
8TH ANNUAL
Andrews Research Conference 2022
Early Career Researchers in STEM
MAY 16–18, 2022 • ANDREWS UNIVERSITY • BERRIEN SPRINGS, MICHIGAN

A SPECIAL WELCOME

The Andrews University Office of Research and Creative Scholarship is pleased to host the eighth annual Andrews Research Conference: Early Career Researchers and Creative Scholars in the STEM Disciplines. Our focus this year includes agriculture, biology, chemistry, computer science, engineering, mathematics, physics, and related disciplines. Together, we seek to understand and engage God's creation and created order.

Our hope for this conference is that it will support the formation of a strong network of young Adventist researchers with themselves and others to enhance their professional development and create opportunities for partnerships while providing a place for them to share their research and discoveries in the context of their faith.

In 2015, the Laser Interferometer Gravitational-wave Observatory (LIGO) made the first detection of gravitational waves. Tiffany Summerscales was part of the team that made this first detection and she continues to be part of the LIGO team that is seeking to unravel the the faint ripples in spacetime predicted by Einstein's theory of general relativity. In the years since 2015, the LIGO-Virgo-KAGRA collaboration have confirmed the detection of more than 90 gravitational wave events, which are starting to answer some of astronomy's most perplexing questions. We are thankful to Tiffany Summerscales for consenting to share some of her insights gained while working on the LIGO team with us.

Anthony Bosman, world expert on Knot Theory has also agreed to be one of this year's plenary presenters. Anthony's research has raised interesting questions around the intersection of infinity, mathematics, philosophy, and theology. In this talk, he will discuss how a philosophical reflection on the nature of infinity and the related theological reflection on the nature of divine omniscience by figures such as Aristotle and Augustine provided the inspiration for Cantor's development of modern set theory.

The Office of Research and Creative Scholarship is grateful for the help of Carlisle O. Sutton, Research Services Coordinator, and Mordekai Ongo, Research Integrity and Compliance Officer, in organizing this conference.

We look forward to our next ARC STEM meeting, in May 2023 which will feature early career scholars in the arts & humanities. Please visit us at *http://www.andrews.edu/research* to learn more about research and academic conferences at Andrews.

Sincerely,

Gary Burdick
Dean of Research
Professor of Physics

Christon Arthur
Provost

CONFERENCE SCHEDULE

MONDAY, MAY 16, 2022

4:00 – 5:00 pm	Registration, Room 238, Buller Hall
5:00 – 6:00 pm	Dinner, Room 238, Buller Hall
6:30 – 8:00 pm	Welcome, Room 208, Buller Hall - Gary Burdick, Professor of Physics and Dean of Research - Christon Arthur, Provost
	Plenary Address, Room 208, Buller Hall ***"6 Years of Gravitational Wave Astronomy"*** **- Tiffany Summerscales,** Professor of Physics, Andrews University

TUESDAY, MAY 17, 2022

8:00 – 9:00 am	Breakfast, Room 238, Buller Hall
9:00 – 9:30 am	Devotional - Rahel Wells, Associate Professor of Biblical Studies
	SESSION A: Mathematics
9:30 – 10:00 am	**"*Exploring Natural Mates in Euclidean and Minkowski Space*"** **Alexander Navarro, Yun Oh**, Andrews University
10:00 – 10:30 am	**"Sequential Involutes and their Geometric Properties"** **Devin Garcia, Yun Oh**, Andrews University
10:30 – 11:00 am	**"*Metric Registration for Curves and Surfaces of Different Topologies*" Daniel Solano**, Brown University
11:00 – 11:30 am	**"*Why measures are so integral: a survey of measure theory*"** **Yaser Monterrey**, University of Connecticut
11:30 – 12:00 pm	**"*Generalizing the 27 card trick*"** **C. Ryan Loga,** Southwestern Adventist University
12:00 – 2:00 pm	Lunch, Terrace Cafe

SESSION B: Environmental Science

2:00 – 2:30 pm

"***Accounting for nonlinear effects of gene expression in transcriptome-wide association studies***"
Mykhaylo Malakhov, University of Minnesota

2:30 – 3:00 pm

"Fate and transport of emerging viral pathogens and fecal indicators in environmental waters"
Justin Greaves, Loyola University

3:00 – 3:30 pm

"Haiti's Deforestation and Energy Utilization"
Nikesha Medard, University of Florida

3:30 – 4:00 pm

"*Building a Scalable Model of the Community-Engaged Educational Ecosystem: Self-Determination Theory, STEM Identity, and Place Attachment*"
Danielle Wood, Alisa Gura, Jay Brockman, Michelle Sawwan, University of Notre Dame

4:00 – 4:30 pm

"*How Wastewater Based Epidemiology using passive samplers was activated on a private university campus to aid in county surveillance of SARS-CoV-2 among underserved communities.* "
Raeann Leal, Deborarh Sumatri, Princess Cervantes, Michael Pecolar, **Sarah Teague**, and **Ryan Sinclair**, Loma Linda University

4:30 – 5:00 pm

Exhibits

"Key Findings from the Food Information Networks Project"
Lauren Lounsbury, **Madison Ward**, **Michelle Sawwan**, University of Notre Dame

"dataMichiana: Understanding a Region's Needs through Data Visualization"
Lauren Lounsbury, Madison Ward, **Michelle Sawwan**, University of Notre Dame

5:00 – 6:00 pm

Dinner, Room 238, Buller Hall

6:30 – 8:00 pm

Plenary Address, Room 208, Buller Hall

"Infinity, Omniscience, and Paradox"

- **Anthony Bosman**, Assistant Professor of Mathematics

WEDNESDAY, MAY 18, 2022

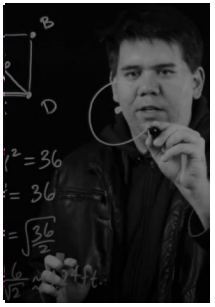
8:00 – 9:00 am	Breakfast, Room 238, Buller Hall
9:00 – 9:30 am	Devotional, Room 208 - Gary Burdick, Professor of Physics and Dean of Research
	SESSION C: Physics and Material Science, Room 208
9:30 – 10:00 am	***Superconductors and topological magnets in graphene moiré heterostructures*** **Robert Polski,** California Institute of Technology
10:00 – 10:30 am	***Analytic Method for Estimating Aircraft Fix Displacement from Gyroscope's Allan-Deviation Parameters*** **Jonathan Wheeler**, Stanford University
10:30 – 11:00 am	***Spectroscopic Analysis of Red Giant Star in Galactic Open Clusters*** **Saulo de Oliveira Cantanhêde**, Universidade Federal do Rio Grande do Sul currently at Andrews University; **Alan Alves-Brito**, Universidade Federal do Rio Grande do Sul; **Rodolfo Smiljanic**, Polish Academy of Sciences; **Beatriz Barbuy,** Universidade de São Paulo; **Pierre North**, École Polytechnique Fédérale de Lausanne; and **Nadège Lagarde**,University Bourgogne Franche-Comté.
11:00 – 11:30 am	**Closing Remarks**

PLENARY SPEAKERS

"6 Years of Gravitational Wave Astronomy"
Tiffany Summerscales
Professor of Physics, Andrews University

Abstract:
In 2015, LIGO (the Laser Interferometer Gravitational-wave Observatory) made the first detection of gravitational waves, the faint ripples in spacetime predicted by Einstein's theory of general relativity that are produced by the most energetic events in the universe. At present, the LIGO-Virgo-KAGRA collaboration have published 90 detections of gravitational wave events, which are starting to answer some of astronomy's most perplexing questions.

Biography:
Tiffany Summerscales is a graduate of Andrews University (BS: Mathematics and Physics) and Penn State University (PhD: Physics). She is a member of the LIGO Scientific Collaboration (LSC) which operates and analyzes the data from the LIGO (Laser Interferometer Gravitational-wave Observatory) detectors. Along with international collaborators that operate the Virgo and KAGRA detectors, the LSC searches for gravitational waves, the faint ripples in the fabric of spacetime produced by colliding black holes as well as other astronomical events.



"*Infinity, Omniscience, and Paradox*"
Anthony Bosman
Assistant Professor of Mathematics, Andrews University

Abstract:
Infinity sits at the intersection of mathematics, philosophy, and theology. In this talk, we sketch how philosophical reflection on the nature of infinity and the related theological reflection on the nature of divine omniscience, by figures such as Aristotle and Augustine, provided the inspiration for Cantor's development of modern set theory. Then we describe how paradoxes arising within set theory made their way back into the doctrine of God and discuss contemporary attempts to resolve the question, "Does God know everything?"

Biography:
Anthony Bosman, PhD, joined the mathematics faculty of Andrews University in 2017 after earning his doctorate in mathematics from Rice University. His research focuses on low dimensional topology, exploring the relationships between knots, links, and 4-manifolds. He has been recognized for his innovative teaching and is active in mentoring undergraduate research.

DEVOTIONAL SPEAKERS

Rahel Wells
Associate professor of Hebrew Bible,
Andrews University

Biography:
Rahel Wells completed graduate degrees in religion and biology, and a PhD in Biblical and Theological Studies from Wheaton College. Rahel is passionate about God's Word and God's world, and seeks to combine these areas in teaching, scholarship and ministry. Her current research focus areas include God's care for animals and the earth, metaphor in the Old Testament, the composition of the Torah, bioethics, and the book of Deuteronomy. Along with various conference presentations on these topics, her recent publications include several journal articles and book chapters, and three book projects in progress (including a commentary on Deuteronomy). A book she co-edited and contributed to, Exploring the Composition of the Pentatuech, was published in 2020 by Eisenbrauns. Rahel is also the current president of the Adventist Theological Society.

Gary Burdick
Dean of Research,
Professor of Physics
Andrews University

Biography:
Gary Burdick is Dean of Research and professor of physics at Andrews University. He joined the physics faculty in 1999 and was appointed Assistant Dean for Graduate Programs in the College of Arts and Sciences in 2007, and he became the Associate Dean for Research and Creative Scholarship in 2010. Born in St. Joseph, Michigan, Dr. Burdick graduated from Southern Adventist University in 1985 with a Bachelor of Science in physics and mathematics. In 1991, he received his doctorate in physics from the University of Texas at Austin. After receiving his PhD, Dr. Burdick held postdoctoral positions in France, Hong Kong, and Virginia before joining the faculty at La Sierra University as assistant professor of physics. Dr. Burdick is a member of the American Physical Society.

In his research area of optical spectroscopy, dealing with electronic (optical) transitions of lanthanide elements in solid-state media, Dr. Burdick has established international collaborations with various research labs in New Zealand, Europe and the United States. He has more than fifty refereed scientific publications and many international conference presentations on his work. Gary Burdick is a member of the American Scientific Affiliation.

PRESENTATION ABSTRACTS

SESSION A: Mathematics

"*Exploring Natural Mates in Euclidean and Minkowski Space*"
Alexander Navarro, Yun Oh, Andrews University

Abstract:
The natural mate of a unit speed curve is generated by letting its principal normal vector be the tangent vector of the new curve. Expanding on Deshmukh et al., we demonstrate that given a curve in three dimensional Euclidean Space, the primitive curve of which it is the natural mate is not uniquely determined, giving a family of curves with the same natural mate. We then explore the second natural mate, demonstrating a simple relationship between its curvature and torsion with those of the curves from which it is generated. We demonstrate several relationships between second natural mates and the lower mates, as well as demonstrate the equivalence of a curve being congruent to one of its natural mates with the curve being planar. We then extend these results to four dimensional Euclidean space, and finally to four dimensional Minkowski space, investigating how results about natural mates in higher dimensional spaces compare to their lower dimensional counterparts.

"***Sequential Involutes and their Geometric Properties***"
Devin Garcia, Yun Oh, Andrews University

Abstract:
In classical differential geometry, a space curve is described by its curvature and torsion. The ratio of torsion-to-curvature is used to classify curves as plane curves, helices, rectifying curves or other types of curves. There are other geometric properties and ways of classifying curves apart from the torsion-to-curvature ratio. The involute of a space curve is a curve whose tangent vector is orthogonal to the tangent vector of the original curve. In this work, we describe a space curve by its curvature and torsion-to-curvature ratio to study the involute of a curve. Our curve description provides a more intuitive approach when constructing and studying the Frenet-Serret apparatus of the involute since it shows the dependence on the nature of the original curve. We derive the Frenet-Serret equations for the involute of any space curve in Euclidean space and compare them with the classical Frenet-Serret equations. We introduce the notion of sequential involutes, or involute of involutes and study their geometric properties.

"*Metric Registration for Curves and Surfaces of Different Topologies*"
Daniel Solano, Brown University

Abstract:
This project presents an important step in shape analysis of submersed curves and surfaces to extend shape comparison to shapes with different topologies. The usual construction of shape space metrics for submersed curves and surfaces are induced from Riemannian metrics defined on the ambient space. These Riemannian distances are computed by solving geodesic matching problems, which cannot be completed in the case of shapes of different topology. This presentation focuses on a relaxation of the matching problem by flowing both shapes in question into auxiliary shapes that are close to each other up to a certain distance, whether that be a varifold, current, or Hausdorff metric. The resulting problem is an optimal control theory problem which balances the energy spent to make the two auxiliary shapes and the size of the topological jump, also called a surgery, as measured by the chosen metric. Shape analysis has already found applications in medical imaging in the field of computational anatomy, where patient anatomical data is compared to healthy templates; allowing for topological differences will expand the scope of the comparative analysis in this application. Future directions include expanding this model to account for more than one topological jump and additional auxiliary shapes as well as modelling the continuous change of topology numerically and theoretically.

"*Why measures are so integral: a survey of measure theory*"
Yaser Monterrey, University of Connecticut

Abstract:
This presentation begins with a brief introduction of measure spaces and integration. There will then be a description of the history of integration and the limits of the Reimann integral which motivates a more general notion of integration with respect to some measure. What follows is an elaboration on measure spaces and their applications (e.g the probability of randomly picking any particular random number is zero) which will finally conclude with various open problems within the field.

"*Generalizing the 27 card trick*"
C. Ryan Loga, Southwestern Adventist University

Abstract:
The 27 card trick is a well known self working card effect which involves sorting cards into piles so as to find a specified card at a predetermined location in a deck of 27 cards. Versions of this trick, including the even more well known 21 card trick, have been known for at least a couple centuries. Various explanations for the phenomenon have been offered. One of the more recent results involves using the ceiling function to determine which set-ups yield an equivalent to the 21 card trick. In this talk we will discuss a generalization of the 27 card trick which uses any number of cards in a deck. This effect uses a non-unique mixed base representation to sort the cards. A proof will also be offered using the ceiling function.

SESSION B: Environmental Science

"*Accounting for nonlinear effects of gene expression in transcriptome-wide association studies*" Mykhaylo Malakhov, University of Minnesota

Abstract:
Transcriptome-wide association studies (TWAS) integrate genome-wide association study (GWAS) data with gene expression (GE) data to identify putatively causal genes for complex traits. The TWAS methodology consists of two stages: in Stage 1 a model is built to impute gene expression from genotypes, and in Stage 2 gene-trait associations are tested using the imputed gene expression. Although TWAS have successfully identified hundreds of significant gene-trait associations and are widely used, all current implementations unrealistically assume a strictly linear relationship between GE and the trait. When the assumption of linearity does not hold, TWAS will suffer from a loss of power. In this study, we extend the standard TWAS framework by considering a quadratic effect of GE in addition to the usual linear effect. We train imputation models for both linear and quadratic gene expression levels in Stage 1, and then include both the imputed linear and the imputed quadratic expression levels in Stage 2. We compare our approach with standard TWAS on the ADNI gene expression data with the IGAP Alzheimer's disease GWAS summary data, as well as on the GTEx (v8) gene expression data with the UK Biobank individual-level GWAS data for LDL and HDL cholesterol. We also validate our approach on different GWAS data, perform suitable model checking, and compare it with more robust TWAS methods. In all of these applications our nonlinear TWAS method was able to identify additional associated genes that were missed by standard TWAS, suggesting its likely power gains and thus the need to account for potentially nonlinear effects of gene expression on complex traits.

"*Fate and transport of emerging viral pathogens and fecal indicators in environmental waters*" Justin Greaves, Loyola University

Abstract:
Sewage contamination in environmental waters is a global problem that affects millions annually. To mitigate this problem and monitor environmental water quality, health regulators commonly use microbial fecal indicators. Fecal indicator bacteria (FIB) are the most common fecal indicators used to date but are poor representatives of viruses due to differential environmental fate. Viral fecal indicators have been proposed as alternatives to FIB; however, data evaluating the persistence and transport of emerging viral fecal indicators under realistic environmental conditions is necessary to evaluate their potential application. Concurrently, emerging viruses, such as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the cause of the ongoing coronavirus pandemic, have placed a national light on wastewater due to the presence of SARS-CoV-2 RNA in wastewater. The potential presence of this virus in wastewater has made suitable indicators of viral fecal pollution increasingly important. In this presentation, I will discuss two main studies that investigate the decay and transport of a number of promising viral fecal pollution indicators. I will also discuss an additional study that examines the decay of SARS-CoV-2 in wastewater. The parameters and model developed through these studies will provide substantial information for the development of viral indicators in water quality monitoring. This work will also provide a basis to better integrate decay and transport into microbial risk of infection models to better protect public health.
y Brockman, Michelle Sawwan, University of Notre Dame

"*Haiti's Deforestation and Energy Utilization*"
Nikesha Medard, University of Florida

Abstract:
Haiti has a rich history that begins far before the island's colonization and extends past the successful revolution that granted their independence. Amidst it all, the country has had its ethical, social, and sustainable battles. Between being under French rule and having the people and land subject to the stressors of slavery, to gaining independence and being charged an excessive debt from their colonizers for their revolt, Haiti faced and continues to face challenges. The latest of these presents itself in the form of the environmental issue of deforestation. Over the past few decades, a multitude of ideas have been publicly circulating regarding Haiti's natural environment. Many have said that Haiti has less than 2% of forestry remaining, almost certainly categorizing the country as a desert, while others go as far as saying the country has nothing of substance left for it. Contrary arguments state that although Haiti faces mass deforestation, the country is not a desert and the damage can be reversed. This project gathers information about Haiti's standing percentage of forestry, the causes of deforestation, and proposals of ways to solve the issue in the form of sustainable solutions. These solutions can create increased resiliency and quality of life in a country with a threatened natural environment.

"*Building a Scalable Model of the Community-Engaged Educational Ecosystem: Self-Determination Theory, STEM Identity, and Place Attachment*"
Danielle Wood, Alisa Gura, Jay Brockman, and Michelle Sawwan, University of Notre Dame

Abstract:
The Community-Engaged Educational Ecosystem Model (CEEEM) is a community-university, cross-institutional partnership to attract and retain underrepresented groups in engineering and science, improve the quality of low-income neighborhoods, and build STEM literacy across the regional workforce. Recent findings from the summer internship program associated with CEEEM in South Bend demonstrate that project-based learning in a collaborative local environment not only fosters STEM engagement among underrepresented students, but that it also contributes to place attachment among those who participate in the internship. Earlier research on the CEEEM argued that project-based learning, working in diverse teams, and engaging in local innovation ecosystems contributed to the outcomes observed. This paper expands on that finding by explaining the internal mechanisms behind those outcomes. Drawing on key constructs from within self-determination theory, we argue that developing competence, autonomy, and relatedness through project-based learning allows student interns to self-identify as STEM professionals. In addition, experiencing distinctive and compelling elements of a local ecology alongside more formalized professional development allows students to integrate future visions of their personal and professional lives with the possibility of continued engagement with the region. We provide measures for key constructs in both domains (STEM identity development and place attachment) empirically across sites, and conclude with providing recommendations on how to assess a local environment for elements that will contribute to such an experience.

"*How Wastewater Based Epidemiology using passive samplers was activated on a private university campus to aid in county surveillance of SARS-CoV-2 among underserved communities.*"
Raeann Leal, **Deborarh Sumatri**, **Princess Cervantes**, **Michael Pecolar**, **Sarah Teague**, **and Ryan Sinclair**, Loma Linda University.

Wastewater Based Epidemiology (WBE) can be used as a rapid, sensitive, and cost-efficient surveillance system for the SARS-CoV-2 in cities, neighborhoods, campuses, and buildings. For two years, Loma Linda University's (LLU) laboratory refined a qPCR protocol using WBE to detect as few as 100 gene copies per 1 liter of wastewater from campus buildings. Samples are collected from specific locations on campus while maintaining an active comparison to twice weekly composite samples from a wastewater treatment facility serving the county of San Bernardino. This study is investigating the cost-effective passive sampling method to determine whether it was effective at detecting SARS-CoV-2 with the same detection rate and sensitivity as the standard grab sampling method. The passive sampler used a sterile packaged sanitary cloth placed in a PVC pipe with holes drilled into the sides for water passage. These samples were left in the sewage flow for 24 hours at three campus locations and then approximately 50ml of liquid wastewater was eluted from the cloth. For comparison, a grab sample method was also used at a discrete time point when the passive sampler was first placed at the campus locations. The weekly samples followed the extraction process and were evaluated using qPCR. The final RT-qPCR data points were analyzed and visualized using SPSS 28 to compare detection sensitivity and quantification cycle values using paired t-tests for significance. The SARS-CoV-2 that were detected using the passive sample method were examined by comparing the quantification cycle (cq) values, the number of positive detections above the LLOQ, and how close they were to the cq values from the San Bernardino city composite samples collected downstream at the wastewater treatment plant. These paired comparisons verified that the passive sampling method was reasonably sensitive at detecting SARS-CoV-2 in wastewater. Overall, the two sampling methods did not produce a significant difference when using paired comparisons. The research team concluded that LLU's academic laboratory could be most effective by mobilizing to assist in building San Bernardino County's (SBC) WBE system. SBC has large areas with underserved populations and will use the passive sampler method to target some sub-sewersheds. Further research will focus on analysis of lessons learned to aid in future research, development, and implementation of a rapid disaster response protocol for Loma Linda University's campus.

SESSION C: Physics and Material Science

"Superconductors and topological magnets in graphene moiré heterostructures"
Robert Polski, California Institute of Technology

Abstract:
Graphene without artificial modifications exhibits metallic and insulating behavior simply based on band structure, without obvious electronic correlation effects. However, a moiré pattern induced by a small rotational offset between layers can flatten the energy bands and introduce an array of phenomena related to correlations. We experimentally map out correlations such as superconductivity, correlated insulators, and topological (orbital) ferromagnetism in twisted bilayer graphene structures, fabricated with tungsten diselenide, at a range of twist angles near the magic angle of ~1.1°. We also observe correlations in twisted graphene multilayers of layer number 3, 4, and 5 near the predicted generalized magic angle. Our map of the correlated phases establishes a hierarchy among the phases, resulting in implications for their origin and the interplay between them, which are still under debate.

"*Analytic Method for Estimating Aircraft Fix Displacement from Gyroscope's Allan-Deviation Parameters*"

Jonathan Wheeler, Stanford University

Abstract:

The noise and drift requirements for a navigation-grade gyroscope are widely known, yet there is no simple analytic model of how the noise and drift of a gyroscope influence the fix displacement error (FDE) of an inertial navigation system (INS). This work derives simple analytical expressions for the cross-track and along-track errors of an aircraft whose INS consists solely of a three-axis gyroscope system with perfect knowledge of the vertical direction. The error signal of each gyroscope is Gaussian white noise and drift modeled as a first-order Markov random walk. These expressions provide a straightforward mean of calculating the FDE of an aircraft as a function of the flight duration, velocity, noise amplitude, drift amplitude, and drift's time constant. These expressions are validated with Monte-Carlo simulations of long flights. This model quantifies the noise-versus-drift trade-off for a gyroscope in an inertial navigation system. It can save time when estimating the noise and drift that a gyroscope must exhibit to satisfy a given position-error requirement, or vice versa. They are used in particular to confirm the values, often cited without demonstration, of the noise and drift required to meet the maximum position error of an aircraft imposed by the Federal Aviation Administration's required navigation performance 10 specification. Finally, it demonstrates that using the minimum in the measured Allan deviation of a gyroscope as a metric of the drift is incorrect, because it fails to capture the drift's time constant. The proper metric is the maximum in the Allan deviation.

"*Spectroscopic Analysis of Red Giant Star in Galactic Open Clusters*"

Saulo de Oliveira Cantanhêde, Universidade Federal do Rio Grande do Sul currently at Andrews University; **Alan Alves-Brito**, Universidade Federal do Rio Grande do Sul; **Rodolfo Smiljanic**, Polish Academy of Sciences; **Beatriz Barbuy**, Universidade de São Paulo; **Pierre North**, Observatoire de Sauverny; and **Nadège Lagarde**, University Bourgogne Franche-Comté.

Abstract:

Stellar clusters are crucial tools to study the age, spatial distribution, dynamics, kinematics, and chemical composition of different Galactic stellar populations in various Galactic components. To this end, we use red giant stars from open clusters to better understand the extra-mixing process through the CNO abundances and $^{12}C/^{13}C$, $^{16}O/^{17}O$, and $^{16}O/^{18}O$ isotopic ratios determined using high-quality spectra in the visible and near-infrared regions. We analyzed the kinematics and chemical composition of 22 K-type giant stars from nine open clusters (NGC188, NGC2682, NGC3680, NGC5822, IC4756, NGC6633, NGC3532, NGC6281, and NGC5460). High-resolution and high signal-to-noise spectra of the NGC188 cluster were obtained with the ESPaDOnS spectrograph at the CFHT in the visible region. The other clusters were observed with the CRIRES spectrograph at the VLT. We use the IRAF software to compute stellar kinematics and MOOG software to obtain the chemical analysis. Through photometric atmospheric parameters and from literature data, using MOOG software, we calculate $^{16}O/^{17}O$ and $^{16}O/^{18}O$ isotopic ratios. The values obtained for kinematics and chemistry of the sample are similar to those found in the literature. The results in the visible and infrared indicate that the extra-mixing process can be analyzed and interpreted using models of thermohaline mixing and/or rotation-induced mixing. They are fundamental to understanding the chemical evolution of red giant stars and answering questions of stellar evolution.

EXHIBIT ABSTRACTS

Key Findings from the Food Information Networks Project
Lauren Lounsbury, Madison Ward, Michelle Sawwan, University of Notre Dame

Abstract:
The 2021 Center for Civic Innovation Food Information Networks (FINs) Team adopted the challenge of identifying healthy food options in the South Bend area. The team compiled data about food availability to use in a single Food Information Network. This collected data is accessible to researchers and provides evidence-based food recommendations for people in the South Bend community. The project aim was to expand the list of food items and recipes involved in the heterogeneous network model, and to make recommendations for applying this technology in other communities. Initial challenges included knowing what food products were available and whether they met proper nutritional needs. The project focused on St. Joseph County, where 15% of the population experiences food insecurity (the national average is 12%). In collaboration with Notre Dame's Department of Computer Science and Engineering, the intern team used Python to web scrape a food API from Spoonacular, a site which contains more than 360,000 recipes. The final result was a program that included a query-based recipe search and an ingredient-based recipe search. It also provided up-to-date food pantry stock level information for a specified food pantry location. The project concludes with recommendations for partnership with local grocery stores. With further development, the project could be implemented in cities across the nation by connecting the Spoonacular API to nearby food pantry data. Data from each locality could then be entered into county and state-level health departments to benefit public policy and research.

dataMichiana: Understanding a Region's Needs through Data Visualization
Lauren Lounsbury, **Madison Ward**, **Michelle Sawwan**, University of Notre Dame.

Abstract:
There is a wealth of data already publicly available, but it is not necessarily easy for non-data-experts to find or understand. The goal of the internship team was to create an easy access data map for the dataMichiana website, produce storyboards for new and existing data layers in ArcGIS, and create and implement a list of desirable features for the dataMichiana website. Storyboards can be used to highlight certain issues and help readers make sense of data by providing additional guidance and context. dataMichiana is the local online platform affiliated with the National Neighborhood Indicators Partnership (NNIP), providing and managing data in the Michiana region served by the Center for Civic Innovation (CCI). Presenting data in an accessible and digestible format is important to increasing public awareness of local issues and for local organizations to advocate for change or to determine where change or improvement is needed.

Future work for this project involves addressing the inequities within the Michiana region that were visualized, such as health, race, and income. Additionally, the creation and development of a data-sharing agreement between Notre Dame and the City of South Bend would be beneficial to future teams, as it would make acquiring new data easier.

ABOUT THE PRESENTERS

Devin Garcia is currently in undergraduate student at Andrews University majoring in physics. He plans to attend graduate school and focus on particle physics research.

Daniel Solano, I am a born and raised Seventh Day Adventist from New Jersey. As a proud son of Costa Rican immigrants, I am a first generation college student and have had a secular education all my life. I have proudly served the Lord by leading campus ministries, Sabbath School and Adventist Youth programs. I continue to serve Him through virtual ministries.

Yaser Monterrey is an alumnus of Andrews University and is currently working towards his PhD in mathematics as a first year graduate student at the University of Connecticut. His primary mathematical interests are in analysis and topology.

Christopher Ryan Loga is an associate professor of mathematics at Southwestern Adventist University in Keene, TX. His research interests include function spaces in harmonic analysis, recreational mathematics, and various other subjects from across the field of mathematics, specifically those that interconnect with multiple topics. He has also taught a wide range of courses including everything from statistics, the calculus sequence, and a liberal arts math course that he designed, to linear algebra, differential equations, and various proof courses such as abstract algebra, real analysis, and number theory. Prior to living in Texas, Ryan spent his life in the Tennessee valley where he met his future wife during his undergraduate studies at Southern Adventist University. He also received his Ph.D in mathematics from the University of Tennessee in Knoxville. Besides teaching and learning, Ryan also enjoys writing, playing guitar, and spending time with his family, especially his one year old daughter.

Mykhaylo Malakhov is a second-year PhD student in the Division of Biostatistics at the University of Minnesota School of Public Health, where he is advised by Dr. Wei Pan and is a member of the Interdisciplinary Biostatistics Training in Genetics and Genomics program. Mykhaylo is broadly interested in statistical methods for genetics and molecular biology. By synthesizing genomic information with other omic data sets, he seeks to uncover how genetic variability impacts the functional pathways that give rise to complex human diseases such as Alzheimer's and cancer. This work is inherently interdisciplinary and draws on a wide range of approaches from causal inference and machine learning to bioinformatics and systems biology. Previously Mykhaylo completed a BS in Mathematics with a minor in Computing at Andrews University, where he augmented his experience with endeavors such as building a solar energy system in Madagascar and studying "maths" in Budapest. He is also a Goldwater Scholar and has research experience at Williams College and UCLA's Institute for Pure & Applied Mathematics.

Justin Greaves. I received my BS from University of Maryland in Civil Engineering and my PhD from the University of Notre Dame in Environmental Engineering. My prior research has mainly focused on the persistence and transport of viral indicators of fecal pollution in water. My future research would examine the fate of viral pathogens in a variety of environmental systems including air, water and soil.

Nikesha Medard. began her collegiate studies at the University of Florida (Go Gators!) studying Computer Science and minoring in Innovation. She got jobs at centers like the Black Affairs office in the Multicultural Center, the Disability Resource Center, the Architecture and Fine Arts Library, and even got into leadership in Adventist Christian Fellowship. During this period of growing in her individuality, Nikesha soon realized that engineering was not her journey, but the one she wanted to follow to make her family proud. Eventually, she decided to follow the path of her passions and switched her major to Sustainability and the Built Environment. This relieving decision opened doors for Nikesha, like working at the UF GeoPlan Center in Geospatial Information Systems (GIS), getting a Foreign Language Academic Studies fellowship to study Haitian Creole, and even gain insight on her future career choice. Nikesha now combines her passions of environmental sustainability, animal conservation, minority studies, urban planning, and uses them to get to her next stage in life which is a Masters in City Planning at one of the universities she has received acceptances from, including University of California, Berkeley, University of Michigan, Georgia Institute of Technology, and more. Nikesha is still passionate about animal care and volunteers at her local shelter as a Vet Tech in her free time. She also loves being outdoors and will even ride her electric scooter to and from campus in place of taking the bus or driving. Most of her time is dedicated to her studies, GIS work, and her current position as President of the UF chapter of Adventist Christian Fellowship. She hopes that as God has shown her the way thus far, He continues to do so as she advances to her next milestones.

Michelle Sawwan serves as a Research Associate for the Center for Civic Innovation. Drawing on her background in the social sciences and community engagement work, she facilitates ongoing partnerships with local stakeholders, and helps the CCI team collect and analyze data for two interdisciplinary research projects on the topics of food access and effective education in STEM. Michelle obtained her Master of Arts in Sociology with a minor in Peace Studies from the University of Notre Dame before going on to conduct applied research and data analysis as an Innovation Fellow at enFocus, Inc. As a graduate student, she examined how prior education and job status affects the political behavior of working professionals in Lebanon. She also studied the network structure of public, private, and civil stakeholders in regional and global scenario planning around issues like climate change, security, and economic development.

Danielle Wood, Center for Civic Innovation's Associate Director for Research, brings a diverse academic and professional background essential to helping develop multi-disciplinary innovative approaches to community challenges. Danielle completed her graduate work at the University of Wisconsin-Madison in Urban and Regional Planning; guided by an interdisciplinary committee, her doctoral research examined how civic data and information is used in collective impact approaches. At the University of Notre Dame, she has designed and taught several project-based courses, such as Community-Based Research, Asset-Based Community Development, and Complex Problem-Solving in the Public Sphere, and has served as co-PI on several NSF proposals. Prior to doctoral studies, Danielle worked across sectors, including as an environmental analyst for the Wisconsin Department of Natural Resources and serving as the executive director of the regional land trust in Madison, Wisconsin.

Jay Brockman, Director of the Center for Civic Innovation, has broad experience in innovation in both academia and industry. He joined the Department of Computer Science and Engineering at Notre Dame as an Assistant Professor in 1992 after receiving his Ph.D. in Electrical and Computer Engineering from Carnegie Mellon University. Prior to that, Brockman worked for Intel Corporation, where he spent a year-long assignment in the Philippines as part of the startup of a new product testing facility. He is a co-founder of Emu Technology, a company with a patented architecture for big data analytics with offices in South Bend and New York and was a recipient of the initial 1st Source Bank Commercialization Award. Brockman is the author of an introductory engineering textbook and has received several awards for his teaching. He received the 2018 Grenville Clark award from Notre Dame, given to a faculty member whose voluntary activities advance the cause of peace and human rights, for his work with Grammy-winning musicians Third Coast Percussion in developing an integrated STEM and music program for schools in South Bend and Elkhart, as well as for his work as one of the founders of the Bowman Creek Educational Ecosystem.

Alisa Zornig Gura, Managing Director of the Center for Civic Innovation, has extensive experience in academic community engagement and management. She has served in STEM community engagement roles since joining the University of Notre Dame in 2006 while specializing in project management, program management, and broader impacts for federal grant proposals. Alisa was the Executive Director of the Northern Indiana Regional Science and Engineering Fair from 2012 to 2016 and served on the Science Education Foundation of Indiana Board of Directors during that time. In addition, her committee work includes several initiatives to broaden participation of underrepresented groups in STEM. She holds a Bachelor of Science degree in Criminal Justice and a Master of Public Affairs degree with a concentration in Nonprofit Administration from Indiana University South Bend, and has served on several local nonprofit boards related to her academic interests.

Raeann Leal is a public health scientist, skilled in environmental epidemiology research. She is compassionate leader with a desire to provide culturally relevant solutions for populations facing an increased risk for health disparities. Her personal experience managing an environmental microbiology laboratory for Loma Linda University (LLU) has allowed her to develop new surveillance techniques for public health laboratories. Raeann is a third year DrPH student at LLU School of Public Health. She has been able to build-up a diverse educational and professional experience in chronic, infectious, and communicable disease prevention. At the beginning of her doctorate, she accepted a position at Riverside County Department of Public Health's infectious disease emergency response where she applied her skills as a preventive health educator for patients exposed to SARS-CoV-2. During her time at Riverside County, she was able to go through multiple trainings with UCLA, John Hopkins, and the California Department of PH on how to manage COVID-19 cases within local counties. At the start of the pandemic, she joined Dr. Ryan Sinclair's environmental microbiology laboratory at LLU as a doctoral research assistant where she began leading a project using wastewater-based epidemiology (WBE) as surveillance tool for tracking the presence and spread of SARS-coV-2 among various vulnerable communities. Her work with environmental epidemiology has expounded to bioinformatics and whole genome sequencing used to examine viral variants. She is currently working with San Bernardino County Public Health laboratory in activating their WBE response tool.

Lauren Lounsbury is the Internship Program Manager for South Bend at the University of Notre Dame's Center for Civic Innovation. Lauren graduated from Bethel University in 2019 with a Bachelor's of Science in International Health. She has previously worked for the Center of Civic innovation as a BCe2 intern and as the We2 Internship Site Coordinator. Lauren enjoys combining her coursework of community development and biological sciences with her heart for people to develop and carry out community engagement projects here in South Bend. Originally a Connecticut native, working in South Bend has made her excited to build a life here.

Madison Ward is the Internship Program Manager for Elkhart at the University of Notre Dame's Center for Civic Innovation
(CCI). Madison graduated from Indiana University South Bend with a Bachelor's of Arts degree in Mass Communications: Public Relations with minors in Sociology and Graphic Design. She was a CCI summer intern in 2020 and received the Bud Ahearn Leadership Award for Elkhart. Madison strives to utilize her communication skills in order to foster positive community engagement focused on sustainability. She has lived in Elkhart for the majority of her life and this has made her motivated to help it prosper through the CCI summer projects.

Robert Polski graduated from Andrews University with majors in mechanical engineering, physics, and mathematical studies. He is currently in the last steps of his doctoral program at Caltech in the department of applied physics and materials science. He researches the physics of electron correlations and topology in materials such as twisted graphene multilayers and InAs/GaSb heterostructures.

Saulo de Oliveira Cantanhêde is an Electrical Electronics Technician from Instituto Federal de Educação, Ciência e Tecnologia do Maranhão (IFMA), campus Santa Inês (2014), BSc in Physics: Astrophysics (2018) and MSc in Physics: Astrophysics (2021) from Universidade Federal do Rio Grande do Sul (UFRGS). Currently, he is an MDiv student at Andrews University. Since 2019, he is an Aspiring Associate member of the Brazilian Astronomical Society (Sociedade Astronômica Brasileira). His research interest includes stellar astrophysics, open clusters, and the chemical and kinematics of the Milky Way.

ANDREWS UNIVERSITY:
STEM PROFESSOR RESEARCH INTERESTS

SUSTAINABLE AGRICULTURE

- *Katherine Koudele* (koudelej@andrews.edu): Dairy management practices; Archaeological faunal remains
- *Garth Woodruff* (woodrufg@andrews.edu): Landscape architecture "sense of place"

BIOLOGY

- *H. Thomas Goodwin* (goodwin@andrews.edu): Systemics, historical dynamics, and paleobiology of fossils; Taphonomy of microvertabrate assemblages
- *Daniel Gonzalez-Socoloske* (gonzalezd@andrews.edu): Behavioral ecology and plasticity of tropical mammals
- *Peter Lyons* (lyons@andrews.edu): Proteolysis regulation of protein and peptide activity
- *David Mbungu* (mbungu@andrews.edu): Neural and hormonal regulation of phonotaxis in crickets
- *Marlene Murray* (mmurray@andrews.edu): Molecular targets of antibipolar drugs
- *Benjamin Navia* (bnavia@andrews.edu): Neural basis of auditory behavior in crickets
- *Denise Smith* (denises@andrews.edu): Breast cancer
- *Brian Wong* (wongb@andrews.edu): Chinese herbs and cancer
- *Robert Zdor* (zdor@andrews.edu): Bacteria-plant interactions
- *James Hayward, Emeritus* (hayward@andrews.edu): Community ecology and paleoecology; History of science

CHEMISTRY & BIOCHEMISTRY

- *D. David Nowack* (nowack@andrews.edu): Cancer marker discovery; Metabolic enzyme inhibition
- *Lisa Ahlberg* (lahlberg@andrews.edu): Organic chemistry; Medicinal chemistry; Culinary chemistry
- *Ryan Hayes* (hayesr@andrews.edu): Synthesis and analysis of dendrimers; Commercialization of novel chemical technologies; Identification of heterocyclic amines from burnt plant proteins
- *Getahun Merga* (mergag@andrews.edu): Synthesis and characterization of noble metal nanoparticles
- *Desmond Murray* (murrayd@andrews.edu): Properties of organic functional groups; Synthesis of small molecules with densely juxtaposed functional groups; Molecular sensing; Hybrid biologics
- *David Randall* (randalld@andrews.edu): Bioinorganic chemistry and spectroscopy; Green inorganic chemistry; Computational chemistry
- *John Rorabeck* (rorabeck@andrews.edu): Forensic chemistry

ENGINEERING

- *Hyun Kwon* (hkwon@andrews.edu): Biosensors; COMSOL simulation; Sensors with mobile technology
- *Jay Johnson* (jrj@andrews.edu): Stellar activity; Plasma sheet
- *Gunnar Lovhoiden* (gunnar@andrews.edu):
- *Boon-Chai Ng* (ngb@andrews.edu): Materials testing; Intermetallic materials

COMPUTER SCIENCE

- *Rodney Summerscales* (summersc@andrews.edu): Natural language processing; Machine learning; Virtual reality
- *Roy Villafane* (villafan@andrews.edu): Data mining; High performance computing; Distributed computing; Operating systems
- *William Wolfer* (wolferb@andrews.edu): Human aspect of software development; Software development methodologies and life cycles

MATHEMATICS

- *Lynelle Weldon* (weldon@andrews.edu): Mathematical modeling and data analysis; Mathematics education, especially for resistant learners
- *Anthony Bosman* (bosman@andrews.edu): Low dimensional topology; Knot theory; 3- and 4-manifolds
- *Shandelle Henson* (henson@andrews.edu): Dynamical systems and bifurcation theory applied to animal behavior and population ecology
- *Joon Kang* (kang@andrews.edu): Nonlinear elliptic and parabolic partial differential equations
- *Robert C. Moore,* Emeritus (moorer@andrews.edu): Math Education
- *Yun Myung Oh* (ohy@andrews.edu): Riemannian geometry; Submanifold theory

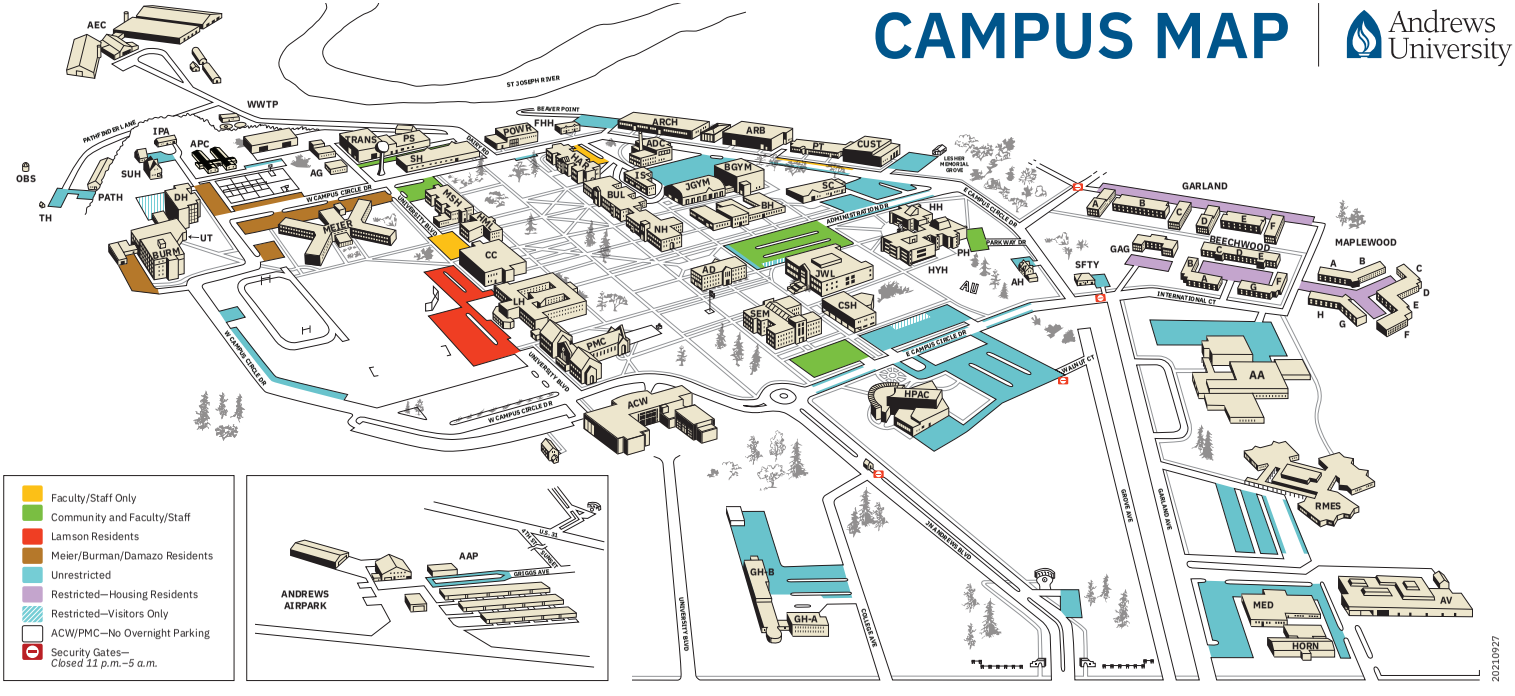
PHYSICS

- *Margarita Mattingly* (mattingl@andrews.edu): High energy particle interactions and jets
- *Gary Burdick* (gburdick@andrews.edu): Theoretical and experimental optical spectroscopy; Faith and science
- *G. Brendan Cross* (garnett@andrews.edu): Solid State Materials
- *Jay Johnson* (jrj@andrews.edu): Stellar activity; Plasma sheet
- *Mickey Kutzner* (kutzner@andrews.edu): Photoionization of atoms
- *Tiffany Summerscales* (tzs@andrews.edu): LIGO and gravitational waves
- *Robert Kingman, Emeritus* (kingman@andrews.edu): Special and general relativity; Cosmology; Laboratory equipment design

NOTES

CAMPUS MAP

Andrews University



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AA Andrews Academy

AAP Andrews Airpark *(Aviation, Seamount Building, Tucker Building)*

ACW Andreasen Center for Wellness *(Athletics, Pool, University Wellness)*

AD Administration Building *(Academic Records, General Counsel, Graduate Studies, Human Resources, On-Campus International Student Services, Marketing & Enrollment Management, President, Provost, Student Financial Services)*

ADC Art & Design Center *(Visual Art, Innovation & Entrepreneurship)*

AEC Agriculture Education Center

AG Agriculture *(Greenhouse)*

AH Alumni House

APC Advent Prayer Center

ARB Arboretum/Grounds

ARCH Architecture

AV Apple Valley Market

BGYM Beaty Gym *(Gymnics)*

BH Bell Hall *(College of Education & International Services, Communication Sciences & Disorders, Counseling & Testing Center, Graduate Psychology & Counseling, Leadership, Teaching, Learning & Curriculum)*

BUL Buller Hall *(History & Political Science, International Languages & Global Studies, Religion & Biblical Languages, Research & Creative Scholarship, Social & Behavioral Sciences)*

BURM Burman Hall *(Men's Residence)*

CC Campus Center *(Campus & Student Life, Dining Services, Faith Engagement, Recreation Center, Student Involvement, Leadership & Activities, University Culture & Inclusion)*

CSH Chan Shun Hall *(Accounting/Economics/Finance, Management/Marketing)*

CUST Custodial Services

DH Damazo Hall *(Women's Residence)*

FHH Forsyth Honors House

GAG Garland Apts G *(University Apartments)*

GH-A Griggs Hall-A *(University Communication)*

GH-B Griggs Hall-B *(Adventist Learning Community, Development, DLiT, Griggs International Academy, Off-Campus Programs, Planned Giving & Trust Services, School of Distance Education)*

HAR Harrigan Hall *(CHHS Dean's Office Engineering, Imaging Services, LithoTech, Photography)*

HML Hamel Hall *(Music)*

HORN Horn Archaeological Museum

HPAC Howard Performing Arts Center *(Howard Center, WAUS)*

HYH Haughey Hall *(Computing, Mathematics, Physics)*

HH Halenz Hall *(Chemistry & Biochemistry, Medical Laboratory Sciences)*

IPA Institute for Prevention of Addictions

IS Information Services *(AIM, ITS, Telecommunications)*

JGYM Johnson Gym

JWL James White Library

LH Lamson Hall *(Women's Residence)*

MEIER Meier Hall *(Men's Residence)*

MSH Marsh Hall *(Crayon Box, Nursing, Population Health, Nutrition & Wellness)*

NH Nethery Hall *(Andrews Core Experience, English, Explore Andrews, Honors, Intensive English, Social Work, Student Success Center, Visual Art, Communication & Design, Undergraduate Education, Undergraduate Leadership, Writing Center)*

OBS Robert & Lillis Kingman Observatory

PATH Pathfinder Building

PH Price Hall *(Biology)*

PMC Pioneer Memorial Church

POWR Power Plant

PS Plant Services

PT Physical Therapy *(Rehabilitation Sciences)*

RMES Ruth Murdoch Elementary School

SC Service Center *(Barbershop, Bookstore, Hair Salon, Post Office)*

SEM Seminary *(Seventh-day Adventist Theological Seminary)*

SFTY Campus Safety

SH Smith Hall *(Sustainable Agriculture, VACD Studios)*

SUH Sutherland House *(Andrews University Press)*

TH Tubing Hill

TRANS Transportation

UT University Towers *(Guest & Convention Services)*

WWTP Wastewater Treatment Plant

Security Gate

Parking passes are required. Please pick up your free visitor parking pass at the Office of Campus Safety.

Office of Research & Creative Scholarship

Gary W. Burdick, PhD
Dean of Research, Professor of Physics

Mordekai Ongo, PhD
Research Integrity and Compliance Officer

Carlisle O. Sutton, MSCID, MDiv
Research Services Coordinator

Office of Research and Creative Scholarship
Buller 234, 8488 E Campus Circle Drive
Berrien Springs, MI 49104-0075

Phone: (269) 815-3745
Email: research@andrews.edu
URL: http://www.andrews.edu/research

Andrews University
Office of Research & Creative Scholarship