WIMIN 2026 - Abstracts of Student Talks

Morning Talks

Applied Math: Environmental - McConnell B04

11:15 am - 11:30 am: Assessing the Use of High Resolution Planet Satellite Data to Improve Harmful Algal Bloom (HAB) Forecasts in Coastal Systems

Speaker: Cynthia Arguijo (Smith College)

Abstract: Harmful algal blooms (HABs) pose a risk to human and ecological health in waterbodies around the US. In coastal and estuarine waters, these blooms are patchy, and change their extent hourly to daily, often occurring in small tributaries and near shorelines. Current technology used operationally to monitor and forecast HABs at NOAA's National Centers for Coastal Ocean Science (NCCOS) have included satellite ocean color imagery from the 300 m spatial resolution Ocean Land Colour Instrument (OLCI). While these daily images have been useful in initiating HAB forecast models, they often cannot delineate the patchiness of algal blooms. With the release of Planet SuperDove data, which are 3 m in spatial resolution and provided almost daily in most locations, it is possible to improve the initiation of HAB forecasting models and provide more accurate forecasts of bloom transport and extent.

This project aimed to identify how detection of HABs from the Planet satellite differed from OLCI. Satellite data from the York River in Virginia was utilized to compare how a major bloom of Margalefidinium Polykrikoides was captured differently by the Planet and OLCI satellites. Using RStudio and Python, the similarities in structure, location, and amplitude of blooms detected by either satellite were evaluated. The analysis suggests that while blooms detected by Planet and OLCI are very spatially similar, the Planet satellite captures finer definition in the intensity of a bloom due to its smaller pixel size. This difference makes Planet a useful tool to implement for increased detail of HAB detection and forecasting in this region.

11:35 am - 11:50 am: Tracking Water Vapor from the 2022 Hunga Volcanic Eruption Using Satellite Data and the Schoeberl and Dessler Trajectory Model

Speaker: Clare Harned (Smith College)

Abstract: The January 2022 submarine eruption of Hunga Tonga-Hunga Ha'apai in the South Pacific injected more water vapor into the stratosphere than any other event in the satellite record. Hunga water vapor bypassed atmospheric barriers to reach a height of 58 km, increasing the stratospheric water vapor burden by ten percent. In the years following the eruption, researchers have attempted to incorporate Hunga into atmospheric transport and climate models but have found that models with reasonable outputs under standard conditions struggle with Hunga water vapor. In this project we used the Hunga eruption as a case study to test transport and dehydration in the Schoeberl and Dessler trajectory model. We used water vapor measurements from the Stratospheric Water and OzOne Satellite Homogenized (SWOOSH) data set to initialize a Hunga plume in both February 2022 and March 2022 over the model's background water vapor field. After running the model through 2025, we compared its water vapor time series to SWOOSH as well as an SD-WACCM run. We found that the trajectory model and SD-WACCM dehydrate the Hunga plume at remarkably similar rates, while the trajectory model allows for easy tracking of water vapor lost to supersaturation and to the tropospheric and mesospheric boundaries. With regards to transport, the trajectory model is not nearly as well-aligned with SWOOSH or WACCM; the vertical winds we derived from MERRA-2 heating rates carry the Hunga plume too high too quickly even in the first few months after the eruption. As an initial attempt at correction, we normalized vertical winds to conserve mass at each pressure level, and the addition of this physical constraint led to better agreement in vertical transport between the model and satellite data. Ongoing work involves applying more

nuanced corrections to the MERRA-2 wind fields to account for latitudinal differences while also looking at the impacts on model transport from transitioning to the ERA5 reanalysis product or a WACCM wind field output. With an improved trajectory model, we could more accurately assess the long-term stratospheric water vapor perturbation from Hunga and the possible contribution of Hunga-impacted air recirculated from the tropics.

11:55 am - 12:10 pm: Monte Carlo Simulations of Membrane Fouling in Microfiltration Operations

Speaker: Abigail Drumm (Worcester Polytechnic Institute)

Abstract: Microfiltration is a water purification method used by municipal facilities to produce potable water that relies primarily on a size-exclusion mechanism. When a contaminated solvent passes through a membrane filter, unwanted contaminants with diameter larger than that of the membrane pores, such as suspended solids, large bacteria, and proteins, are retained on the membrane. This foulant build-up occludes the area open for fluid flow, impairing the efficiency of filtration operations by decreasing the flux through the membrane over time. Backwashing is a strategy to restore filtration wherein clean water is processed backward through the membrane to dislodge attached foulants. The overarching goal of this work is to determine the optimal backwashing parameters (duration, frequency, and flux) to ensure sufficient membrane recovery without sacrificing more clean water than is needed.

We developed a 2D Monte Carlo model to simulate forward filtration and backwashing through constant pressure, dead-end, flat-sheet membranes, and benchmarked it against lab-scale experiments (Drumm & Bernardi, PRE, 2025). Then, we extended our model to approximate the more complicated hollow-fiber membrane geometry and were able to qualitatively capture constant-flux filtration operations in such systems. Our next step aims to incorporate long-term fouling mechanisms into our model to capture foulant build-up during cake filtration which can lead to biofilm formation.
This research was funded by NSF CBET-2211001.

Graph Theory - McConnell B10

11:15 am - 11:30 am: The Cop Number of Token Graphs

Speaker: Nathaniel Chinman (Brown University), Lucy Stenger (Williams College)

Abstract: Cops and Robbers is a two player vertex-pursuit game played on graphs. In the game, several cops attempt to capture a single robber. The *cop number* of a graph G is defined to be the minimum number of cops needed to guarantee capture of the robber playing on G. Given a graph G and positive integer k, we can construct the *k-token graph of G*. The vertices of the token graph are all the size-k subsets of $V(G)$, and two vertices are adjacent if their symmetric difference is an edge of G. We investigate the cop number of token graphs of various simple graphs, including caterpillar graphs and complete bipartite graphs.

11:35 am - 11:50 am: Domination Number of Token Graphs of Complete Bipartite Graphs

Speaker: Beatrice Pedroni (Williams College)

Abstract: Given a graph G and positive integer k, we can construct the k-token graph of G, $F_k(G)$. The vertices of the token graph are all the size-k subsets of $V(G)$. Two token graph vertices are adjacent if their symmetric difference is an edge of G. We present results fully classifying the domination number of 2-token graphs of complete bipartite graphs, $F_2(K_{n,m})$. We bound the domination number of general k-token graphs of complete bipartite graphs by using maximal degree and independence number.

11:55 am - 12:10 pm: Every Interesting Cubic Graph Has at Least Fourteen Vertices: A New Computer-Assisted Proof

Speaker: Felicia Flores (Wesleyan University)

Abstract: This presentation covers the theory of a new computer-assisted proof I developed for a known result, every interesting cubic graph has at least fourteen vertices. My Alloy specification proves that an intermediate object that I have introduced – an interesting graph skeleton – has at least fourteen vertices. Then, I traditionally prove that this implies that an interesting cubic graph also has at least fourteen vertices. For background, the foundation of this work was formed during a final project for an automated reasoning course offered at Wesleyan University and was completed after the course's conclusion in collaboration with the instructor, Robert Rose. I was motivated by how strenuous of a task it was to write my paper "Every Interesting Cubic Graph Has at Least Fourteen Vertices: A Revised Proof" in collaboration with Karen L. Collins which fills in omitted details of a proof found in the paper "Girth Six Cubic Graphs Have Petersen Minors" by Neil Robertson, Paul D. Seymour, and Robin Thomas. My original contribution to structural graph theory at this time is aimed at incorporating computer-assisted tactics into historic proofs to lay the groundwork for new methodologies that can be utilized to solve open problems in the future.

Algebra - McConnell 101

11:15 am - 11:30 am: Differential Equations and Reversed Dickson Polynomial

Speaker: Upasana Aryal (Knox College)

Abstract: Dickson polynomials constitute an important family of special polynomials with significant applications in algebra, number theory, finite fields, coding theory, and cryptography. Even though it is well-known that the Dickson polynomials of the first kind and second kind satisfy second-order linear homogeneous differential equations, complete derivations of the results are often stated in literature without proof. In this work, we first investigate the differential equations satisfied by Dickson polynomials of the first, second and (k+1)th kinds.

Reversed Dickson polynomials were introduced in 2009 by interchanging the roles of the variable and the parameter of Dickson polynomials. They have mainly been studied in the literature for their permutation behaviour over finite fields, but their differential properties have received comparatively less attention. We therefore investigate reversed Dickson polynomials of the first kind, the second kind, and the (k+1)th kind for their differential properties, and obtain the differential equations satisfied by them.

11:35 am - 11:50 am: Dickson Self-Reciprocal Polynomials

Speaker: Sy Quoc Uy Vo (Knox College)

Abstract: Dickson polynomials of the first kind were introduced by Leonard Eugene Dickson in the 1890s in the context of investigating polynomials that induce permutations of finite fields. They have many notable algebraic properties and are widely used in cryptography, coding theory, and polynomial research. The introduction of Dickson polynomials of the $(k+1)$th kind in 2012 unified earlier approaches and offered new insights into their behavior over different algebraic structures. Self-reciprocal polynomials are polynomials whose coefficients form a palindrome. They play an important role in coding theory, as well as in the development of efficient factorization algorithms. In this work, we investigate self-reciprocal polynomials arising from Dickson polynomials. We give a complete classification of self-reciprocal polynomials over the ring of integers and $\mathbb{Z}_p$, where p is a prime different from 3. We also present our current work in characteristic 3.

11:55 am - 12:10 pm: Transition Matrices for Character Bases of the Symmetric Group

Speaker: Beth Anne Castellano (Dartmouth College)

Abstract: A symmetric function is a formal power series in infinitely many variables that is invariant under permutations of its variables. Symmetric functions have deep connections to the representation theories of GL_n and S_n, and there are many lovely combinatorial relationships among the five classical, homogeneous bases for symmetric functions. Orellana and Zabrocki recently introduced inhomogeneous bases of symmetric functions that evaluate to characters of S_n. These are called the irreducible character basis and the permutation character basis. These new bases are related to longstanding open problems in combinatorial representation theory including the restriction problem and the Kronecker problem.

In our work, we describe combinatorial interpretations for the transition matrices from the permutation character basis to classical bases of symmetric functions. In particular, we use Lyndon words and tableau combinatorics to express the permutation character basis in terms of the homogeneous, monomial, Schur, and elementary bases for symmetric functions.

Applied Math: Biological Sciences - McConnell 102

11:15 am - 11:30 am: Reducing a Multi-Compartment Model of the Populations in the Spinal Dorsal Horn to Single-Compartment Spiking Neurons

Speaker: Fiona Stern (Middlebury College)

Abstract: The spinal dorsal horn is the first site of sensory and pain processing in the central nervous system, and many existing computational models capture its circuitry in rich biophysical detail. However, this level of detail can make models hard to analyze and computationally expensive, raising the question of how much complexity is actually needed to reproduce the circuit's function. We reduced a published dorsal horn model (Medlock et al., 2022) containing hundreds of cells, each modeled by multiple compartments, to a simplified model with only a few neurons, each modeled by a single compartment. To start, we tuned parameters so that individual single-compartment neurons match the firing behavior of the original model's multi-compartment neurons. We then built a minimal excitatory-inhibitory circuit from these reduced neurons and tested it against a functionally important property of the dorsal horn: pain inhibition, the suppression of nociceptive (painful) firing by simultaneous non-painful input. The reduced circuit successfully reproduces this effect, demonstrating that a single-compartment spiking framework can capture key computations of the full model. These findings lay the groundwork for a simpler, more tractable spiking model of the dorsal horn, with future work aimed at testing its behavior under a broader range of circuit conditions.

11:35 am - 11:50 am: Investigating Extensions on a Spiking Neural Network Model

Speaker: Olivia Henry (Williams College)

Abstract: The primary visual cortex of the brain is integral in the processing of sensory information, with individual neuron subtypes playing distinct roles. We use a spatially distributed neural network model to study the role of these neuron subtypes in shaping network dynamics. Our model is composed of four distinct neuron populations: one excitatory (E) and three inhibitory (PV, SOM, VIP) populations, with each neuron modeled as an exponential integrate-and-fire unit. We consider an extension of previous work, periodic input, in an effort to increase its experimental relevance.

We stimulate neuron populations with periodic input, rather than static, providing a novel mechanism for understanding network dynamics. We find that forcing frequency in gamma (20-80 Hz) and beta (10-20 Hz) ranges to E and PV neuron populations entrains the system to oscillate at similar frequencies; however, comparable stimulation of SOM and VIP neurons do not. Prior work identified that patients with schizophrenia have abnormal gamma oscillations within the visual cortex. Our findings implicate PV as a key driver of gamma and beta-band activity and suggest that their dysfunction may contribute to the abnormalities observed clinically. Additionally, these results pave the way for further research examining the impact of SOM neurons on beta oscillations.

11:55 am - 12:10 pm: Modeling Two-Cylinder Hydrodynamics in Biological Flows: Comparing Stokes and Brinkman Regimes

Speaker: JungBin Park (Middlebury College), Weronika Wozny (Middlebury College)

Abstract: Microorganisms drive fluid motion by rotating appendages and beating cilia. In an open, homogeneous fluid these low-Reynolds-number flows are well described by the Stokes equations, but many biological settings, such as mucus, biofilms, and ciliated tissues, are crowded by a porous microstructure that screens the flow and is more faithfully captured by Brinkman flow. We investigate the hydrodynamics of rotating structures in crowded environment Using the Method of Regularized Stokeslets and its Brinkman analogue in an unbounded two-dimensional domain, we compute the induced flow and the torque on dual rotating cylinders. We validate the solver against known analytical results, including the single-cylinder torque, and investigate the effect of varying gap distances between two cylinders.

Discrete Geometry - McConnell 103

11:15 am - 11:30 am: Maximizing Facets and Weighted Counting of Integer Points in Various Polytopes

Speaker: Maya Cox (Wellesley College), Katelyn Zhou (Wellesley College)

Abstract: We will present two projects on polytopes. Symmetric edge polytopes (SEPs) are formed from finite simple graphs. We study how the number of facets of SEPs can be determined from its corresponding graph by counting maximal bipartite subgraphs. We make progress towards determining which graphs on a given number of vertices and edges maximize the number of facets in their corresponding SEPs. Order polytopes are built from partially ordered sets. We derive new combinatorial formulas for computing the weighted count of integer points in dilates of these polytopes and obtain an algorithm which is significantly asymptotically faster than open-sourced SOTA.

11:35 am - 11:50 am: Posets of Hyper (b, t)-ary Partitions are Distributive Lattices

Speaker: Elsa Frankel (Wellesley College)

Abstract: Posets of integer partitions, ordered by refinement, were criticized for unruly structural behavior by both Birkhoff and Ziegler. However, recent work of Propp, McConville, and Sagan demonstrated that such posets of hyperbinary partitions (all parts are powers of two, with at most two of each part) are distributive, with posets of join irreducible elements isomorphic to the well-studied class of fence posets.

We provide a generalization of this result for hyper (b, t)-ary partitions, where all parts are powers of some positive integer b, and multiplicities are restricted to $t \geq b$. Then, we show that posets of hyper (b, t)-ary partitions are indeed also distributive lattices.

11:55 am - 12:10 pm: k-Flat Intersections: Extensions of Radon and Helly-Type Results

Speaker: Sarah Ludwigson (Connecticut College)

Abstract: Radon's theorem and Helly's theorem are two important results in discrete geometry about the intersections of convex sets. In this talk, we will discuss the theorems of De Santis that extend these results to intersections containing affine flats of dimension k, as well as new results that extend variations of Radon and Helly theorems in a similar way. We will specifically discuss an outline of the proof for the generalization of the colorful Radon theorem. This research was done at the NYC Discrete Math REU during the summer of 2026. This is joint work with Pablo Soberón (Baruch College).

Afternoon Talks

Materials Science - McConnell B04

2:30 pm - 2:45 pm: A Spectral Characterization of Perfect State Transfer in Non-Hermitian Tridiagonal Matrices

Speaker: Andrew Rittenberg (University of Hartford), Emily Shteynberg (New York University)

Abstract: In quantum mechanics, the states of quantum particles are described using probability. Perfect state transfer (PST) occurs when a quantum state localized at one site evolves to a target site with probability one. Equivalently, PST from the first site to the N-th site occurs when there exist some time $t > 0$ and $\varphi \in \mathbb{R}$ such that

$$e^{it\mathbf{H}}\mathbf{e}_1 = e^{i\varphi}\mathbf{e}_N,$$

where $\mathbf{H}$ is a Hermitian tridiagonal matrix, and $\mathbf{e}_1$ and $\mathbf{e}_N$ are standard basis vectors corresponding to the first and N-th sites, respectively. A. Kay gave a spectral characterization of Hermitian tridiagonal matrices $\mathbf{H}$ that realize PST. We extend this result to a class of non-Hermitian tridiagonal matrices that arise in models recently studied by physicists (X. Z. Zhang et al., M. Znojil). In particular, we show that these matrices achieve PST exactly when $\mathbf{H}$ is symmetric across the antidiagonal, and the spacings between consecutive eigenvalues λ_k are given by $\lambda_{k+1} - \lambda_k = m_k \frac{\pi}{t}$ for some $m_k \in \mathbb{Z}$ for $k = 1, 2, \ldots, N-1$. We then provide an algorithm for constructing such matrices from some sets of eigenvalues that satisfy the condition.

2:50 pm - 3:05 pm: Director Field and Shape Optimization in Nematic Tactoids

Speaker: Yiting Chu (Mount Holyoke College), Isabella Delmonte (Mount Holyoke College)

Abstract: At equilibrium, droplets of nematic liquid crystals often form spindle-like shapes known as tactoids. We study the optimal shape and director field configuration in such droplets, examining how defect formation and director field orientation change with tactoid width and aspect ratio under tangential anchoring. Furthermore, we provide a parameter study which explores relationships between the ratio of elastic to surface constants and the aspect ratio of the tactoid. Consistent with previous experimental work, we observe uniform, bipolar, and diagonal patterns depending on the tactoid's size and aspect ratio.

Number Theory - McConnell B10

2:30 pm - 2:45 pm: Conjecture of Gross – Fourier Coefficients on G_2 and Cubic Twist L-Values

Speaker: Maya Chang (Boston College)

Abstract: Benedict Gross has a conjecture relating the square roots of the central values of a certain L-function of a cuspidal eigenform f to the Fourier coefficients of the lift of f, to the group G_2, denoted by F. We describe methods to compute the central values of the L-function of f, twisted by a totally real cubic étale algebra E, $L(f \times V_E, s)$. We will provide evidence for this conjecture of Gross via comparison with Fourier coefficients of F on G_2 computed by Aaron Pollack. This is joint work with Michael Hoffman.

2:50 pm - 3:05 pm: Elliptic Curve Cryptography: What and Why

Speaker: Araceli Friedman-Pitti (Smith College)

Abstract: This will be an expository talk on the principles underlying elliptic curve cryptography, as well as the reasons to use it over more traditional RSA-based systems. I will begin with a brief overview of elliptic curves and the group of rational points, focusing on elliptic curves in finite fields. Then, I will explain how elliptic curve cryptography uses the point group in finite fields to encrypt information. Finally, I will discuss the discrete logarithm problem and how elliptic curve cryptography is more efficient than RSA.

3:10 pm - 3:25 pm: Observations on the Minimal Degree of Consecutive Row Sums in the Negative Binomial Expansion Modulo p

Speaker: Halima Dieye (Middlebury College)

Abstract: This research studies the negative binomial expansion modulo a prime (p), $R_j(t) = (1 + t)^{-j}$, and its connection with the Pascal triangle. Using Lucas' theorem, we analyze the generating functions by investigating row sums representing $R_j(t)$ for differing j values and determine their minimal term. When summing p^k rows, explicit formulas are obtained and can be extended to arbitrary number of consecutive rows. These results highlight the relationship between generating functions, modular arithmetic and the the structure of the Pascal triangle.

Music and Math Education - McConnell 101

2:30 pm - 2:45 pm: Calculus Research Study: Statistical Examination

Speaker: Sabrina Wang (Smith College), Yuehan Zhao (Smith College)

Abstract: Although Calculus I and II students at Smith College report comparatively strong self-efficacy and sense of belonging, their mathematical identity – how much they see themselves as "math people" – lags behind both. This gap holds across demographic groups. Drawing on survey and interview data collected from Fall 2024 through Spring 2026, this mixed-methods study examines how sense of belonging, self-efficacy, and mathematical identity develop among Smith College calculus students, with particular attention to students historically underrepresented in mathematics.

Specifically, this study examined differences in the affective outcomes of Smith College students based on factors such as first-generation status, receipt of financial aid, and disability status. It employed statistical tests and regression models, with the visualization of the result. By combining quantitative patterns with students' personal accounts, this study highlights the difference between feeling capable of doing mathematics and seeing oneself as a mathematician. Ultimately, the findings aim to inform improvements to the calculus program and foster a more inclusive mathematical community in which all students can succeed.

This is part of an ongoing research project at Smith College that received IRB approval and started in the Fall of 2024 with the help of Dr. Vasu.

2:50 pm - 3:05 pm: A Statistical Analysis of Attitude: Case Study of Chinese Undergraduates in the US and Western Classical Music

Speaker: Carly Zhang (Mount Holyoke College)

Abstract: One's attitude toward music is a social-psychological phenomenon shaped by individual experiences and sociocultural contexts. Drawing on the ABC Model of Attitude, this study investigates affective, behavioral, and cognitive dimensions of attitudes toward Western classical music among Chinese undergraduates studying at U.S. colleges through a mixed-methods framework. The quantitative component uses survey data to examine how dimensions of musical experience are associated with variation in students' attitudes. Two-sample tests of differences in means, simple linear regression, and forward model selection will be used, with particular emphasis on the relationship between the affective and behavioral components. The qualitative component draws on semi-structured interviews examining students' musical experiences in greater depth. Thematically coded interview data will be analyzed through code-co-occurrence analyses and represented in heat maps to explore associations between affect and cognition, as well as behavior and cognition. Together, the analyses demonstrate how quantitative and qualitative methods can be integrated to investigate the multidimensional structure of musical attitudes.

3:10 pm - 3:25 pm: Modifications to the Spiral Array: Exploring a Computational Approach to Music Analysis

Speaker: Rose Bittle (Smith College)

Abstract: The Spiral Array is a geometric model of musical tonality and exists as a tool in computer-aided music analysis. The model was first published in 2000 by Elaine Chew, PhD, in her thesis, Towards a Mathematical Model of Tonality. This project aimed to restructure the Spiral Array, limiting user ambiguity and optimizing the application of musical key finding. The existing model defines pitch, chord, and key location to form a series of spirals dependent on a set of flexible weights. In our research we were able to identify potential issues with the pitch definitions themselves and experiment with methods of addressing concerns by modifying existing pitch definitions and key algorithms produced by the model's original creator. Additionally, we were able to improve the model's potential for musical key finding by modifying these weights through gradient descent, given parameters derived from the Overtone Series and observations of common tonal practice. Our current model and algorithm allow users to analyze the key center of a musical excerpt in a way that is largely consistent with the overtone series and common tonal practice. This talk will highlight the journey of troubleshooting an existing model, demonstrate our successes, and provide insight into the field of Music Information Retrieval. This talk will also work to demonstrate what it might look like to design an independent research project in the mathematical sciences as an undergraduate student with interdisciplinary interests.

Geometry and Topology - McConnell 102

2:30 pm - 2:45 pm: Building New Families of Einstein Spaces via Lie Algebra

Speaker: Peilin Zhang (Wellesley College)

Abstract: Einstein solvmanifolds are an important class of homogeneous Riemannian manifolds that provide a connection between Lie theory and differential geometry. Recent work by Kerr and Payne introduced a new family of Einstein solvmanifolds coming from attached metric Lie algebras constructed by removing simple roots from affine Kac–Moody Lie algebras. These attached solvmanifolds inherit the Einstein property of the ambient solvmanifold while exhibiting geometric properties that differ from those of symmetric spaces. Their work established the general construction and presented explicit computations for a representative example, which motivates the study of larger families.

My project explores the family of attached Einstein solvmanifolds associated with the special linear Lie algebra $\mathfrak{sl}(n, \mathbb{R})$. The primary objective was to obtain explicit formulas for the mean curvature vector and Ricci endomorphism, providing a detailed description of the curvature of this family. Rather than approaching the general case directly, I first carried out computations for the $\mathfrak{sl}(3, \mathbb{R})$, $\mathfrak{sl}(4, \mathbb{R})$, and $\mathfrak{sl}(5, \mathbb{R})$ cases. For each example, I constructed orthonormal bases adapted to the attached metric Lie algebra, computed the adjoint and J-operators, determined the dual basis of the Cartan subalgebra, and calculated the mean curvature vector and Ricci endomorphism. Comparing these examples showed recurring patterns that naturally extended to arbitrary dimension.

Using these observations, I generalized the computations to arbitrary dimension and higher-order truncations by allowing powers of the polynomial variable t up to degree m, thereby deriving general formulas for the mean curvature vector and Ricci endomorphism on each root space of the attached solvmanifold. These formulas provide a complete description of the curvature for the attached Einstein solvmanifolds associated with $\mathfrak{sl}(n, \mathbb{R})$ and extend the original computations from a single example to the general family. Furthermore, the resulting curvature formulas verify the Einstein condition by showing that

$$\mathrm{Ric}^n - \mathrm{ad}_H = \lambda \, \mathrm{Id}^n,$$

confirming that the curvature computations agree with the Einstein property established by the general Kerr–Payne construction. The approach developed in this project provides a framework for studying attached Einstein solvmanifolds through Lie algebra computations. The resulting formulas also provide a foundation for extending similar curvature calculations to other classical Lie algebras and investigating larger families of attached Einstein solvmanifolds.

2:50 pm - 3:05 pm: Computing the Hilbert Measure for Non-Coregular Representations of the Special Orthogonal Group

Speaker: Belle Roberge (Skidmore College)

Abstract: The elements of the Lie group $SO(m)$ rotate points in the m-dimensional space $\mathbb{R}^m$. Given a collection of k vectors in $\mathbb{R}^m$, the invariant polynomials are generated by the dot products and determinants of these vectors. If we want to integrate a function of these k vectors that is invariant under the $SO(m)$-action, we can take advantage of these invariants to simplify our integral. Specifically, we can change variables to these invariants to reduce the number of variables we're integrating over. In order to do this we need a function called the Hilbert measure that connects the integral in terms of the original coordinates to the integral in terms of the invariants. We will present computations of the Hilbert measure for the cases of k points in $\mathbb{R}^m$ that have a property called non-coregularity.

3:10 pm - 3:25 pm: $\mathbb{Z}$-Orbifold Euler Characteristic of Special Orthogonal Groups Acting on k Copies of Euclidean Space

Speaker: Lyra Eis (Skidmore College)

Abstract: The Euler characteristic is a very important invariant describing the shape of objects with an integer value. This value has many applications that help us understand shapes that are difficult to visualize, and as such many generalizations of it have been made. One such generalization is the $\mathbb{Z}$-orbifold Euler characteristic, which applies to a shape as well as a collection of symmetries; in addition to describing the shape itself, the $\mathbb{Z}$-orbifold Euler characteristic also describes the symmetries that fix individual points.

One common way to describe symmetries in math is with a structure called a group. The group we are concerned with is the set of rotations of Euclidean space, called the special orthogonal group. In this talk we describe the computation of the $\mathbb{Z}$-orbifold Euler characteristic of the special orthogonal group $\mathrm{SO}(n)$ acting on k vectors at once.

Combinatorics and Geometric Topology - McConnell 103

2:30 pm - 2:45 pm: Operations on Web Graphs: Flips, Orbits, and Rotations

Speaker: Julia Steinberg (Smith College), Katarina Peteranderl (Smith College), Wendy Zheng (Smith College)

Abstract: Webs are a type of planar graph that diagrammatically model representations of quantum groups. Graph-theoretic operations on webs correspond to linear algebra operations on the underlying vectors, meaning that linear algebra problems can be solved using combinatorics. Webs naturally arise in fields such as knot theory and topology.

We define strandings on webs as colored, directed edges that form paths through the web according to certain rules. One method for finding all of the strandings of a web graph is to find the global flip orbits of the web. We define orbits, global flips, and single flips, and present work on more efficient methods for finding orbits. We also present conjectures on constructing rotation-invariant web bases.

2:50 pm - 3:05 pm: Minimal Equilateral Triangle Number of Bands with n Half-Twists

Speaker: Sonali Bellam (Smith College), Leo Jurkiewicz (Smith College)

Abstract: We investigate the minimal number of rigid equilateral triangles required to construct bands with n half-twists, denoted F_n. We first consider the Euler characteristic of these bands to establish general structural properties, demonstrating that the number of vertices, boundary edges, interior edges, and faces are equal. As a result we achieve a baseline minimum of 6 faces for any band F_n. We then discuss an upper bound on F_n by describing the construction of annuli with an arbitrary number of twists. Finally, we begin an investigation of constructions within the tetrahedral-octahedral lattice which restricts all dihedral angles in a triangulation to $70.52°$. We conclude with open questions concerning the exact minimum triangle number of these surfaces and the role of geometric constraints within.

3:10 pm - 3:25 pm: Go, Gadgets and Widgets: A Gadget Framework for Shared-Agent 2-Player Games

Speaker: Eliana Lippa (Homeschooled High School)

Abstract: Complexity theory is an area of theoretical computer science which deals with the complexity of certain kinds of yes-or-no questions, often by embedding such yes-or-no question into another. These questions vary from very specific things like "Given a level of Mario, can the player win?" and "Given a game state in Go, can Black win?" to much more abstract scenarios like "Is there a solution to this boolean formula?" or "Is there a path with certain properties in this graph?"

In previous work, a framework known as single-player motion-planning gadgets was developed to aid in the discussion of certain types of these problems, such as whether a Mario level is winnable, along with many other single-player games. These 'gadgets' are state machines, with states that describe where entities entering them leave. This framework naturally leads to the yes-or-no question of whether, given a network of gadgets, is it possible to get from point s to point t, which is useful for proving hardness for such problems.

In this talk, we will we modify this framework to deal with two-player motion-planning gadgets, which we will call widgets. One of the easiest ways to see widgets in action is an interpretation of an old proof by Lichtenstein and Sipser, which addresses the aforementioned question about Go, and serves as our primary example throughout the talk

Algebra and Networks - McConnell 404

2:30 pm - 2:45 pm: Recovering Spatial Position from Cross-Modal Image Correspondences

Speaker: Jayleen Jiang (Mount Holyoke College)

Abstract: Visual localization recovers a camera's 6-DoF pose from 2D–3D correspondences. We extend this to the cross-spectral case: localizing an infrared (IR) image against a 3D map built from RGB video. Our pipeline retrieves candidate frames by embedding images via aggregated local descriptors ranked by cosine similarity. Candidates are verified by enforcing the epipolar constraint via MAGSAC-robust essential matrix estimation, then lifted to 2D–3D correspondences solved with PnP-RANSAC, with a final pose-consensus gate for accept/abstain decisions. We report retrieval quality/runtime trade-offs and end-to-end localization coverage on real indoor sequences, showing how successive geometric checks govern accuracy versus coverage in cross-spectral localization.

2:50 pm - 3:05 pm: Infection Spread on Networks with Finite Contagious Time: A Probabilistic Approach

Speaker: Amina Kanamatova (Smith College)

Abstract: My thesis studies the spread of infection on finite graphs under a probabilistic model with limited contagious time. Each infected vertex remains contagious for two time steps. For a graph with i infected vertices, we define $(P_{ij})_t$ to be the probability that exactly j vertices are infected at time t. We analyze the number of infected vertices and compute the probabilities $(P_{ij})_t$. Results are obtained for several graph families, including path graphs, cycles, stars, and complete graphs. For each, we determine the stabilized distribution of the number of infected vertices and identify how the graph structure influences the spread. We also compare these results with those obtained under the base probabilistic model, in which vertices remain infected and contagious for an infinite amount of time.

3:10 - 3:25 pm Beyond the Odd Cycle Condition: Exploring Cohen–Macaulay Graph Edge Rings

Speaker: Navila Zaman (Connecticut College)

Abstract: Graph toric ideals connect the combinatorial structure of graphs with the algebraic properties of polynomial rings. A graph satisfying the odd cycle condition has a normal, Cohen–Macaulay edge ring, but what happens when this condition fails? This research investigates that question through theoretical analysis and computational experiments in Macaulay2. We examine connected non-bipartite graphs, focusing on small cases, and compare their toric ideals, depths, and binomial generators. We establish a sharp edge threshold: a connected simple graph on $(n \geq 7)$ vertices that fails the odd cycle condition has at most $(\binom{n}{2} - 9)$ edges. This bound restricts the search for graphs whose edge rings may fail to be Cohen–Macaulay. Within this search, our computations show that edge count alone does not determine Cohen–Macaulay status, motivating a closer examination of the generators associated with even closed walks. The research introduces the relevant graph-theoretic and algebraic concepts, presents the threshold result, and discusses ongoing efforts to identify structural patterns that distinguish Cohen–Macaulay from non-Cohen–Macaulay edge rings.