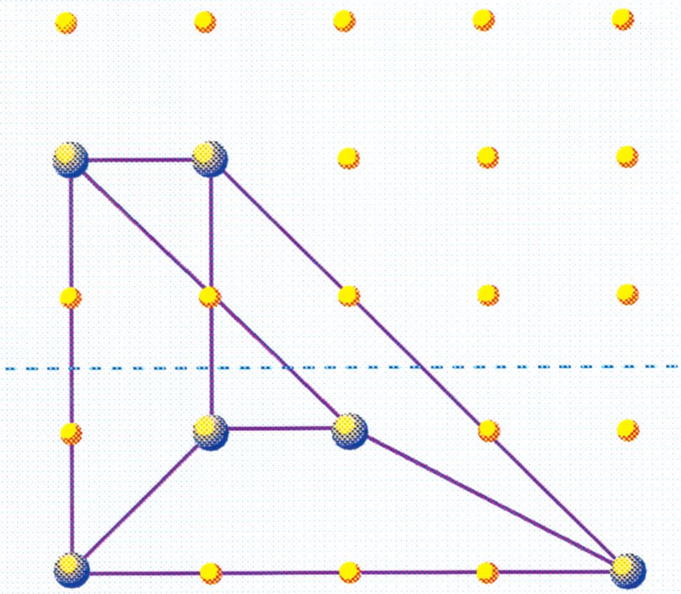


FIGURE 1. A manifold which is not Kähler

The OLIVER CLUB

presents

Susan Tolman

Princeton University

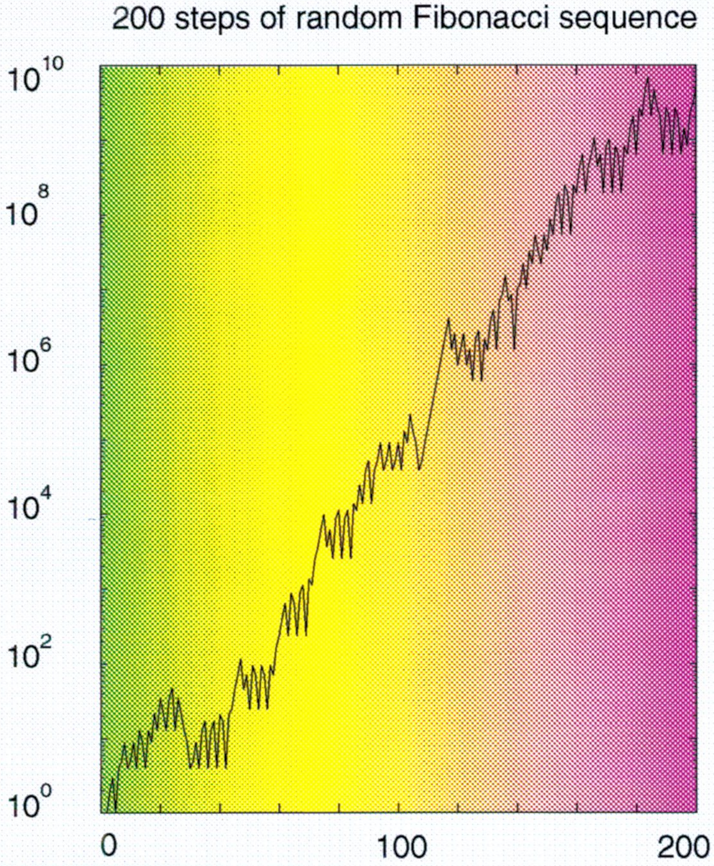
Thursday, March 6
4:15 p.m.
328 White Hall

Equivariant symplectic topology and picturology

Abstract

The basic philosophy of picturology is that the fundamental problems in equivariant symplectic topology can be rephrased as simple questions about pictures associated to the symplectic manifolds. We show how these ideas can be used to help determine if a manifold is Kähler, classify manifolds with large torus actions, and related questions. This is based on a joint work with Y. Karshon.

Refreshments will be served at 3:45
in the math department lounge.



The OLIVER CLUB

presents

Nick Trefethen

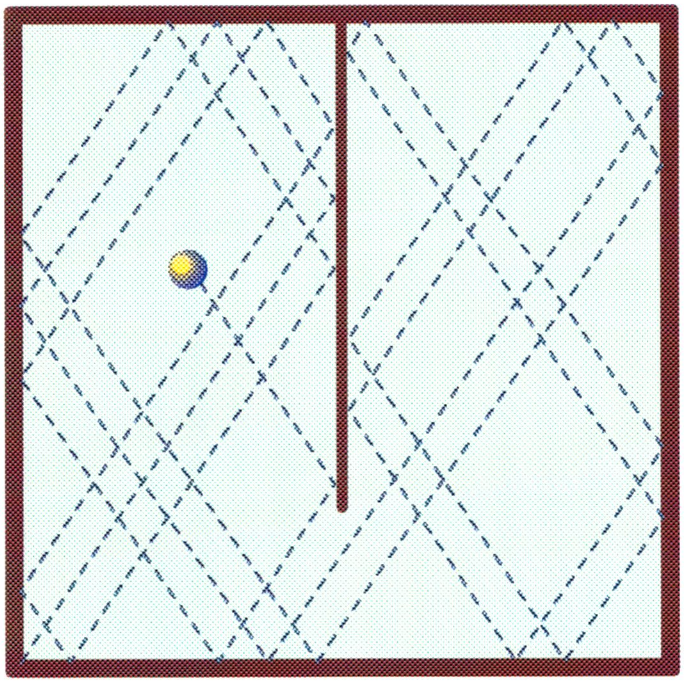
Department of
Computer Science
Cornell University

Thursday, March 27
4:15 p.m.
328 White Hall

Random triangular matrices and random Fibonacci sequences

What's the condition number of a random N x N triangular matrix? How big is the Nth term in a Fibonacci sequence, if the usual plus signs are replaced by plusses or minuses at random? These problems are related, and the answer to both is: exponentially large. In a number of cases we have been able to determine the (almost sure) exponential growth rates as N -> infinity. The mathematics blends Markov chains and dynamical systems with a hint of fractals and wavelets. This is joint work with PhD student Divakar Viswanath.

Refreshments will be served at 3:45
in the math department lounge.



The OLIVER CLUB

presents

John Smillie

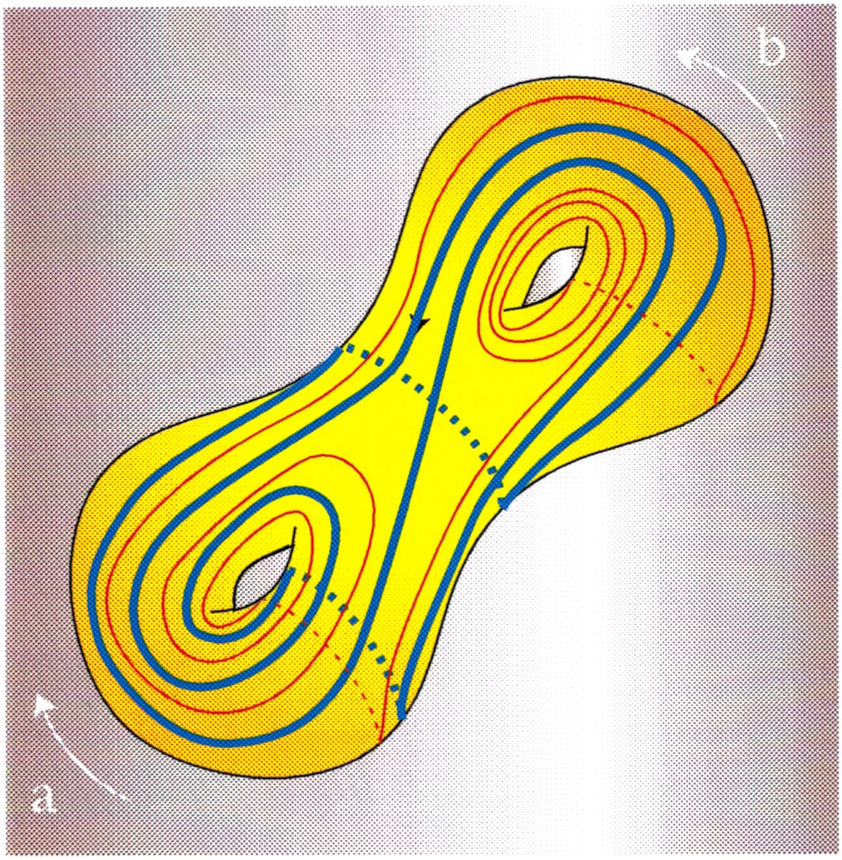
Cornell University

Thursday, April 3
4:15 p.m.
328 White Hall

Billiards on Polygonal Tables

Questions involving the behavior of billiard trajectories in planar domains have a long history in dynamical systems. We can ask for example whether a given trajectory is periodic or whether it fills up the billiard table in some s ense. When the domain is a polygon the problem has a special character. There are general results that allow us to describe the behavior of almost every trajectory but these results fall short if we want to know about the behavior of some specific trajectory. The list of ``completely analyzable'' polygonal tables in which we can describe the behavior of every trajectory is quite short. Prior to 1989 it consisted of rectangles and three very special triangles. In 1989 Willian Veech expanded this list. This talk is devoted to some of the ramifications of Veech's discovery. In particular I will describe joint work with Rick Kenyon describing which triangular tables have the property that their billiard flow can be ``completely analyzed''. The techniques include ``scissors congruence'' invariants and elementary number theory.

Refreshments will be served at 3:45
in the math department lounge.



The OLIVER CLUB

presents

Cynthia Hog-Angeloni

Cornell University
and Frankfurt

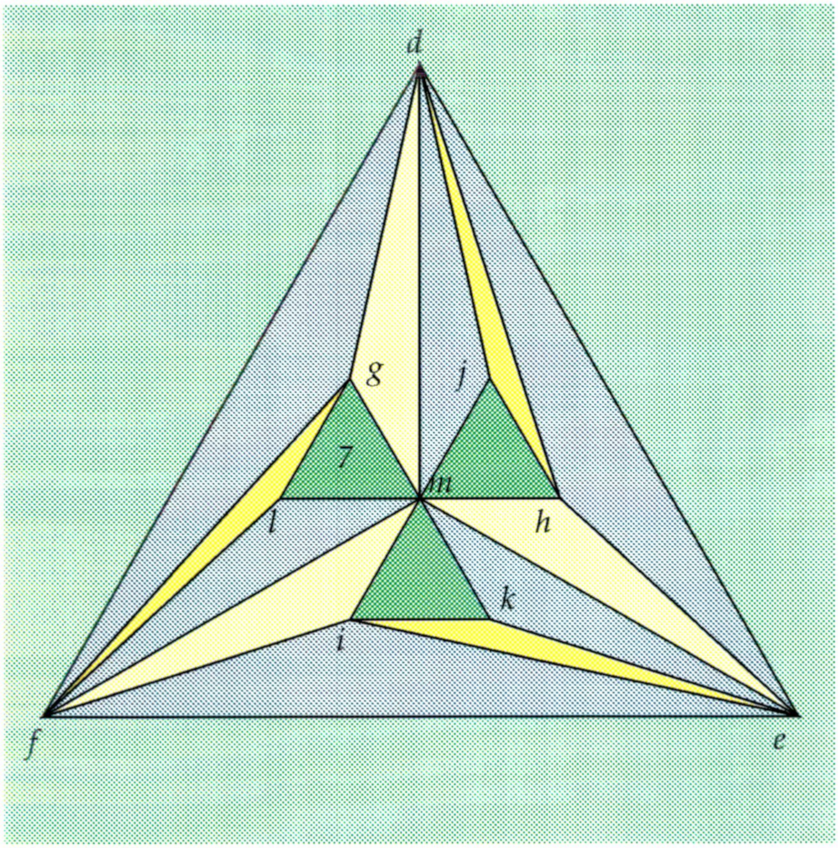
Thursday, April 10
4:15 p.m.
328 White Hall

DETECTING 3-MANIFOLD PRESENTATIONS

Given a triangulation of a compact, connected, oriented 3-manifold there is an easy algorithm for finding a presentation of its fundamental group. We want to study the converse: which presentations of 3-manifold groups arise in this way? In 1968 L. Neuwirth exhibited an algorithmic solution to this problem, which was refined, for 2-generator presentations, to a pencil-and-paper algorithm by Osborne and Stevens in 1974. I will explain these algorithms and show how to generalize Osborne and Stevens work to presentations with any finite number of generators.

Since the homotopy theory of 2-dimensional complexes reduces essentially to the analysis of presentations of a group, this problem provides a link from this theory, with its many longstanding open conjectures (e.g. the Andrews-Curtis Conjecture, the Zeeman Conjecture, the Whitehead Conjecture) to the theory of 3-dimensional manifolds.

Refreshments will be served at 3:45
in the math department lounge.



The OLIVER CLUB

presents

Siye Wu

Institute for
Advanced Study,

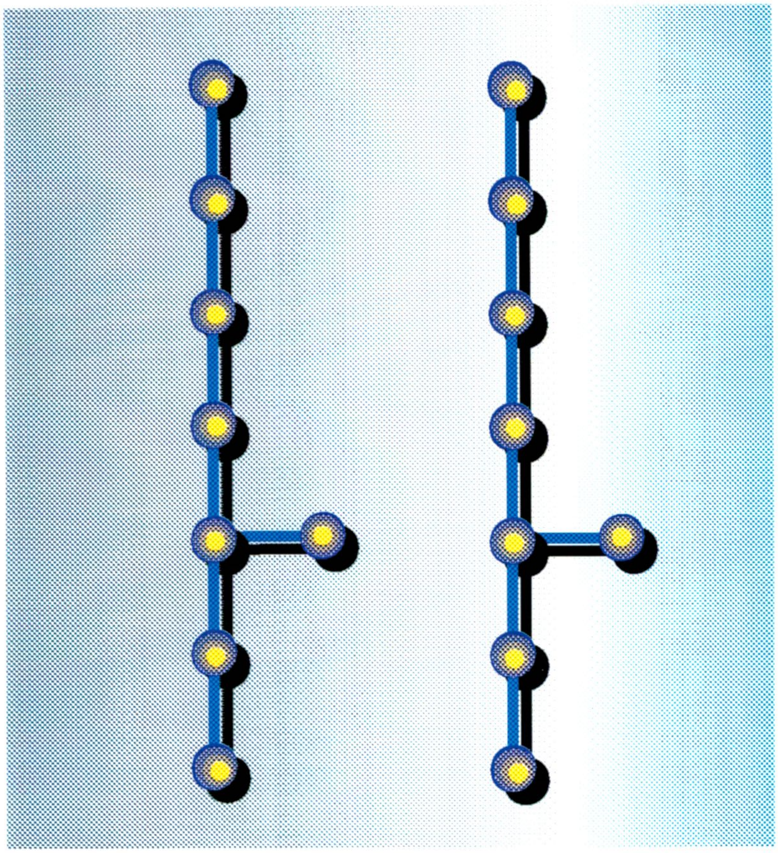
Thursday, April 17
4:15 p.m.
328 White Hall

Equivariant Holomorphic Morse Theory

Abstract

Morse theory relates the topology of a manifold to the critical points of the functions on it. We compare the usual Morse theory for real functions to a holomorphic setting in which a group acts holomorphically on a Kähler manifold. We establish the holomorphic Morse inequalities and use them to compute the Dolbeault cohomology groups from the fixed-point information.

Refreshments will be served at 3:45
in the math department lounge.



The OLIVER CLUB

presents

Bob Friedman

Columbia University

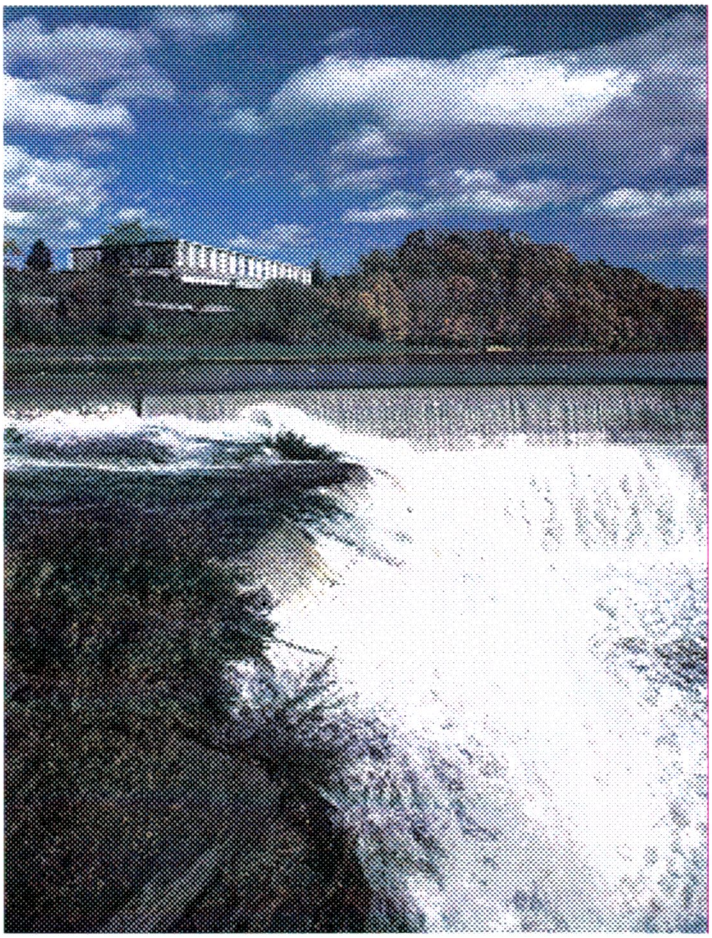
Thursday, April 24
4:15 p.m.
328 White Hall

Vector Bundles and F Theory

Abstract

We discuss recent joint work with Morgan and Witten relating mathematical structures arising from string theory to several quite classical and concrete questions in algebraic geometry. In particular, we describe a method for constructing stable holomorphic bundles with structure group E_8 X E_8 on certain complex three-dimensional manifolds arising in string theory and relate this method to the study of similar objects on elliptic curves and to certain classically studied algebraic surfaces.

Refreshments will be served at 3:45
in the math department lounge.



The OLIVER CLUB
and
The CORNELL
TOPOLOGY FESTIVAL

present

Bruce Kleiner

University of
Pennsylvania

Friday, May 2
4:30 p.m.
Kaufmann Auditorium
Goldwin Smith Hall

The large-scale geometry of spaces of non-positive curvature

In the early 1970's, Eberlein and O'Neill introduced visibility manifolds -- a class of Riemannian manifolds with nonpositive sectional curvature -- and showed that in many respects they resembled hyperbolic manifolds. Their work was a precursor of Gromov's theory of word-hyperbolic groups (the fundamental group of a closed manifold with nonpositive curvature is word-hyperbolic iff it is a visibility manifold), which has had an impact on numerous topics in geometry, dynamics, group theory, and topology. After recalling some background, I will discuss phenomena that can arise when the visibility condition fails, a "higher dimensional" visibility condition that allows one to prove analogs of well-known properties of Gromov-hyperbolic spaces for arbitrary manifolds with nonpositive curvature, and applications. A key ingredient in these results turns out to be the topology of singular limit spaces that one can associate with nonpositively curved manifolds (the limit spaces associated with a visibility manifold are R-trees).