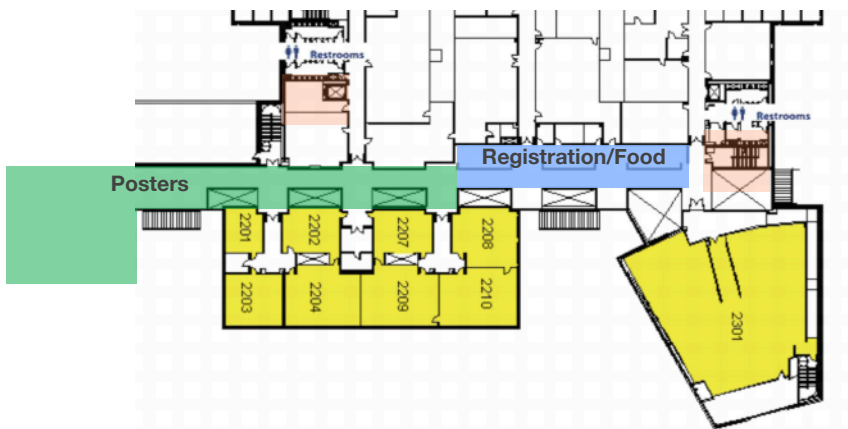


All events are on the second floor of the JMU HHS Building



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 check in to room 2201 now.

Be sure to stick around for the Prize Session at the end of the day; all talk and poster presenters and all volunteers will be awarded prizes at the session.

10:00-11:00 Opening Address

auditorium 2301



Geometry Old and New: From Euclid to String Theory

Dr. Robert Bryant
Director of the Mathematical Sciences Research Institute (MSRI)

Classical geometry is based on notions of symmetry and congruence, and these ideas, while very old, have deeply influenced our understanding of the physical world. The idea of modeling the world through principles of least action or least energy are tied to symmetry in deep ways. In this talk, I will survey the history of how this relationship was uncovered by mathematicians such as Euler, Gauss, Lie, and Noether and is still developing in our modern understanding of the world, from Einstein's theory of relativity even to contemporary versions of string theory.

Support for the Shenandoah Undergraduate Mathematics and Statistics Conference is provided by:

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

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



11:10-11:25 Parallel Talks Session 1*(choose one of six talks)***2203 Frobenius Modules and Generic Polynomials**

Anthony Sanchez, Arizona State University

In this presentation, we examine the group of units $G = E^*$ of any finite dimensional associative algebra E over the finite field F_q , and prove that we can always explicitly construct G -generic polynomials in $F_q(t_1, \dots, t_n)[X]$, where $n \leq \dim(E)$, using Matzat's theory of Frobenius Modules.

2204 Hyperplane Arrangements and GKZ Systems

Paxton Turner, Louisiana State University

The purpose of the project is to study and find relationships between two families of DE arising from hyperplane arrangements - GKZ (Gelfand-Kapranov-Zelevinsky) Systems and Gauss-Manin Connections. We focus on the arrangements of points in the complex line and lines in generic position in the complex plane.

2207 Estimating Explained Variation for an Underlying Linear Model Using Logistic RegressionCaroline Hollingsworth, James Madison University
Amanda Miller, James Madison University

Our goal in this research is to find the explained variation for the underlying linear models using the logistic model. We propose a two stage nested model for estimating ρ^2 using R_L^2 and Monte Carlo simulation methods were used to estimate the parameters of the model.

2208 Feasibility For LMI Constraints

Bryan Karlovitz, West Chester University

We present an algorithm for solving the convex feasibility problem with linear matrix inequality constraints.

2209 Modeling Fitness of *Onthophagus taurus*: The Effects of Density on Mating SuccessEmily Cate, James Madison University
Theresa Dalmut, James Madison University

Male *Onthophagus taurus* dung beetles have a characteristic dimorphism that leads to differing reproductive strategies. The effect of varying density on male mating success was measured with the use of simulation software. Minor mating success was more advantageous over major mating success under lower density conditions.

2210 Minimizing Surface Area of Bubbles and Bubble Films

Charles Rong, Winston Churchill High School

Bubbles, besides being fun to play with, have interesting physical and mathematical properties. They will adopt the shape of minimal energy, and therefore minimal surface area for a given volume. We study efficient ways to divide a rectangle into three equal areas and provide estimations for rectangles of various shapes.

11:30-11:45 Parallel Talks Session 2*(choose one of six talks)***2203 Constructive Proof of the Cubic Case of Kronecker-Weber**

Michael Mudarri, Hood College

The Kronecker-Weber theorem implies that the splitting field of a cubic polynomial f with rational coefficients is contained in a cyclotomic field. I will discuss an algorithm for representing the roots of f as cyclotomic numbers using the cubic formula and classical facts from the theory of cyclotomy.

2204 How To Win Every Time

Morgan Brown, University of Mary Washington

The focus of this project was to investigate numerical solutions to the wave equation. By creating this model, we gain a better understanding of subjects from earthquakes to stringed instruments, but in particular this project focused on developing a sure way to beat a carnival game.

2207 On the Gamma-Half Normal Distribution and its Applications

Kristen Knight, Austin Peay State University

The gamma-half normal distribution is found to be unimodal and bimodal. Results for moments, limiting behavior, mean deviations, Shannon entropies, and Fisher information matrix are provided. The method of maximum likelihood estimation is proposed for estimating the model parameters. Real data sets are used to illustrate applications.

2208 Global Dynamics of Pulse-Coupled Oscillators

Ryan Gryder, College of William and Mary

This research took a previously constructed numerical technique which rigorously proved the existence of fixed points and connecting orbits for a dynamical system of three oscillators coupled via a directed 3-cycle and automated the algorithm to allow for arbitrary parameters such as heterogeneous coupling strengths and different network topologies.

2209 Optimal Strategies for Arrival and Departure for *Onthophagus Taurus*Jennifer Roth, James Madison University
Lauren Taylor, James Madison University

Onthophagus taurus is a species of dung beetle that displays a characteristic male dimorphism. Due to the short time period that dung pads are available, arrival and departure times are key in determining reproductive success. We mathematically analyzed dispersal strategies, and determined an optimal strategy.

2210 Disturbing Patterns in Knot TheorySeong Ju (Charlie) Kim, James Madison University
Ryan Stees, James Madison University

What is a knot? What is the determinant of a knot? What is a spiral knot? We will discuss strange patterns that occur in the determinants of spiral knots and results we've discovered thus far. Finally, we will pose some open questions on this topic.

11:50-12:05 Parallel Talks Session 3

(choose one of six talks/panels)

- 2202 **Panel Session on Graduate School**
Nathan Axvig, Virginia Military Institute
N. Rao Chaganty, Old Dominion University
Yu-Ju Kuo, Indiana University of PA
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 faculty members.
- 2203 **The Location of Eigenvalues of Doubly-Cyclic Z_+ Matrices**
Zachary Price, The College of William & Mary
The doubly-cyclic Z_+ matrix is a type of matrix with structure similar to that of a circulant. For a certain classification of such matrices, the half-plane location of their eigenvalues can be fully described.
- 2204 **Static Two-Dimensional Sponge Deformation**
Brianna Lynn, George Mason University
Mauro Rubio, George Mason University
The shape of elastic physical objects can be modeled by partial differential equations. We describe an approach to determine the elasticity parameter of a sponge under compression from experimental measurements. After solving the partial differential equations, we used the Nelder-Mead Method to determine the elastic parameter.
- 2207 **Commutative Calculus on Continuous Functions**
Matt Parker, University of Virginia
Integration and differentiation do not commute; the focus of the talk will be to present a method for deriving and integrating continuous functions which, to the greatest possible extent, commutes with itself.
- 2208 **Self-Stabilizing Algorithms for Minimal Double Dominating Sets**
Traymon Beavers, James Madison University
Michelle Rose, Mount St. Mary's University
Self-stabilizing algorithms play a key role in fault tolerant distributed computing as they account for the inevitable fact that all computers eventually fail and still allow a network to function properly. We propose two distributed self-stabilizing algorithms that result in a minimal double dominating set of nodes., Virginia Military Institute
- 2209 **Accurately Modeling Zooplankton Mortality Rates**
Catherine King, College of William and Mary
Zooplankton are an important feature in marine ecosystem models, as they are the main grazer of phytoplankton and help in recycling materials. Modeling zooplankton dynamics correctly is increasing in importance because zooplankton grazing has been shown to impact critical issues ranging from eutrophication to climate change.

2210 **Braid-Theoretic Approach to Knot Floer Homology**

Michaela Stone, Alfred University

We present a braid-theoretic approach to combinatorially computing knot Floer homology and the transverse invariant. Beginning with the braid word, we algorithmically compute a nice Heegaard diagram which is adapted to this braid. We argue that this algorithm is, in general, significantly faster than the previous algorithm involving grid diagrams.

12:10-12:25 Parallel Talks Session 4

(choose one of six talks/panels)

- 2202 **Panel Session on Graduate School CONTINUED**
This panel began in the previous session. People should feel free to enter or leave during the break as the discussion continues.
- 2203 **Elliptic Curves over the Complex Field**
James Grenier, Radford University
An elliptic curve is a non-singular projective plane curve that when constructed over the complex field is topologically equivalent to a torus. In our project we detailed the necessary mathematical machinery and studied the characteristics of doubly periodic functions set over the complex field, including the Weierstrass P-function.
- 2204 **Differential Harnack Estimates on Non-linear Heat Equations**
Ian Pendleton, University of California Berkeley
Benjamin Fayyazuddin-Ljungberg, Cornell University
Bowei Liu, Princeton University
We discuss differential Harnack estimates for $w_t = \Delta w + a w(\log w)$ and $w_t = \Delta w + c w(1-w)$ on complete manifolds with nonnegative Ricci curvature. The first equation is related to the Ricci flow and gradient Ricci solitons. We improve upon Y. Yang (2008) and deduce sharpness if $a > 0$ or M closed.
- 2207 **Cauchy Riemann Equations for an Associative Algebra**
Winston Spencer Leslie, Liberty University
Minh Nguyen, Liberty University
We study how differentiation of functions of a complex variable may be generalized. In particular, we examine differentiation of functions over an associative algebra. Examples which exhibit parallels with complex-differentiable functions are discussed.
- 2208 **Effects of Momentum Trading on Asset Prices**
Neeraj Vijay, George Mason University
Geometric Brownian motion is a standard model used for asset pricing. We amend this model by factoring in herding effects resulting in cascades of buying and selling amongst the agents being simulated. The resulting large and sudden price moves are similar to those that occur in real financial markets.

2209 **Clustering in the Cell Cycle**

Nathan Breitsch, Ohio University

Clustering occurs when groups of cells synchronize their progress through the cell cycle. A simple feedback model can reproduce clustering. We will investigate this model to learn why clustering occurs and to gain insight into how cells communicate as a population.

2210 **Whitney-Tutte Polynomials of Ribbon Graph N-cables**

Phillip Jedlovec, Vanderbilt University

In this talk, I will demonstrate how successive cablings of a link diagram change its ribbon graph. I will also give a linear recursion on n for the Whitney-Tutte polynomial of the n -cable of any ribbon graph and a simpler recursion for ribbon graphs of alternating link diagrams.

Modeling Steroid Addiction Among Young Athletes in America

Quarail Hale, Norfolk State University

Area Ratios of Squares

Matthew Jobrack, Longwood University

Mathematical Modeling and Analysis of Bio-Heat Transfer in Biological Tissue

Sang Yun Kim, Bridgewater College

On the gamma-half normal distribution and its applications

Kristen Knight, Austin Peay State University

Abu Kebboe-Anthony, St. Mary's College of Maryland

Iron Accumulation in the Cell

Jessica Lunsford, East Tennessee State University

Water Quality Monitoring in Maryland's Tidal Waterways

Christopher Rackauckas, Oberlin College

Mathematical Modeling of the Fluid-Structure Interactions in Cerebral Saccular Aneurysms by Implicit Finite Difference Methods

Joseph Renaud, George Mason University

Invariant Measures for Hybrid Stochastic Systems

Anthony Sanchez, Arizona State University

The Wave Equation in One Dimension

Peter Slattery, University of Mary Washington

Cube Dissection Puzzles

Chris Thatcher, Longwood University

Analysis of the Difference between Perceived and Actual Performance in Developmental Math Courses at Wesley College

Kasey Thompson, Wesley College

What Do Math and LEGOs Have in Common?

Carrie Winterer, St. Mary's College of Maryland

The Making of Pi: Lessons in Approximation

Audrey Wong, Mary Baldwin College

Celia Wu, Mary Baldwin College

Mathematical Modeling of the Symbiotic Relationship between Rhizobium Bacteria and Legumes

Alexandra Zeller, George Mason University

12:30-2:00 Lunch and Poster Session

2nd floor hallway and foyer

Lunch: Those who registered for lunches have stars on their nametags and can pick up lunches near registration at 12:30. Poster presenters may pick up their lunches earlier. At 1:00, those who did not reserve a lunch may take a box lunch if any remain. You may eat in any of the talk rooms or side rooms.

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

Happy Cube Puzzles

Jeffrey Anway, Longwood University

Modeling and Simulation of Piracy Detection off the Horn of Africa

Cameron Armstrong, Virginia Military Institute

Stephen Mascioli, Virginia Military Institute

Catadioptric Sensors: MOSA Mirror's Ultra Wide Field of View

Shalise Ayromloo, St. Mary's College of Maryland

Clustering in the Cell Cycle

Nathan Breitsch, Ohio University

Rotations with Quaternions Through Geometric Algebra

Nathan DiDomenico, James Madison University

Keith Thrasher, James Madison University

Generic Polynomials for Transitive Subgroups of Degree 8 and 9

Bradley Burdick, Ohio State University

A Generalization of Vassiliev's Planarity Criterion

Tyler Friesen, Ohio State University

Athletic Participation and its Time Commitment

Erich Gillespie, Wesley College

AMC Workshop: This year we will not be conducting an AMC Workshop. High school participants should attend their choice of student parallel talks.

2:00-2:15 Parallel Talks Session 5*(choose one of six talks/panels)*

- 2202 **Panel Session on Careers and Industry**
John David, Virginia Military Institute
Matthew Digiosaffatte, Army Capabilities Integration Center
Eva Strawbridge, James Madison University
What can you do with a math degree? What kinds of companies and institutions value mathematical talent? Find out from this panel of people with experience using mathematics outside of academia.
- 2203 **A Relaxation of Steinberg's Conjecture**
Owen S Hill, College of William and Mary
A graph is (c_1, c_2, \dots, c_k) -colorable if the vertex set can be partitioned into k sets V_1, V_2, \dots, V_k , such that for every i the subgraph $G[V_i]$ has maximum degree at most c_i . We show that every planar graph without 4- and 5-cycles is $(1, 1, 0)$ -colorable and $(3, 0, 0)$ -colorable.
- 2204 **A Model for Nosocomial Infections in an ICU**
Andre Kurepa Waschka, North Carolina State University
Using individual based modeling, we create a model for the spread of nosocomial (hospital acquired) infections in Intensive Care Units. By randomly assigning patients' infection statuses and health care workers' contamination statuses, the model shows the possible scenarios for the disease outbreak in an ICU.
- 2208 **Support Vector Machines and the Exterior Point Method**
Anna-Rose Wolff, George Mason University
Support Vector Machine (SVM) learns an unknown function by recognizing underlying patterns within data sets. SVM is used to find the support vectors that contain the most important information about the unknown function. We develop an optimization algorithm for finding support vectors based on an exterior-point method and data decomposition.
- 2209 **Water Quality Monitoring in Maryland's Tidal Waterways**
Christopher Rackauckas, Oberlin College
Our team assessed parameter measurements of the Chesapeake Bay and simulated data to find areas of water quality concern using the Wilcoxon Signed-Rank Test, and ranked the stations. The results showed that overall the bay was in good health, though the simulation questions the applicability of the Wilcoxon Signed-Rank Test.
- 2210 **Analysis of the Two-Player Sowing Game: Dakon**
Luis Parada, James Madison University
Dakon is a two-player sowing game, part of the large group of Mancala-type games. The game of Dakon has some unique properties that make it a one-player game. The so called: winning opening moves. These will be analyzed historically and mathematically to create a better understanding of the game.

2:20-2:35 Parallel Talks Session 6*(choose one of six talks/panels)*

- 2202 **Panel Session on Careers and Industry CONTINUED**
This panel began in the previous session. People should feel free to enter or leave during the break as the discussion continues.
- 2203 **The Tutte-Krushkal-Renardy Polynomial for CW Complexes**
Bradley Burdick, Ohio State University
The Tutte polynomial is a classic invariant defined for graphs. We verify that properties held by the Tutte polynomial generalise to the Tutte-Krushkal-Renardy polynomial. We verify that the free term is the number of spanning trees, that the classical duality identity generalizes, and the existence of an analogous contraction-deletion relation.
- 2204 **Iron Accumulation in the Cell**
Jessica Lunsford, East Tennessee State University
Friedreich's ataxia is a genetic disease that leads to iron accumulation in cells. Using a mathematical model incorporating the cytoplasm and mitochondria, iron regulatory pathways are simulated. The model features processes responsible for iron balance in a healthy cell. Relevance to other iron regulatory disease mechanisms, including cancer and anemia.
- 2208 **Using Maxwell's Equations to Optimize Surface Plasmon Generation**
Dan Weingarten, George Mason University
Our project focuses on developing an optimization algorithm for finding geometric parameters of the grating nanodevice that provides efficient conversion of energy between the Gaussian beam and Surface Plasmon Resonance modes. We will focus on the derivations of the gradients for the optimized criterion from the solution to Maxwell's equations.
- 2209 **Paleoclimatology and Climate Field Reconstruction**
Eric Cawi, George Mason University
In climate change research, it is important to utilize accurate historical temperature approximations. Most methods use proxies such as tree rings to develop their approximations. We study these methods to develop error bounds for the estimates and discover the effect of adding other explanatory variables like carbon dioxide.
- 2210 **Applications of Catalan Numbers**
Xiaotong (Phoebe) Jiang, Sweet Briar College
This research examines the definition, properties, and applications generated by Catalan numbers. The main purpose of this research is to explore how Catalan numbers are applied in a rich variety of combinatorial cases and to produce an accessible write-up that can be understood by undergraduates and nonmathematicians alike.

2:40-2:55 Parallel Talks Session 7*(choose one of six talks/panels)***2202 Panel Session on REUs and Summer Programs**

Selma Elsarrag, Mary Baldwin College
Alan Jamieson, St. Mary's College of Maryland
Ian Pendleton, University of California, Berkeley
George Shakan, University of Wyoming

Want to learn more about Research Experience for Undergraduates programs and other summer opportunities in mathematics? Find out from this panel of students and faculty.

2203 Pebbling Numbers of Samurai Sudoku and Chessboard Graphs

Lisa Borum, Randolph-Macon College

In this talk we will explore graph pebbling applied to Samurai Sudoku, King's Graphs, and Knight's Graphs. A proof that Samurai Sudoku is Class 0 will be presented as well as lower bounds for the pebbling numbers of graphs with edges defined by the moves of the King and Knight.

2204 A Statistical Model to Detect Copy Number Variation

Elizabeth Cangialosi, University of Delaware
Aashish Gadani, University of Maryland College Park

Copy number variation (CNV) occurs when large segments of a genome are duplicated. Using a massive amount of DNA read fragments from *Daphnia pulex*, a species with a known genome, we present a new statistical model that identifies CNV regions. Methods for preprocessing read fragments are also suggested.

2207 Catadioptric Sensors: MOSA Mirror's Ultra Wide Field of View

Shalise Ayromloo, St. Mary's College of Maryland
Abu Kebboe-Anthony, St. Mary's College of Maryland

To capture a wide-angle field of view for photography, and surveillance, catadioptric sensors are developed. Previous studies captured a wide-angle field of view with minimum distortion using catadioptric sensors. However, capturing an ultra-wide field of view is done for the first time.

2208 Surface Plasmon Generation

Kyle Shaw, George Mason University

Developing an optimization algorithm for finding geometric parameters of the grating nanodevice that provide the efficient conversion of energy between the gaussian beam and the surface plasmon resonance modes. We'll be focusing on the geometry update, efficient meshing, and solving Maxwell's equations with the finite element method at each iteration.

2209 Athletic Participation and its Time Commitment

Erich Gillespie, Wesley College

Athletic participation has been a staple in American society, as well as our world's society, for a number of years and its affluence as a contributor to our culture is considerable. This study examined the relationship between athletic participation and academic performance among athletes at Wesley College.

2210 Slide and Swap Permutation Groups

Onyebuchi Ekenta, Washington and Lee University
Paul Jang, Washington and Lee University

We investigate a variation of the famous 15-puzzle that can be played on any 3-regular graph. We classify the resulting permutation groups which results in a general case and one interesting exceptional case. The exception gives a novel and elementary presentation for the simple group of 168 elements.

3:00-3:15 Parallel Talks Session 8*(choose one of six talks/panels)***2202 Panel Session on REUs and Summer Programs CONTINUED**

This panel began in the previous session. People should feel free to enter or leave during the break as the discussion continues.

2203 Automorphism Groups of Directed Strongly Regular Graphs

Chetak Hossain, University of California, Berkeley
George Shakan, University of Wyoming

Two infinite families of vertex-transitive directed strongly regular graphs are described. Transitive automorphism groups of these graphs are determined. The structure of the automorphism groups is a semidirect product of cyclic groups. The relationship between the directed strongly regular graphs and the orbital graphs of their permutation groups is discussed.

2204 Microarray Meta-analysis of Metabolic Syndrome in Rat Kidneys

Keith W. Zirkle, James Madison University
Lauren van Reesema, James Madison University
Jonah Williams, James Madison University

Microarray studies, while expensive, provide an enormous amount of data. When combined with other studies, both sample size and statistical power is increased. We combined 5 studies investigating metabolic syndrome, an umbrella term including hypertension, obesity, and diabetes. We analyzed gene regulation in rat kidneys using a meta-analysis technique.

2207 Modeling and Simulation of Piracy Detection off the Horn of Africa

Cameron Armstrong, Virginia Military Institute
Stephen Mascioli, Virginia Military Institute

A model was developed in order to better understand the capabilities of U.S. naval sea and air assets off the Horn of Africa that are used to combat piracy. This model simulated possible plane routes and pirate detection probabilities based off of realistic operating conditions.

2208 Optimal Digital Elevation Model Estimation

Catherine Watkins, Johns Hopkins University
Konstantina Tsintsifas, Rutgers University

The current method of DEM formation consists of two steps: identification and association of fiducial points, then in the generation step solving for DEM

parameters. We formulate a one-dimensional strategy, whose basis is a minimization problem, which can be used to generate a DEM without the use of fiducial points.

2209 ***Modeling Steroid Addiction Among Young Athletes in America***

Quarail Hale, Norfolk State University

We model the dynamics of illegal steroids use between at-risk individuals, steroid users, steroid users in treatment, and recovered steroid users with a system of nonlinear ordinary differential equations while taking into account relapse and proper steroid prevention education.

2210 ***On Unit Triangle and Square Tilings***

Lisa Piccirillo, Boston College

The tiling completion problem (GoodmanStrauss, 2000) questions the decideability of if some proset of tiles tile a given boundary. We prove that in \mathbb{R}^2 for oriented unit triangle and square tiles the problem is decideable, and give criteria. For unoriented tiles, given a tileable boundary, we give the canonical proset.

3:15-3:55 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 candy corn contest!

3:45-4:00 Prize Session

auditorium 2301

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

4:00-5:00 Closing Address

auditorium 2301



Adventures in Mathmagic Land

Chuck Sonenshein,
Mathematician and Magician

This is a fun filled adventure into the world of math and magic. Charles Sonenshein, the mathematician, will transform into Chuck Sunshine, the magician. All of the magic will contain elements of mathematics. Be prepared for audience participation. The emphasis will be on having fun!