Midstates Consortium for Math and Science

Undergraduate Research Symposium in the Physical Sciences, Mathematics, and Computer Science

Washington University in St. Louis

November 4-5, 2016

Beloit College - Carthage College - Colorado College - Grinnell College
Gustavus Adolphus College - Hope College - Knox College
Lawrence University - Luther College - Macalester College
St. Olaf College - University of Chicago
Washington University in St. Louis

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Friday, November 4

All Friday evening events are at the Sheraton Clayton Plaza Hotel:
7730 Bonhomme Ave., Clayton, MO 63105

5:00-6:30 pm: **Registration**

6:30-7:45 pm: **Dinner buffet**

7:45-8:00 pm: **Greetings**

Prof. Michael Seymour, Director MCMS, Hope College

Prof. John Bleeke, Washington University in St. Louis

8:00-9:00 pm: **Janet Andersen Lecture**

Andrew Beveridge, Professor of Mathematics, Macalester College

"To Catch a Thief: Pursuit-Evasion in Two Dimensions"

9:15 pm: **Group photo**

Saturday, November 5

All Saturday events are at the Laboratory Sciences Building (LSB), Throop Drive, WUSTL campus

7:45 - 8:00 am: **Load Bus and vans - bus departs at 8:00am sharp**
for Washington University campus Groups with cars or vans will drive themselves; the bus is for everyone else. If not staying at the hotel Saturday night, please check bring your luggage.

8:15-9:00 am: **Continental breakfast on campus**

9:00-10:45 am**: Oral sessions**

A - LabSci 250, B - LabSci 300

9:00-9:15 am: A1.1, B1.1

9:15-9:30 am: A1.2, B1.2

9:30-9:45 am: A1.3, B1.3

9:45-10:00 am: **Break and set-up for poster session 1**

10:00-10:15 am: A2.1, B2.1

10:15-10:30 am: A2.2, B2.2

10:30-10:45 am: A2.3, B2.3

10:45-11:45 am: **Poster session 1**

LabSci Rettner Gallery and Floor 3 Hallway

12:00-1:30 pm: **Lunch and panel discussion**

Holmes Lounge

Panel discussion: "Life in Graduate School"

Graduate student panelists:

Gina Tran (Knox, Chemistry)

Tabbetha Bohac (U. of Chicago, Chemistry)

Brian Wieliczka (St. Olaf, Chemistry)

Nicolettte Laird (Knox, Computational and Systems Biology)

Robin Wheelus (St. Olaf, Institute of Materials Science and Engineering)

1:45 – 4:00 pm: **Oral sessions**

C - LabSci 300, D - LabSci 250 , E - Lab Sci 201

1:45-2:00 pm: C1.1, D1.1, E1.1

2:00-2:15 pm: C1.2, D1.2, E1.2

2:15-2:30 pm: C1.3, D1.3, E1.3

2:30-2:45 pm: C1.4, D1.4, E1.4

2:45-3:00 pm: **Break and set-up for poster session 2**

3:00-3:15 pm: C2.1, D2.1, E2.1

3:15-3:30 pm: C2.2, D2.2, E2.2

3:30-3:45 pm: C2.3, D2.3, E2.3

3:45-4:00 pm: C2.4, D2.4

4:00-5:00 pm: **Poster session 2**

LabSci Rettner Gallery and Floor 3 Hallway

5:00 pm: **Meeting concludes; pick up box dinners to go**

5:15 pm: **Bus leaves for Sheraton Clayton Hotel at 5:15 sharp**

2016 Janet Andersen Lecture Award

To Catch a Thief: Pursuit-Evasion in Two Dimensions

Andrew Beveridge
Professor of Mathematics
Macalester College

Abstract: How many guards does it take to catch a thief? It depends on the layout of the building and on the sensory information available to the guards. Do the guards have cameras that track the thief, or can the thief hide to confuse the guards?

This is an example of a motion planning problem, a field of great interest to robotics researchers. This particular class of problems is called "Pursuit-Evasion Games." We will talk about pursuer tactics in two-dimensional domains, and determine the minimum number of pursuers required in various environments. We will consider the full-visibility game (where pursuers know the location of the evader at all times) and the line-of-sight game (where they require an unobstructed view of the evader).

With driverless Uber cars hitting the streets in Pittsburgh, can driverless pursuit be far behind? Come to this talk to educate yourself about our future robotic overlords.

About Professor Beveridge, from a nomination letter submitted by one of his colleagues:
"Andrew's research program is energetic and successful, and he has established himself as an internationally known mathematician in the field of probabilistic combinatorics. He works on problems in finite Markov chains, random graph models, and competitive/cooperative games. He is uniquely positioned in our department to teach in all four areas of our curriculum: math, applied math, statistics, and computer science. His leading role in the field is evidenced by the quantity and quality of publications he has written, the standard of the journals in which he has published, the fame of some of his coauthors, his invitations to talk at research conferences, and by his refereeing work."

"What truly distinguishes Andrew from other outstanding colleagues is his skill at mentoring undergraduates in research projects. He is genuinely able to get undergraduates involved in a meaningful way with theoretical mathematics research, no easy feat. Andrew's years of experience outside of academe bring a level of professionalism that have helped form his ideas about expectations and team-work. His research is particularly appropriate for Macalester because its problems are so appealing to students (who wouldn't want to study the game of cops and robbers?), and many of them are very accessible."

Information about the Janet Andersen Lecture Award

Professor Janet Andersen was a beloved faculty member in the Hope College Mathematics Department and served enthusiastically as the Midstates Consortium Director for five years before her life ended tragically in an automobile accident in November 2005. As a teacher and scholar, Janet was devoted to providing creative, high quality learning experiences for her students, and she herself was always learning as she was teaching. As Consortium Director, she looked for ways to connect with and support natural science faculty, both new and experienced.

To honor Janet's work with students and faculty in her teaching, research and service to the Consortium, the Janet Andersen Lecture Award was established in 2008. Each year, two faculty nominees from Consortium institutions are selected by the Executive Committee to present the Janet Andersen Lecture at one or both of the fall Undergraduate Research Symposia on a topic of his or her expertise.

Year of Award	Biological Sciences and Psychology Recipients	Physical Sciences, Mathematics and Computer Science Recipients
2008	David Hall, Biochemistry Lawrence University	Jeff Wilkerson, Astrophysics Luther College
2009	Ken Yasukawa, Biology Beloit College	Robert Jacobel, Physics St. Olaf College
2010	Sarah Elgin, Molecular Biology Washington University in St. Louis	Graham Peaslee, Nuclear Physics Hope College
2011	William Hammer, Paleo-geology Augustana College	George Lisenksy, Materials Chemistry Beloit College
2012	Eric Cole, Biology St. Olaf College	Tim Pennings, Mathematics Hope College
2013	Daniel Hornbach, Biology & Environmental Studies, Macalester College	Bradley Chamberlain, Chemistry Luther College
2014	Phoebe Lostroh, Molecular Biology, Colorado College	Kevin Crosby, Physics & Astronomy and Computer Science, Carthage College
2015	Laura Listenberger, Biology and Chemistry, St. Olaf College	Julie Bartley, Geology Gustavus Adolphus College
2016	Maria Burnatowska-Hledin, Chemistry and Biology, Hope College	Andrew Beveridge, Mathematics Macalester College

Oral Session A – Saturday, 9:00 – 10:45, LabSci 250

Session	Presenter	College/University	Title of Presentation
A1.1 9:00	Saeed Roschdi	Beloit College	Investigating enzyme active-site geometry and stereospecificity in the undergraduate biochemistry lab.
A1.2 9:15	Austin Szczodrowski	Carthage College	Surfactants with Immobilized Catalysts for Micelle-Facilitated Organic Synthesis
A1.3 9:30	Emily McClure	Grinnell College	Microwave-assisted Synthesis of α-Keto Substituted Chalcones
	9:45 – 10:00: Break and Set-up for Poster Session 1		
A2.1 10:00	Sandeep Acharya	Beloit College	Computer Analysis of Blockade Games
A2.2 10:15	Yolanda Zhang	Beloit College	Graph Properties of Blockade Games
A2.3 10:30	Manasvi Sagarkar	University of Chicago	Automatic metric for evaluating story generation

Oral Session B – Saturday, 9:00 – 10:45, LabSci 300

Session	Presenter	College/University	Title of Presentation
B1.1 9:00	Ionatan Kuperwajs	Macalester College	Neural Processing of the Optic Flow Field: Perception of Self-Motion
B1.2 9:15	Michael Ray	Lawrence University	Imaging the mitochondrial structures of beer yeasts
B1.3 9:30	Yezi Yang	Macalester College	Zooming in and out: big data tools in studying metastatic melanomas at single-cell resolution
	9:45 – 10:00: Break and Set-up for Poster Session 1		
B2.1 10:00	Isaac Friend	University of Chicago	Geometrizing a space of Adinkra networks for supersymmetric representation theory
B2.2 10:15	Anastassia Doktorova	Colorado College	Constant Vector Curvature of Lorentzian 3-Dimensional Spaces with Diagonalizable Ricci Operator
B2.3 10:30	Abdel-Rahman Madkour & Phillip Nadolny	St. Olaf College	Finding Minimal Spanning Forests in a Graph

Poster Session 1 – Saturday, 10:45 – 11:45, LabSci Rettner Gallery and Floor 3 Hallway

Oral Session C – Saturday, 1:45 – 4:00, LabSci 300

Session	Presenter	College/University	Title of Presentation
C1.1 1:45	Breanna Wydra	Lawrence University	Identification of blue pigment in a 15th century illuminated manuscript using Raman spectroscopy
C1.2 2:00	Katherine Taylor	University of Chicago	Progress Towards the Total Synthesis of an Unnamed Brominated Diterpene
C1.3 2:15	Jess Browder-Long	Beloit College	Synthesis and evaluation of a proton reduction catalyst for making hydrogen
C1.4 2:30	Megan Roozeboom, Grant Myres	Luther College	Analyzing the binding relationship between curcuminoids and HSA by Steady State Fluorescence Spectroscopy
2:45 – 3:00: Break and Set-up for Poster Session 2			
C2.1 3:00	Brieana Linton	Hope College	PIGE Analysis of Textiles and Papers Containing PFAS
C2.2 3:15	Elise Le Boulicaut	Gustavus Adolphus College	Electronic Detection and Diagnosis of Health and Illness of Premature Infants
C2.3 3:30	Rebecca Katz	Knox College	The Accelerated Development of Bacterial Antibiotic Resistance in Microenvironments
C2.4 3:45	Lucas Myers	Lawrence University	Robust tracking algorithm to follow microtubules moving in gliding assays

Poster Session 2 – Saturday, 4:00 – 5:00, LabSci Rettner Gallery and Floor 3 Hallway

Oral Session D – Saturday, 1:45 – 4:00, LabSci 250

Session	Presenter	College/University	Title of Presentation
D1.1 1:45	Augustus Lowry	Lawrence University	Mechanical Properties of the Microtubule: Background and Methodology
D1.2 2:00	Anh Hoang	Lawrence University	Mechanical Properties of the Microtubule: Results and Outlook
D1.3 2:15	Lee Ehudin	University of Chicago	Ftrace: easy accuracy testing for floating point arithmetic implementations
D1.4 2:30	Hanbo Shao & Olivia Chandrasekhar	Colorado College	Invariants of the Free-Fermion Vertex Algebra under the Action of Z/2
2:45 – 3:00: Break and Set-up for Poster Session 2			
D2.1 3:00	Aedan Gardill	Lawrence University	Growth and Structure of Cr-Doped ZnO Thin Films
D2.2 3:15	Sarah McCarthy	Grinnell College	Magnetic anisotropy in single crystals of RNiGe2 (R = Gd, Tb, Dy)
D2.3 3:30	William Imoehl	Luther College	An analysis of the radiative decays of the Upsilon(2S) state of bottomonium
D2.4 3:45	Caleb Sword	Hope College	Determination of the Nuclear Structure of Unstable O25

Poster Session 2 – Saturday, 4:00 – 5:00, LabSci Rettner Gallery and Floor 3 Hallway

Oral Session E – Saturday, 1:45 – 4:00, LabSci 201

Session	Presenter	College/University	Title of Presentation
E1.1 1:45	Richard Noriega	Beloit College	On Theta Activity in Human EEG
E1.2 2:00	Thomas Kirk	St. Olaf College	The characterization of sheng reed vibrational modes
E1.3 2:15	Sohair Abdullah	Colorado College	Rosette Harmonic Surfaces
E1.4 2:30	Maithreya Sitaraman	University of Chicago	A symmetrization process to characterize Lights Out setups
2:45 – 3:00: Break and Set-up for Poster Session 2			
E2.1 3:00	Allison Bartz	Grinnell College	Current events: formation, growth, and development of a current sheet in an eruptive solar flare
E2.2 3:15	Johnny Li & Cameron Kuchta	Beloit College	Tracking Clumps Through the F Ring with Cassini Images During Ring-Plane Crossing
E2.3 3:30	Jisheng Zhang	Grinnell College	Constraining hot Jupiter's atmospheric structure and dynamics through Doppler shifted emission spectra

Poster Session 2 – Saturday, 4:00 – 5:00, LabSci Rettner Gallery and Floor 3 Hallway

Poster Session 1 – Saturday, 10:45 – 11:45, LabSci Rettner Gallery and Floor 3 Hallway

Session	Presenter	College / University	Title of Presentation
1.01	Judy Yoo	Washington University in St. Louis	The Molecular Mechanism of Sensory Synapse Formation
1.02	Rebecca Chen, Lindsay Berkhout	University of Chicago	Precision photometry on the SDSS photometric system
1.03	Karen Perez Sarmiento	Macalester College	GMRT HI Imaging of Selected LARS+eLARS Galaxies
1.04	Ayush Kumar	Washington University in St. Louis	A Deep Network for Predicting Epoxidation of Drug-like Molecules
1.05	Kevin Krause	Carthage College	Molecular dynamics simulations of chiral molecular micelles
1.06	Jue Wang	Grinnell College	Conformational analysis of the protein MTHFR utilizing hydrogen-deuterium exchange and mass spectrometry
1.07	John Pavek	Gustavus Adolphus College	Controls on Mercury and Methylmercury Concentrations in the Saint Louis River and its Tributaries
1.08	Rachel Lund	Gustavus Adolphus College	Are riparian areas an important source of mercury to rivers?
1.09	Zican Shen	Grinnell College	Total Synthsis and Biological Evaluation of Tryptophan Xnortide B Derivatives
1.10	Kyle Cushman	Hope College	Development and Optimization of Amperometric Glucose Biosensors Based on Glucose Oxidase and Tris[5-amino-1, 10-Phenanthroline] Iron(II) Polymer Films
1.11	Craig Laing	Washington University in St. Louis	Lead Iodide Nanocrystal Synthesis for Single Crystal Conversion Studies to Lead Perovskites
1.12	Alejandro Beltran	Knox College	Synthesis and characterization of thermotropic substituted copper (II) heteroleptic metallomesogens with 2-ethylhexanoate ligands
1.13	Joseph Romo	Macalester College	The Assembly of Carbon Macrocycles through Alkene Metathesis
1.14	Alexander Prophet	St. Olaf College	Characterization of a pulsed gas expansion instrument for energy transfer and high speed flow studies
1.15	Margaret Lee	University of Chicago	The Synthesis and Structural Analysis of Vanadium Hollandites

Poster Session 1 – Saturday, 10:45 – 11:45, LabSci Rettner Gallery and Floor 3 Hallway			
Session	**Presenter**	**College / University**	**Title of Presentation**
1.16	Daniel Clark	Hope College	Developing monovalent ion parameters for the Optimal Point Charge (OPC) water model
1.17	Heather Martin, Laura Krings, Jack Haggett	Carthage College	Surfactants With Reversible Linkers for Micelle Facilitated Organic Synthesis
1.18	MItchell Adams	Luther College	Investigation of the Effects of Surface Ligand Identity on the Optical Properties of CdSe Nanocrystals
1.19	Alan Ruvim Ginzburg	University of Chicago	Direct observation of a correlated excitonic spectral diffusion in the Fenna-Matthews-Olson complex
1.20	Viet Dao, Charles Fossey	Gustavus Adolphus College	Measuring the Evolution and Influence in Society's Information Networks using the Logistic Equation
1.21	Qisheng Li	Macalester College	Creating the World of Wikipedia - Exploratory Search and the Cartography of Data
1.22	Shane Coffield	University of Chicago	Improved Estimation of Atmospheric Particulate Matter Using Remote Sensing with Public Health Applications
1.23	Leonard Shaw	University of Chicago	Using Lipid Biomarkers to Understand Deep Ocean Organic Particle Flux
1.24	Kiefer Green	Beloit College	Finding Theta Oscillations Using Independent Component Analysis
1.25	Suzannah Tebon	Beloit College	UP Phase Characterization
1.26	Matthew Sandgren	Hope College	Predicting Dengue Fever Incidence
1.27	Khoa Ho	Grinnell College	Structural Characterization of RNiGe2 (R = Gd,Tb,Dy)
1.28	Jillian Rix	Grinnell College	Harvesting wind energy to detect weak signals using mechanical stochastic resonance
1.29	Kieran Berton, Halle Hund, Kali Gustafson	St. Olaf College	Photolithography of Microstructures for Investigations of High-speed Micro-scale Friction
1.30	Ananya Pillutla	University of Chicago	Autocorrelation of ultrafast pulses for quantum materials research

Poster Session 2 – Saturday, 4:00 – 5:00, LabSci Rettner Gallery and Floor 3 Hallway			
Session	**Presenter**	**College / University**	**Title of Presentation**
2.01	César Mendoza	Macalester College	A High Angular Resolution View of the Neutral Hydrogen Gas in the TOL1924-416 Interacting System
2.02	Emily Witt	St. Olaf College	DuOCam: A Two-Channel Camera for Simultaneous Photometric Observations of Stellar Clusters
2.03	Elisabeth Rutter	Carthage College	NMR investigation of the effect of pH on micelle formation of the surfactant L-Undecyl Phenylalaninate
2.04	Madison Fellows	Grinnell College	Computational study of CO adsorption on a platinum-modified faujasite zeolite
2.05	Ashley Trojniak	Hope College	surMOF-14: Investigating the Metal Organic Structure
2.06	Claire Cody	Knox College	Electronic structure and catalytic activity of an iron complex bearing a donor-modified tridentate α-diimine ligand
2.07	Peter Pedersen	Macalester College	Application of Bis(trimethylsilyl)butadiyne in 1,2,3-Triazole Synthesis: 5-Ethynyl-1,2,3-Triazole Derivatives
2.08	Chae Kyung Jeon	Grinnell College	Characterization of MTHFR oligomers utilizing H/D exchange coupled with LC-MS
2.09	Jia Shi, Kalpit Modi	St. Olaf College	Developing Tetramethylammonium Formate as a Probe of Biopolymer Surface Areas
2.10	Andrew Molina	University of Chicago	Observed in vitro Lipid Dynamics to Confirm Novel Model for CNS Myelinogenesis
2.11	Emma Streff	Washington University in St. Louis	Total synthesis of a library of unnatural derivatives of lingzhiol
2.12	Forrest Lloyd	Beloit College	A Snapshot of the Future: An Analysis of Catalog Descriptions for Future Earth Science Teachers
2.13	Zixi Wang	Grinnell College	Gas Phase Proton Exchange Mechanism for Protonated and Sodiated Histidine and Histidine Derivatives
2.14	Grace Kunkel	Hope College	Bottom-up polyol synthesis of tetrahedrite nanoparticles
2.15	Radiandra Soemardi	Knox College	Synthesis, characterization, and reactivity studies of iron dibromide complexes bearing para-substituted alpha-diimine ligands

Poster Session 2 – Saturday, 4:00 – 5:00, LabSci Rettner Gallery and Floor 3 Hallway

Session	Presenter	College / University	Title of Presentation
2.16	Justin Finkel	Washington University in St. Louis	Changing U.S. Extreme Temperature Statistics
2.17	Andrew Novick	Washington University in St. Louis	Studying the synthesis of cuprous oxide nanocrystals for catalytic purposes
2.18	Marissa Solorzano	Hope College	Identifying the Expression Patterns of xCT in Zebrafish to Determine its Role in Neuroregeneration
2.19	Xinyu Liu	Macalester College	Pre-monomer peptidomimetic synthesis using thiol-ene click chemistry
2.20	Justin Pacholec	St. Olaf College	A Personalized, Adaptive, Online Training Program for Postlingually Deafened Cochlear Implant Users
2.21	Lyndsy Miller	Hope College	Synthesis and Biological Studies of Dinuclear Arene Ruthenium Glycoconjugates
2.22	Higinio Jasso	Grinnell College	Growth and resistivity analysis of rare earth single crystals
2.23	Jaehong Choi	St. Olaf College	Neutral scalar condensation in an extended Abelian Higgs model
2.24	Zoe Cohen	Washington University in St. Louis	Automatic Sleep Stage Classification using a Neural Network Algorithm
2.25	Anne O'Donnell	Hope College	Bio-Inspired Control of Civil Infrastructure
2.26	Jorge Benitez	Hope College	Noise monitoring using wireless sensor nodes
2.27	Megan Treichel	Grinnell College	Impedance Studies of Silyl/Carbonate Electrolyte Blends

Abstracts for all sessions listed in order by presenters last name

Presenter(s): Sohair Abdullah, Colorado College
Session: E1.3
Title: Rosette Harmonic Surfaces
Advisor(s): Jane Mcdougall, Mathematics, Colorado College
Co-Author(s): Jane McDougall

Abstract: A harmonic mapping is a univalent harmonic function of one complex variable. We obtain a family of harmonic mappings on the unit disk whose images are rotationally symmetric "rosettes" with n vertices, n belonging to 3. For any even number of vertices, the family of harmonic mappings includes an infinite number of minimal surfaces as lifts of the corresponding harmonic mappings. Moreover, for each even number of vertices there is one minimal graph, with piecewise constant height on the disk boundary, that may be completed in R3 by rotations. In particular, for a four-sided rosette mapping there exists an embedded triply periodic minimal surface.

Presenter(s): Sandeep Acharya, Beloit College
Session: A2.1
Title: Computer Analysis of Blockade Games
Advisor(s): Darrah Chavey, Computer Science, Beloit College
Co-Author(s): Darrah Chavey, Yaodan Zhang, Hugh Smith

Abstract: Blockade game is a subcategory of combinatorial games played in a graph with at least one empty vertex. The players are allowed to move along an edge to an empty spot. The game ends if the player has no such move to make. Blockade games can be played in many different graphs with not much difference in rules to play. We analyzed the aspects of the game that make it exciting to play and then found some graphs that can generate equivalent interest among the players of the game. Our main research tool was the computer program that is specifically designed to analyze the blockade games. My major contribution was designing the Graphics User Interface which allows even non-programmers to change the search criteria and use many features of our program. Linking the game simulation and the graph drawing code with the interface was another major task. Our program also gives different statistical and non-statistical information such as win percentage, no. of turns to win, and winning positions. The use of the computer program combined with the application of mathematical concepts hugely helped us explore this class of combinatorial games.

Presenter(s): MItchell Adams, Luther College
Session: P1.18
Title: Investigation of the Effects of Surface Ligand Identity on the Optical Properties of CdSe Nanocrystals
Advisor(s): Molly Wilker, Chemistry, Luther College
Co-Author(s): Andrea Wagner

Abstract: Semiconductor nanocrystals have been identified as promising light-absorbing materials to be used in a wide range of applications. The use of photoexcited electrons in semiconductor nanocrystals as reducing agents is an intriguing way of harvesting photon energy to drive chemical reactions. This presentation describes research efforts to understand how the surface chemistry of CdSe nanocrystals affects their optical and electron transfer properties. After the CdSe native surface ligands were exchanged for thiol-based ligands with a range of functionalities, the extent of ligand exchange was monitored using vibrational spectroscopy. Insights from electronic spectroscopy were used to discuss the ways in which ligand exchange and ligand identity could be used to control optical properties of the CdSe nanocrystals.

Presenter(s): Allison Bartz, Grinnell College
Session: E2.1
Title: Current events: formation, growth, and development of a current sheet in an eruptive solar flare
Advisor(s): Daniel Seaton, Jonathan Darnel, Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder
Co-Author(s):

Abstract: The standard model of coronal eruptions predicts that in the wake of an eruptive solar flare, magnetic field lines connecting the escaping plasma and the solar photosphere will stretch and reconnect in a current sheet. Here we report on what appears to be the direct observation of one such current sheet, which formed in the wake of a coronal mass ejection (CME) and X4.9 flare on 25 February 2014. Following the eruption, a faint, narrow structure extended from the solar surface upwards in the direction of the CME. We used DEM analysis to estimate the temperature of the structure, showing it was around 8 MK. We measured the approximate length and width of the structure with a combination of algorithm and visual inspection to determine the reconnection rate, which was about 0.004–0.007, consistent with previous studies of reconnection in current sheets. There have been only a few reports of this sort of measurement using data from AIA on SDO before, and the results support current flare models by confirming that the observed sheetlike structure has a temperature and a reconnection rate consistent with predictions by existing models.

Presenter(s): Alejandro Beltran, Knox College
Session: P1.12
Title: Synthesis and characterization of thermotropic substituted copper (II) heteroleptic metallomesogens with 2-ethylhexanoate ligands
Advisor(s): Thomas W. Clayton, Chemistry, Knox College
Co-Author(s): Thomas W. Clayton

Abstract: Copper carboxylates are known to form complexes with a paddlewheel geometry. When those carboxylate ligands have long chains, the copper dimers often have liquid crystalline mesophases. The melting point of these mesophases is understood to vary according to chain length and other structural features such as chain branching and the presence of alkenes. Our research group has discovered that in addition, varying the composition of these copper dimers will lower the melting point by including a mixture of carboxylate ligands. The ligand 2-ethylhexanoate presents interesting characteristics due to its branched structure and chiral center. In effort to isolate room temperature liquid crystals, mono, di, and tri substituted dimers utilizing the 2-ethylhexanoate ligand constant were synthesized. Additionally, caprolactam adducts of promising compounds were synthesized. Results today suggest 2-ethylhexanoate is a versatile ligand in producing copper dimers that have surprisingly low melting and large ranges of mesophase stability. Characterization included polarized optical microscopy (POM), melting point, differential scanning calorimetry (DSC), elemental analysis, and FT-IR spectroscopy.

Presenter(s): Jorge Benitez, Hope College
Session: P2.26
Title: Noise monitoring using wireless sensor nodes
Advisor(s): Courtney Peckens, Engineering, Hope College
Co-Author(s):

Abstract: Environmental noise monitoring is quickly increasing in relevancy due urbanization. However, certain measures can be taken to negate the noise. The Jack H. Miller Center for Musical Arts on the campus of Hope College was built with noise cancellation purposes in mind due to the building's close proximity to railroad tracks. The purpose of this research was to develop a network of wireless sensors to measure the noise levels both outside and inside of the Jack H. Miller Center in order to validate the

effectiveness of the noise cancellation features of the building. The node designed used the Sparkfun Sound Detector board as transducer for measuring audio signals, and this transducer was calibrated in the Jack H. Miller Center to establish a baseline for a conversion from Analog-to-Digital Converter readings to decibel units. The calibration was performed using a Type 2 Sound-Pressure Level meter, consistent with IEC 651 guidelines. The next steps in this research are to interface the sound detector board with a microcontroller that can sample at a frequency of at least 12 kHz and then to design a way for the microcontroller to wirelessly transmit data to a computer for processing.

Presenter(s): Kieran Berton, Halle Hund, Kali Gustafson, St. Olaf College
Session: P1.29
Title: Photolithography of Microstructures for Investigations of High-speed Micro-scale Friction
Advisor(s): Brian Borovsky, Physics, St. Olaf College
Co-Author(s): Halle G. Hund, Kali Gustafson, Brian Borovsky

Abstract: What determines the friction and wear between two objects in sliding contact? Although Da Vinci, Amontons and Coulomb discovered the classical laws of friction centuries ago, this question remains a puzzle for researchers seeking to understand friction at the atomic level. Rapid progress has been made over the last thirty years with the arrival of experimental techniques capable of probing surface forces on ever smaller length scales. These advances promise to help solve the technical challenges currently plaguing the development of microscopic machines. The devices, known as microelectromechanical systems (MEMS), may serve as the mechanical counterpart to integrated circuits, but progress remains slow as structural materials and lubricant strategies continue to be developed. We discuss experiments in which a microscale probe and a resonating disk of single-crystal quartz are put into contact to replicate the sliding conditions found inside micromachines, with rough contacts, high shear speeds, and lubricant films only one molecule thick. This semester, we learned and implemented a method for fabricating microscale structures with ultraviolet photolithography. Characterization of the structures using optical and electron microscopies played a key role in optimizing our procedures. The fabricated features will serve both as test sites for friction studies and as location markers to enable post-test, ex-situ wear analysis.

Presenter(s): Jess Browder-Long, Beloit College
Session: C1.3
Title: Synthesis and evaluation of a proton reduction catalyst for making hydrogen
Advisor(s): George Lisensky, Department of Chemistry, Beloit College
Co-Author(s): George Lisensky

Abstract: The reduction of protons to hydrogen $2\ H^+ + 2\ e^- \longrightarrow H_2$ requires less energy in the presence of a catalyst, either one metal that changes by two oxidation states or two metals that change by one oxidation state. The pursuit of sustainable and efficient molecular hydrogen production has led researchers to the chemistry of dithiolate-bridged di- and tri-iron complexes. These earth-abundant metal complexes mimic the active site of [FeFe]-hydrogenases. Hydrogenases are enzymes that catalyze the reduction and oxidation of protons to molecular hydrogen. A promising biomimetic complex, $Fe_3(CO)_9Te_2$ (1), is synthesized and evaluated for catalytic ability using cyclic voltammetry. Addition of trifluoroacetic acid (TFA) shows minor catalytic activity at the first iron reduction and significant activity before the second. In the presence of acid, a new reduction peak appears at a lower potential (-1.55V vs. Fc/ Fc+) than the second iron reduction, presumably due to the reduction of a protonated reduced species. Evaluation of catalytic activity suggests this complex is a viable proton reduction catalyst.

Presenter(s): Rebecca Chen, Lindsay Berkhout, University of Chicago
Session: P1.02
Title: Precision photometry on the SDSS photometric system
Advisor(s): Richard Kron, Astronomy and Astrophysics, University of Chicago
Co-Author(s):

Abstract: High precision photometry involves a measurement of the light coming from different sources in a field and a calibration of their magnitudes. One can correct the instrumental magnitudes of known comparison stars to their magnitudes within a specific photometric system and then adjust the unknown sources in the field by the same zeropoint. This allows the measured flux to be expressed on a physical scale (Watts m^{-2} Hz^{-1}). This kind of photometry is particularly useful for projects involving fluctuating sources. There is a need for a method to accurately obtain these magnitudes on telescopes such as the 24" at Yerkes Observatory and the 20" at Stone Edge Observatory, which are frequently used for remote and local projects relating to magnitude measurement. Our project pieced together a methodology using APT and TOPCAT to obtain precise magnitudes in the SDSS photometric system. We achieved less than 5% external precision and less than 3% internal precision on multiple images in two filters on the Y24 and are currently working on doing the same with SEO. These numbers are reasonable for this kind of photometry but can continue to be improved through different methods of analyzing the data or improved photometric conditions.

Presenter(s): Jaehong Choi, St. Olaf College
Session: P2.23
Title: Neutral scalar condensation in an extended Abelian Higgs model
Advisor(s): Prabal Adhikari, Physics, St Olaf College
Co-Author(s): Prabal Adhikari

Abstract: The low-energy ground state of the theory of strong interactions (Quantum Chromodynamics) consists of pions and baryons. In real QCD with three colors, mass gap associated with the pion is much smaller than the mass gap associate with baryons. As such there is a clean scale separation. However, in two-color QCD, lowest mass pions and lowest mass baryons have the same mass in the isospin limit. This is because while baryons in the 2-color limit are made out of two-valence quarks and pions out of one valence quark and one anti-quark. In the presence of a magnetic field, 2-color QCD has a ground state that becomes superconducting, meaning that the imposition of small test electric fields leads to a resistance-free current. The quintessential theory that describes superconductivity is the Abelian Higgs model. Here, we construct an extended Abelian Higgs model which consists of two charged scalars and a neutral scalar that couple to each other through a quartic interaction and study the magnetic properties of such a system. As in the standard Abelian Higgs model, we find the existence of vortices with a caveat. The neutral scalar also condenses in the extended Abelian Higgs model given certain conditions are met.

Presenter(s): Daniel Clark, Hope College
Session: P1.16
Title: Developing monovalent ion parameters for the Optimal Point Charge (OPC) water model
Advisor(s): Brent P. Krueger, Chemistry, Hope College
Co-Author(s): John C. Dood

Abstract: Molecular dynamics (MD) simulations are used to model the structure and movement of macromolecules. The gold standard for MD is to explicitly include water molecules using one of several standard models. Recently, a new water model, Optimal Point Charge (OPC), has been developed with simulation performance that compares better to experiment than existing models in its class (Izadi, Anandakrishnan, Onufriev, J. Phys. Chem. Lett., 2014, 5, 3863-3871). For this new water model to be

useful, Lennard-Jones (LJ) parameters must be developed for at least a few monovalent ions. In this study MD simulations were used to develop these parameters. Preliminary results are presented including: extensive convergence testing of Hydration Free Energy, Lattice Constants (LC), and first peak position of radial distribution functions (RDF's); as well as surfaces showing the dependence of the RDF and LC on various LJ parameters within the OPC water model.

Presenter(s): Claire Cody, Knox College
Session: P2.06
Title: Electronic structure and catalytic activity of an iron complex bearing a donor-modified tridentate α-diimine ligand
Advisor(s): Helen M. Hoyt, Chemistry, Knox College
Co-Author(s):

Abstract: An anhydrous, paramagnetic iron dibromide complex bearing the tridentate ligand dppNNN has been synthesized and characterized by 1H NMR spectroscopy. A closer analysis of the electronic structure, including spin state and magnetic properties of the compound, has been performed by X-Ray crystallography, Mössbauer spectroscopy, Evans' analysis, and density functional theory computations. These investigations support the electronic structure of the compound as a redox-innocent ligand bound to a high spin Fe(II) species. Preliminary studies show activation by sodium naphthalenide can promote hydrosilylation of 1-hexene with phenylsilane. Future work includes optimizing the activation process by testing different activators in order to obtain higher yields and more consistent results for catalytic hydrosilylation.

Presenter(s): Shane Coffield, University of Chicago
Session: P1.22
Title: Improved Estimation of Atmospheric Particulate Matter Using Remote Sensing with Public Health Applications
Advisor(s): Mohammad Al-Hamdan, National Space Science and Technology Center, Universities Space Research Association
Co-Author(s): Erica Burrows, Breanna Crane

Abstract: Satellite measurements of aerosol optical depth (AOD) have been shown to be correlated with ground measurements of atmospheric particulate matter (PM2.5), which in turn has been linked to respiratory and heart diseases. The strength and shape of the correlation between AOD and PM2.5 vary greatly across the U.S. Here we develop and validate improved PM2.5 models in the Midwest based on remotely sensed AOD and meteorological data. Our regression models show higher correlations and greater predictive power than previous models, especially using the Moderate Resolution Imaging Spectroradiometer (MODIS) Collection 5.1 and the 10km spatial resolution. We accomplish this by incorporating meteorological variables along with AOD to derive PM2.5 concentrations. In addition, we implement Center for Disease Control (CDC) data to show a connection between PM2.5 and specific health risks.

Presenter(s): Zoe Cohen, Washington University in St. Louis
Session: P2.24
Title: Automatic Sleep Stage Classification using a Neural Network Algorithm
Advisor(s): Arye Nehorai, Electrical Engineering, WUSTL
Co-Author(s):

Abstract: For this project I developed and tested a neural network algorithm for the purpose of performing automatic sleep stage classification. Sleep is typically classified into five different stages: wake, N1, N2, N3/N4, and REM (rapid eye movement). The classification is based on various standards set by the American Academy of Sleep Medicine (AASM) and requires a trained sleep technician. In this

project I wrote a neural network algorithm to perform classification based on these standards, thus making the process automatic. The neural network algorithm was developed by improving and building on previous iterations, the final result being a classifier capable of discriminating between five different classes with 80.82% accuracy.

Presenter(s): Kyle Cushman, Hope College
Session: P1.10
Title: Development and Optimization of Amperometric Glucose Biosensors Based on Glucose Oxidase and Tris[5-amino-1,10-Phenanthroline] Iron(II) Polymer Films
Advisor(s): Kenneth Brown, Chemistry, Hope College
Co-Author(s): Kenneth Brown

Abstract: Glucose biosensors are typically used for detecting blood glucose levels in diabetics. These sensors electrochemically detect glucose through a specific mechanism that involves biochemical and physical transducers. A method to form the enzyme layer onto the physical transducer was optimized. Electrochemical behavior of Tris[5-amino-1,10-Phenanthroline] Iron(II) polymer films was investigated as a redox mediator in a glucose biosensor. The biosensors gave the largest response in the pH range of 7-8. Interferences including ascorbic acid and lactic acid did not give a false positive response. There was no significant difference between the detection of glucose using a biosensor stored at room temperature versus one stored at 4°C. The detection limit of the biosensors was found to be 0.30 mM which corresponds to a signal to noise ratio of 3:1.

Presenter(s): Viet Dao, Charles Fossey, Gustavus Adolphus College
Session: P1.20
Title: Measuring the Evolution and Influence in Society's Information Networks using the Logistic Equation
Advisor(s): Thomas LoFaro, Mathematics, Computer Science and Statistics, Gustavus Adolphus College
Co-Author(s): Zach Brown, Charlie Fossey

Abstract: We develop models that predict the flow of information for five different time periods in history, each with their own dominant media type. We use a density-dependent logistic function to measure the saturation of the population of the United States as information “bits” are introduced through the media. Based on the media type observed, we vary the rates of information spread. Our model also accounts for the quality of the information source and the receptiveness of the audience in receiving the bit. We find that as technology increases, it takes less time for the information to fully saturate the population, ranging from several years in our early model, to a few days in the present day model. We then use regression analysis to predict each media types rise and fall in the history of the United States. From this, we developed a piecewise function that allows us to account for the interaction of all media types in their relevant time period. We proportion this based on the US population and number of households, so we can compare the influence that each media type has an average person in any given year. We then extend the function to the year 2050 and interpret the model’s validity at that point. Applying our model to an abstract hypothetical situation, we establish a “truth” bit and a “lie” bit and determine initial rates of spread for each. We then remark upon the effects of modifying information and how the cascade of skewed information quickly permeates the entirety of society. This provides an interesting analysis on the validity of information spread through media, as the “lie” bit spreads much quicker. We then discuss bias and its influence on audience receptiveness and therefore the spread of the information using communication theories that are widely applied.

Presenter(s): Anastassia Doktorova, Colorado College
Session: B2.2
Title: Constant Vector Curvature of Lorentzian 3-Dimensional Spaces with Diagonalizable Ricci Operator
Advisor(s): Corey Dunn, Mathematics, California State University San Bernardino

Abstract: This research revealed that Lorentzian, 3-Dimensional model spaces, whose curvature tensor's associated Ricci operator is diagonalizable, will have constant vector curvature (we say model space *M* has *cvc(ε)* for some $\varepsilon \in \mathbb{R}$) under some cicumstances. In these circumstances, we know the value of ε, and ε is unique. In the circumstances where the model space does not have cvc(ε), we know which vectors in the model space prevent it from having cvc(ε). These vectors form a subspace tangent to the light cone (which is the null space)..

Presenter(s): Lee Ehudin, University of Chicago
Session: D1.3
Title: Ftrace: easy accuracy testing for floating point arithmetic implementations
Advisor(s): Henry Hoffmann, Computer Science, University of Chicago
Co-Author(s): Henry Hoffmann

Abstract: Previously, testing the accuracy of floating point arithmetic implementations in the context of different applications has been time consuming and error-prone. These tests generally involved manually rewriting each application to use a different floating point arithmetic implementation. An automatic solution to this problem would be able to greatly speed up accuracy tests of different floating point implementations. To meet this need, we propose ftrace: an instrumentation tool that automatically replaces floating point operations with user-defined functions. One significant application for ftrace is finding the optimal accuracy for a fixed-point approximation of floating point operations in applications. Fixed-point arithmetic is often used in applications that cant't afford the accuracy of full IEEE floating point arithmetic. Accuracy data for fixed-point arithmetic was collected from 4 applications using ftrace: A radar application, an implementation of the Black-Scholes formula to calculate the prices of stock options, an application that tracks the 3D pose of a human body, and a program that performs a content-based similarity search for images. Using ftrace we automatically explored 63 accuracy levels for fixed-point arithmetic in these applications and found that using 18 bits of accuracy was sufficient to produce results equivalent to fully accurate IEEE arithmetic in these applications.

Presenter(s): Madison Fellows, Grinnell College
Session: P2.04
Title: Computational study of CO adsorption on a platinum-modified faujasite zeolite
Advisor(s): Heriberto Hernandez-Soto, Chemistry, Grinnell College
Co-Author(s): Katie Parrish

Abstract: We studied the adsorption of carbon monoxide (CO) on a platinum-modified faujasite (Pt-FAU) zeolite by performing quantum-mechanics: molecular-mechanics (QM:MM) computations as implemented in the ONIOM method. The QM portion was modeled using the hybrid density functional method B3LYP in combination with the SDD basis set. The MM part was modeled using the universal force field, UFF. We used two different Pt-FAU zeolite clusters (Si11O12AlPt, Si4O4AlPt) embedded in the zeolite framework as our model system. Two distinctive adsorption geometries were modeled. The first of these is when the oxygen in CO interacts with the active site (platinum) and the second adsorption geometry is due to interaction of CO by the carbon atom. The former interaction is the strongest one of the two and it is characterized by covalent interactions. As revealed by natural bond orbital analysis, these interactions are due to σ donation and a π back-bonding.

Presenter(s): Justin Finkel, Washington University in St. Louis
Session: P2.16
Title: Changing U.S. Extreme Temperature Statistics
Advisor(s): Jonathan Katz, Physics, Washington University in St. Louis
Co-Author(s): Jonathan Katz

Abstract: The rise in global mean temperature is a significant and oft-cited statistic, but by definition a limited one. Globally averaged statistics obscure the finer-scale local effects which can vary drastically. Furthermore, the mean statistic obscures the behavior of maxima and minima. These data are critical for understanding the human and ecological impacts of climate change, for example because of the damage to crops from a few unseasonal events. In the present work, we devise a metric to quantify the frequency of pointwise extremes across a set of monitoring stations. The metric is a normalized running frequency, whose deviation from unity (its value in an unchanging climate) indicates the frequency of temperature records. Monte Carlo simulations provide a distinctive template for the metric under both stationary and changing temperature distributions. We compute the metric across 1218 weather stations in the Lower 48 states, and find significantly fewer low records than expected. Record highs, by contrast, exhibit no significant trend. The metric can also be adjusted in regional and seasonal averaging scale to detect trends not visible in the continental statistics. Work is ongoing to iterate through the possible scales.

Presenter(s): Isaac Friend, University of Chicago
Session: B2.1
Title: Geometrizing a space of Adinkra networks for supersymmetric representation theory
Advisor(s): Ursula Whitcher, Mathematics
Co-Author(s): Adam Artymowicz, Sally Dong, Kelly Schwiker

Abstract: Faux and Gates defined Adinkras, graphical representations of supersymmetric field theories. By generating the set of all three-color Adinkras with four open and four closed nodes, and defining and computing a bilinear form on a space of corresponding matrix nonuplets, we discover a lattice structure on the space of Adinkras. This structure is also present for spaces of four-color Adinkras, which represent N=1 supersymmetry algebras.

Presenter(s): Aedan Gardill, Lawrence University
Session: D2.1
Title: Growth and Structure of Cr-Doped ZnO Thin Films
Advisor(s): Sara Chamberlin, Physics, Lawrence University
Co-Author(s):

Abstract: There is a constant search for more efficient materials for use in electronics. Zinc Oxide (ZnO) is a well-known semiconductor used in numerous applications. However, the effects of doping ZnO with chromium (Cr) are less documented. Using spray pyrolysis—a robust and industrially relevant technique—an aqueous solution of Zn and Cr nitrates is sprayed onto a heated substrate to create thin films of polycrystalline $(Zn_{1-x}Cr_x)O$ with various Cr concentrations below x=0.05. X-ray diffraction (XRD) is used to verify the retention of ZnO's structure, verifying that Cr substitutes for Zn in the crystal lattice. XRD can also give detailed information about the crystal lattice parameters and crystallite size—both important in understanding the effectiveness of our growth process. Verifying with XRD that we have grown good crystalline material is the first step to increasing the understanding of $(Zn_{1-x}Cr_x)O$, and we hope to next investigate the optical and electrical characteristics of doped ZnO.

Presenter(s): Alan Ruvim Ginzburg, University of Chicago
Session: P1.19
Title: Direct observation of a correlated excitonic spectral diffusion in the Fenna-Matthews-Olson complex
Advisor(s): Greg Engel, Chemistry, The University of Chicago
Co-Author(s): Brain Rolczynski

Abstract: For its survival, chlorobium tepidum depends on harvesting solar energy efficiently. It contains the Fenna-Matthews-Olson complex (FMO), which aids in this process by quickly transporting energy to its reaction centers. After the observation of long-lived coherences in FMO, it was proposed that quantum energy transfer aids in this process. Quantum energy transfer depends on electronic character in the coherences. Other models have subsequently been proposed, suggesting that the observed coherences may be vibronic or purely vibrational. One key distinction among these interpretations is how the excitons interact with their local environments. Electronic coherences are usually more short-lived, but they can be prolonged if the excitons experience correlated environmental perturbations. Using ultrafast 2D electronic spectroscopy and new analytical methods, we directly observe the environmental interactions for each exciton distinguishably, demonstrating that (a) even without considering correlated motions, the excitons individually experience synchronized environmental interactions for approximately a picosecond, and (b) the environments between distinct excitons are correlated.

Presenter(s): Kiefer Green, Beloit College
Session: P1.24
Title: Finding Theta Oscillations Using Independent Component Analysis
Advisor(s): Erin Munro, Mathematics, Beloit College
Co-Author(s): Richard Noriega, Suzannah Tebon

Abstract: Prior research using independent component analysis observed theta type oscillations in slow-wave sleep of rats whereas before theta had only been observed in REM sleep and while awake, so this could simply be a false positive. In order to confirm that the observed presence of theta oscillations using independent component analysis means that theta is actually present, we need to know the probability of a false positive. We present an explorative mathematical model for recordings of the brain in order to determine the probability of observing a theta type signal using independent component analysis. We find the probability of observing theta that is not significant at the 97.5% level.

Presenter(s): Khoa Ho, Grinnell College
Session: P1.27
Title: Structural Characterization of $RNiGe_2$ (R = Gd,Tb,Dy)
Advisor(s): Charles Cunningham, Physics, Grinnell College

Abstract: Single crystals of the rare earth ternary intermetallic compounds $RNiGe_2$ (R = Gd,Tb,Dy) were grown using the flux method for the first time. The structure was determined by X-ray single-crystal diffraction to be orthorhombic, space group Cmcm, $CeNiSi_2$-type with partial Ni occupancy. These crystals were found to order antiferromagnetically at low temperatures with easy axis along the c-axis. Magnetic moments are localized on the rare earth atoms.

Presenter(s): Anh Hoang, Lawrence University
Session: D1.2
Title: Mechanical Properties of the Microtubule: Results and Outlook
Advisor(s): Douglas S. Martin, , Lawrence University
Co-Author(s): Anh T. N. Hoang, Augustus J. Lowry

Abstract: Microtubules (MTs) are essential cellular components that fill a variety of structural needs, such as providing infrastructure for cell shape and intracellular transport, while also playing a key role in cell division. Despite their structural importance, there is not firm agreement concerning the bending stiffness of MTs. To elucidate this property, we use a gliding assay in which MTs are propelled above a

surface by bound motor proteins. Here we present the relationship between MT stiffness and length. Additionally, our experimental data prompts a modification to the widely accepted model for the gliding assay, an unanticipated, but exciting result. It is our hope that these results lend clarity to the current models for MT bending stiffness, while enabling a more accurate determination of this important structural property.

Presenter(s): William Imoehl, Luther College
Session: D2.3
Title: An analysis of the radiative decays of the Upsilon(2S) state of bottomonium
Advisor(s): Todd Pedlar, Physics,

Abstract: The bottomonium system provides a rich hydrogen-like spectrum of radiative decays. This analysis will investigate radiative decays of the Upsilon(2S) state of bottomonium using data collected in the Belle experiment at KEK in Japan. This project will measure the branching fraction of the decay Upsilon(2S)→Chi(1P)+γ, that is, the rate at which the Upsilon(2S) state decays radiatively to the Chi(1P) triple states. In addition, this analysis will measure the branching fraction for the decay Upsilon(2S)→γ+Chi(1P)→ γ+Upsilon(1S)→l+l-, where l+l- indicates lepton pairs. We also will explore angular distributions of the two photons produced in these decays, by which we may determine if the anomalous magnetic moment is consistent with zero as predicted by the Standard Model.

Presenter(s): Higinio Jasso, Grinnell College
Session: P2.22
Title: Growth and resistivity analysis of rare earth single crystals
Advisor(s): Charles E. Cunningham, Physics, Grinnell College

Abstract: Presenting a poster of the flux growth method for growing rare earth single crystals of the rare earth nickel digermanide family of compounds, as well as reporting the procedures and results of resistivity measurements for single crystals of gadolinium nickel digermanide and terbium nickel digermanide, in particular. High purity metals were melted together at high temperatures in sealed ampoules, and let to cool down over many hours to form high quality single crystals. X ray analysis of the crystal structures confirmed that the crystals formed are in fact gadolinium nickel digermanide and terbium nickel digermanide. Resistivity measurements showed that both of these crystals exhibit linear decreasing in resistivity as temperature drops, until they reach metamagnetic transition temperatures at around 21 K and 33 K respectively, suggesting magnetic ordering below these temperatures. Further magnetic testing confirmed antiferromagnetic ordering below these temperatures.

Presenter(s): Chae Kyung Jeon, Grinnell College
Session: P2.08
Title: Characterization of MTHFR oligomers utilizing H/D exchange coupled with LC-MS
Advisor(s): Elaine Marzluff, Chemistry, Grinnell College

Abstract: Methylenetetrahydrofolate reductase (MTHFR) is an enzyme that catalyzes the reduction of 5,10-methylenetetrahydrofolte and is homotetramer in its active form. There are two interfaces within the homotetramer with one being asymmetrical. At low concentration (0.5uM), MTHFR is known to dissociate into dimers, and can lead to loss of enzyme activity due to lack of stability. Thus, understanding the conformational changes of MTHFR would give further understanding about stability and enzyme activity. Probing of the protein with deuterium in solution can provide valuable information about conformation changes over time. We use hydrogen-deuterium exchange coupled with liquid chromatography and mass spectrometry. The H/D exchange rate is dependent on solvent accessibility, and we look for changes in mass over time. In this study, we vary concentrations from 0.25uM to 30uM of MTHFR, and probe the protein with deuterium at various timescales from 0 minute to 360 minutes. Our study shows that as we increase the timescale, we see shift in mass. We observed no significant difference in relative deuteration from 3.75uM to 30uM. However, at 0.25uM and 0.5uM, relative deuteration was higher than samples at 3.75uM to 30uM. This suggest that there are either conformation changes in MTHFR or dissociation of MTHFR tetramer.

Presenter(s): Rebecca Katz, Knox College
Session: C2.3
Title: The Accelerated Development of Bacterial Antibiotic Resistance in Microenvironments
Advisor(s): Robert Austin, Physics, Princeton University
Co-Author(s): R J Morris, T V Phan, K.C. Lin, Rebecca Katz, Julia Bos, Robert H Austin

Abstract: I developed a method for further exploring of the effect of heterogonous environments, specifically those with stress gradients, on evolution. Escherichia coil were successfully grown in such an environment, called a death galaxy, involving micofabicated structures. The data I obtained demonstrates the ability of my procedure to establish a closed, sterile system that can easily be observed over time. This new method of building death galaxies offers the ability to gather data that the first experiments in this area did not. The ability to view individual cells allows for selective genomic sequencing of bacteria of interest. Of equal importance to future research efforts, the system I set up has the capacity for both liquid and gas rate and content control. It is also more easily replicated than previous methods for constructing a heterogonous 2-D environment. While there are still design features that can be improved on overall the new death galaxy offers promise for further experimentation. Current work is being done on bacteria acting in concert to increase mobility.

Presenter(s): Thomas Kirk, St. Olaf College
Session: E1.2
Title: The characterization of sheng reed vibrational modes
Advisor(s): James Cottingham, Physics, Coe College
Co-Author(s):

Abstract: The sheng is an Asian mouth organ consisting of a number of bamboo pipes enclosed in a wind chamber with bronze free reeds at the end of each pipe inside the chamber. The reed in each pipe typically includes a small wax tuning weight near the free end of the reed tongue. The determination of modes of vibration of these reeds, especially how the tuning weight changes those modes of vibration, is the topic of this paper. Recent research has investigated the acoustics of sheng pipes and compared the measured impedance of sheng pipes augmented with pipe resonators with a theoretical model. This research employs finite element analysis software to construct a theoretical model of sheng reeds and compare that model with measured vibrational analysis data gathered with a laser vibrometer. The primary emphasis is on how well the predicted resonance frequencies compare with measured resonance frequencies of the reed as indicated in a response curve. Also compared are the predicted nodal and antinodal positions along the length of the reed with the measured nodal positions. [Research supported by National Science Foundation REU grant PHY-1004860.]

Presenter(s): Kevin Krause, Carthage College
Session: P1.05
Title: Molecular dynamics simulations of chiral molecular micelles
Advisor(s): Kevin Morris, Chemistry, Carthage College
Co-Author(s): Kevin B. Krause, Jordan Ingle, Yayin Fang, Kevin Morris

Abstract: The physiological properties of mirror image molecules, or enantiomers, can vary dramatically. Thus, it is important that racemates are separated into their respective enantiopure forms so that the properties of R and S enantiomers can be studied separately. In capillary electrophoresis, enantiomers are separated by their different interactions with chiral molecular micelles. A molecular micelle is a macromolecule where surfactant monomers are bound to one another. This project is part of an ongoing effort to characterize how the enantiomers of chiral drugs bind to molecular micelles. The molecular micelle poly-(sodium undecyl-(L,L)- leucine-leucine) (poly(SULL)) was investigated along with the chiral molecules oxprenolol, propranolol, 1,1'-bi- 2-naphthol, and lorazepam. Each pair of enantiomers was placed in one of the six predicted binding pockets of poly(SULL). For each intermolecular complex,

molecular dynamics simulations were used to calculate the solvent accessible surface areas of each ligand, the inter- and intramolecular hydrogen bonds formed, and binding free energy of the ligand to each pocket. These results allowed us to propose a predictive model of chiral recognition in poly(SULL) and similar MM.

Presenter(s): Ayush Kumar, Washington University in St. Louis
Session: P1.04
Title: A Deep Network for Predicting Epoxidation of Drug-like Molecules
Advisor(s): S. Joshua Swamidass, Department of Pathology and Immunology, Washington University in St. Louis
Co-Author(s): Tyler B. Hughes

Abstract: A major driver of drug toxicity expenses are unexpected adverse drug reactions, which are frequently caused by reactive drug metabolites. Epoxides are one of the most common types of reactive metabolites, and our study focuses on developing a deep convolutional network capable of identifying the site of epoxidation (SOE) and epoxidized molecules in order to provide a rapid screening tool for a key drug toxicity risk. In order to determine the generalizability of the final model, a cross-validation protocol and external test set were used. The average site AUC and top-two metrics were used to evaluate the accuracy of the two models. The final epoxidation model that was developed was able to determine SOEs within the molecules in the cross-validation dataset with an average site area under the curve (AUC) of 95.9%. Similar accuracies were demonstrated by the model for the external test set with a 93.7% average site AUC. We have shown that our model not only identifies molecules capable of epoxidation, but also the specific sites of epoxidation, which can direct rational structural modifications to make drugs safer. This novel model can be used for early-drug screening and provide researchers with another tool to limit drug toxicity.

Presenter(s): Grace Kunkel, Hope College
Session: P2.14
Title: Bottom-up polyol synthesis of tetrahedrite nanoparticles
Advisor(s): Mary E. Anderson, Chemistry, Hope College
Co-Author(s):

Abstract: Bottom-up fabrication of tetrahedrite, a thermoelectric material, has potential to yield nanoparticles with high figures of merit via a cost and energy efficient synthetic route. Thermoelectric materials, which convert waste heat into electrical current and vice versa, can provide relief from the current energy crisis. Conventional, top-down methods for production requires high temperatures (~1000 K) and lengthy reaction times (~weeks); and many thermoelectric materials contain rare earth metals. Tetrahedrite ($Cu_{12}Sb_4S_{13}$) possesses exceptional thermoelectric properties, in part due to low thermal conductivity attributed to its complex unit cell. Pure tetrahedrite nanoparticles were synthesized using a modified polyol process, a solution-phase solid-state technique, and were characterized by powder x-ray diffractometry, scanning electron microscopy and energy dispersive x-ray spectroscopy. Sulfur content, starting materials, reaction temperature, and ramp time were tested to study phase purity and copper enrichment concerns. Scaling-up the syntheses from the production of 100 mg to 2 g was accomplished in order to obtain thermoelectric properties from a single batch synthesis. Initial measurements for Seebeck coefficient and electrical resistivity show improvement over tetrahedrite produced by conventional methods. Thermal conductivity measurements are underway. Successful doping of Cu sites with Zn has been accomplished and thermoelectric characterization of this material is also underway.

Presenter(s): Ionatan Kuperwajs, Macalester College
Session: B1.1
Title: Neural Processing of the Optic Flow Field: Perception of Self-Motion
Advisor(s): David J. Heeger, Neural Science, Psychology, New York University
Co-Author(s): David J. Heeger, Elisha P. Merriam

Abstract: Previous research has suggested that the visual system estimates heading direction and angular velocity using only the instantaneous velocity of each vector in the perceived optic flow field. However, we propose that the brain also utilizes the change in the flow field over time, as the structure of the visual scene is continuously evolving as the observer moves through their respective environment. In our experiment, we had observers judge heading direction in three distinct cases: translation only, translation with a moving fixation point (real eye movement), and translation and rotation with a stationary fixation point (simulated eye movement). Additionally, we used two different visual stimuli for these cases: envelopes that acted as a repeat of past experiments, and phases that distinguish the instantaneous flow field from the change in the flow field over time. Our preliminary results indicate that the instantaneous flow field does not suffice to estimate heading and angular velocity. This is due to the fact that in simulated eye movement, phase motion conditions, observers misinterpret angular rotation as additional translation.

Presenter(s): Craig Laing, Washington University in St. Louis
Session: P1.11
Title: Lead Iodide Nanocrystal Synthesis for Single Crystal Conversion Studies to Lead Perovskites
Advisor(s): Bryce Sadtler, Chemistry, Washington University in St. Louis
Co-Author(s):

Abstract: We report the synthesis of lead iodide crystals of various sizes grown via solution-phase colloidal chemistry and the conversion of microcrystals of lead iodide to polycrystalline methyl-ammonium lead iodide perovskite crystals. Two strategies to synthesize lead iodide nanoparticles were explored by investigating different solvent systems and using different lead and iodide precursors. The different solvent systems combined ethylene glycol with either isopropanol or 1,4-butanediol and precipitated microcrystals of lead iodide from lead nitrate and potassium iodide. Polyvinylpyrrolidone and hexadecyltrimethylammonium bromide were used as surfactants to control the crystal size and growth rate to produce nanoscale crystals of lead iodide. Alternate sources of lead and iodide to synthesize nanocrystals were investigated using lead oleate and tetrabutylammonium iodide. The lead oleate precursor produced only large particles. Additional work is needed to determine if either method can produce colloidal nanocrystals of lead iodide. Solar cell efficiencies of polycrystalline films are strongly correlated with crystal size, morphology, and size distribution. Better understanding the solid-state transformation of lead iodide will help us control the morphology of polycrystalline films of CH3NH3PbI3. Through the solution-phase reaction of lead iodide with methylammonium iodide, we successfully synthesized polycrystalline methylammonium lead iodide perovskite crystals with grain size of 100 nm.

Presenter(s): Elise Le Boulicaut, Gustavus Adolphus College
Session: C2.2
Title: Electronic Detection and Diagnosis of Health and Illness of Premature Infants
Advisor(s): John Delos, Physics, College of William and Mary
Co-Author(s):

Abstract: Premature infants are particularly vulnerable to illnesses such as sepsis, which is an infection of the blood. Early diagnosis of these events can greatly reduce mortality for these babies. However, exterior signs of illness are very difficult to interpret for such weak infants and appear rather late in the infection stage. Heart rate monitoring can provide early warning of a baby's risk of contracting sepsis. Therefore, our goal is to develop a model that will best predict the risk of sepsis based on a subject's

heart rate characteristics. Past research has developed a concept called the HeRO score (Heart Rate Observation), which is a measure of how likely a baby is to develop sepsis in the near future. Our research focuses on a new way of calculating the HeRO score in an attempt to provide more accurate predictions. To do so, a statistical analysis was conducted on a data set from a clinical trial, which included heart rate signals for 3,000 babies across 8 hospitals, out of which 974 sepsis events were recorded. Several multivariable logistic regression models were developed and used to create a novel HeRO score. This new method seems encouraging, as it shows an important increase of the score between periods when the babies were considered healthy and periods when they were considered sick. This could provide nurses and doctors with a more accurate estimate of the risk of impending sepsis, therefore allowing them to administer the appropriate treatment at the right time and thus save lives.

Presenter(s): Margaret Lee, University of Chicago
Session: P1.15
Title: The Synthesis and Structural Analysis of Vanadium Hollandites
Advisor(s): J Paul Attfield, Chemistry, University of Edinburgh
Co-Author(s): James Cumby

Abstract: Hollandites are characterized by the formula $A_xM_8O_{16}$, where A is a large cation and M is a transition metal. Vanadium hollandites can be created with a variety of A cations, allowing for specification of the vanadium oxidation state, which in turn affects electronic properties. Hollandites with a structure of $Bi_xV_8O_{16}$ are of particular interest because they have been shown to exhibit a metal-insulator transition (MIT) for $1.72 < x \leq 1.80$, but the cause of the MIT is unknown. This project studies the $Bi_xV_8O_{16}$ and related $Bi_xBa_yV_8O_{16}$ series of hollandites through crystallography at low temperature in order to obtain a better understanding of the origin of the MIT. The various bismuth and barium-bismuth compounds were synthesized by heating appropriate oxides under vacuum, and x-ray crystallography was conducted at Diamond Light Source. It was found that in hollandites exhibiting a MIT, structural transitions could be seen at < 50K. In hollandites that did not exhibit a MIT, no structural transition was present at < 50K, suggesting that the structural transition is instrumental to the presence of a MIT. Further work on this project will focus on determining the new structures observed, and examining how such crystallographic structural changes enable the MIT.

Presenter(s): Johnny Li & Cameron Kuchta, Beloit College
Session: E2.2
Title: Tracking Clumps Through the F Ring with Cassini Images During Ring-Plane Crossing
Advisor(s): Britt Scharringhausen, Physics and Astronomy, Beloit College
Co-Author(s):

Abstract: Using images collected from Cassini, the spacecraft orbiting Saturn, during a 2005 ring-plane crossing, plots were created out of the vertical brightness of portions of the image perpendicular to the ring. These plots were filtered in order to remove background noise and to remove scattered light. Peaks of clumps are selected in the graph and tracked through five consecutive images. These clumps are areas within the ring that contain a higher density of particles and are brighter than the area around them. To actually calculate the velocity, the change in longitude is determined by locating the peak of the clump within the brightness graph. The longitude is calculated based on the images' location. This is computed by using the location of the moons in some images as reference points. The location is denoted in offset right ascension (dRA) and offset declination (dDec) in the North Celestial Pole reference frame. An average velocity is found and used to estimate the clumps' distance from Saturn, which is used to compute the orbital speed. By iterating these variables a radius is converged upon and the reappearance of the clump in future images is predicted.

Presenter(s): Qisheng Li, Macalester College
Session: P1.21
Title: Creating the World of Wikipedia - Exploratory Search and the Cartography of Data
Advisor(s): Shilad Sen, Statistics and Computer Science, Macalester College
Co-Author(s): Brooke Boatman, Jaco Dippenaar, Rebecca Gold, Qisheng Li, Monica Ngô, Sarah Pujol, Anja Beth Swoap

Abstract: While search engines like Google effectively answer specific information requests ("where is Macalester College") they are not designed to support exploratory tasks ("help me understand the field of psychology"). Inspired by real-world maps that help people explore information spatially, we created interactive visualizations of English Wikipedia as geographical maps with countries, borders, and so on. We started by extracting basic information from Wikipedia such as titles and categories, and generating 200-dimensional vector embeddings of English Wikipedia using the Word2Vec neural network. We then used the t-SNE algorithm to embed the 200-dimensional vectors into 2-D (x,y) space and removed outliers using signal processing techniques. To simulate cartographic features, we clustered points to identify countries and drew borders using Voronoi tessellations. We created topographical contours based on density and centrality, determined "city popularity" using article pagerank and page views and added roads to represent interrelationships. Further work will create map representation of Macademia - a website visualizing connections between researchers and their research interests. We also plan to develop a public web service that will allow anybody to visualize any information space using our techniques.

Presenter(s): Brieana Linton, Hope College
Session: C2.1
Title: PIGE Analysis of Textiles and Papers Containing PFAS
Advisor(s): Graham Peaslee, Physics, Notre Dame University
Co-Author(s): Graham F. Peaslee, Paul A. DeYoung, Cody L. Berkobien, John P. Harron, Shannon M. Urbanik, Megan E. Czmer, David M. Lunderberg, Jane A. Sedlak, Greg J. Campbell,

Abstract: Per- and polyfluoroalkyl substances (PFASs) are chemical compounds used as powerful, long-lived surfactants in many consumer products. These fluorochemicals are present in stain-resistant and waterproof carpets, fabrics and papers. PFAS coatings have become an area of public concern due to their environmental persistence, ability to bioaccumulate, and suspected human toxicity. A variety of tests have been conducted in order to better understand the relationship between these PFAS coatings and consumer products. Particle induced gamma-ray emission (PIGE) spectroscopy is an established ion beam analysis technique that has been used to quantitatively measure light elements, including fluorine, in diverse target materials. This novel spectroscopic method for detection of PFAS has been used on textiles and papers to identify those that have a PFAS coating. By comparison to standards constructed in the laboratory, quantitative measurements of the nmol F per cm^2 of material are possible. PIGE has been proven as an inexpensive, rapid, and non-destructive method for total fluorine analysis on textiles and papers.

Presenter(s): Xinyu Liu, Macalester College
Session: P2.19
Title: Pre-monomer peptidomimetic synthesis using thiol-ene click chemistry
Advisor(s): Leah Witus, Chemistry, Macalester College
Co-Author(s): Trinity Gao and Demani Shikomba

Abstract: Peptides and proteins are able to achieve a vast array of functions, including sophisticated binding and catalysis, from combinations of just twenty natural amino acids. Peptidomimetics, analogues of peptides, can expand natural peptide diversity by including non-natural backbone structures and unnatural side chain functionalities. We are working towards a pre-monomer peptidomimetic synthesis route, which separates backbone elongation and side chain addition into independent steps, allowing more accessible solid phase synthesis without the need for extensive synthesis of individual protected

monomers. This is achieved by using click-coupling reactions with reactive handles on a pre-monomer backbone. Specifically, an unnatural amino acid containing an alkene, allylglycine, is being used as the pre-monomer, such that a thiol derivative side chain can be coupled through thiol-ene click chemistry. We have been optimized the coupling efficiency of this reaction on the solid phase by testing different light sources, solvents, reagent equivalents, and reaction times. We have found conditions that achieve a high coupling efficiency, and we are now working towards longer peptidomimetics.

Presenter(s): Forrest Lloyd, Beloit College
Session: P2.12
Title: A Snapshot of the Future: An Analysis of Catalog Descriptions for Future Earth Science Teachers
Advisor(s): Caitlin N. Callahan, Geology, Grand Valley State University
Co-Author(s): Caitlin N. Callahan

Abstract: Undergraduate students who are intent on becoming K-12 Earth Science teachers must develop not only their disciplinary content knowledge but also their knowledge of how to teach the content. A course catalog description provides a snapshot summary of the material students can expect to learn over a semester. In this project, we use course descriptions to answer the following research question: how common are courses that integrate geoscience content with either pedagogical theories, instructional techniques, or knowledge of how to apply science standards to lesson development? We analyzed 81 course descriptions from institutions located in the states within the North-Central section of the Geological Society of America. To be included, each description had to reference Earth Science content as well as Pre-service teachers. We coded each course description for mention of the following: Assessment, Instructional Techniques, Theories of Learning and Teaching, and Curriculum Standards. Of the 81 courses, 45 had at least one of these codes with many having only one. Of those with more than one code, all eight courses with mention of Assessment also included the code for Instructional Techniques; ten courses mentioned both Instructional Techniques and Theories of Learning and Teaching.

Presenter(s): Augustus Lowry, Lawrence University
Session: D1.1
Title: Mechanical Properties of the Microtubule: Background and Methodology
Advisor(s): Douglas S. Martin, Physics, Lawrence University
Co-Author(s): Anh T. N. Hoang

Abstract: Microtubules (MTs) are essential cellular components that fill a variety of structural needs, such as providing infrastructure for cell shape and intracellular transport, while also playing a key role in cell division. Despite their structural importance, there is not firm agreement concerning the bending stiffness of MTs. To elucidate this property, we use a gliding assay in which MTs are propelled above a surface by bound motor proteins. Here we present the relationship between MT stiffness and length. Additionally, our experimental data prompts a modification to the widely accepted model for the gliding assay, an unanticipated, but exciting result. It is our hope that these results lend clarity to the current models for MT bending stiffness, while enabling a more accurate determination of this important structural property.

Presenter(s): Rachel Lund, Gustavus Adolphus College
Session: P1.08
Title: Are riparian areas an important source of mercury to rivers?
Advisor(s): Jeff Jeremiason, Chemistry, Gustavus Adolphus College
Co-Author(s): Jeff Jeremiason, Nathan Johnson, Kevin Ng, Carl Mitchell

Abstract: Fish consumption advisories exist for Minnesota water bodies due to mercury contamination. In this project we examined hydrologic exchange between rivers and riparian areas in five systems. The five chosen rivers have the highest levels of mercury in game fish in the state of Minnesota. Another system with low levels of mercury in the fish was chosen as a contrasting system. We seek to determine

if this exchange could be an important contributor of methylmercury burdens in fish. We hypothesize that riparian areas may provide ideal conditions for the methylation of mercury and that ground water flow may be a significant input of methylmercury to many riverine systems. To test our hypothesis, we installed wells at multiple riparian locations to determine the direction of ground water flow. We also installed piezometers to allow us to sample water in multiple soil layers to assess methylmercury concentrations. Preliminary data suggest that porewaters in contact with the riverbed may be important areas of mercury methylation. Ground water methylmercury concentrations were highly variable amongst systems and no clear trends were observed to date.

Presenter(s): Abdel-Rahman Madkour & Phillip Nadolny, St. Olaf College
Session: B2.3
Title: Finding Minimal Spanning Forests in a Graph
Advisor(s): Professor Matthew Wright, Mathematics, Statistics and Computer Science, St. Olaf College
Co-Author(s): Philip Nadolny

Abstract: In the computation of multidimensional persistent homology, a popular tool in topological data analysis, a family of planar graphs arises. We have studied the problem of partitioning these graphs in a way that will be useful for parallelizing the persistent homology calculation. Specifically, we desire to partition an edge-weighted, undirected graph G into k connected components, $G_1,\cdots,G_k$. Let w_i be the weight of a minimum spanning tree in component G_i. For our purposes, an ideal partition is one that minimizes $max\{w_1,\cdots,w_k\}$. This problem is known to be NP-hard in the case of general graphs and we are unable to find this specific problem in the graph partitioning literature. We propose two approximation algorithms, one that uses a dynamic programming strategy and one that uses a spectral clustering approach, that produce near-optimal partitions in practice on a family of test graphs. We present detailed descriptions of these algorithms and the analysis of empirical performance data.

Presenter(s): Heather Martin, Laura Krings, Jack Haggett, Carthage College
Session: P1.17
Title: Surfactants With Reversible Linkers for Micelle Facilitated Organic Synthesis
Advisor(s): David Brownholland, Chemistry , Carthage College
Co-Author(s): Laura Krings, Jack Hagget

Abstract: Organic solvents contribute to 85% or more of total waste in the chemical industry, demonstrating the need to identify mechanisms of reducing organic solvent use in organic reactions. Alternatives such as supercritical fluids, ionic liquids, water, and using solvent-free conditions are in development and use. Water is an excellent alternative as it is low in energy costs, can be sustainably generated and is abundant. Unfortunately, water is often unsuitable for many organic reactions as most organic reactants and reagents are water insoluble. However, recent work demonstrated aqueous micellar solutions are capable of conducting organic reactions under aqueous conditions. Micelles facilitate organic reactions in aqueous conditions as the water insoluble organic material is entropically driven into the micelle interior, thus providing a medium for the reaction. Micelles have even been shown to conduct some reactions more efficiently and at room temperature, thus lowering the energy costs involved in these organic reactions. We are focused on designing and synthesizing a novel surfactant which self-aggregates into micelles capable of immobilizing starting materials or catalysts to the interior of the micelle through an alkene functional group. We report progress on the synthesis of an alkene-terminating steroidal-PEG surfactant synthesized from lithocholic acid in five steps, where the alkene can reversibly attach catalysts and reactants. The Δ22 steroid was synthesized through an oxidation-decarboxylation pathway with appropriate protection/deprotection. The PEG headgroup installation was originally attempted through a Fischer esterification strategy, but after encountered challenges, we are currently focused on DCC coupling reactions.

Presenter(s): Sarah McCarthy, Grinnell College
Session: D2.2
Title: Magnetic anisotropy in single crystals of $RNiGe_2$ (R = Gd, Tb, Dy)
Advisor(s): Charles Cunningham, Physics, Grinnell College

Abstract: Single crystals of RNi_xGe_{2-y} (R = Gd, Tb, Dy) were grown utilizing the flux growth method and were analyzed magnetically. Throughout the compound family, x-ray diffraction revealed different deficiencies – $DyNi_{0.9}Ge_2$, $TbNi_{0.9}Ge_{1.9}$, $GdNiGe_2$ – but I will refer to them as $RNiGe_2$ in this poster. All three compounds order antiferromagnetically below their Néel temperatures (TN), with Dy and Gd at 21 K and Tb at 33 K. Curie-Weiss paramagnetism is confirmed by a linear inverse susceptibility above TN for all three compounds, and the drastic slope differences between the Tb and Dy axes suggest strong anisotropy. Both Dy and Gd undergo one metamagnetic transition at 20 kOe, and Tb undergoes two at 40 and 55 kOe. The c-axis for all three compounds is the easy axis of magnetization.

Presenter(s): Emily McClure, Grinnell College
Session: A1.3
Title: Microwave-assisted Synthesis of α-Keto Substituted Chalcones
Advisor(s): Stephen R. Sieck, Chemistry, Grinnell College

Abstract: The synthesis of α-keto substituted chalcones has been optimized through the microwave-assisted Knoevenagel condensation with catalytic amounts of piperidine in solvent-free conditions for sixty minutes. Additionally, the equivalence of ketone to aldehyde increased to 2:1 for total consumption of the aldehyde. All products were purified through flash column chromatography. The successful synthesis of these compounds adds to the library of α-substituted chalcones synthesized through the microwave-assisted Knoevenagel condensation and provides a facile alternative to previous methodologies.

Presenter(s): César Mendoza, Macalester College
Session: P2.01
Title: A High Angular Resolution View of the Neutral Hydrogen Gas in the TOL1924-416 Interacting System
Advisor(s): John Cannon, Astronomy and Physics, Macalester College
Co-Author(s): Karen Sarmiento

Abstract: This poster presents new HI images at high angular resolution of the Lyα-emitting starburst TOL 1924-416 galaxy system. The low frequency data was obtained from the GMRT (Giant Metrewave Radio Telescope) in Pune, India. This new HI images show an extended HI tidal structure extending from TOL 1924-416 [α,∂ (J2000.0 = 19h27m58.2s, -41d34m32s] to its companion galaxy ESO 338-IG04B [J2000.0 = 19h27m31.6s, -41d38m54s] with a relatively low redshift of 0.009453 and 0.009507, respectively. This poster shows the moment zeroth and one maps generated with GMRT data, which seem to show more structure than the images created with the Very Large Array (VLA)C-configuration, however the total integrated flux is only about half of that obtained with the VLA C-configuration.

Presenter(s): Lyndsy Miller, Hope College
Session: P2.21
Title: Synthesis and Biological Studies of Dinuclear Arene Ruthenium Glycoconjugates
Advisor(s): Amanda Eckermann, Maria Burnatowska-Hledin, Chemistry, Biology, Hope College
Co-Author(s): Luke Wisniewski, Lauren Kennington

Abstract: Due to the severe toxicity of anticancer platinum complexes and acquired drug resistance, research has focused on arene ruthenium complexes as viable alternatives. Arene complexes of the formula $[areneRu(\mu_2\text{-}L)Cl]_2$ and $(areneRu)_2(\mu_2\text{-}L)_3^+$ (L = alkyl thiolate) are known to be cytotoxic with IC_{50} values in the micromolar and submicromolar ranges, respectively. Our hypothesis is that glucose ligands

will improve specificity of cymene ruthenium complexes for cancerous cells over normal cells. Reaction of the sodium salt β-D-thioglucose with $[cymeneCl_2Ru]_2$ forms $[(cymene)Ru(\mu_2\text{-thioglucose})Cl]_2$ (**1**) and $(cymeneRu)_2(\mu_2\text{-thioglucose})_3^+$ (**2**). After optimization of reaction conditions, these compounds were successfully purified by HPLC and NMR characterized. The properties of these compounds in vitro were probed in a somatic line (HUVEC), a breast cancer line (T47D), and a cisplatin resistant cell line (A2780cis). Analysis with alamarBlue® revealed a reduction in metabolic activity and cell death was observed through microscopy in T47D and A2780cis cell lines treated with **1** but not in the HUVEC cell line. No effect towards any of the cell lines was observed when treated with **2.**

Presenter(s): Andrew Molina, University of Chicago
Session: P2.10
Title: Observed in vitro Lipid Dynamics to Confirm Novel Model for CNS Myelinogenesis
Advisor(s): Ka Yee C. Lee, Chemistry, University of Chicago
Co-Author(s): Ka Yee C. Lee

Abstract: The myelin sheath is an insulating, compacted, multilamellar biological membrane that facilitates efficient propagation of action potentials down neuronal axons, and is critical for proper physiological function. Recently, University of Chicago neurobiologist Sara Szuchet proposed a novel mechanism for myelin formation in the central nervous system (CNS) to address fundamental flaws in the established model. To investigate this mechanism, we designed in vitro experiments to probe the biophysical interactions of myelin lipids as they self-assemble into tubules and transition into lamellar form. Specifically, using TEM imaging, we have observed the self-assembly of tubules consisting of 100% galactosylceramide (GalCer), a fundamental glycolipid of CNS myelin. We have similarly investigated how 2-component systems of GalCer/Cholesterol and GalCer/Plasmalogen transition from stable tubule structures to larger aggregates of lower curvature upon decreasing GalCer concentration. Our results suggest that these structures of major myelin lipids can be stable precursors for myelination. Using fluid-cell AFM, we have begun to investigate how these self-assembled tubules interact with supported lipid bilayers in HEPES buffer solution (pH 7.4) with hopes of observing a fusion event between the structures that would be experimental evidence of the proposed Szuchet model for the biological mechanism of myelin formation.

Presenter(s): Lucas Myers, Lawrence University
Session: C2.4
Title: Robust tracking algorithm to follow microtubules moving in gliding assays
Advisor(s): Douglas Martin, Physics, Lawrence University
Co-Author(s):

Abstract: Microtubules play many important roles in the cell, including structural support, and, as such, it is useful to understand their mechanical properties. The gliding assay is one procedure that allows us to measure these mechanical properties. Thermal fluctuations that occur in the gliding assay medium exert forces on the microtubules, and by observing the way in which microtubules respond to these forces, we can back calculate the bending stiffness. However, the precision with which we can measure bending stiffness is intrinsically limited by statistics: the view of our microscope restricts the time over which we can measure microtubule fluctuations. In this talk, we present a way in which we can extend the viewing time of this system by algorithmically tracking individual microtubules, with the goal of automatically moving the sample to keep the specific microtubule in the field of view. We hope to use this technique in order to extend our data acquisition time by more than tenfold, with a threefold improvement in precision.

Presenter(s): Richard Noriega, Beloit College
Session: E1.1
Title: On Theta Activity in Human EEG
Advisor(s): Erin Munro, Mathematics, Beloit College
Co-Author(s):

Abstract: Theta oscillations, a specific type of electrical activity in the brain, is thought to have occurred only when either a human is awake or when they are in REM sleep. However, it could be possible that theta oscillations exist outside of these two states. This idea arose from preliminary results in rats, and is going to be furthered by utilizing Independent Component Analysis (ICA), a mathematical technique, to find neural sources in Electroencephalogram (EEG) recordings of human sleep. This use of ICA has almost never been practiced previously. Despite this, I was able to actively search for theta outside of REM sleep and wakefulness in human EEG recordings. This research could potentially give us a deeper understanding on the implications of sleep and learning during non-REM sleep through a possible connection with theta.

Presenter(s): Andrew Novick, Washington University in St. Louis
Session: P2.17
Title: Studying the synthesis of cuprous oxide nanocrystals for catalytic purposes
Advisor(s): Bryce Sadtler, Chemistry, Washington University in St. Louis
Co-Author(s):

Abstract: Nanocrystals have been playing an increasingly significant role in society. Platinum and gold nanoparticles have been used in catalytic converters and targeted drug delivery, respectively. Morphology plays an important role in the performance of nanoparticles, particularly in catalysis. In order to optimize nanocrystal performance, further work is necessary to better understand the effects of morphology on catalytic performance for specific reactions and catalysts. Cuprous oxide, a well-established nanocrystal catalyst that has demonstrated the ability of oxidizing carbon monoxide and producing hydrogen gas from water, was chosen as the subject of our work. The effects of a variety of factors on the size and morphology of cuprous oxide were determined. An argon atmosphere was shown to smooth the edges of the particles, relative to their synthesis under atmospheric conditions. The surfactant PVP was shown to facilitate the growth of the [111] crystal facet, leading to an octahedral shape, while ascorbic acid allowed for only [100] to grow, resulting in cubic structures. With these results, cuprous oxide nanocrystals can be reliably produced in a variety of shapes and sizes, allowing for further work to be conducted on evaluating the effects of different morphologies—and their resultant crystal facets--on catalytic activity.

Presenter(s): Anne O'Donnell, Hope College
Session: P2.25
Title: Bio-Inspired Control of Civil Infrastructure
Advisor(s): Courtney Peckens, Engineering, Civil Emphasis , Hope College
Co-Author(s):

Abstract: Civil infrastructure is constantly at risk for failure due to unpredictable high impact loadings, including earthquakes and high winds. Over the course of the last decade, a bio-inspired wireless sensor node has been developed for the purpose of more effective structural monitoring and control. This node draws inspiration in its functionality from the mammalian cochlea found in the inner ear and benefits of the node include its real time frequency decomposition capabilities as well as its ability to compress high amounts of data. In this study, a bio-inspired control algorithm, which draws inspiration from the mechanisms employed in the biological central nervous system for sensing and control, was applied to a single story structure in order to produce more effective methods of control. Specifically, the structure's performance when subject to control was studied in depth by analyzing, via simulations, the behavior of the structure using various dynamic models. It was found that this algorithm produced effective displacement control by reducing the maximum displacement of the single story structure by 42.90% and normalized displacement by 32.33%.

Presenter(s): Justin Pacholec, St. Olaf College
Session: P2.20
Title: A Personalized, Adaptive, Online Training Program for Postlingually Deafened Cochlear Implant Users
Advisor(s): Richard Brown, Computer Science, St. Olaf College
Co-Author(s): Jeremy Loebach

Abstract: This project represents the culmination of the past 6 years of research into the development of a training program for postlingually deafened adult cochlear implant (CI) users. We have created an online, adaptive, and scalable training program that aims to help CI users learn to hear with their devices. The program was built using HiPerCiC, a Django-based web framework that enables students to efficiently create online research applications. The training itself is grounded in theories of cognition, perceptual learning, generalization, and basic speech and language processing. Four days a week, a user taking part in the program will complete a series of training modules, each of which targets a specific aspect of hearing: traditional linguistic tasks, such as meaningful sentence identification and word recognition, as well as non-speech paralinguistic tasks such as talker voice recognition and the identification of environmental sounds. At this time, few supervised training programs exist for adult cochlear implant users. Our training program innovates over existing options by accommodating multiple levels of proficiency, featuring open set responses, and providing users with instant feedback. The adaptive nature of the program requires users to always improve, automatically including more difficult items as participants show mastery of previous levels.

Presenter(s): John Pavek, Gustavus Adolphus College
Session: P1.07
Title: Controls on Mercury and Methylmercury Concentrations in the Saint Louis River and its Tributaries
Advisor(s): Jeff Jeremiason, Chemistry, Gustavus Adolphus College
Co-Author(s):

Abstract: The goal of this project is to determine what controls the variation in mercury and methylmercury concentrations in the Saint Louis River and its tributaries. The St. Louis River and many of the tributaries receive significant loads of sulfate from mining operations and there is concern that the excess sulfate loading may be enhancing the methylation of mercury and exacerbating fish mercury levels. Samples were collected periodically from selected sample sites and analyzed for mercury , methylmercury (MeHg), dissolved organic carbon (DOC), specific UV absorbance (SUVA), iron , and sulfate , and concurrently measuring the flow at each site. It was found that the elevated sulfate concentration as a result of mine outflow, had no correlation with Hg or MeHg concentrations. DOC concentration and flow both correlated strongly with Hg and MeHg in sites that were not affected significantly by a lake or reservoir.

Presenter(s): Peter Pedersen, Macalester College
Session: P2.07
Title: Application of Bis(trimethylsilyl)butadiyne in 1,2,3-Triazole Synthesis: 5-Ethynyl-1,2,3-Triazole Derivatives
Advisor(s): Ronald Brisbois, Chemistry, Macalester College
Co-Author(s): Tia Eskridge, Hoang Anh Phan

Abstract: The 1,2,3-triazole scaffold is an important pharmacophore and a versatile, increasingly leveraged, substructure in biochemical, materials, polymer, and metal-coordinating applications. Continuing advances in 1,2,3-triazole construction, by either non-catalyzed or metal-catalyzed azide/alkyne cycloaddition, foster further creative use. We recently developed and reported (Tet. Lett. 2013, 54, 272) a general protocol for the synthesis of 4,5-bis(trimethylsilyl)-1,2,3-triazoles via thermal Huisgen cycloaddition between azides and bis(trimethylsilyl)acetylene. Extending this work, we have

optimized a protocol for reacting bis(trimethylsilyl)butadiyne with azides to form 5-trimethylsilylethynyl-4-trimethylsilyl-1,2,3-triazoles in good to excellent yield. Preliminary results indicate that the combined catalytic action of Cu(I)/Ag(I)/L-ascorbate(Na) causes very efficient bis-desilylation on these compounds, whereas reaction with only catalytic Ag(I) selectively desilylates just the trimethylsilylethynyl moiety.

Presenter(s): Karen Perez Sarmiento, Macalester College
Session: P1.03
Title: GMRT HI Imaging of Selected LARS+eLARS Galaxies
Advisor(s): John Cannon, Astronomy Department of Physics and Astronomy, Macalester College
Co-Author(s): Cesar Mendoza Davila

Abstract: The Lyman Alpha Reference Sample (LARS) and its extension (eLARS) form the most comprehensive effort to date to study the details of Lyman Alpha radiative transfer in galaxies. Direct imaging of Lyman Alpha emission from the Hubble Space Telescope is supplemented by a wealth of multi-wavelength observations designed to probe the complex processes that contribute to the escape or destruction of Lyman Alpha photons as they resonantly scatter in the neutral ISM. The 42 LARS+eLARS galaxies span a range of physical properties, including mass and star formation rate. In this work, we present new GMRT HI imaging of selected LARS+eLARS galaxies designed to study the detailed morphology and kinematics of the HI gas. HI column density images and velocity fields are compared to SDSS imaging.

Presenter(s): Ananya Pillutla, University of Chicago
Session: P1.30
Title: Autocorrelation of ultrafast pulses for quantum materials research
Advisor(s): Joseph W. Orenstein, Material Science Division, Lawrence Berkeley National Lab
Co-Author(s): Arielle Little, Shreyas Patankar

Abstract: Quantum materials research is an expanding area of research in physics and material science. The Orenstein lab at Lawrence Berkeley National Lab uses ultrafast laser pulses to probe quantum materials. Ultrafast laser pulses on the femtosecond (10^{-15}) time scale cannot be measured using standard electronics. In this project we build an autocorrelator— an optical device to accurately measure pulse length in time. The autocorrelator relies on a time delay mechanism, interferometry, and non-linear optics to measure the length and chirp, change in frequency, of the pulse. We hope to use this device to diagnose pulses for experiments using the techniques of ultrafast pump-probe and Terahertz (THz) generation.

Presenter(s): Alexander Prophet, St. Olaf College
Session: P1.14
Title: Characterization of a pulsed gas expansion instrument for energy transfer and high speed flow studies
Advisor(s): Rodrigo Sanchez Gonzalez, Chemistry, St. Olaf College
Co-Author(s): Andrew Salij

Abstract: Fundamental studies involving high speed flows have motivated the development of small scale facilities that can replicate conditions relevant to high speed flight. This work reports the characterization of the St. Olaf Pulsed Hypersonic Improved Test (STOPHIT) Cell, an apparatus designed to generate pulsed supersonic homogeneous gas expansions using converging- diverging nozzles. Characterization of three aluminum converging-diverging, or de Laval, nozzles using fast pressure transducers yielded Mach numbers of 4.07 ± 0.12, 5.06 ± 0.04, and 6.40 ± 0.02, with good spatial homogeneity across their exit. A replica of the Mach 4.07 nozzle was 3D-printed using Acrylonitrile Butadiene Styrene (ABS) and subsequently characterized, resulting in a flow with a Mach number of 4.04 ± 0.05 and high spatial uniformity, demonstrating the viability of 3D-printing for efficient nozzle construction. Additionally, the performance of fuel injectors as a pulsed gas source for the

STOPHIT Cell was assessed. Performance in terms of mass flow and opening time was characterized and it was found suitable to replace commonly used pulse solenoid valves at a lower cost and with simple driving electronics.

Presenter(s): Michael Ray, Lawrence University
Session: B1.2
Title: Imaging the mitochondrial structures of beer yeasts
Advisor(s): Douglas S. Martin, Dave J. Hall, Physics, Chemistry, Lawrence University

Abstract: Mitochondria are dubbed the powerhouses of the cell; however, their function in the cell is understood well beyond the production of energy. Mitochondria are involved in the cellular response to stress, apoptosis, and prion function. Thus, the function of mitochondria is critical to addressing aging, cancer, and neurodegenerative diseases. Yeasts are important model organisms for mitochondria that are also used in the production of bread and beer. While mitochondrial shape is well characterized in model yeasts, it is unknown in brewing yeast. Moreover, mitochondrial structure is related to metabolism and hence the fermentation process. Measuring yeast metabolism during the fermentation process offers valuable insight into mitochondrial function because different yeasts have different metabolic statuses during fermentation. Here, we present initial findings of the mitochondrial shapes of brewing yeasts that have different fermentation profiles.

Presenter(s): Jillian Rix, Grinnell College
Session: P1.28
Title: Harvesting wind energy to detect weak signals using mechanical stochastic resonance
Advisor(s): Barbara Breen, Physics, Grinnell College
Co-Author(s):

Abstract: Wind is free and ubiquitous and can be harnessed in multiple ways. Stochastic resonance (SR) is a counterintuitive phenomena where, in certain nonlinear systems, the presence of noise helps rather than hinders the detection of a weak signal. A low-amplitude periodic signal can “recruit” random noise, enhancing its amplitude. We demonstrate mechanical stochastic resonance in a tabletop experiment that harvests wind energy to amplify weak periodic signals detected via the movement of an inverted pendulum. Unlike earlier mechanical stochastic resonance experiments, where noise was added via electrically driven vibrations, our broad-spectrum noise source is a single flapping flag. The regime of the experiment is readily accessible, with wind speeds $\sim$ 20 m/s and signal frequencies $\sim$ 1 Hz. We readily obtain signal-to-noise ratios on the order of 10 dB.

Presenter(s): Joseph Romo, Macalester College
Session: P1.13
Title: The Assembly of Carbon Macrocycles through Alkene Metathesis
Advisor(s): Dennis Cao, Chemistry, Macalester College
Co-Author(s):

Abstract: The assembly of supramolecular macrocycles has recently become an area of intensified research interest. Their unique and symmetric structures have the ability to encapsulate other molecules within their structural cavity and can be designed to bind with charged or neutral substrates. In addition, macrocycles offer a high level of specificity, as their selectivity of for certain chemical species is a function of many parameters, most importantly being that between the substrate size and the macrocycle’s cavity size. These unique properties of these structures may allow for a myriad of potential applications, such as targeted drug delivery. We are attempting to synthesize macrocycles and cages by exploiting the 109° angle of sp3 carbons to direct the assembly of pentagonal shapes – the interior angle of a pentagon is 108°. Di-topic alkene monomers will be exposed to alkene metathesis conditions with the hypothesis that macrocycles will be the thermodynamically favored products of the metathesis equilibrium.

Presenter(s): Megan Roozeboom & Grant Myres, Luther College
Session: C1.4
Title: Analyzing the binding relationship between curcuminoids and HSA by Steady State Fluorescence Spectroscopy
Advisor(s): Olga Michels, Chemistry, Luther College
Co-Author(s): Matthew Amann

Abstract: Curcuminoids are a class of photoactive organic compounds that have been found to have practical application in Photodynamic Drug Therapy (PDT). To understand the practicality of a given curcuminoid in PDT the binding relationship to the protein Human Serum Albumin (HSA) at physiological pH 7.4 must be identified. This particular parameter can be analyzed through a variety of photophysical studies. In particular, quenching studies and the use of a Stern-Volmer plot provides insight to the K_{sv} value and in turn, the determination of the k_b (binding constant). Another parameter of interest is the number of binding sites between a given curcuminoid and HSA. This can be analyzed through the relationship between fluorescence intensities and curcuminoid concentrations. Alternative and future methods of analysis include Benesi-Hildebrand plots and identification of thermodynamic parameters. The data obtained thus far indicates that there is consistently one binding site for the curcuminoids within HSA. Further analysis will provide more concrete information pertaining to the overall binding coefficients and stoichiometric relationships.

Presenter(s): Saeed Roschdi, Beloit College
Session: A1.1
Title: Investigating enzyme active-site geometry and stereospecificity in the undergraduate biochemistry lab.
Advisor(s): Theodore Gries, Chemistry, Beloit College
Co-Author(s):

Abstract: The three-dimensional nature of enzymes' reactions with their substrates leads to exact spatial orientations and stereoselectivity of the catalytic reactions. Dehydrogenases that use NAD^+ as the cofactor usually show specificity for the ri or si face of the C4 hydrogen on the nicotinamide ring. This stereospecificity can be determined through the use of 1H NMR and a reaction using deuterated substrates. A biochemistry lab is presented combines the analysis of the intermolecular interactions that occur within the three dimensional architecture of the enzyme's active site between the enzyme, cofactor, and substrate based on a recent crystal structure of yeast alcohol dehydrogenase with improved deuterated reaction conditions that allow for one-tube reactions to analyze the stereospecificity of the yeast alcohol dehydrogenase using 1H NMR.

Presenter(s): Elisabeth Rutter, Carthage College
Session: P2.03
Title: NMR investigation of the effect of pH on micelle formation of the surfactant L-Undecyl Phenylalaninate
Advisor(s): Kevin Morris, Chemistry, Carthage College
Co-Author(s):

Abstract: NMR spectroscopy was used to study micelle formation by the amino acid-based surfactant L-Undecyl Phenylalaninate (und-Phe). Amino acid-based surfactants like und-Phe are used in the pharmaceutical, food, and cosmetic industries because they are biodegradable, biocompatible, have a low toxicity, and can be produced using renewable materials. In und-Phe, a polar amino acid head-group is bound a hydrophobic hydrocarbon chain. In aqueous solution, the hydrocarbon chains have a low affinity for the solvent, while the polar head-groups experience favorable interactions with the aqueous phase. NMR measurements of the surfactant's critical micelle concentration (CMC) showed that und-Phe micelles began to form at concentrations around 6.0 mM in solutions containing the anionic surfactant

and sodium counter-ions. Micelles formed, though, in the 3.5-4.0 mM range in solutions containing either arginine or lysine counter-ions. In addition, NMR diffusion experiments showed that arginine and lysine counter-ions bound to und-Phe micelles below pH 9.0, but dissociated from the micelle surface at high pH. Finally, two dimensional NMR experiments suggested that the mechanism of arginine and lysine binding to und-Phe micelles was different and that when the und-Phe molecules formed micelles, their aromatic rings rotated toward the non-polar micelle core.

Presenter(s): Manasvi Sagarkar, University of Chicago
Session: A2.3
Title: Automatic metric for evaluating story generation
Advisor(s): Kevin Gimpel, Computer Science, Toyota Technological Institute Chicago
Co-Author(s):

Abstract: Existing evaluation metrics for generation models like ROUGE and BLEU have been shown to not correlate highly with human judgement outside of their target domains like machine translation and summarization. We propose a new automatic evaluation metric for our task of sequence to sequence story generation which uses human annotations along with relevant features to predict a score for the story on criteria like interestingness and relevance as well as an overall score that correlates strongly with human judgement.

Presenter(s): Matthew Sandgren, Hope College
Session: P1.26
Title: Predicting Dengue Fever Incidence
Advisor(s): Yew Meng Koh, Mathematics, Hope College
Co-Author(s):

Abstract: The Aedes genus of mosquito is the vector for at least three viral diseases - Dengue Fever (DF), Zika and Chikungunya. In many regions of the world, an upward trend in DF and Zika infections is observed. Using disease data from the Singaporean Ministry of Health and population data from the Singapore Department of Statistics, various statistical models are fit to DF, Dengue Hemorrhagic Fever (DHF; an often-fatal complication of Dengue Fever) and Chikungunya. These models differ in their consideration of the overall data structure, and have different underlying assumptions. Of particular interest is a prediction model based on neural networks, which we present. The merits and performance of these models are discussed and the accuracy of predictions made by each model are compared. The statistical method for determining prediction bounds for the neural network model is also discussed. These prediction models provide an objective method for public health management and policy making.

Presenter(s): Hanbo Shao & Olivia Chandrasekhar, Colorado College
Session: D1.4
Title: Invariants of the Free-Fermion Vertex Algebra under the Action of Z/2
Advisor(s): Michael Penn, Mathematics and Computer Science, Colorado College
Co-Author(s): Olivia Chandrasekhar

Abstract: Many authors, most famously H. Weyl in the early 20th century, have studied rings of polynomial invariants. More recently, A. Linshaw and co-authors adapted classical invariant theory to study the invariance of vertex algebras. Drawing on Linshaw's methods, our work describes a linear isomorphism from classically invariant polynomial rings to quantum operator algebras that allows us to apply the first fundamental theorem of invariant theory. Specifically, we study the invariance of the rank n free-fermion vertex algebra under the action of the Z/2 group and obtain its minimal generating set.

Presenter(s): Leonard Shaw, University of Chicago
Session: P1.23
Title: Using Lipid Biomarkers to Understand Deep Ocean Organic Particle Flux
Advisor(s): Maureen Conte, Ecosystems Center, Marine Biological Laboratory
Co-Author(s): Emily Maness, J.C. Weber, Maureen Conte

Abstract: The oceanic water column hosts a sinking flux of organic matter consisting of nutrients and detrital products of marine ecosystems. The molecular composition of this organic particle flux can be used to illuminate deep ocean ecological processes. This study examined lipid biomarkers in the deep ocean sinking particle flux and suspended particles collected at the Oceanic Flux Program (OFP) time-series site in the Sargasso Sea, an oligotrophic region typical of mid ocean gyres. Three main classes of lipid biomarkers were analyzed: sterols, fatty acids, and hopanoids. These biomarkers were used to determine the sources of the organic matter in deep ocean particles and the ecological processes leading to the remineralization and release of bioavailable nutrients. The organic composition of sinking particles shifts from enrichment in fresh phytoplankton-derived biomarkers to animal-derived materials from spring to fall. Bacterially-derived biomarkers such as hopanoids decreased from spring to fall and increased in relative abundance with depth. Biomarker composition in suspended particles reveals a conversion from fresh phytoplankton-derived organic detritus in the upper ocean to more bacterially-enriched material in the deep ocean. The findings of this study show the power of lipid biomarkers in providing novel insights on organic particle flux and ocean biogeochemical cycling.

Presenter(s): Zican Shen, Grinnell College
Session: P1.09
Title: Total Synthesis and Biological Evaluation of Tryptophan Xenortide B Derivatives
Advisor(s): Erick Leggans, Chemistry, Grinnell College
Co-Author(s):

Abstract: Xenortide B, a nature product isolated from bacteria, Xenorhabdus nematophilia, is a simple variant of tripeptide that has diverse biological activity, such as anti-bacteria, anti-fungal and anti-malaria. A newly designed Plasmodium-selective proteasome inhibitor that also shows anti-malaria ability has a similar structure as xenortide B. Based on the similarities and differences of these two compounds, we synthesized tryptophan xenortide B derivatives, hoping to find the specific portions of molecule that attribute to the biological activity.

Presenter(s): Jia Shi, Kalpit Modi, St. Olaf College
Session: P2.09
Title: Developing Tetramethylammonium Formate as a Probe of Biopolymer Surface Areas
Advisor(s): Jeff Schwinefus, Chemistry, St. Olaf College
Co-Author(s): Kalpit Modi

Abstract: The surface areas of biopolymers comprise of different functional groups. By utilizing a chemical probe, we can validate which functional groups of a biopolymer that are exposed and hidden during a chemical reaction. Previous studies have used relatively small organic molecules like glycine betaine to see how they might interact with function groups on model compounds. By building on the previous research done on glycine betaine, we studied the interactions between a tetramethyl-ammonium formate (TMAF) and different functional groups. Depending on functional group, the interactions are either favorable or unfavorable. TMAF can be used to probe certain functional groups by exploiting these characteristics and as a result, use it as a probe to investigate biopolymer surface area changes. To characterize these interactions, we used vapor pressure osmometry. The μ23, the derivative of the chemical potential, was determined for each model compound. Our studies show that TMAF act similarly to glycine betaine and shows promise as a probe for biopolymer surface areas.

Presenter(s): Maithreya Sitaraman, University of Chicago
Session: E1.4
Title: A symmetrization process to characterize Lights Out setups
Advisor(s): Sarah Ziesler, Mathematics, University of Chicago
Co-Author(s):

Abstract: The σ+ Lights Out puzzle is a game played on some geometrical grid wherein there is a bulb and a switch on each tile and the switches are wired so that flipping any switch changes the state of not only the bulb in its own tile but also of those in all adjacent tiles. A geometrical arrangement is said to be completely solvable if every initial configuration of `on' and `off' bulbs has a unique configuration of `switch flips' to turn all the bulbs in the initial configuration off. By symmetrizing elements of the kernel of the σ+ linear map, I present a method by which geometrical arrangements which have axes/planes of symmetry may be characterized as completely solvable or otherwise. The advantage of this method is that it can be used to reduce the complete solvability characterizations of more complicated arrangements to those of simpler arrangements, and therefore can be used to categorize these arrangements in a manner that is less cumbersome than previous polynomial approaches. I apply this method to reduce the characterizations of diamonds and surface grids on cylinders, capped-cylinders, tori, cones, capped-cones and spheres to the characterizations of rectangular grids. I also demonstrate how this method of symmetrizing elements of the kernel can be used to uncover many of the well-studied patterns regarding the characterization of m x n rectangular grids.

Presenter(s): Radiandra Soemardi, Knox College
Session: P2.15
Title: Synthesis, characterization, and reactivity studies of iron dibromide complexes bearing para-substituted alpha-diimine ligands
Advisor(s): Helen Hoyt, Chemistry, Knox College
Co-Author(s):

Abstract: As reported by Huynh and co-workers, condensation of 2,3-butanedione and 4-tert-butylaniline results in the formation of a para-tert-butylphenyl substituted alpha-diimine ligand (4tBuDI). Similarly, the condensation of acenaphthenequinone and 4-tert-butylaniline results in a new para-tert-butylphenyl substituted bis(imino) acenaphthene ligand (4tbuBIAN) that was characterized using NMR and IR spectroscopy, elemental analysis, melting point analysis, and X-ray crystallography. New iron dibromide complexes were isolated upon mixing these ligands with iron dibromide, resulting in the formation of the corresponding iron precatalysts 4tBuDIFeBr_2 and 4tBuBIANFeBr_2. These precatalysts have been characterized by 1H NMR spectroscopy, and the connectivity for the 4tBuDIFeBr_2 precatalyst has been confirmed by X-ray crystallography. Preliminary catalytic hydrosilylation activity for these precatalysts upon reduction is currently under investigation.

Presenter(s): Marissa Solorzano, Hope College
Session: P2.18
Title: Identifying the Expression Patterns of xCT in Zebrafish to Determine its Role in Neuroregeneration
Advisor(s): Brent P. Krueger, Chemistry, Hope College
Co-Author(s): Nicole A. Ladd, Kevin C. Franz, Christopher O. DaSilva, Leah A. Chase, Aaron P. Putzke

Abstract: System xc– is a heterodimeric amino acid transporter comprised of an transmembrane light chain unit, xCT, and an extracellular heavy chain unit, 4F2HC. System xc– has been shown to exchange intracellular glutamate for extracellular cystine, which is then reduced within the cell to cysteine, the limiting reagent for glutathione production. Glutathione is a reducing agent that is important in reducing oxidative stress, which untreated can trigger cell death. It has been shown that system xc– is strongly expressed in the central nervous system, particularly in neuroprotective cells such as astrocytes and microglia. It is believed the reduction of oxidative stress in the environment of neurons and neuroprotective cells is critical to allow new neurons to be produced in processes such as neuroregeneration. The current focus of this study is to qualitatively determine the expression patterns of

the xCT gene in zebrafish embryos using in situ hybridization. This is in preparation for exploring the role that xCT plays in neuroregeneration using laser ablation to mimic spinal cord injury in vivo. Preliminary results of in situ hybridization will be presented.

Presenter(s): Emma Streff, Washington University in St. Louis
Session: P2.11
Title: Total synthesis of a library of unnatural derivatives of lingzhiol
Advisor(s): Vladimir B. Birman, Chemistry, Washington University in St. Louis
Co-Author(s): Emma Streff, Vladimir B. Birman

Abstract: Lingzhiol, a tetracyclic meroterpenoid, has an unprecedented structure and exhibits selective inhibitory activity toward p-Smad proteins, which is relevant to the treatment and prevention of renal fibrosis, a common and often fatal final pathway of chronic kidney disease. Discovered by Cheng and colleagues, lingzhiol was isolated in minute quantities from Ganoderma lucidum, a tropical fungus commonly used in traditional Chinese medicine under the name ling-zhi. Dr. Vladimir Birman and Krishna Sharma Gautam have recently published a novel 9-step synthesis of lingzhiol, which utilizes an acid-catalyzed semipinacol rearrangement of a glycidyl alcohol intermediate. Using variations on this flexible scheme, a library of unnatural lingzhiol derivatives are being synthesized, with particular focus on altering the substitution pattern on the benzene ring. These derivatives will be sent to the Washington University School of Medicine for further investigation of their antifibrotic and neurotrophic activities.

Presenter(s): Caleb Sword, Hope College
Session: D2.4
Title: Determination of the Nuclear Structure of Unstable ^{25}O
Advisor(s): Dr. Paul DeYoung, Physics, Hope College

Abstract: One of the primary goals of nuclear physics research is to better understand the force that binds nucleons. This can be accomplished by studying the structure of neutron-rich isotopes. For this experiment, excited ^{25}O nuclei were formed by a collision between a 101.3 MeV/u ^{27}Ne ion beam and a liquid deuterium target at the National Superconducting Cyclotron Laboratory. One resulting reaction involved two-proton removal from ^{27}Ne particles, which created excited ^{25}O nuclei that decayed into three neutrons and an ^{22}O fragment. The four-vectors for the neutrons and ^{22}O fragments were determined, allowing the calculation of the decay energy for this process on an event-by-event basis. However, another reaction would also take place, in which an alpha particle was stripped from the beam, creating ^{23}O nuclei that decayed into an ^{22}O fragment and a single neutron. In order to distinguish between ^{22}O fragments and neutrons from both ^{25}O and ^{23}O isotopes, GEANT4 simulations of each decay process were conducted in order to uncover their distinguishing characteristics. By successfully correlating simulated decay processes to experimental data, the relative cross sections of the two decay processes will be determined, and their decay energies will reveal more about their nuclear structures.

Presenter(s): Austin Szczodrowski, Carthage College
Session: A1.2
Title: Surfactants with Immobilized Catalysts for Micelle-Facilitated Organic Synthesis
Advisor(s): David Brownholland, Chemistry, Carthage College

Abstract: In many ways, water is an ideal solvent: it is cheap, abundant, renewable, non-toxic, and non-flammable, making it an excellent alternative to the organic solvents used in chemical reactions. Unfortunately, the water insolubility of most organic compounds limits its use as a solvent. Significant progress has been made in micellar catalysis, in which organic reactions take place in the organic medium in the interior of the micelle. We are designing surfactants that generate micelles containing immobilized catalysts capable of catalyzing reactions, such as the Mannich or aldol reactions, within the interior of the micelle and are able to be immediately recycled without any purification or isolation. Specifically, we report progress on the synthesis of a steroidal-based surfactant containing a proline-derivative linked to the D-ring of the steroid. This novel surfactant is synthesized from Lithocholic acid in

six steps. We hypothesize that this new surfactant can be utilized to generate micelles capable of catalyzing stereoselective reactions. Future work will focus on the ability of these micelles to catalyze stereoselective reactions as well as the ability to reuse the micelles. The physical properties of the micelles will be characterized by dynamic light scattering (DLS), cryo-TEM, and pulse-field gradient (PFG) NMR.

Presenter(s): Katherine Taylor, University of Chicago
Session: C1.2
Title: Progress Towards the Total Synthesis of an Unnamed Brominated Diterpene
Advisor(s): Scott. A Snyder, Chemistry, University of Chicago
Co-Author(s): Jennifer Pitzen, Florian Schevenels

Abstract: Brominated natural products of the labdane family likely arise in Nature from enzymatically-promoted halonium-induced cascade cyclizations from simple, alkene-based precursors. In this work, we propose to achieve a biomimetic synthesis of an unnamed brominated labdane-type natural product through a cascade process that will forge 3 rings at once from a tetrahydrofuran substituted with appropriate activating groups and a polyene chain. Key to the success of this approach, we believe, will be the use of $Et_2SBr•SbCl_5Br$ (BDSB), a novel brominating reagent developed by the Snyder group that has been used extensively for polycyclization reactions. Overall, this presentation will present four different routes to access the core tetrahydrofuran ring: two starting from trans-b-hydromuconic acid, one starting from furfural, and one commencing from dihydrofuran.

Presenter(s): Suzannah Tebon, Beloit College
Session: P1.25
Title: UP Phase Characterization
Advisor(s): Erin Munro, Mathematics,
Co-Author(s): Kiefer Green, Richard Noriega, Erin Munro

Abstract: UP phases are periods of high amplitude neural firing that are a characterizing aspect of slow wave sleep. In order to better understand the potential effects of UP phases in slow wave sleep we investigate where UP phases originate. UP phase origins are determined by latency calculations based on current source density data. By using Independent Component Analysis we are able to locate sources of neural activity and look at their contribution to the overall neural activity that is picked up by the recording electrode. This has led to the locating of two neural sources, BL5 and SUB. UP phases during sleep dominated by BL5 or SUB activity originated in different locations. This could lead to better understanding of what causes UP phases and their potential effects on sleep.

Presenter(s): Megan Treichel, Grinnell College
Session: P2.27
Title: Impedance Studies of Silyl/Carbonate Electrolyte Blends
Advisor(s): Leslie J. Lyons, Chemistry, Grinnell College
Co-Author(s): Leslie J. Lyons

Abstract: Electrolyte blends containing organosilyl molecules are promising replacements for current carbonate-based electrolytes, which are often flammable and toxic. Organosilicon-based electrolytes exhibit many desirable qualities, including low flammability, high thermal and electrochemical stability, and low toxicity. The ionic conductivity of electrolyte blends containing analogues of a fluoro-organosilyl molecule, ethylene carbonate, and ethyl methyl carbonate was measured using AC impedance spectroscopy in the temperature range from 0°C to 50°C. All electrolytes examined contained the salt

$LiPF_6$. The conductivities of the electrolyte blends tested depend greatly on their viscosity and the analogue of the organosilyl molecule that was used. All electrolyte blends tested exceeded the conductivity threshold of 1.0 mS/cm. The analogue identified by the name OS3-V was found to be the most effective organosilyl component, and when blended in intermediate amounts with ethylene carbonate and ethyl methyl carbonate it achieved equal conductivity (6.8 mS/cm @ 298.15 K) with the all-carbonate control.

Presenter(s): Ashley Trojniak, Hope College
Session: P2.05
Title: surMOF-14: Investigating the Metal Organic Structure
Advisor(s): Mary E. Anderson, Chemistry, Hope College
Co-Author(s): Monica L. Ohnsorg, Brandon H. Bowser, and Mary E. Anderson

Abstract: Metal-organic frameworks (MOFs) are highly porous, crystalline materials with applications including sensing, drug delivery, and gas storage. Some MOF systems can be deposited as thin films anchored to a substrate with a self-assembled monolayer (SAM) resulting in a surface-anchored MOF (surMOF). The growth mechanism of the MOF-14 system composed of Cu^{2+} ions and 1,3,5-tris(4-carboxyphyenyl) benzene has been studied as a surMOF via atomic force microscopy, infrared spectroscopy, and ellipsometry. A Van der Merwe growth mechanism was observed contrary to the Volmer-Weber growth mechanism of a similar surMOF, HKUST-1. This raises the question of whether the surMOF-14 exists as a multilayer, framework, or a hybrid. To investigate this question, the surMOF-14 was deposited on different SAMs and exposed to ammonia to determine if the MOF-14 system responded similarly to the HKUST-1 surMOF. Due to similarities in crystal structure to the HKUST-1 and MOF-14 systems, MOF-399 was also studied. Preliminary results indicate a growth mechanism more similar to surMOF-14 than the HKUST-1 surMOF. Future work includes more advanced analysis to investigate molecular orientation and crystallinity within the thin film.

Presenter(s): Jue Wang, Grinnell College
Session: P1.06
Title: Conformational analysis of the protein MTHFR utilizing hydrogen-deuterium exchange and mass spectrometry
Advisor(s): Elaine Marzluff, Chemistry, Grinnell College
Co-Author(s):

Abstract: The protein MTHFR is the only known enzyme to catalyze the folate reduction reaction in human bodies. Mutations in MTHFR can cause MTHFR defects, which are associated with cardiovascular disease and atherosclerosis. This project investigates conformational changes caused by mutations occur along the MTHFR catalytic triad, specifically looks at the mutation on the 28th position, E28Q, when the glutamate is replaced by glutamine. The loss of negative charge from the glutamate disturbs direct exchange of a hydride between folate and FAD. Hydrogen-Deuterium Exchange (HDX), an advanced technique used to probe the protein dynamics, and mass spectrometry (MS) are applied to determine the MTHFR conformational changes. During H/D exchange, hydrogen atoms on the amide backbone of the protein are replaced by deuterium atoms and cause mass shifts. Making comparisons of relative deuteration levels between WT and mutant E28Q intact proteins, the mutant shows a higher relative deuteration level. In this study, 15 reference peptides identified near the mutation site, the folate binding site, and the MTHFR binding surface show more deuterium labels added in mutant E28Q, which confirm that MTHFR mutation affects the protein conformation along the catalytic triad.

Presenter(s): Zixi Wang, Grinnell College
Session: P2.13
Title: Gas Phase Proton Exchange Mechanism for Protonated and Sodiated Histidine and Histidine Derivatives
Advisor(s): Elaine Marzluff, Chemistry, Grinnell College
Co-Author(s):

Abstract: The proton exchange mechanism of protonated histidine and its sodiated derivatives were investigated in the gas phase via computational methods and the Hydrogen/Deuterium Exchange (HDX), monitored by mass spectrometry. While computation offered information on energy barrier of a mechanism, the HDX provided the rate and the number of the proton exchange. Three fast proton exchanges in protonated histidine were found from the protons on the 3-nitrogen of the imidazole side chain and the N-terminus. Sodium ion was found to increase the energy barrier of the proton exchange in histidine, Gly-His and His-Gly, and decrease the access to the labile protons in the complex.

Presenter(s): Emily Witt, St. Olaf College
Session: P2.02
Title: DuOCam: A Two-Channel Camera for Simultaneous Photometric Observations of Stellar Clusters
Advisor(s): Darren L. Depoy, Astronomy Physics and Astronomy, Texas A&M University
Co-Author(s): Erin R. Maier, Darren L. DePoy, Luke M. Schmidt

Abstract: We have designed the Dual Observation Camera (DuOCam), which is capable of simultaneous photometric observations at red and blue wavelengths. The instrument was designed for implementation on the 0.9 m, f/13.5 telescope at McDonald Observatory. Light collected by the telescope passes into DuOCam's optical assembly, where it is collimated, split into red and blue wavelengths and focused onto two independent charge-coupled devices (CCDs). In order to test the effectiveness of the camera, observations of both open and globular stellar clusters were carried out at McDonald Observatory. The resulting data was used to construct R vs. B-R color-magnitude diagrams for each cluster. Using isochrone fitting, the age, metallicity, and distance of each cluster will be determined.

Presenter(s): Breanna Wydra, Lawrence University
Session: C1.1
Title: Identification of blue pigment in a 15th century illuminated manuscript using Raman spectroscopy
Advisor(s): Allison M. M. Fleshman, Chemistry, Lawrence University
Co-Author(s):

Abstract: Illuminated manuscripts are hand-written, elaborately decorated books which were produced mostly during the Middle Ages. Given their historical value, the forensic analysis of their composition is of great importance to the art historian and conservator. Pigment identification is of particular significance to the dating, authentication, and cultural interpretation of these manuscripts, as a scribe's choice depended not only on time period but also on the socioeconomic status of the buyer. In this talk, I will present an analysis of the blue pigment used within a 15th century Book of Hours. The analysis was performed via Raman spectroscopy due to its non-destructive nature. Matching the resulting spectra to known pigments has revealed the blue to be azurite, an inorganic pigment which was common during the time period. The identification of azurite in the Book of Hours provides further support for the manuscript's 15th century dating and will also assist in its proper conservation.

Presenter(s): Yezi Yang, Macalester College
Session: B1.3
Title: Zooming in and out: big data tools in studying metastatic melanomas at single-cell resolution
Advisor(s): Wei Wei, Molecular and Medical Pharmacology, David Geffen School of Medicine at UCLA
Co-Author(s): Marcus Bintz, Dazy Johnson, Yapeng Su

Abstract: Big data have been challenging and facilitating medicine in unprecedented ways. At single-cell resolution, abundant cytometry data are produced each day and ample information is to be deciphered from the resulting data. On the other hand, big data tools operate on collections of information and produce insights into complex systems. They have exhibited an increasingly important role in cancer research, especially at single-cell resolution, while undergoing significant development and optimization themselves. We describe and compare several algorithms and visualization techniques in single-cell cancer research, including the Markov chain model, Gene Set Enrichment Analysis (GSEA), t-Distributed Stochastic Neighbor Embedding (t-SNE) dimensional reduction algorithm, spanning-tree progression analysis of density-normalized events (SPADE) and Principal Component Analysis (PCA). We also discuss the ways in which these models and algorithms are used in studying metastatic melanomas. For instance, we use a stochastic cell transition model built from a time-homogeneous Markov chain model, GSEA analysis for analyzing higher dimensional temporal alterations in gene expression profiles, t-SNE and normalized PCA, among others. By investigating melanocytic to neural crest de-differentiation upon BRAF inhibition using the above algorithms and visualization tools, we are able to better characterize the effects of targeted cancer therapy.

Presenter(s): Judy Yoo, Washington University in St. Louis
Session: P1.01
Title: The Molecular Mechanism of Sensory Synapse Formation
Advisor(s): Robert Gereau, Anesthesiology, Washington University Schoo
Co-Author(s):

Abstract: Estimated to cost the country over 635 billion dollars per year, in both treatment costs and lost productivity, pain is an exigent issue in society today. Two classes of proteins, neurexins and neuroligins, have been shown to play a large role in the specificity of synaptic connectivity, critical to developing a more comprehensive understanding of the mechanisms by which pain signals are processed. With this in mind, we propose the hypothesis: β neurexins in sensory neurons influence interactions neuroligins, altering aspects of synapse formation. A co-culture of sensory neurons, isolated from mouse dorsal root ganglia, and fibroblast COS7 cells transfected with neuroligin DNA adhesion molecules and presynaptic terminals were immunostained and then imaged. To isolate the effects of the neurexin gene, a conditional gene knockout technique using viral vectors was implemented in order to knockout the genes coding for β neurexins. Under the premise of our hypothesis, there would be distinctly increased synapse formation in sensory neuron cultures containing neurexins. This would be indicated by the number of stained adhesion molecules and presynaptic terminals in the contrasting confocal images, showing that trans-synaptic interactions of neurexins and neuroligins play a large role in the specification of synaptic connections.

Presenter(s): Jisheng Zhang, Grinnell College
Session: E2.3
Title: Constraining hot Jupiter's atmospheric structure and dynamics through Doppler shifted emission spectra
Advisor(s): Eliza Kempton, Physics, Grinnell College
Co-Author(s): Elize Kempton; Emily Rauscher

Abstract: Recently, astronomers successfully observed the atmospheres of extrasolar planets (planets orbiting stars other than the Sun) using ground-based telescopes equipped with spectrograph capable of observing at high spectral resolution. However, few studies have examined how the 3-D atmospheric dynamics could affect the emitted light of hot Jupiters, a class of exoplanets with similar size to Jupiter

but orbiting much closer to their host stars. Here, we present a model to explore such influence on the hot Jupiters' thermal emission spectra. We investigate the extent to which the effects of 3-D atmospheric dynamics are imprinted on planet-averaged emission spectra. We couple a 3-D general circulation model of hot Jupiter atmospheric dynamics (Rauscher & Menou, 2012) with a radiative transfer solver to predict the planet's emission spectrum as a function of its orbital phase. For the first time, we self-consistently include the effects of the line-of-sight atmospheric motions (from winds and rotation) to produce Doppler-shifted spectral line profiles, and focus on two benchmark hot Jupiters, HD 189733b and HD 209458b. We find that the intensity and the Doppler shift of the spectrum can be used to diagnose key properties of the dynamical atmosphere – the longitudinal temperature and wind structure, and its rotation rate.

Presenter(s): Yolanda (Yaodan) Zhang, Beloit College
Session: A2.2
Title: Graph Properties of Blockade Games
Advisor(s): Darrah Chavey, Math & Computer Science, Beloit College
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Abstract: Blockade games are a class of games where the players alternate turns moving their pieces along edges of a graph from one vertex to an unoccupied vertex, where you lose the game if you have no legal move to make on your turn. Our research attempted to identify some properties of a graph that make the associated blockade game "interesting". Our team approached this from both a mathematical viewpoint of identifying and proving properties of graphs that generate good games, and a computer simulation viewpoint, simulating the play of the game for candidate graphs. I was responsible for the mathematics aspect of our research. Several "real-life" versions of these games exist, all on graphs with high degrees of connectivity. The focus of my research was on "maximal blockade games" where the two players have as many pieces as possible, so that only 1 or 2 vertices are initially unoccupied. My research showed that good games with 1 unoccupied vertex must not contain vertices of degree 1, and good games with 2 unoccupied vertices must not contain an edge whose removal disconnects the graph. Focusing on smaller graphs, I also analyzed alternatives for the graphs used in such "real-life" games.

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