Panel Session #1
Nobel 1412
2:30-3:30

Panel Chair: Ben Menke ‘22

Morgan Mellum ’23 – “CT Reconstruction of a Wasp Preserved in Amber”

Wasps represent a diverse array of organisms with varied interactions in terrestrial ecosystems. Chalcidoidea is one of the very diverse lineages of wasps with an estimated 500,000 species, over 22,000 of which have been described. One of the more poorly understood families in the Chalcidoidea superfamily is Diversinitidae, which was recently placed under the superfamily by Haas et al. (2018). There have not been many species descriptions of wasps in this family, resulting in uncertainty of the evolutionary history of this group of organisms. Here, a fossil wasp encased in Burmese amber was chosen due to it’s high definition preservation of morphology. CT images and microphotographs of this fossil wasp were generated. Using these images, a high-resolution 3D rendering of the wasp was created. An analysis of key morphological characteristics of the fossil wasp confirmed it’s placement in Diversinitidae. As this amber is Late Cretaceous in age, this specimen increases our knowledge about the family Diversinitidae and its evolutionary position within the superfamily Chalcidoidea.

Faculty mentors: Julie Bartley, Erik Gulbranson, and Ryan McKellar (University of Regina)

Hannah Hansen ’22, Christen Gibson ’21, Amber Simon ‘21– “Ligand Design & Synthesis: Synthesizing Small Molecules to Bind to PfGCN5”

Malaria is a disease caused by the parasite Plasmodium Falciparum, commonly found in mosquitos. While malaria is not common in the United States, it is very common in third-world countries where resources are more scarce. Malaria has mutated over the years and has become resistant to some of the drugs used to treat it today. Our research this summer was synthesizing new small molecules in order to inhibit the bromodomain of the PfGCN5 protein found in P. Falciparum in order to find a new way to treat the disease. Through multiple steps including looking at computational reads, reading previous works on certain syntheses and bromodomain research, and figuring out an efficient synthesis of these small molecules, we were able to synthesize multiple compounds and test them against the desired bromodomain using ProF NMR to find out which molecules show promising results.

Faculty mentor: Scott Burr

Katelyn Espe ’23 – “Using the Engineering Design Process to Build a CNC Router”

The goal of this project was to design and build a CNC router for use in the Olin Hall machine shop. Computer numerical control routers are a form of subtractive manufacturing that can be used on both large and small scales. I followed the engineering design process to create a 3D model of a CNC router, including both manufactured parts and parts that needed to be machined, which were assembled to create a 3-axis CNC router. Future plans include finalizing the electronic setup and producing instructional materials for others to replicate this design.

Faculty mentor: Liz Boatman

Katie Lillemon '24 – "Using Gene Editing to Investigate Protein and Phenotype changes in Arabidopsis thaliana"

CRISPR/Cas9 is being utilized to perform a gene knockout of the TEN1 gene in the CST complex of Arabidopsis thaliana telomeres. The CST complex is made up of three genes (CDC1, STN1, and TEN1) and is believed to play a role in the maintenance of telomeres in plants and other eukaryotic organisms. While some is known about CDC1 and STN1, TEN1 has been studied very little. Previous research suggests that mutating the TEN1 gene produces several developmental defects like DNA damage and stem cell dysfunction in Arabidopsis. The purpose of this research is to determine if the point mutation of the TEN1 gene results in a gain of function or disables TEN1 completely, as well as to determine how the removal of the TEN1 gene will change the protein-protein interactions of the telomere.

Non-presenting authors: Brendon CarlsonSather '22, Eamonn McCullough '22
Faculty mentor: Katherine Leehy

Panel #2
Nobel 1413
2:30-3:30

Panel Chair: Emma Nelson ‘22

Clara Billings ‘23 – “Metal Binding Properties of Myohemerythrin and Metalloprotein II from Hediste diversicolor”

In this study, the metal binding properties of two highly similar metalloproteins from Hediste diversicolor are analyzed and compared. A non-heme di-iron oxygen storage protein, Myohemerythrin (Hd myoHr), and a cadmium detoxification protein, Metalloprotein II (Hd MPII), were purified from transformed Escherichia coli cells, subjected to apo preparation procedures, and reconstituted with desired metals. In vivo, Hd myoHr is bound to iron whereas Hd MPII is bound to cadmium. However, their 80.8% identical amino acid sequence suggests that both proteins should bind to iron as well as cadmium. Establishing accurate methodology for purification, as well as apo preparation and metal reconstitution for both Hd myoHr and Hd MPII, will aid in the determination of metal binding properties including metal affinity and protein to metal stoichiometry. These results are of particular interest for the development of novel catalytic metalloproteins constituted from protein engineering. UV/Visible Spectroscopy and ESI-Mass Spectroscopy results indicate that, in vitro, both proteins can successfully bind to either iron or cadmium, and that both proteins preferentially bind to cadmium when presented with a 50/50 mixture of iron and cadmium. Further analysis using ESI-MS will be applicable for the determination of protein to metal stoichiometry.

Faculty mentor: Brandy Russell

Audrey Ochtrup-Dekeyrel ’22, Josie Kleckner ’23, Emiy Gerencer ’23 – “Big Hill Farm Summer Internship”

Student run-micro farm Big Hill Farm had a record year in production, and partnership. Interns Emily, Audrey, and Josie will share their experiences and perspective on the impact of Big Hill Farm on their summer at Gustavus.

Faculty Mentor: Jeff Jeremiason

Haley Jostes ‘23 - Mercury Analysis and Method Development

Mercury is naturally occurring. However, human activity has greatly enhanced the environmental levels of this element. Mercury is a neurotoxin and it bioaccumulates; thus, having accurate measurements of environmental levels is imperative to public health and indicative of the well-being of an ecosystem. Current analysis methods are time-consuming and expensive as they require two different procedures to determine the values of inorganic and methylmercury. Due to the time and material costs of current practices, the development of a new method using HPLC coupled with ICP-MS was initiated. HPLC allows for the separation of compounds using a mobile and stationary phase, each of which has multiple manipulatable variables. The purpose of this project was divided into two components, sample and automation. The sample goals were to advance from mercury spiked water to biological standards, and ultimately to field samples. The automation goal was to progress from a manual fraction method to an automatic system. Spiked water and biological standards were successfully separated in an automated coupled system. However, following many trials, it was revealed that the HPLC separation column was clogging via lipid introduction. To combat this, options for an additional filtration step were explored and evaluated. Further work is necessary to optimize this step to create a sustainable analysis method. Should the remaining goals be met, one would be able to run a single method to obtain values for both inorganic and methylmercury, making the analysis of samples less time-consuming and significantly more cost-effective.

Faculty mentor: Jeff Jeremiason

Caden Gunnarson '23 - Development and Application of a Web-Based Simulator for Two-Dimensional Liquid Chromatography

Currently there are a variety of high performance liquid chromatography (HPLC) simulators available in a variety of formats (i.e., free vs. paid; executable vs. web-based), and with varying levels of sophistication. However, to the best of our knowledge all existing simulators support one-dimensional separations only. In this work we have developed a graphical user interface (GUI; web-based) and application programming interface (API) for interacting with two core simulation components previously described in the literature, with options for both one-dimensional, and two-dimensional separations in heartcutting or comprehensive modes. The first core simulation component is based on calculation of the widths and retention times of injected analyte pulses, and is computationally inexpensive, allowing fast simulations. The second scheme, based on the Craig countercurrent distribution model, is computationally expensive but more accurate under more conditions. Methods can be rapidly prototyped against scheme one, then finalized with the second scheme. Both schemes can use Linear Solvent Strength (LSS) or Neue-Kuss retention modeling. The interface displays chromatograms with realistic peak shapes, which can be helpful to guide 2D-LC method development in cases where mobile phase mismatch is serious. Each separation dimension or individual heartcut can use different separation conditions, including column dimensions, stationary phase type, particle size, mobile phase type and strength (isocratic or gradient mode), and interface conditions such as dilution via Active Solvent Modulation. The interface is available on the web with no download required, and the source code is on GitHub and licensed under CC BY-NC-SA 4.0.

Non-presenting authors: Thomas Lauer, Tyler Brau '19
Faculty mentor: Dwight Stoll

Panel Session # 3
Nobel 1540
2:30-3:30

Panel Chair: Callie Coleman ‘22

Meghan Sinn ’22 – “Do Old Mothers Produce Old Eggs”

Females across species have lower reproductive fitness as they age, yet there is little known about the causes and nature of female reproductive senescence. The fruit fly, Drosophila melanogaster, is a powerful model organism used to study reproduction, senescence, and evolution. However, rarely are these phenomena examined together. Because of their similarities with other animals at the cellular level, Drosophila can help identify common mechanisms of reproductive senescence among diverse species - including humans. It was previously determined that eggs from old females are less likely to hatch than those from young females. This research project examined whether or not older females devoted the same quantity of resources to their eggs as young females. Both fertilized and unfertilized eggs were collected and run through two different assay techniques in order to determine the protein content in eggs from old and young mothers. The assays were successful in determining the protein content of single Drosophila eggs, but the two assays gave varying concentrations, so we were unable to determine a trend between age and protein quality.

Faculty Mentor: Margaret Bloch-Qazi

Axel Lange ‘22 – “Development of 2D-LC Method for Comprehensive Analysis of Protein Compounds”

VLPs
Two-dimensional liquid chromatography provides researchers with significantly better separation performance and allows for more comprehensive analysis of samples. Heart-cutting is a technique that allows for the selection of 1D peaks for more detailed analysis and can be repeated multiple times. In this study, the intermediate component of the 2D-LC system, the loops used for collecting the sample and moving it forward to the second dimension, was experimented with to gain a better understanding of how the system works and to achieve acceptable separations in better amounts of time. Loop size, number and material type were all tested, along with a new method introduced in the latest update of the 2D-LC software, known as multi-ject, which allows for a significant time decrease compared to traditional multiple heart-cutting, while maintaining the same functionality.

Faculty mentor: Dwight Stoll, Tina Dalhseid

Trevor Kempen ’24 – “Effects of Pressure on Retention of Small Analytes”

Commercial UPLC systems are capable of operating under higher pressures than older models. Experiments run under UPLC conditions benefit from improved resolution and quicker runtime.

However, changes in retention are observed with pressure increases in these experiments. These shifts lead to selectivity changes that can interfere with method development and routine analysis. For these reasons, the dependence of retention on pressure has become a more prevalent topic. In this study, a variety of low molecular weight compounds including acids, bases, and neutrals, were studied in reversed-phase separations. Changes in retention factors for compounds across a 500 bar increase in pressure levels ranged from -17.7% to 30.9%. The data suggests properties of the molecules are important in determining the effect of pressure on retention. As chromatographers shift to higher pressure runs, understanding pressure effects can help explain unexpected changes in selectivity.

Faculty mentor: Dwight Stoll

Luke Dragseth '23- The Addition of High PZC Minerals to Reactores In Order to Facilitate Anion Retention.

Across Minnesota, woodchip bioreactors have begun being used in an attempt to mitigate nitrate runoff from fields. These reactors process water and use biotic processes to convert nitrates into nitrogen gas, safely removing it from the water. However bioreactores are only partially effective. They can only process so much water at a time, and during rain events they are often overrun, forcing water to bypass them untreated. In order to improve bioreactores a theory was devised to increase the flow capacity of these reactors while still retaining the same nitrate reducing capabilities. One of the reasons nitrate is so easily leached from fields is due to its negative charge, as most soil is also negatively charged. This causes nitrates to be repelled from the soil, and easily washed out. But in order to retain nitrates it may be possible to create positively charged substrates which hold them instead of repel them. These substrates are created of minerals with high PZC (point of zero charge) that form a positive surface charge when saturated by neutral pH water. This positive surface charge may be able to hold nitrates within the substrate while letting water pass through. This would allow bioreactores to increase their flow rate temporarily while still retaining nitrates for later conversion to nitrogen gas.

Faculty mentor: Laura Tripplet

Panel Session #4
Nobel 1412
3:30-4:30

Panel Chair:TBD

Katya McDonald ’22 – “Differences in Cross-Reactive Maternal IgA to E. coli”

Maternal IgA is the most abundant immunoglobulin in breastmilk and is known to both prevent and promote bacteria colonization in babies by selectively binding to the gut microbiota. This binding is critical to commensal colonization and pathogenic exclusion. The IgA content reflects the antigenic stimulation of the mother’s mucosal immune system. E. coli is capable of being either a commensal or a pathogenic bacterium. Specifically, one of the diseases it can cause is late-onset neonatal sepsis(LOS). This is an increasingly prevalent disease that targets preterm infants. In LOS, pathogenic bacteria colonize the gut and then cause systemic infection. Therefore, to combine these topics, we used enzyme-linked immunosorbent assays (ELISAs) to measure total and cross-reactive IgA in unpasteurized donor breastmilk. In particular, we measured cross-reactivity to multiple commensal and pathogenic E. coli strains. We found that total IgA concentration decreased over time post-partum but that cross-reactive IgA concentration(a subset of total IgA) increases or stays the same over time postpartum. We also learned that donor breastmilk has different binding abilities to different strains of bacteria unique to each individual. In the future, we would like to conduct a longitudinal study to evaluate how cross-reactivity and total IgA concentration over time. Additionally, it would be valuable to measure binding ability by other metrics, investigate why binding capabilities vary by strain/what factors determine binding ability, and perform similar ELISA experiments with mouse stomach contents/mammary glands.

Mentor: Kathryn Knoop, Mayo

Collin Carlson ’22 – Completion of The Sustainability Tracking, Assessment & Rating System (STARS) for Gustavus Adolphus College

A program of The Association for the Advancement of Sustainability in Higher Education (AASHE), the Sustainability Tracking, Assessment & Rating System, better known as STARS, is a self-assessment tool used by institutions of higher education to measure their sustainability progress. STARS will help Gustavus set and meet additional sustainability goals while fostering collaboration and information-sharing across our campus. STARS will also enable Gustavus to benchmark sustainability efforts with peer institutions. Participating in STARS requires a substantial amount of data collection in four main categories, Academics, Engagement, Operations, and Planning & Administration. By participating in STARS, Gustavus can earn positive recognition for our sustainability efforts while helping to generate new ideas to reach our sustainability goals. STARS integrates sustainable activities and efforts across all campus sectors from curriculum and research to operations and administration, thereby constructing a comprehensive view of our institution’s sustainability efforts.

Faculty Mentor: Jeff Jeremiason, Kari Wallin, Chuck Niederriter

Mariel Castillo ’24, Kathryn Cash ’24 –“Quantifying and Analyzing Mercury Levels”

Mercury is a toxic heavy metal known to build up in water systems and bioaccumulate in fish and other aquatic organisms. This bioaccumulation can lead to mercury poisoning if contaminated fish are consumed. There are a variety of studies that are being conducted on mercury in the environment. One such study is taking place at the Marcell Experimental Forest in northern Minnesota. This project is quantifying mercury levels in a peatland bog. This is done to continually verify that mercury deposition is decreasing. Another project that is focused on mercury is the Saint Louis River Estuary restoration project in Duluth, Minnesota. This project is focused on decreasing the amount of mercury that is available for methylation. This is accomplished by adding a biochar into the system to prevent the mercury from methylating. The most recent results from this project suggest that this is in fact beneficial in decreasing the methylation of mercury.

Faculty mentor: Jeff Jeremiason

Annabel Smith ’24, Kade Copple ’24 – “Identifying Natural Substrate Binding of PfGCN5”

In sub-Saharan Africa, the primary malaria-causing protozoan is Plasmodium falciparum. PfGCN5 is a histone acetyltransferase which plays a critical role in epigenetic regulation in response to stress and genes responsible for antimalarial drug resistance. PfGCN5 uses a bromodomain, a protein region that recognizes and binds to acetylated lysine. The natural substrate for the bromodomain of PfGCN5 is unknown. Fluorinated PfGCN5 bromodomain was expressed using E. coli, purified through size exclusion and nickel affinity chromatography, and confirmed using gel electrophoresis and protein-observed fluorine NMR (PrOF NMR). In order to identify the histone and acetylation marks to which PfGCN5 binds, solid phase peptide synthesis was used to incorporate a single acetylated lysine into peptide sequences to be screened using PrOF NMR. A computational method was developed using Rosetta FlexPepDoc to dock and screen peptide sequences to guide peptide synthesis and verify results.

Faculty Mentor: Scott Bur

Panel #5
Nobel 1413
3:30-4:30

Panel Chair:

Tessa Bierbaum '23, Kimberly Hareland '24 – "Characterization of Proteases Involved in Neurodegeneration"

In every eukaryotic cell, there are vacuoles and/or lysosomes that are responsible for the degradation of waste that the cell produces. If all goes according to plan, this should be a continuous process. However, sometimes a process goes wrong and waste cannot be delivered properly to the vacuole. When this happens in neurons, it can lead to neurodegeneration due to the death of neuron cells. The process with how proteases in vacuoles and lysosomes degrade waste is still widely unknown, and this project searches to find how these proteases interact with other proteins to degrade them.
The main questions we are trying to answer with this research are how proteins are degraded in the vacuole and how neurological diseases may develop due to misfolded proteins and inactive proteases. To do this, we intend to express PEP4 and PRB1 in E. coli cells in order to create large scale protein purification. We then intend to extract and purify the protein, and observe their biochemical properties.

Faculty Mentor: Brooke Shields

Maria Sylvester '24 – "Efficacy of Mathematical Models in Predicting Retention Time of Polypeptides Under Varying HPLC Conditions"

There are several mathematical models used to describe the relationship between certain variables and retention time in high performance liquid chromatography (HPLC). The ability to make accurate predictions of retention time using these models decreases the amount of time and materials spent on method optimization; however, the complexity of these models makes errors common and difficult to find once detected. Therefore, the use of a prediction software could prove advantageous as it allows for a quick calculation with less opportunity for human error. The linear solvent strength (LSS) and Neue-Kuss (NK) retention models are commonly used. Using an internally developed software, the initial and final mobile phase conditions needed to elute the analyte (a polypeptide) at the halfway point of a 30 minute separation were predicted. In this presentation we will discuss the outcomes of these predictions for the polypeptides insulin, angiotensin, and melittin.

Faculty Mentor: Dwight Stoll

Hannah Schroeder '22, Cora Hentges '23 - The role of preexisting layer on the distribution of leucosome networks in partially molten rocks from the Pioneer Mountains, ID

The Pioneer Mountains are a metamorphic core complex in Idaho that underwent large magnitude extensional deformation in the Eocene, which exposed once partially molten high

grade metamorphic rocks called migmatites. Migmatites are important for understanding continental differentiation because they can tell us about the melt generations, melt transfer, and magma accumulation. In the Pioneers there are both igneous and sedimentary parent rocks forming two distinct migmatitic gneisses: paragneiss and orthogneiss. Migmatites have lighter areas referred to as leucosomes which are the former partial melt, and darker areas referred to as the residuum which is the partially melted parent rock. The rocks are formed where melt is being created and transferred as the melt is moving from the deep to the upper crust. In these zones leucosome networks are created and if these networks are self-sustaining it can tell us a lot about what is happening in other areas of the crust, since a self-sustaining system helps us understand the criteria needed for melt to move freely towards the surface, potentially feeding plutons.
In this study, we are investigating the effect of preexisting layers has on the formation and organization of leucosome networks. Since the orthogneiss and paragneiss of the Pioneer Mountains have the same deformation history, it allows us to understand how preexisting layering affects the results. Through measuring the thickness and spacing of the leucosomes conclusions can be made on whether a system is self organized, by determining if the spacing and thickness are scale invariant. For this study traverse of migmatites were made for a range of paragneiss and orthogneiss outcrops in the area. By studying both paragneiss and orthogneiss we are able to determine the range of scale for the self organized leucosome networks in the Pioneer Mountains

Faculty mentor: Rory McFadden

Angel Obiorah '24 - Comparison of Experimental and Simulated Separations of Charged Compounds by Ion-Exchange Chromatography

This research project was focused on the ion exchange mode of High-Performance Liquid Chromatography (HPLC), which separates compounds based on differences in their charges. The foundational retention factor data from isocratic (constant mobile phase composition) and gradient (varying composition) methods for different compounds were gathered. These data were used to improve predictions we can make using HPLC simulation tools with the goal of reducing time spent actually conducting experiments in research, and improving cost-effectiveness in labs where hundreds of such methods are carried out daily using expensive instrumentation. In collaboration with researchers at Virginia Commonwealth University (VCU), the data were fed into simulation tools and used to predict elution times for the organic molecules. The predictions were then compared to experimental results and the accuracy was assessed. Future work will involve collecting more data to train retention models used in the simulation to improve the accuracy of retention predictions. This would make improve the efficiency of the pharmaceutical drug development process where HPLC plays a key role.

Faculty mentors: Dwight Stoll, Tina Dahlseid Himali Somaweera

---

Sarah Genet '23, Cameron Gaspord '22 - Paleo landscapes and climate of the Upper Cretaceous, New Mexico

The Late Cretaceous is notable for concluding with the extinction of the non-avian dinosaurs during the cataclysmic Cretaceous-Paleogene (K-Pg) mass extinction. However, the time preceding the extinction is hypothesized to have been characterized by a prolonged global cooling trend in addition to the increased dominance of angiosperm flora on land. This study seeks to study the pre-extinction landscape and ecosystems of an area close to the impact site of the K-Pg mass extinction in order to provide a more detailed baseline of terrestrial ecosystems prior to the extinction. Multiple disciplines are deployed in this study to characterize the environment and paleoclimate. Fossil soils (paleosols) are studied for their morphology, mineralogy, and geochemistry to develop an understanding of the geospatial variation of the soil environment during this time; as well as the ecology of these ancient landscapes. The science of tree-ring dating (dendrochronology) is applied to well-preserved fossil tree rings of cypress trees at three stratigraphic levels to interpret the change in paleoclimate over time. The results of this study thus far recognize new soil-forming environments as compared to earlier work as well as novel insight into distinct niches for angiosperm-dominated wetland environments and cypress-dominated wetlands. Paleoclimate is interpreted to be relatively warm, with high secondary productivity in the soil environment. Iron mobilization and mineralization was a ubiquitous process acting on these landscapes and likely reflects an active soil microbial community operating under seasonally oxygen-depleted conditions. Dendrochronologic analysis indicates a distinct change from low-frequency oscillatory climate behavior towards higher-frequency oscillatory climate behavior. Prominent beetle-boring outbreaks preserved in tree rings show no correlation to the oscillatory climate behavior, and may reflect event-based meteorologic change. Such events are correlated to enhanced wood growth, and may reflect warming events and/or enhanced rainfall.

Faculty Mentor: Erik Gulbranson

Hassan Almusawy'23 – "Analysis of dicamba in the gas phase using SPME fibers and Density Functional Theory"

Dicamba is a chlorinated o-anisic acid commonly used as an herbicide. Dicamba is a volatile compound known for moving across fields with ease. This mobility is known as dicamba drift. Dicamba drift has led to crop failure worldwide. Annually, millions of crops are damaged by dicamba drift. Analysis of dicamba's gas phase is novel and this project focuses on techniques to help prepare gas phase dicamba for aforementioned analysis. The technique used was Agilent's solid phase microextraction (SPME) fiber injection technology in tandem with the BSTFA as a derivatization agent. Analysis was done in an Agilent GC-MS which pointed to both short derivatization times and short extraction times as the most effective mode of preparation. Additionally, this analysis is aided by density functional theory (DFT) to establish preliminary

transition state calculations for the reaction of dicamba and hydroxide. The predicted resultant transition state and frequency calculation between dicamba and a hydroxide show a Meisenheimer complex in which a hydroxide replaces a chlorine in preparation for an alcohol substitution.
Faculty Mentor: Amanda Nienow

Austin Witt ’22, Kelly Carlson ‘22 - Redefining Marriage: A Comparative Analysis of Feminine Agency in Charlotte Brontë’s Jane Eyre and Louisa May Alcott’s Little Women

Nineteenth century social scrutiny of marital law produced a period of literary works attempting to undermine the gendered and social hierarchies of marriage. Charlotte Brontë’s novel Jane Eyre and Louisa May Alcott’s novel Little Women redefine marriage by providing women with more opportunities of feminine agency. Brontë’s protagonist, Jane, insists upon validating her own self-possession throughout her relationships in an attempt to achieve an equal partnership. Jane Eyre speaks on the oppression of women, on the importance of self-possession, and argues means of changing traditional ideologies of marriage. Meanwhile, Alcott intends to avoid all pressures of class and gender hierarchies to provide her ‘little women’ with her own rendition of marriage options. Focusing on Meg and Jo, Alcott aims to present more viable options for women to gain agency through marriage, largely emphasizing the practice and preparedness needed to manage the household. As nineteenth century authors, both Brontë and Alcott are invested in providing feminine readers with different pathways of achieving agency inside of marriage, effectively capturing an audience that questions the ‘ideal’ form of marital unions in order to envision a healthier version of conjugal love.

Keywords: marriage, Jane Eyre, Little Women, women writers

Faculty Mentor: Vera Foley

Ana Zaalishvili ’22 - Mechanical detection of liquid sorption and evaporation in thin deposited solid films

Nanoscale films deposited on surfaces are widely used in science and industry. The physics of these interfacial layers is often more complex than their bulk or macroscopic counterparts. Due to this difference, properties such as hydrophobicity, absorption, and diffusion need to be investigated at the nanoscale. We used a Quartz Crystal Microbalance (QCM), due to its mass sensitivity and simplicity of use, to investigate two important physical aspects of deposited films. We explored the nanoscale absorption of water into different materials using QCMs. By monitoring the mechanical resonance frequency of a QCM we can detect sub-monolayer changes in adsorbed mass. These measurements were compared to the corresponding macroscopic contact angle measurements, a traditional way of measuring the hydrophobicity of the surface. We found discrepancies between these measurements, which could be due to the porous nature of our SiO_2 coated QCMs. Additionally, we put spin-coated polystyrene films of thickness < 1 micron on the QCMs and found that 10-25% of the residual toluene solvent remained in the film. Part of the solvent left the samples through evaporation, and rest through heating the sample above the glass transition temperature and annealing in vacuum. The presence of residual solvent will affect material properties which are commonly studied in various fields. Both hydrophobicity measurements and solvent evaporation are important characteristics for nanoscale film fabrication and optimization. We are planning on making SiO2 coated QCMs ourselves to avoid porosity and explore this phenomenon further.

Non-presenting authors: Yannic Gagnon, Connie Roth
Faculty mentor: Justin Burton, Emory University

Alexandru Florea '22 - Comparison of image quality in simulated multislice T2SE MRI reformats using different slice profiles: Application to prostate
Over the years MRI has gained traction as a reliable diagnostic tool in detecting prostate cancer, eliminating the need for more invasive detection methods such as biopsies when MRI indicates a small likelihood of significant cancer. Previous work has demonstrated methods for improved resolution in the slice select direction of T2 weighted spin-echo (T2SE) imaging with a 2D multislice acquisition, allowing for improved resolution in sagittal and coronal reconstructions from native axial scans. However, points near zero in the slice profile spatial frequency response cause significant loss of information at and around these spatial frequencies. Here, we report evidence that new slice profiles better recover low to middle spatial frequency information and present improved recovery of larger spatial frequency information. Work is ongoing to compare preliminary results and experimental data to identify further areas for improving reconstruction accuracy.

Non-presenting authors: Eric Borisch, Roger Grimm
Faculty mentor: Stephen Riederer, Mayo

Annika Silverberg '22, Elisabeth Kray '23 - Detection of Dicamba in the Gas Phase Using TF-SPME and Twister Devices with GC-MS

Dicamba is a chlorinated herbicide commonly used on corn, soybeans, and other commercial crops. Some farmers plant dicamba resistant soybeans to allow for the safe use of this herbicide, however dicamba is severely volatile, which allows it to drift into nearby non-resistant crops, causing irreversible damage. Because of this, it's important to study the volatility of dicamba in the gas phase to further understand how it behaves after it's applied to crops. This study used Gerstel Thin-Film Solid Phase Microextraction (TF-SPME) and Twister technologies in the Agilent GC-MS (gas chromatograph-mass spectrometer) to optimize parameters for studying dicamba in the gas phase. It was found that a TF-SPME and a Twister device used in unison provide the most optimal absorbance for the detection of dicamba in the gas phase. This optimized method was then used to measure dicamba in a field after it had been sprayed, studying air, soil, and leaf samples. It was found that the headspace above the soil samples is the optimal medium for this current method, showing the greatest detection of dicamba when measured in the GC-MS in conjunction with TF-SPME and Twister devices together.

Faculty mentor: Amanda Neinow

Monse Perez Barrios '24 - Katakana Fighter

This presentation will introduce Katakana Fighter, a free educational video game designed to help develop the production and reception skills of Katakana, Katakana's reading speed, and familiarity with Japanese vocabulary using Katakana. We will demo the game, discuss the design and development process, and share lessons learned.

Non-presenting authors: Yumiko Yoshioka
Faculty mentor: Jeremy Robinson

Dhareni Melanie Kistnasmy '21 - Characterizing Oil Thickness To Improve Oil Spill Response

An oil slick is a film of oil floating on water. When an oil spill occurs, the response techniques differ upon the oil thickness. For instance, thicker slicks are easier to remove than thinner ones. This project aims to improve the methodology of characterizing oil thicknesses. With a defined method, the eventual goal is to test the efficiency of sensors and devices that claim to accurately and precisely measure oil thickness. In turn, the understanding of how thick an oil slick is helps responders and damage assessment teams determine how much oil is on the surface, the oil's fate and transport and what actions are required.

Non-Presenting Authors: Wesley Lambert
Faculty mentor: Nancy Kinner, University of New Hampshire