WiMSoCal Symposium

5^{th} Annual Women in Mathematics in Southern California Symposium

October 27, 2012
University of Southern California

Titles and Abstracts

Keynote Address by

Erica Flapan

Pomona College

Topological Symmetry Groups

Chemists have defined the *point group* of a molecule as the group of rigid symmetries of its molecular graph in $\mathbb{R}^3$. While this group is useful for analyzing the symmetries of rigid molecules, it does not include all of the symmetries of molecules which are flexible or can rotate around one or more bonds. To study the symmetries of such molecules, we define the *topological symmetry group* of a graph embedded in $\mathbb{R}^3$ to be the subgroup of the automorphism group of the abstract graph that is induced by homeomorphisms of $\mathbb{R}^3$. This group gives us a way to understand not only the symmetries of non-rigid molecular graphs, but the symmetries of any graph embedded in $\mathbb{R}^3$. The study of such symmetries is a natural extension of the study of symmetries of knots. In this talk we will present results about the topological symmetry group and how it can play a role in analyzing the symmetries of non-rigid molecules.

About the speaker: Erica Flapan received her BA from Hamilton College in 1977 and her PhD from the University of Wisconsin in 1983.

She was a post-doc for two years at Rice University and for one year at the University of California at Santa Barbara. She joined the faculty at Pomona College in 1986. Since 2006, she has been the Lingurn H. Burkhead Professor of Mathematics at Pomona College. In addition to teaching at Pomona College, Flapan has been teaching regularly at the Summer Mathematics Program for freshmen and sophomore Women at Carleton College. In 2010, Flapan won the Distinguished Teaching Award from the Southern California and Nevada Section of the Mathematics Association of America. Then in 2011, Flapan won the Mathematical Association of Americas Haimo award for distinguished college or university teaching of mathematics.

She has done research in knot theory and 3-manifolds. She is also one of the pioneers of the study of the topology of graphs embedded in 3-dimensional space, and has published extensively in this area and its applications to chemistry and molecular biology. In addition to her research papers, she has published an article in the College Mathematics Journal entitled, "How to be a good teacher is an undecidable problem," as well as three books. Her first book, entitled "When Topology Meets Chemistry" was published jointly by the Mathematical Association of America and Cambridge University Press. The second book entitled "Applications of Knot Theory," is a collection of articles that Flapan co-edited with Dorothy Buck. Most recently, Flapan co-authored an elementary textbook entitled "Number Theory: A Lively Introduction with Proofs, Applications, and Stories" with James Pommersheim and Tim Marks, published by John Wiley and sons. She is currently at work on a new book tentatively entitled Knots, Molecules, and the Universe: An Introduction to Topology.

Brandi Bailes, Cal Poly Pomona
Optimization in Baseball Lineups

In major league baseball there is great emphasis put on star performers - finding them, rating them, paying them millions of dollars, and filling the starting lineup with them - with almost no attention given to optimization, statistically or economically. Here, we use the plethora of available baseball statistics to help resolve baseball's optimization conundrum. By using the statistic "Runs Created," based off a combination of several non-fielding baseball statistics, we attempt to find the weakest players who still create a strong enough lineup to meet a desired minimum expected winning percentage against an opposing team. Our work is heavily based on the paper "Quasigeometric Distributions and Extra Inning Baseball Games" by Darren Glass and Philip Lowry. Our contribution is in applying their ideas to optimize starting lineups, and in creating a MATLAB-based routine and user interface that sabermetric-minded managers could use in putting together their starting lineups.

Alona Chubatiuk, USC
Estimation of an unknown probability distribution using stick-breaking priors

We will describe a nonparametric Bayesian (NPB) method for estimating an unknown probability distribution of the parameters of population models. This method is based on a stick-breaking representation of the Dirichlet prior. We discuss the benefits of using the stick-breaking representation and compare the performance of this method with the nonparametric maximum likelihood (NPML) method and a nonparametric Bayesian marginal method based on the Polya urn sampling. Results for some benchmark data sets will be presented.

Amanda Curtis, UC Santa Barbara
Classifying annihilator ideal graphs of commutative artinian rings

In this talk we investigate the annihilating-ideal graph of a commutative ring, introduced by Behboodi and Rakeei. Our main goal is to determine which algebraic properties of a ring are reflected in its annihilating-ideal graph. We prove that, for artinian rings, the annihilating-ideal graph can be used to determine whether the ring in question is a PIR or, more generally, if it is a dual ring. Moreover, with one trivial exception, the annihilating-ideal graph can distinguish between PIRs with different ideal lattices.

Jackie Dewar, Loyola Marymount

Women and Mathematics: A Course and a Scholarly Investigation

The 1978 publication of Math Equals by Teri Perl inspired the development of a course, Mathematics: Contributions by Women, first offered as a general education course and later redesigned for future K-12 mathematics teachers. Evidence gathered from students showed this course promoted the adoption of more expert views of mathematics and prompted resolve to teach equitably. A recent case study of four former students now teaching in LA schools sought to determine how these views and intentions were carried forward into their teaching. The findings led to unexpected questions and reflections about equity in collegiate classrooms and mathematics departments. Information about the course, the study, and the new questions will be presented in this talk. More information is available at http://myweb.lmu.edu/jdewar/wam thanks to funding from the MAA's Tensor Women and Mathematics grant program.

Jacqueline Dresch, Harvey Mudd

Two-layer mathematical modeling of gene expression: Incorporating DNA-level information and system dynamics

High-throughput genome sequencing and transcriptome analysis have provided researchers with a quantitative basis for detailed modeling of gene expression using a wide variety of mathematical models. Two of the most commonly employed approaches used to model eukaryotic gene regulation are systems of differential equations, which describe time-dependent interactions of gene networks, and thermodynamic equilibrium approaches that can explore DNA-level transcriptional regulation. To combine the strengths of each of these approaches, we have constructed a two-layer mathematical model that provides a dynamical description of a gene regulatory system, using detailed DNA-based information, as well as spatial and temporal protein concentration data. For model implementation, we developed a semi-implicit numerical algorithm for solving the model equations and have demonstrated the efficiency of this algorithm through stability and convergence analyses. We test the model using this semi-implicit algorithm to simulate a Drosophila gene regulatory circuit that drives development in the dorsal-ventral axis of the blastoderm embryo, involving three genes. Where protein and DNA-level information is available, our two-layer model provides a method to recapitulate and predict dynamic aspects of eukaryotic transcriptional systems.

Cynthia Flores, UC Santa Barbara
The great wave of translation

Solitary waves are a beautiful phenomenon. They are difficult to produce physically and mathematically. During this expository talk we will describe the Benjamin Ono equation and how it admits solitary wave solutions and some persistence properties of its solution flow.

Selenne Garcia-Torres, USC
Structured Two-Stage Population Model with Migration

A structured population is one where there are consistent differences among the members of the population as a function of some attribute such as age, size, or physiological condition as they develop. Here we partition the population by reproductive maturity. We take two such populations of the same species in somewhat adjacent locations and consider migration between the two locations. When constant breeding and migration is considered we propose simple conditions under which the model has a unique periodic state that is globally attractive with respect to the open first quadrant. These conditions are much simpler than those given by other authors. Results and further work for more than two locations and periodic cases will be discussed.

Kaitlyn Hood, UCLA
Asymptotics and Numerics of Inertial Migration

Inertial migration of neutrally buoyant spheres in microchannels has been well documented experimentally. Asymptotic theory predicts that the lateral force should scale with the radius of the particle to the third power. However, numerical data predicts a power law with exponent three. Using numerical data, we propose an asymptotic theory with a subdominant inertial term, which reconciles these opposing scaling laws.

Weiwei Hu, USC
Feedback stabilization of Boussinesq Equations and Approximation

Theoretical and numerical results for feedback control of the Boussinesq Equations are discussed. The problem is motivated by design and control of energy efficient building systems. In particular, new low energy concepts such as chilled beams and radiant heating lead to problems with Dirichlet, Neumann and Robin type boundary conditions. It is natural to consider control formulations that account for minimizing energy consumption and providing reasonable performance. We discuss a LQR type control problem for this system with Robin/Neumann boundary control inputs and apply the results to a

2D problem to illustrate the ideas and demonstrate the computational algorithms.

Maree Jaramillo, UC Santa Barbara
Smooth Metric Measure Spaces with Bakry-Emery Ricci Curvature Bounded Below

In this talk, we will introduce some well-known results for Riemannian manifolds that relate lower bounds on Ricci curvature to topological invariants of the space. We will then discuss whether or not such results can be extended to smooth metric measure spaces when the Bakry-Emery Ricci curvature is bounded below.

K. Grace Kennedy, UC Santa Barbara
A Diagrammatic Multivariate Alexander Invariant of Tangles

Recently, Bigelow de ned a diagrammatic method for calculating the Alexander polynomial of a knot or link by resolving crossings in a planar algebra. I will present my multivariate version of Bigelow's calculation. The advantage to my algorithm is that it generalizes to a multivariate tangle invariant up to Reidemeister I.

Ashley Klahr, UC San Diego
Embedding Cycles and Bipartite Graphs in $PG(n, q)$

Our work builds from that of Lazebnik, Mellinger, and Vega about the embedding of graphs in finite projective planes. First, we expand on their findings on embedding cycles in $PG(2, q)$ by taking cycles in 2 dimensions and piecing them together to get a cycle in three dimensions. Then similarly we piece together cycles in $n - 1$ dimensions to get a cycle in n dimensions. Additionally, we expand their findings on embedding bipartite graphs in $PG(2, q)$ by looking at bounds for complete bipartite graphs that can be embedded in $PG(3, q)$.

Jaclyn Lang, UCLA
Introduction to p-adic modular forms

This will be an expository talk introducing the ideas of Serre and Hida to define p-adic modular forms. We will trace the development of these notions and indicate how they are used in current problems in number theory.

Elizabeth Leyton Chisholm, UC Santa Barbara
On Linearity of Euclidean Artin Groups

In this talk, I will give an overview of the journey towards a proof that Euclidean Artin groups are linear. I will discuss the history of the question of linearity of the braid groups, go through some aspects of a proof that braid groups are linear, and describe a potential modification to this proof that may extend to a proof that Euclidean Artin groups are linear.

May Mei, UC Irvine
Forbidden Symmetries: Modeling Quasicrystals

The Nobel Prize-winning discovery of quasicrystals has spurred much work in aperiodic sequences and tilings. One such example is the family of one-dimensional discrete Schrodinger operators with potentials given by primitive invertible substitutions on two letters, which are a one-dimensional model of quasicrystals. We prove results about spectral properties of these operators using tools from hyperbolic dynamics.

Deanna Needell, Claremont McKenna College, Claremont
Robust image recovery via total-variation minimization: A story through pictures

Compressed sensing is a new field which shows that reliable, nonadaptive data acquisition, with far fewer measurements than traditionally assumed, is possible. In this talk we will introduce the fundamental ideas behind compressed sensing, as well as new results for image compression and reconstruction via total variation. The talk will be motivated primarily through images, and includes one example in particular that highlights a new shift in the role women play in the field of image processing.

Cynthia Northrup, UC Irvine
Forcing a model in which $\diamond$ Fails

Introduced by Paul Cohen to prove the independence of CH and AC, forcing is used to extend a transitive model M by adjoining a new set G in order to obtain a larger transitive model M[G] called a generic extension. Our choice of partial order, or notion of forcing, determines what is true in the generic extension. I will present an introduction into the Prikry and Radin forcings, as well as an intuitive idea of a $\diamond$-sequence. We are interested in using an iteration involving Radin forcing in order to obtain a model of the failure of $\diamond$.

Lucy Odom, Cal State Fullerton
Dendritic Cell Based Immunotherapy for Melanoma

Dendritic cells (DC) are important immunostimulatory cells that facilitate antigen transport to lymphoid tissues and provide stimulation of cytotoxic T lymphocyte (CTL) cells. In this paper, we attempt to understand the details of the regulation and kinetics of the DC-CTL interaction in the DC-based immunotherapeutic treatment of human melanoma cancer. We study a previously defined model, which integrates dendritic cell populations in the blood, spleen, and the tumor. Ultimately, we are interested in applying analysis of the model towards higher rates of efficacy of DC treatment. (In joint work with Aparna Sarkar)

Aparna Sarkar, Pomona College
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Katie Walsh, UC San Diego
The Coefficients of the Colored Jones Polynomial

The colored Jones polynomial is a generalization of the Jones polynomial, a knot invariant. I will define the polynomial a few different ways and discuss its conjectured connection to the volume of the knot (i.e. the Hyperbolic Volume Conjecture). I will also discuss some recent results by Armond and Dasbach as well as Garoufalidis and Le about patterns in the coefficients of the polynomial and some conjectures about patterns in the coefficients that relate to the volume.

Liming Wang, Cal State LA
SAT – a critical quantity for noise attenuation in feedback systems

Feedback modules, which appear ubiquitously in biological regulations, are often subject to disturbances from the input, leading to fluctuations in the output. Why are there multiple feedback loops in biological systems? What are their functions? Do they affect a system's noise property? In this talk, we will answer these questions by introducing a critical quantity: SAT (the signed activation time) that dictates the noise attenuation capability in feedback systems. Our findings suggest that the inverse relationship between the noise amplification rate and the signed activation time could be a general principle for many biological systems regardless of specific regulations or feedback loops.

Katarzyna Williams, USC
Distribution of Visits to Balls in a Mixing Dynamical System

We study the statistical properties of hitting times within a dynamical system with polynomial decay of correlations. We show that visits to a metric ball follow an almost Poisson distribution with the error terms converging to zero as the radius of the ball is sent to zero.

Laura Zirbel, UC Santa Barbara
Knotting in a New Model for Self Avoiding Random Walks

We describe a new, ergodic algorithm to generate random walks of specified thickness in $\mathbb{R}^3$, and will outline the proof of ergodicity. We will then use the data resulting from our implementation of this method to describe the relationship between the presence and nature of knotting and length, thickness and shape of the random walk.