All events are on the second floor of the JMU HHS Building

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James Madison University Department of Mathematics and Statistics, College of Science and Mathematics, Office of the Special Assistant to the President for Diversity, Office of Admissions at JMU, Pi Mu Epsilon, and Mathematics and Statistics Club

Contributions of books, puzzles, games, and other prizes from the following sponsors of SUMS:

Schedule

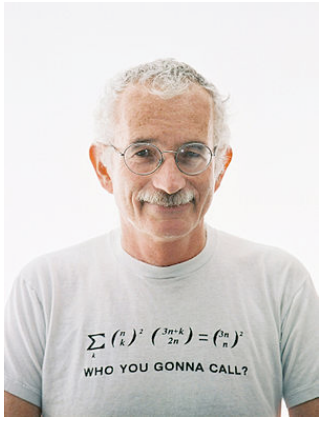
9:00-10:00 Registration and Breakfast *2nd floor hallway*

If you have not registered online, please visit the registration table in the foyer and sign in. If you pre-registered then you can find a printed nametag at the registration table.

Poster presenters should go to room 2201 at this time to check in.

Be sure to stick around until the end of the day for the Prize Session! Every student presenting a talk or poster who attends the Prize Session will receive a prize, the winners of the poster competition will be announced, and there will even be a few prizes for the audience.

10:00-11:00 Opening Address *room 2301*



SUMS

Dr. Doron Zeilberger
Rutgers University

Summary: Some Sums sum, some do not seem to sum. Why?

While Doron Zeilberger has worked on many topics, his work on Sums is the Summit of his research.

Dr. Zeilberger received his doctorate from the Weizmann Institute of Science in 1976, and has made numerous important contributions to combinatorics, hypergeometric identities, and q-series. Zeilberger gave the first proof of the alternating sign matrix conjecture, noteworthy not only for its mathematical content, but also for the fact that Zeilberger recruited nearly a hundred volunteer checkers to "pre-referee" the paper. Together with Herbert Wilf, Zeilberger was awarded the American Mathematical Society's Leroy P. Steele Prize for Seminal Contributions to Research in 1998 for their development of WZ theory, which has revolutionized the field of hypergeometric summation. In 2004, Zeilberger was awarded the Euler Medal; the citation refers to him as "a champion of using computers and algorithms to do mathematics quickly and efficiently." Wikipedia

11:10-11:25 Parallel Undergraduate Talks I *(choose one of four talks)*

2210 ***The Protocol Paradox of Approval Voting***
Sarah Kunkler, College of William and Mary

In approval voting, the outcome is not a function of the preferences alone; the preference protocols chosen rival the individual preferences in determining the outcome. This inconsistency creates a difference in outcomes. Through simulations, I found that the resulting paradox occurs quite frequently which questions the functionality of approval voting.

2209 ***Generalized Dihedral Groups and Geometry***
Barbara Brown, University of Mary Washington

Given any abelian group G, the generalized dihedral group of G is the semi-direct product of $C_2 = \{\pm 1\}$ and G, denoted $D(G) = C_2 \ltimes_\varphi G$. We will characterize the abelian generalized dihedral groups, and then we will dihedralize the abelian groups up to order 15 as well as **R** and characterize them algebraically.

2204 ***Numerical Modeling and Analysis of Fluid Structure Interaction in Biological Systems***
Avis Foster, George Mason University

Using a wave equation and boundary conditions derived from a combination of Fourier series, a spring-mass equation, and a simplified Navier-Stokes Equation, a method of lines numerical approach was created to obtain solutions to a model problem that predicts the behavior of the arterial wall.

2203 ***Separating Signals With Independent Component Analysis***
Jamey Szalay, James Madison University

For this undergraduate research, we present methods of separating linear combinations of independent signals. In particular, we will discuss 4th order cumulant tensor based algorithms.

11:30-11:45 Parallel Undergraduate Talks II *(choose one of four talks)*

2210 ***The Commutant of the Tridiagonal Pattern***
Olivia Walch, College of William and Mary

Several properties of the set of patterns that allow commutativity with the tridiagonal pattern are discussed (along with their applications to other patterns whose graphs are trees), and the concept of a "minimally sufficient set" is introduced.

2209 ***Harmonic Maps on Cayley Graphs and Compactification***
Robert Abramovic, Johns Hopkins University

On Cayley graphs, we compare general harmonic maps to those induced by group homomorphisms and relate this to algebraic group structure. Introducing graph Floyd compactification, we explore its relationship with the Dirichlet problem. Furthermore, we compare graph boundaries up to homeomorphism, giving applications to the hyperbolic groups of M. Gromov.

2204 ***Analysis of 3D Potts Model Monte Carlo Simulation of Crystalline Grain Growth***
Josh Snyder, George Mason University

The Potts Model Monte Carlo simulation is a popular tool for modeling grain growth in polycrystalline materials. Better understanding of these processes can lead to technological advances. The goal of this work is to analyze coarsening rates during microstructure evolution and compare the Monte Carlo model to other existing models.

2203 ***Numerical Estimates of Temperature Changes Using Finite Difference Methods***
Elizabeth Bernat, University of Mary Washington

We studied the diffusion of heat energy through conduction in a two-dimensional region. To do this, we used the finite difference method with successive over-relaxation iteration to approximate solutions to Laplace's equation, also known as the steady state heat equation.

11:50-12:05 Parallel Undergraduate Talks III *(choose one of four talks)*

2210 ***AYO/MANCALA***
Reginald Ford, David Melendez, Juan Ortega, and Melinda Vegara, James Madison University

We investigate the ways in which one can win sowing games like Mancala, Ayo and others. We developed an "unplay" algorithm and used pruning mechanisms to generate game trees.

2209 ***An asymptotic for class numbers of positive fundamental discriminants***
Hudson Harper, University of South Carolina

In this talk I will discuss a conjecture of Gauss on the class numbers of real quadratic fields. In particular we focus on fields of positive fundamental discriminant. Using genus theory and the theory of binary quadratic forms combined with numerical experiments, we improve upon previous asymptotics for class numbers.

2204 ***Modeling Phase Separation in Ternary Alloys***
James O'Beirne, George Mason University

We examine a type of phase separation, nucleation, which occurs after an alloy is quenched. Nucleation is characterized by the formation of discrete droplets of an individual material throughout the domain; this process weakens the composition of the material. We simulate this phenomenon using the Cahn-Morral model and numerical continuation.

2203 ***Retrieving Economic Parameters of Asset-Flow Equations***

Marlene Ouayoro, George Mason University

This research attempts to replicate the observed price points of financial instruments by modeling with the Caginalp-Balenovich differential equation. We fit the equation to the observed curve using the Gauss-Newton Method to estimate the initial parameters and initial values of the data.

12:10-12:25 Parallel Undergraduate Talks IV *(choose one of four talks)*

2210 ***Prove that Sum: W-Z verses Counting***
Samantha Dahlberg, Grand Valley State University

There are many ways to prove mathematical identities. In this talk, two very powerful methods will be presented, the W-Z method and combinatorial (counting) arguments, both of which are short and elegant proofs. We will compare and contrast the strengths and challenges of these two methods.

2209 ***A Look at the ABC Conjecture via Elliptic Curves***
Beihua Yan, University of Virginia

There are close connections between elliptic curves and ABC triples. Two important results are proved. The first gives a method for finding new ABC triples. The second states conditions under which the power of the new ABC triple increases or decreases. Algorithms stemming from these two results will be presented.

2204 ***Mathematical modeling of the nociceptive withdrawal response of the tail in spinalized rats***
Nina Bence and Glenn Young, James Madison University

Our goal was to quantify biomechanical contributions to the tail withdrawal response in rats by modeling the tail as a spring-mass system. The 11-segment model incorporated mass, length, rotational elasticity and damping between each segment. Results suggest the direction and magnitude of response are influenced by neural and biomechanical factors.

2203 ***Parameter Estimation in a System of Differential Equations***
Franz Hamilton, George Mason University

Given data points and a system of differential equations, the objective is predicting future values. Differential equations often have unknown parameters. Discovering the value of the parameter(s) so that future predictions can be made is the challenge. We explore this concept using the shooting method along with the Gauss-Newton method.

12:30-2:00 Lunch and Poster Session *2nd floor hallway and foyer*

Lunch: Those who registered for SUMS online can pick up box lunches from the registration/food area starting at 12:30. Poster presenters and judges should jump to the front of the line to collect their lunches quickly. At 1:00, those who did not reserve a lunch may take a box lunch if any remain.

Poster Session: Students will be near their posters to answer questions during the lunch period. Stop by and see their excellent work! Poster judging will start at 1:00.

Pebbles in Graph Theory
Cameron Atkins, James Madison University

Ill posedness of the backward heat equation
Joseph Bae

Microarray and Meta-analysis on Bordetella avium
Melissa Bechard and Victoria Stratton, James Madison University

Trigonometric Functions
Patricia Bellew, James Madison University

Solutions to Laplace's Equation in Modeling Heat Conduction
Kathryn Christian, University of Mary Washington

Topological Demons: Recycled IN 3-SPACE!
Samuel DuVal, James Madison University

Math in Games
Kaira Ewald, James Madison University

AYO/MANCALA
Reginald Ford, David Melendez, Juan Ortega, and Melinda Vegara
James Madison University

Signal Processing and Acoustic Data
Leah Haling, James Madison University

Vega Estimation
Ryan Harter, James Madison University

A Mathematical Solution to Sudoku
Rachel Kozlowski, James Madison University

Diffusion on a Grid
Jonathan Legendre, James Madison University

The Music of Physics
Kyle Miner, James Madison University

Where Are the Mathematicians in the Math Curriculum?
Kirsten Poland, James Madison University

Writing Fractions the Egyptian Way
Jessica Remmes, James Madison University

Compartmental model for the transmission of pandemic H1N1/09
Cory Simon, University of Akron

Analysis on Fractals - Orthogonal Polynomials on the Sierpinski Gasket
Elizabeth Tuley, Univeristy of Maryland

Series and Sequences
Jason Von Hoene, James Madison University

Knots and Unknots
Jesse Wagner, Indiana University of Pennsylvania

Allocation of Monetary Resources in HIV infected Community
Immanuel Williams, University of Maryland Baltimore County

AMC Workshop

From 2:00-3:40 a workshop on preparing for high school AMC mathematics competitions runs concurrently with the afternoon SUMS program, in room 2208, for interested high school students, parents, and faculty.

2:00-2:15 Parallel Undergraduate Talks V *(choose one of four talks)*

2210 ***Comparison of Priors for Estimation of Binomial Parameters***
Dallas Joder, James Madison University

Using computer simulation, the performance of five priors at Bayesian estimation of binomial parameters were compared in terms of coverage and confidence interval length. Methods of comparison and the applicability of informative priors to practical research are discussed.

2209 ***Unraveling Untangle***
Lydia Garcia and Kylie Robillard, St. Mary's College of Maryland

We explore an impartial combinatorial game called Untangle. Players take turns making Reidemeister moves on a projection of the unknot, until it is untangled. Our results cover winning strategies for some families of games.

2204 ***Compartmental model for the transmission of pandemic H1N1/09***
Cory Simon, University of Akron

The H1N1/09 influenza virus differs from seasonal influenza in its greater prevalence among younger individuals. We propose an age-dependent compartmental model for disease transmission that captures this phenomenon. The model incorporates data describing the sociological interaction between different age groups, separating sociological and biological contributions to the disease transmission rate.

2203 ***Field-Induced Motion of a Ferrofluid Droplet through Immiscible Viscous Media***
Satyasheel “Monty” Korpe, Virginia Tech

The effect of applied magnetic fields on motion of a ferrofluid droplet through immiscible viscous media. The droplet is assumed to be a solid sphere under Stokes Flow, and the magnetization is described by a Langevin Function. Travel time is simulated using Numerical Methods.

2:20-2:35 Parallel Undergraduate Talks VI *(choose one of four talks)*

2210 ***Exchange Rate Behavior***
James Manning, University of South Carolina

This project examines Olympic host nations’ exchange rates relative to a basket of world currencies during the games. Using Geometric Brownian Motion model, data suggests that, generally, U.S. currency remains stable when hosting, while foreign hosts’ change. Multinomial logistic regression on aggregate economic data predicts direction of movement surprisingly well.

2209 ***Multivariate Tutte polynomial of graphs and HOMFLYPT polynomial of links.***
Robert Bradford, Ohio State

Theorems of F. Jaeger and L. Traldi relate the HOMFLYPT polynomial of links to the Tutte polynomial of graphs by substituting a double edge tangle on each edge of the graph. We generalize the theorem to a larger class of links using operations that correspond to addition and multiplication of tangles.

2204 ***Traveling Wave Dynamics of Dengue Fever***
Andrea Faatz, The College of William and Mary

Dengue Fever is a significant world health issue. For effective public health planning, an understanding of disease spread dynamics is needed. Traveling waves of infection, emanating from Bangkok, have been observed from Thailand’s epidemiological data. We model Dengue movement with a multi-patch system of equations and observe similar traveling waves.

2203 ***Panel Session on REUs and Summer Programs***
Robert Abramovic, Johns Hopkins University
David Melendez, James Madison University
Dr. Kane Nashimoto, James Madison University

Want to find out more about Research Experience for Undergraduates programs and other summer opportunities in mathematics? Find out how to apply and what to expect, from students and faculty who have participated in such programs.

2:40-2:55 Parallel Undergraduate Talks VII *(choose one of four talks)*

2210 ***Phase Field and Atomistic Modeling of Grain Boundaries***
Michael Atkins, George Mason University

Grain Boundaries are of paramount importance in Materials Science; thus, the ability to accurately describe their behavior and extract material properties from their behavior is important. In this talk we present a continuum model of a grain boundary and compare it to a well studied atomistic model.

2209 ***The second order coefficient of the ascending or descending Conway Polynomial for virtual knots as a determinant.***
Theodore Dokos, Ohio State University

The second order coefficient of the Conway Polynomial for real knots can be expressed as the determinant of a matrix through the Matrix Tree Theorem. We generalize to the Ascending (and Descending) Conway Polynomials for virtual knots using a Directed Matrix Tree Theorem.

2204 ***Allocation of Monetary Resources in HIV infected Community***
Immanuel Williams, University of Maryland Baltimore County

A mathematical model was created to simulate an HIV outbreak in a third world country with a community-based economy in which monetary resources. This model is used to gain intuition to potentially inform policy decisions on how to allocate monetary resources between the infected providers and infected consumers.

2203 ***Panel Session on Graduate School in Mathematics and Statistics***
Dr. Pam Arroway, North Carolina State University
Dr. Randall Helmstutle, University of Mary Washington
Dr. John Ong, Mary Baldwin College

What is graduate school really like? How do you apply? What schools should you consider? How important is the GRE subject test? Find out from this panel of students and faculty members.

3:00-3:15 Parallel Undergraduate Talks VIII *(choose one of three talks)*

2210 ***Computer Model of Gravitational Lensing Systems***
Philip Naudus, George Mason University

In order to reverse the distorting effects of gravitational lensing, we numerically solve the gravitational lens equation (in reverse) to map images back onto the plane of the source galaxy. Our method found the distribution of dark matter in the lensing galaxy and determined properties of the source galaxy.

2209 ***Geometric Covering Spaces of Julia Sets***
Tarik Aougab, University of Pennsylvania

We define the notion of a geometric covering space and apply it to the Basilica Julia set, classifying geometric double covers of the Basilica up to isometry. Furthermore, We construct periodic infinity-fold covers and analyze the spectrum of the Laplacian on these covers.

2204 ***The framework of solving an optimization problem***
Yichen Zhou, University of Virginia

In this presentation, we will take a simple look at a typical dynamic optimization problem. We introduce two methods to get the optimal solution: one involves the application of general derivative and convex projection theorem, and another involves Lagrangian multipliers and the existence of optima is proved by Kuhn-Tucker Theorem.

2203 ***Panel Session on Careers and Industry in Mathematics***
Dr. Greg Coxson, Technology Service Corporation
Dr. Ralph Wojtowicz, Metron, Inc.
Dr. Paul Schuette, US Food and Drug Administration

What can you do with a math degree? What kinds of companies value mathematical talent? Find out from this panel of people with experience using mathematics outside of academia.

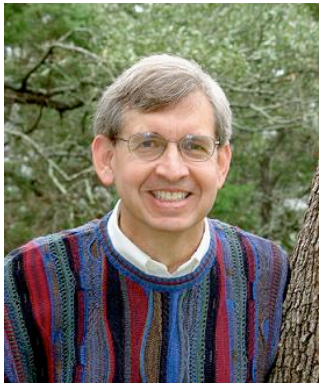
3:15-3:45 Afternoon Tea *2nd floor hallway*

Please join us for tea, coffee, and tasty treats in the HHS foyer. This is your last chance to enter the M&M contest!

3:45-4:00 Prize Session *room 2301*

After tea please join us in congratulating all of our student presenters and the winners of the poster competition and the M&M contest.

4:00-5:00 Closing Address *room 2301*



The Fourth Dimension

Dr. Michael Starbird
University of Texas at Austin

The fourth dimension sounds eerie, mysterious, and exciting; and it is. Untying knots, stealing gold bricks from closed iron safes, unfolding hypercubes and linking spheres are all part of the journey. We are transported to this abstract domain by a powerful method of creating ideas, namely, thinking insightfully about the world that we know well. A deep understanding of the simple and familiar is the key to exploring the complex and mysterious, and the fourth dimension illustrates that principal magnificently.

Michael Starbird received his B.A. degree from Pomona College and his Ph.D. in mathematics from the University of Wisconsin, Madison. He has received more than a dozen teaching awards including the Mathematical Association of America's 2007 national teaching award. He is a popular lecturer, having presented more than a hundred invited lectures since 2000. Starbird's books include, with co-author Edward B. Burger, the award-winning mathematics textbook for liberal arts students "The Heart of Mathematics: An invitation to effective thinking" and the trade book "Coincidences, Chaos, and All That Math Jazz: Making Light of Weighty Ideas." With David Marshall and Edward Odell he co-authored "Number Theory Through Inquiry." His Teaching Company video courses in the Great Courses Series include "Change and Motion: Calculus Made Clear", "Meaning From Data: Statistics Made Clear", "What are the Chances? Probability Made Clear", and "Mathematics from the Visual World". These courses reach tens of thousands of people in the general public annually. In 1989, Starbird was UT's Recreational Sports Super Racquets Champion.