Summer Science Research Program
Ohio Wesleyan University

2021 Research Project Information Sheet

(Faculty information sheet)

Submission Deadline: 11 February 2021

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Geography

Specific title of research project

Modeling A Central Ohio Regional Food Network for Sustainable Outcomes

Faculty mentor supervising research

Name: Dr. Ashley Allen and Dr. John Krygier*

Department: Geology and Geography

Campus phone: 740-368-3624

Email address: alallen@owu.edu

*We're collaborating with John and his cross-institutional coalition. He is not seeking SSRP funding

Anticipated research dates (10 weeks):

Beginning: June 1, 2021

Ending: August 6, 2021

Requested number of students

one _x__

two _____

If requesting two students: Please indicate the rationale for requesting two students, including willingness to work with just one student if that is all that can be placed in your project.

N/A

Will this project be conducted in-person or remotely?

In-person only _____

Remote only _____

Either in-person or remote ____x_____
(to be decided upon after consultation with faculty mentor and student researcher)

Minimum qualifications of student researcher (be as specific as possible)

- Must have previous geography or environmental studies coursework
- Must have experience working with GIS data and mapping software
- Must have interest in sustainability, environmental justice, and food systems
- Must have knowledge of (or be willing to learn) modeling software like SketchUp or AutoCAD

Description of the research project (one page maximum)

Creating and maintaining sustainable food systems, particularly networks of distribution and access, is becoming more and more imperative as humans are faced with a changing climate, as well as social. political, and economic stressors. This issue has become more emergent in the past year, as the COVID-19 pandemic showed the public how crises can, and do, impact food security (Savary et al. 2020). The global food system is incredibly complex, so researchers are attempting to assess these potential impacts by examining 'local' (or more accurately, scaled down) networks of food production, distribution, and access to understand the sustainability and resilience of our current food systems, as well as what could be done to mitigate loss in the case that these networks are interrupted (Savary et al. 2020).

Understanding these components of the food system through mapping and modeling assessments can also help scientists to understand other environmental and sustainability factors such as energy usage in manufacturing and distribution, climate change resilience and analyzing complex systems for environmental management and risk reduction (see Jacobi et al. 2019, , Halbe and Adamowski 207, and Melkonyan et al. 2017). This project seeks to contribute to that research by mapping current food distribution and access networks across central Ohio (including production, distribution, and place of access or sale) in order to understand the scope and scale of our food production and access networks, including grocery stores, farmers markets, and even universities.

In practice, the chosen student and I will create maps and models of current food distribution networks to visualize and assess the current state of these networks within Central Ohio (including miles traveled from farm to plate, urban food access and distribution, demands on "local" food production, and how and to whom food is distributed throughout Ohio's communities). We will then analyze the statistical and practical sustainability of our current food systems, and create maps and models of idealized, equitable, and just modes of food access throughout the region.

This project will draw from and contribute to ongoing projects at Ohio Wesleyan, including Dr. John Krygier's current work with regional food networks across Ohio Universities, a coalition of faculty, staff and administrators from OWU, Kenyon, Denison, Otterbein, Ohio State, and Ohio State – Marion. This coalition is currently focusing on collecting data on the economic impact of food access across institutions, the standards and aspirations of participating in "local" food networks, the systems in place for tracking and visualizing these data, and the geographic data surrounding food producers, distributers, and access points (via Brian Snyder). The student chosen to complete this SSRP would aid the coalition in the third and fourth aims of the project, as well as learn valuable information about the *whys* of sustainability science at various scopes and scales. The project will also contribute to Ohio Wesleyan's ongoing initiative to aid student knowledge and practice in diversity, equity, and inclusion.

Through the student's experience they will:

- Create, analyze, and assess GIS maps and 3D models to visualize current food distribution networks
- Collaborate with a coalition of professional scholars at universities across Ohio on actionable science and sustainability initiatives and gain practical knowledge of sustainability and food systems in central Ohio and beyond
- Have the opportunity to present a poster of the summer research results at the East Lakes Division of the American Association of Geographers Annual Meeting in October 2021.

References:

Halbe, Johannes and Jan Adamowski. 2019. Modeling sustainability visions: A case study of multi-scale food systems in Southwestern Ontario. *Journal of Environmental Management* 231: 1028-1047.

Jacobi, Johanna, Grace Wambugu, Maria Ngutu, Joracio Augstburger, Veronica Mwangi, Aymara Llanque Zonta, Stephen Otleno, Boniface P. Kiteme, José M. F. Delgado Burgoa, and Stephen Rist. 2019. Mapping food systems: A participatory research tool tested in Kenya and Bolivia. *Mountain Research and Development* 39(1): R1-R11.

Melkonyan, Ani, Klaus Krumme, Tim Gruchmann, and Gustavo De La Torre. 2017. Sustainability assessment and climate change resilience in food production and supply. *Energy Procedia* 123: 131-138.

Savary, Serge, Sonia Akter, Conny Almekinders, Jody Harris, Lise Korsten, Reimund Rötter, Stephen Waddington, and Derrill Watson. 2020. Mapping disruption and resilience mechanisms in food systems. *Food Security* 12: 695-717.

Snyder, Brian W. Personal communication. January 26, 2021.

Submit the research proposal

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Summer Science Research Program
Ohio Wesleyan University

2021 Research Project Information Sheet

(Faculty information sheet)

Submission Deadline: 11 February 2021

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)
Neuroscience, psychology

Specific title of research project
Examining Cognitive and Brain Functions through Video Games

Faculty mentor supervising research

Name: ___Kira Bailey_____

Department: _____Neuroscience/Psychology_____

Campus phone: ___3808_____

Email address: ____kmbailey@owu.edu_____

Anticipated research dates (10 weeks):

Beginning: ____7/1/21_____

Ending: _____8/6/21_____

Requested number of students

one _____

two __X___

Will this project be conducted in-person or remotely?

In-person only _____

Remote only ___X_____

Either in-person or remote _____
(to be decided upon after consultation with faculty mentor and student researcher)

Minimum qualifications of student researcher (be as specific as possible)
For this project, the student should have an interest in understanding human cognition through video games. Prior coursework or experience with the coding and/or electroencephalography (measurement of human brain waves) is strongly preferred, but students willing to learn these skills are encouraged to apply. The student should be comfortable learning new computer software. Completion of any of the following courses is strongly recommended, but not necessarily required: Introduction to Neuroscience (NEUR 250), Cognitive Neuroscience (PSYC 342), Computational

Neuroscience (NEUR 323). Students who have taken CS courses or have prior experience with programming in any language are encouraged to apply.

Description of the research project (one page maximum)

A growing body of evidence suggests that action video game (AVG) experience is associated with improvements in visual/spatial attention and executive functioning (Feng, Spence, & Pratt, 2007; Green & Bavelier, 2003, 2006, 2007; Green, Pouget, & Bavelier, 2010; West, Stevens, Pun, & Pratt, 2008) and changes in brain function (Knols et al., 2017). The significance of this finding lies in the implication that the skills acquired in an AVG might be transferred to other contexts (Boot, Blakely, & Simons, 2011; Green & Bavelier, 2003), which contrasts with findings from a wealth of training paradigms wherein improvements in performance transfer very narrowly (to highly similar tasks) or not at all (Ball et al., 2002; Hertzog et al., 2009; Owen et al., 2010).

The seemingly broad transfer of skills from AVGs after little to moderate amounts of training (10 to 50 hours) has led some researchers (Bavelier et al., 2012; Green & Bavelier, 2008) to recommend the use of AVGs in training protocols among populations that would benefit from enhanced visual attention and cognition (e.g., older adults, pilots, military personnel). These recommendations may be premature, however; there are several methodological criticisms of the past research (Boot, Blakely, & Simons, 2011; Bisoglio et al., 2014). One criticism is that the use of readily available commercial video games does not allow for strong experimental control over the numerous variables that could influence cognitive skills. At this point it is nearly impossible to know what features of a given video game are training which cognitive skills.

The proposed project is designed to address this criticism by developing a new video game specifically designed to train cognitive skills. In addition to allowing the researchers greater control over important variables, this game will also allow for simultaneous recording of brain activity during game play, which only a few studies have achieved (e.g., Mondejar et al., 2018). This would allow us to examine brain changes during, as well as after, video game training, which may provide information about the mechanisms of video game effects that could be used to develop future training protocols.

Submit the research proposal

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Summer Science Research Program
Ohio Wesleyan University

2021 Research Project Information Sheet

(Faculty information sheet)

Submission Deadline: 11 February 2021

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Data Analytics; Politics and Government

Specific title of research project

An Experimental Approach to Attitudes About Human Rights

Faculty mentor supervising research

Name: Nicholas Dietrich

Department: Data Analytics (In Math and Computer Science)

Campus phone: 217-685-2505

Email address: nmdietrich@owu.edu

Anticipated research dates (10 weeks):

Beginning: June 1, 2021

Ending: August 6, 2021

Requested number of students

one _X

two _____

If requesting two students: Please indicate the rationale for requesting two students, including willingness to work with just one student if that is all that can be placed in your project.

Will this project be conducted in-person or remotely?

In-person only _____

Remote only _____

Either in-person or remote __X__ (most likely remote due to Covid, but we'll see)
(to be decided upon after consultation with faculty mentor and student researcher)

Minimum qualifications of student researcher (be as specific as possible)

- Experience working with data
- Some experience using R or similar data software
- An interest in human rights, behavioral data, or social science research (broadly defined)

Description of the research project (one page maximum)

See attached.

Submit the research proposal
Please save as a **pdf** and email completed form to ssrp@owu.edu as an attachment (pdf file) with the subject line "Proposal for *faculty name*"

An Experimental Approach to Attitudes About Global Human Rights
2021 Summer Science Research Project Proposal
Nicholas Dietrich

This research project aims to design and implement a survey experiment to assess how people form opinions about international human rights practices. In particular, under what circumstances do citizens support their own country taking action against foreign regimes that abuse human rights? This is a consequential question because leaders often consider public opinion when deciding whether to punish international "bad actors" with naming and shaming, economic sanctions, or intervention.

This study builds on my previous survey experiment, "Explaining Support for International Action Against Human Rights Abusers," which is forthcoming at the *Journal of Human Rights*. That article explored how the quality of information in reports of human rights abuse affected support for international action against the offending regime. This was a good first step, but leaves a number of other considerations unexplored: the impact of appeals to empathy or emotion, preconceived opinions of the target country, and the mitigating influence of state denials or justifications, to name a few. The specific treatment conditions tested in this research will be determined in consultation with the student researcher.

I will work with the student researcher to carry out the following responsibilities:

1. Read some background literature, including the previous survey experiment, to develop an understanding of quantitative social science.
2. Design a survey experiment to test the influence of one or more unexplored factor(s) on support for international human rights action. In doing so, the student researcher will learn how to design treatment and control conditions and use factorial designs to test hypotheses.
3. Analyze the data after we field the survey experiment. The student researcher will learn to conduct exploratory and descriptive analysis on experimental data, apply linear models to estimate treatment effects, create data visualizations, and present results in a format suitable for publication in a scientific journal.
4. Write a description of the research procedures for the manuscript (if time allows).

We will field the survey experiment on Amazon's Mechanical Turk or a similar online platform. We will use the funds budgeted for research supplies to recruit participants. Conditional on acceptable performance, the student researcher will be listed as an author when submitting the manuscript for publication.

I will work closely with the student researcher throughout the project. The student researcher should have at least some experience working with data, preferably in R or a similar software, and an interest in social science research (broadly defined).

Summer Science Research Program
Ohio Wesleyan University

2021 Research Project Information Sheet

(Faculty information sheet)

Submission Deadline: 11 February 2021

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)
Organismal biology (functional morphology, thermal physiology)

Specific title of research project
Life in the City: Adaptations to Urban Environments in Introduced Lizards

Faculty mentor supervising research

Name: __Eric Gangloff_____

Department: ___Zoology_____

Campus phone: _740-368-3892_____

Email address: __ejgangloff@owu.edu_____

Anticipated research dates (10 weeks):

Beginning: ___1 June_____

Ending: _____6 Aug_____

Requested number of students

one _____

two X

Will this project be conducted in-person or remotely?

In-person only __X____

Remote only _____

Either in-person or remote _____
(to be decided upon after consultation with faculty mentor and student researcher)

Minimum qualifications of student researcher (be as specific as possible)
Students should have the following qualifications:

(1) Experience with handling live animals;
(2) Experience with meticulous record keeping and/or data collection;
(3) Students with interest in evolutionary biology and/or physiology preferred;
(4) Ability to work flexible hours under sometimes uncomfortable conditions (long field days);
(5) Experience with the scanning electron microscope (SEM) is preferred but not required (first position only);

(6) Comfort with traveling abroad in a place where English is not the primary language (some knowledge of French is helpful but not necessary; second position only).

Description of the research project (one page maximum)

In the 1950s, a young boy from a wealthy Cincinnati family smuggled about 10 wall lizards (*Podarcis muralis*) from a vacation in Italy and released them in his backyard. Today, hundreds of thousands of these animals can be found throughout the metropolitan Cincinnati area, expanding north into Ohio and south into Kentucky. Our research project seeks to understand what makes for a successful species in such novel environments – how are these lizards able to do so well in an urban center on a new continent? There are many dimensions to this question. Our work this summer will focus on two areas:
(1) how lizard morphology (body shape) allows them to live in highly anthropogenic landscapes and (2) how these ectotherms utilize their environment to achieve appropriate body temperatures. To explore these questions, we will make observations in the field (at various sites in Cincinnati) and conduct experiments with lizards in the lab.

Position 1: *This student will be focused on identifying relationships between form and function in lizard bodies*. Specifically, we are interested in how leg and toe shape affect an animal's ability to move under different conditions, including short-distance sprinting, endurance running, climbing, and clinging to vertical surfaces. This project will involve three primary components: (a) characterizing the environment that lizards are using in the wild (and by 'wild' here I mean various stone walls and abandoned lots in Cincinnati), (b) conducting experiments with animals in the lab to measure running and climbing speed, and (c) using the scanning electron microscope (SEM) and computer software to measure lizard claw size and shape. For this last aspect, the student will be co-mentored with Dr Laura Tuhela-Reuning. This project builds upon work conducted by student Princeton Vaughn this past year and will involve collaboration with him. I encourage interested students to learn more about what we've done so far by watching this short presentation by Princeton: https://youtu.be/lZF1_iXbw3w.

Position 2: *This student will be focused on understanding how lizards use their environment to achieve desired body temperatures and how these temperatures affect their ability to function*. This will involve making field observations and conducting laboratory experiments to examine the thermal physiology of lizards. This student will learn to use a thermal imaging camera and how to use software to extract data from thermograms (thermal images). We will conduct intensive field sampling and observation of lizard populations in various habitat types across urban Cincinnati. We will address the following biological questions:

- What are the minimum, maximum, and average activity temperatures of *P. muralis* in natural habitats?
- How do ambient temperature and humidity affect thermoregulatory behaviors?
- How precisely do they thermoregulate?
- How are these behaviors affected by age class, sex, and reproductive status?
- How do these behaviors vary among lizards in different types of habitats?

Both students will work together, potentially along with other students in the lab, on these projects. This is especially important for fieldwork, where we work as a team. We will hand capture lizards (using the well-established and safe lasso method), collect morphometric data (including but not limited to body length, head dimensions, leg length, mass), and mark lizards brought into captivity with a medical cauterizer. Depending on travel restrictions, we may spend 2-3 nights at a time in the Cincinnati area to conduct field work. Students will also assistant with care of captive animals.

Also depending on travel restrictions, the student in the second position may have the opportunity to travel to France as part of a group of students that have received a Theory-to-Practice grant to conduct research in partnership with French collaborators. This work is in the south of France in the Pyrenees mountains, at the Station d'Ecologie Théorique et Expérimentale du CNRS in the small village of Moulis. If we are able to make this happen, it will be approximately the second half of the SSRP program (after 1 July). Interested students can see more about the work there on my research blog: http://lezardsdemontagne.blogspot.com/.

Submit the research proposal

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Summer Science Research Program
Ohio Wesleyan University

2021 Research Project Information Sheet

(Faculty information sheet)

Submission Deadline: 11 February 2021

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Cellular and developmental genetics

Specific title of research project

Characterization of novel nematodes

Faculty mentor supervising research

Name: ____Danielle Hamill_____

Department: ____Zoology_____

Campus phone: ____740-368-3888_____

Email address: _____drhamill@owu.edu_____

Anticipated research dates (10 weeks):

Beginning: ___June 1_____

Ending: ___Aug. 6_____

Requested number of students

one __X__

two _____

If requesting two students: Please indicate the rationale for requesting two students, including willingness to work with just one student if that is all that can be placed in your project.

Will this project be conducted in-person or remotely?

In-person only __x___

Remote only _____

Either in-person or remote _____
(to be decided upon after consultation with faculty mentor and student researcher)

Minimum qualifications of student researcher (be as specific as possible)

Students should have completed at least one upper-level course in BIOL, BOMI, or ZOOL with preference given to students who have taken a molecular-focused course with lab. Students must be comfortable using microscopes.

Description of the research project (one page maximum)

The Hamill lab uses nematodes including *C. elegans*, to study questions related to cell and developmental biology. We are also interested in comparative studies between related nematode species. We have been studying several newly isolated strains that we think may not be previously described. The work this summer will continue with this project. Our analysis will include marked mating experiments to see if males of one type can fertilize and produce fertile offspring when mated with hermaphrodites of another type. We will also use time-lapse video microscopy to characterize the rate and patterns of early development. In addition, we will be collecting information on brood sizes and lifespan. We also will measure adult worms for comparison to each other and to published species. For molecular comparisons, we will extract DNA and amplify and sequence conserved genes. The suitability of using CRISPR genome editing in these worms will also be explored. The ultimate goals of our work will be to establish if any of these are new species and to describe the particular ways they are both similar to and different from each other and from *C. elegans.*

Submit the research proposal

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Summer Science Research Program
Ohio Wesleyan University

2021 Research Project Information Sheet

(Faculty information sheet)

Submission Deadline: 11 February 2021

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Animal behavior, Microscopy

Specific title of research project

Paternity, mating behaviors, and gestated ovary characterization in Poeciliid fishes

Faculty mentor supervising research

Name: Tami Panhuis and Shala Hankison

Department: Zoology

Campus phone: 740-368-3859 (Panhuis) and 740-368-3869 (Hankison)

Email address: tmpanhui@owu.edu and sjhankis@owu.edu

Anticipated research dates (10 weeks):

Beginning: 2 June 2021

Ending: 8 Aug 2021

Requested number of students

one X

two _____

If requesting two students: Please indicate the rationale for requesting two students, including willingness to work with just one student if that is all that can be placed in your project.

Will this project be conducted in-person or remotely?

In-person only X

Remote only _____

Either in-person or remote _____
(to be decided upon after consultation with faculty mentor and student researcher)

Minimum qualifications of student researcher (be as specific as possible)

Ability to work independently is a must. Completion of Animal Behavior is preferred, but not required. Project includes both behavioral observations and bench work (microscopy/molecular), so student interest in both areas is critical.

The students should be comfortable working at a microscope for several hours a day, they should have good dexterity and patience, good note taking skills, and be willing to sacrifice and work with fish and fish embryos (following approved IACUC protocols).

The student will also be involved in animal care (cleaning, feeding, etc), including some weekend work.

Description of the research project (one page maximum)

Students will get an opportunity to work in the Hankison and Panhuis labs of the Zoology Department. Projects are focused on mating behavior, paternity analysis, and histological characterization of the gestated ovary in Poeciliid fishes from the genus *Poecilia* and *Poeciliopsis*. Below is a description of the two projects.

Hankison Lab Project:
An ongoing question related to courtship and mating behaviors is how these relate to actual reproductive success. In the sailfin molly, *Poecilia latipinna*, males exhibit a wide range of mating behaviors, from performing elaborate courtship to elicit female cooperation, to sneaky copulation attempts, which females often try to avoid, along with post-copulatory sperm competition. Females, too, have a range of responses (Farr et al 1986). They may actively solicit male courtship and cooperate during sperm transfer, or may avoid certain males that lack preferred characteristics. There may also be cryptic choice, in which females may preferentially use some sperm over other sperm. Finally, use of stored sperm, mating order, timing of mating relative to the female's reproductive cycle, and other factors may all influence which male(s) actually fertilize the eggs.

This project seeks to combine behavioral observations of male and female *P. latipinna* courtship behaviors with paternity testing of offspring to determine whether certain behaviors correlate with mating success. Previous work has suggested that at least half of all broods are sired multiply. We will start by travelling to Florida (Gulf coast) to collect fish on a multi-day trip. Once we return, we will acclimate the new fish and start the project. We will record mating behaviors of known females and males. We will also collect DNA samples from fish and characterize the DNA using a suite of microsatellites, short pieces of repeated DNA. Microsatellites have already been developed for *P. latipinna* for use in paternity testing.

Once we have offspring from the matings of known females with sets of males, we will determine paternity and look for patterns relating paternity to observed mating behaviors. While paternity can be influenced by the suite of circumstances detailed above, patterns that we observe may allow us to better understand the outcome of specific mating behaviors on fitness.

Panhuis Lab Project:
Poeciliids from the genus *Poeciliopsis* give live birth and successful gestation of the embryos depends on maternal provisioning of nutrients to the developing embryo. For some species in the genus these maternal nutrients are provided as large amounts of yolk that sustain the embryo during gestation. In other species, the mother produces little amounts of yolk and thus must continually transfer nutrients to the embryo throughout development. In these matrotrophic species, a placental tissue has evolved that facilitates the exchange of substances between the mother and the embryo. In the Panhuis lab there is an interest in understanding the function and structure of this placental tissue. One way, of several, that we do this is by studying the morphological specializations of the placenta – both maternal and embryonic features involved in maternal-fetal nutrient exchange. This summer we will focus on the analysis of prepared histological slides of five *Poeciliopsis* species that vary in their degree of placentation. These slides were made from the gestating ovary of females and should reveal the specific maternal and embryonic placenta features. By comparing maternal and embryonic morphological features across five closely related species that differ in their degree of

maternal-nutrient transfer, we will learn how these specializations evolved.

These projects (Hankison and Panhuis) will provide the student an opportunity to learn several lab techniques, such as compound and dissecting microscopy, fish behavior analysis, field collection, fish husbandry, micropipetting, DNA extraction, PCR, histology, scientific literature analysis, scientific note taking, and digital microscopy software and analysis. The student will also be exposed to several key topics in biology, including animal behavior, microscopy, histology, molecular biology, phylogeny, comparative evolution, comparative morphology, and genetics.

Submit the research proposal

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Summer Science Research Program
Ohio Wesleyan University

2021 Research Project Information Sheet

(Faculty information sheet)

Submission Deadline: 11 February 2021

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Astrophysics

Specific title of research project

Starspots on LO Pegasi

Faculty mentor supervising research

Name: Robert Harmon

Department: Physics and Astronomy

Campus phone: 3778

Email address: roharmon

Anticipated research dates (10 weeks):

Beginning: May 31

Ending: August 6

Requested number of students

one _____

two __X__

Will this project be conducted in-person or remotely?

In-person only _____

Remote only _____

Either in-person or remote _____X_____ (It will depend on my Covid vaccination status.)
(to be decided upon after consultation with faculty mentor and student researcher)

Minimum qualifications of student researcher (be as specific as possible)

Successful complete of PHYS 111 Lab

Description of the research project (one page maximum)

Even as imaged by the Hubble Space Telescope, stars appear to be featureless pinpoints. As a result, it is necessary to use indirect techniques in order to obtain information about their surface features. This project uses a particular technique for doing that called Light-curve Inversion (LI).

Of particular interest are “starspots,” which are analogous to sunspots on the Sun, and are known to be present on certain classes of stars. Like sunspots, starspots are believed to be manifestations of stellar magnetic fields. The study of starspots can thus provide valuable insights into the physics of the magnetic dynamos operating in the Sun and other stars.

If there is a dark spot on the surface, then every time the star’s rotation carries the spot into view from Earth, there will be a dip in the star’s brightness. If we knew in detail the appearance of the star’s surface, a relatively straightforward calculation would allow us to predict the star’s brightness as a function of time, i.e., its light curve. With LI we attempt to go in the other direction: knowing the light curve, determine the appearance of the star’s surface. This is not a simple matter, because the problem is ill-posed, in that very different surfaces can give rise to nearly identical light curves. This arises because the effects of a large number of small bright and dark patches on the surface would nearly but not completely cancel, such that their presence would impart a lowamplitude, high-frequency “ripple” on the light curve as the star rotates. This ripple would look very similar to random noise, with the result that a straightforward attempt to find the surface that best replicates the observed light curve will produce a surface peppered with spurious bright and dark spots that are merely noise artifacts. LI circumvents this problem by constraining the solution so as to favor surfaces which are “smooth” and thus free of noise artifacts in a well-defined sense.

The student or students who work on this project will apply LI to a particular star, LO Pegasi, that is particularly well-suited for a summer research project: It is well-placed for observation in June and July, and it has a short 10.153-hour rotation period, making it relatively easy to gather enough data for analysis of its starspots. Images of a star field surrounding LO Pegasi will be obtained using a QSI 632 CCD camera and B, V, R and I photometric filters at OWU’s Perkins Observatory. Standard reductions (dark subtraction and flat fielding) will be performed on the images in order to reduce random noise and systematic errors. Then differential aperture photometry will be used to obtain the light curve (plot of intensity vs. time) of LO Pegasi as seen through each filter. Using multiple filters significantly improves the latitude resolution of the technique by taking advantage of the wavelength dependence of the limb darkening (center-to-edge dimming) of the stellar surface. The light curve data will then be analyzed via LI to produce maps of the stellar surface. This summer’s data will also be compared to data obtained from 2014-2020.

Summer Science Research Program
Ohio Wesleyan University

2021 Research Project Information Sheet

(Faculty information sheet)

Submission Deadline: 11 February 2021

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Mathematical modeling, coding, population and community ecology

Specific title of research project

Exploring ecological stability in real communities using mathematical and modeling approaches

Faculty mentor supervising research

Name: Dr. Craig Jackson (Math) and Dr. Amy Downing (Zoology)

Department: Math and Computer Science, Zoology

Campus phone: X3659 (Jackson) X3890 (Downing)

Email address: chjackso@owu.edu , aldownin@owu.edu

Anticipated research dates (10 weeks): **Requested number of students**

Beginning: ___June 1st_____ one _X

Ending: _____August 6th_____ two _____

If requesting two students: Please indicate the rationale for requesting two students, including willingness to work with just one student if that is all that can be placed in your project.

Will this project be conducted in-person or remotely?

In-person only _____

Remote only _____

Either in-person or remote __X_
(to be decided upon after consultation with faculty mentor and student researcher)

Minimum qualifications of student researcher (be as specific as possible)

Coursework: Math 110, Biol 122, Some coding experience strongly preferred

Description of the research project (one page maximum)

Ecological stability is a term used to describe a wide range of attributes such as the temporal variability in populations and communities, their resistance and resilience to disturbance, and community resistance to invasion or extinction. Stability in ecological systems is a multifaceted concept that has been studied by both theoretical and experimental ecologists. However, these groups of researchers have often utilized different measures of stability due to the fact that experimental ecologists tend to engage in statistical analyses of time-series population data while theoretical ecologists tend to start from abstract mathematical models.

In previous work [1] we used a first-order multivariate autoregressive model (MAR) to estimate theoretical community matrices from time-series data collected from experimental plankton communities. These community matrices describe species-specific interaction strengths across a range of community compositions and allow for a comparison between temporal stability typically measured by empiricists and stability measures typically measured by theoreticians. These community matrices were also used to derive estimates of interaction strengths between multiple plankton groups which were then compared to measures of stability to investigate the question of which kinds of interactions are most associated with stability.

There are several avenues open to students who are interested in delving further into this topic:

1) Investigate the distribution of species interaction strengths across community composition. In the experiment described above there were approximately 90 individual mesocosms representing 15 different plankton communities. To what degree does the interaction strength between a particular species pair depend on the overall community composition? Are these interaction strengths statistically different across treatments?

2) Does the patterning of interaction strengths in the food web determine stability? Are certain species-specific interactions more or less important for determining stability? Do strong interactions paired with weak interactions matter? In our previous study we looked at averages of interaction strengths across various categories of species interaction. However, another approach would be to examine the number of weak/strong interactions and how they are distributed in the community matrix.

3) Investigate the same questions as the original study but applied to a new dataset of plankton communities. Are the findings of the original study replicated? If there are important differences, what could possibly explain this?

4) Investigate the same questions as the original study but applied to a different set of theoretical measures of stability.

[1] A. L. Downing, C. Jackson, *C. Plunkett, *J. Ackerman Lockhart, *S. M. Schlater, M. A. Leibold, *Temporal stability vs. community matrix measures of stability and the role of weak interactions*, Ecology Letters **23**:10 (2020) 1468-1478.

(* indicates undergraduate student coauthor)

Submit the research proposal

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Summer Science Research Program
Ohio Wesleyan University

2021 Research Project Information Sheet

(Faculty information sheet)

Submission Deadline: 11 February 2021

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Statistics – Specifically, methodological statistics (development and assessment of new methods in statistical inference potentially useful in practice)

Specific title of research project

Inference for regression model coefficients when data has been subjected to censoring.

Faculty mentor supervising research

Name: _____Scott Linder_____

Department: ___Mathematics and Computer Science_____

Campus phone: _8-3660_(email is preferred)_____

Email address: _____rslinder@owu.edu_____

Anticipated research dates (10 weeks):

Beginning: Standard start date__

Ending: ___Standard end date___

Requested number of students

one _x__

two _____

If requesting two students: Please indicate the rationale for requesting two students, including willingness to work with just one student if that is all that can be placed in your project.

N/A

Will this project be conducted in-person or remotely?

In-person only _____

Remote only _____

Either in-person or remote __X__
(to be decided upon after consultation with faculty mentor and student researcher)

Minimum qualifications of student researcher (be as specific as possible)

Required: Math 230 (Applied Statistics) credit; Knowledge of programming (e.g. CS 110 or obtained otherwise).

Optimal: Math 365 (Applied Statistical Models) or Math 350 (Probability)

Description of the research project (one page maximum)

In many clinical and industrial settings, data are subjected to *censoring*. For example, subjects in a clinical trial or longitudinal study leave the study, and information about the subject is only available to this time. Or, in an industrial setting, 1000 electronic components are run continuously, and the experiment ends when 100 of them fail – measurements have been taken for the 900 non-failing components up to the experiment's end.

Of course, in such settings, a common objective is to study the relationship between two or more variables. In one grim example, 100 monkeys are fed a highly atherosclerotic diet, and ends when the 10^{th} monkey dies. When a monkey dies at time X, an autopsy is performed and some response Y (e.g. plaque in artery) is recorded. Measurements of Y may only be taken when a monkey dies. These experiments would take a long time if we started with 10 monkeys and waited for all of them to die. Interest is in the relationship between X and Y.

The problem is, statistical inference requires understanding the sampling distributions of model parameter estimates (statistics). There is a well developed and widely applied methodology suitable for situations in which no censoring occurs. However, censoring impacts the sampling distributions of these estimates, and they are typically mathematically intractable.

In this work, we consider the simple linear regression model (the most basic regression model), and examine the impact of censoring on the sampling distributions of standard parameter estimates (for correlation and for slope). We propose simple modifications to their sampling distributions to account fo the impact of censoring. We then consider the use of these modified sampling distributions to develop inferences (confidence intervals or significance tests) appropriate to the setting in which censoring occurs. Finally, we examine the performance of these inference methods. This kind of work is heavily simulation oriented, but requires an understanding of statistical principles and theory.

When I work with a student, my goal is to expose them to the entire process… documentation of the problem, development of a solution, analysis of the solution's performance, and writing up the results (with a paper in LaTex). I also require my students to prepare a presentation (sometimes just for me).

Submit the research proposal
Please save as a **pdf** and email completed form to ssrp@owu.edu as an attachment (pdf file) with the subject line "Proposal for *faculty name*"

Summer Science Research Program
Ohio Wesleyan University

2021 Research Project Information Sheet

(Faculty information sheet)

Submission Deadline: 11 February 2021

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Computer Science- Artificial Intelligence

Specific title of research project

Artificial Intelligence for Modern Board Games

Faculty mentor supervising research

Name: Sean McCulloch

Department: Mathematics and Computer Science

Campus phone: 3663

Email address:stmccull@owu.edu

Anticipated research dates (10 weeks):

Beginning: June 1

Ending: Aug 6

Requested number of students

one XXX

two _____

Will this project be conducted in-person or remotely?

In-person only _____

Remote only _____

Either in-person or remote XXX (I'd prefer in person, but we'll see what the future brings)
(to be decided upon after consultation with faculty mentor and student researcher)

Minimum qualifications of student researcher (be as specific as possible)

Successful completion of CS210. More CS classes are always better.

Description of the research project (one page maximum)

Much work has been done in the past on designing Artificial Intelligence (AI) programs to play "classic" board games, such as Chess, Checkers, Othello, and Go. Many of these games have programs that are sufficiently advanced that they beat the best human players (see, for example, Refs. [1-3]). In the last ten to twenty years, however, there has been a rise in "abstract" or "European-style" board games. These differ from the board games many of us have played as children (such as Monopoly or Life) in several areas: (1) the games are typically short, many finishing in 90 minutes or less; (2) the games usually emphasize player interaction in some way (components such as bidding, competing for scarce resources, or trading/negotiation are commonly seen); and (3) the games often are based around hidden information, so that nobody can know the whole state of the game. These factors, especially the last two, make designing an AI for these games a challenge, and so much less has been done analyzing these games, and what has been done has much room for improvement (some examples include Refs. [4, 5], while other game companies have been developing AI programs for sale, usually as mobile apps). I have personally created a game-theoretic agent to play the game Football Strategy [6], and past summer students have created an agent for the game Battle Line that is based on probability [7].

Previous summer students have also begun work on agents for the games Modern Art (a multiplayer auction game), Euro Rails (a game where players create rail lines and deliver goods), Pandemic (a cooperative game where players work together to cure diseases before it outbreaks across the world), and Scotland Yard (a semi-cooperative where a team of detectives work together to find the hidden "Mr. X"). This summer's SSRP student can either extend the work in these programs, refine the Football Strategy or Battle Line programs, or begin work on an entirely new game.

References

[1] M. Campbell, A.J. Hoane Jr., F. Hsu, Artificial Intelligence **134**, 57 (2002).

[2] J. Schaffer, J. Culberson, N. Treleoar, B. Knight, P. Lu, D. Szafron, Artificial Intelligence **53**, 273 (1992).

[3] M. Buro, Artificial Intelligence **134**, 85 (2002).

[4] C. Heyden, Master's Thesis, 2009. [http://www.personnel.unimaas.nl/uiterwijk/Theses/MSc/Heyden_thesis.pdf].

[5] F. Schadd, Master's Thesis, 2009. [http://www.unimaas.nl/games/files/msc/fschadd_thesis.pdf].

[6] S. McCulloch, *A Game-Theoretic Intelligent Agent for the Board Game Football Strategy*, MAICS 2015, p. 121-125.

[7] S. McCulloch, D. Bladow, T. Dobrow, H. Wright. *Deep Barca: A Probabilistic Agent to Play the Game Battle Line,* MAICS 2017, pp, 145-150

Submit the research proposal

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Summer Science Research Program
Ohio Wesleyan University

2021 Research Project Information Sheet

(Faculty information sheet)

Submission Deadline: 11 February 2021

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Organic, Inorganic and Organometallic Chemistry

Specific title of research project

Investigation of Dipyrrin Complexes for Small Molecule Activation

Faculty mentor supervising research

Name: _____Allen Pistner_____

Department: _____Chemistry_____

Campus phone: _____x3519_____

Email address: _____ajpistne@owu.edu_____

Anticipated research dates (10 weeks):

Beginning: _____6/1/21_____

Ending: _____8/6/21_____

Requested number of students

one __x___

two _____

If requesting two students: Please indicate the rationale for requesting two students, including willingness to work with just one student if that is all that can be placed in your project.

Will this project be conducted in-person or remotely?

In-person only ___x____

Remote only _____

Either in-person or remote _____
(to be decided upon after consultation with faculty mentor and student researcher)

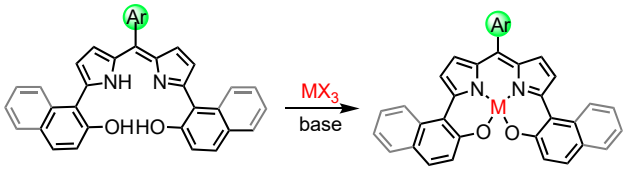
Minimum qualifications of student researcher (be as specific as possible)

CHEM 110, 111, 260, and 261 (or currently enrolled in CHEM 261 Spring 2021)

Description of the research project (one page maximum)

Ligand scaffolds that possess the ability to participate in redox activity have recently been an active area of research. The intriguing ability of these systems to act as an electron reservoir allows for the development of new catalysts even when coordinating to redox-inactive metals.[i-iii] This has led to the increase in design of complexes containing earth-abundant metals capable of performing transitions that were previously reserved for expensive rare-earth metals.[iv-vi]

This project will continue to build on the development of a bis(phenolate)dipyrrin ligand scaffolds. This will allow for the redox activity to be tuned, affording the ability to influence the reactivity. These redox active complexes will be synthesized using the following route (Scheme 1),[vii] while varying the electronic character of the aryl substituents. Students working over the summer will focus on synthesizing metal complexes and characterizing them through NMR, uv-vis spectroscopy, electrochemistry, etc. along with evaluating their catalytic activity.



Scheme 1. Synthesis of dipyrrin complexes.

The multi-electron redox activity of the dipyrrin ligand scaffold provides the opportunity for catalysis for transformations requires more than two electrons typically provided by the change in the oxidation state of the central metal. The ability of the ligand scaffold to act an as electron reservoir provides the opportunity to pursue challenging transformations such as the reduction of dioxygen into water. The redox activity engendered by the dipyrrin ligand scaffold make these promising candidates to serve as electrocatalysts for the reduction of O_2 to 2 H_2O. This electrocatalytic activation of oxygen has potential applications in the construction of fuel cells.[viii]

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[i] Blackmore, K. J.; Ziller, J. W.; Heyduk, A. F. *Inorg. Chem.*, 2005, *44*, 5559.
[ii] Haneline, M. R.; Heyduk, A. F. *J. Am. Chem. Soc.*, 2006, *128*, 8410.
[iii] Zarkesh, R. A.; Ziller, J. W.; Heyduk, A. F. *Angew. Chem. Int. Ed.*, 2008, *47*, 4715.
[iv] Lyaskovskyy, V.; de Bruin, B. *ACS Catalysis*, 2012, *2*, 270.
[v] Praneeth, V. K. K.; Ringenberg, M. R.; Ward, T. R. *Angew. Chem. Int. Ed.*, 2012, *51*, 10228.
[vi] Luca, O. R.; Crabtree, R. H. *Chem. Soc. Rev.*, 2013, *42*, 1440.
[vii] Nakano, K.; Kobayashi, K.; Nozaki, K. *J. Am. Chem. Soc.*, 2011, *133*, 10720.
[viii] Zhang, W.; Lai, W.; Cao, R. *Chem. Rev.*, 2017, *117*, 3717.

Summer Science Research Program
Ohio Wesleyan University

2021 Research Project Information Sheet

(Faculty information sheet)

Submission Deadline: 11 February 2021

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Animal Behavior, Evolution, Endocrinology

Specific title of research project

Behavior, physiology, and reproductive success in two species of North American wrens

Faculty mentor supervising research

Name: _____Dustin Reichard_____

Department: _____Zoology_____

Campus phone: ____x2890_____

Email address: ____dgreicha@owu.edu_____

Anticipated research dates (10 weeks):

Beginning: _____May 31_____

Ending: _____Aug 2_____

Requested number of students

one __X___

two _____

Will this project be conducted in-person or remotely?

In-person only ___X____

Remote only _____

Either in-person or remote _____
(to be decided upon after consultation with faculty mentor and student researcher)

Minimum qualifications of student researcher (be as specific as possible)

- **Must be able to *wake up early*** (pre-dawn) and hike on uneven terrain in hot, humid conditions in the presence of biting insects such as ticks, mosquitos, and flies.
- Must be willing to handle live birds (adults and nestlings) and collect blood samples (no previous experience necessary, training will be provided!)
- Completed BIOL 122 (preferred) or BIOL 120

Description of the research project (one page maximum)

Research in my lab focuses broadly on the evolution of animal communication and the physiological mechanisms of behavior, specifically how circulating hormone levels both affect and are affected by different behaviors. We investigate these topics in a variety of free-living (wild) songbird species, but our primary focus is two closely related species of wrens that both nest in bird boxes. House and Carolina Wrens differ in a variety of life history characteristics that make them a compelling comparative study system. House wrens are migratory, experience a shorter breeding season, and coexist at much higher densities than Carolina Wrens, which are sedentary and found in central Ohio year-round. My lab studies both species using a collection of 200 nest boxes in the Delaware area. Students that work in the lab gain skills in handling and extracting birds from mist nets, bird banding, blood sampling and processing, behavioral observation, audio recording, and field data collection and management. In the summer of 2021, there are two research projects that we are conducting.

1. **Antipredator behavior in House Wrens**

   Songbirds produce altricial young that are wholly dependent on their parents for food, warmth, and protection from predators for the first few weeks of life. The guild of predators that targets young songbirds is diverse and includes mammals, snakes, and birds of prey. These predators also pose different risks to parents engaging in nest defense depending on the ability of the predator to capture and kill an adult songbird. In 2020, we found that female House Wrens defend equally against a simulated rodent and snake predator at their nest box by diving at and, in some cases, hitting the predator repeatedly. These results indicate that females do not modify their behavior according to predator type and the perceived risk to themselves. However, rodents and snakes rarely capture and kill adult House Wrens, so the risk to the female may have been equivalent despite the stark differences between the two predators. This summer, we plan to repeat this experiment, but we will replace the rodent with a simulated bird of prey that is a common predator for adult wrens. Our hypothesis is that female House Wrens will respond differently to these two predator types, and we predict that they will defend less aggressively in the presence of the bird of prey, which poses a greater risk of injury or death. Students will monitor nest boxes, introduce the simulated predators during the nestling stage, and score antipredator behavior. We will also capture and band the parent House Wrens so that we can differentiate between parents during the behavioral trials.

2. **Song repertoire size, sharing, and fitness in House and Carolina Wrens**

   Animals use a variety of signals to attract mates and defend territories, and among songbirds, vocalizations are one of the most prominent forms of communication. The total number of unique songs that an individual produces is referred to as his/her repertoire, and the repertoires of different individuals can have both shared and unshared song types. Previous research investigating the adaptive role of song repertoires has yielded largely mixed results, and it remains unclear why repertoire sizes range from one to thousands of songs across different species. House and Carolina Wrens each produce small repertoires of distinct songs that vary in length and complexity. We will record the repertoires of individuals of both species and test for a relationship between repertoire size and reproductive success. We will also estimate repertoire sharing between males on neighboring territories and test for a relationship between song sharing and reproductive success. We will collect song recordings actively with handheld parabolic microphones as well as passively with automated recordings units that can be placed on the territory of individual males to record continuously for weeks at a time. Students will learn how to visualize and collect measurements from these recordings using bioacoustics software.

Submit the research proposal

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Summer Science Research Program
Ohio Wesleyan University

2021 Research Project Information Sheet

(Faculty information sheet)

Submission Deadline: 11 February 2021

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Environmental Science / Geography / Energy

Specific title of research project

Determining Campus-wide Solar Power Potential

Faculty mentor supervising research

Name: Dr. Nathan Rowley

Department: Geology & Geography / Environment & Sustainability

Campus phone: 740-368-3619

Email address: NROWLEY@OWU.EDU

Anticipated research dates (10 weeks):

Beginning: 01 June

Ending: 06 August

Requested number of students

one X

two _____

If requesting two students: Please indicate the rationale for requesting two students, including willingness to work with just one student if that is all that can be placed in your project.

Will this project be conducted in-person or remotely?

In-person only _X_____

Remote only _____

Either in-person or remote _____
(to be decided upon after consultation with faculty mentor and student researcher)

Minimum qualifications of student researcher (be as specific as possible)

This student must have:

- Strong time management skills. This work will require the student to work in a computer lab for several hours a day (alone).
- Comfort with using technology (computer, GIS, drones) or have the willingness to learn using these instruments / tools

Preferred qualification: some GIS and / or remote sensing experience

Description of the research project (one page maximum)

The field of remote sensing is one that learns about the world around us, but without physical contact with the medium. Primarily, the field has utilized tools, such as satellites and drones, to collect data about various objects and surfaces, both in our atmosphere, on the ground, and even below ground. The field of geography is one that applies spatial and temporal thinking to better understand our world. Combined, this project will utilize remote sensing and geographic data and methods to develop a robust 'solar potential' for the Ohio Wesleyan campus.

Historically, the state of Ohio has not been at the forefront of renewable energies, and this is especially true with solar-generated electricity. However, in the past decade, technology advances and increases in the demand (along with some political will), the price of renewable energies has plummeted, often, strongly competing with the price of electricity generated from non-renewables (e.g., coal, natural gas).

Recently, google has lead an effort to promote the use of renewables, particularly solar – they have done this through their Google Project Sunroof. In it, they provide detailed information on the ability for a particular address to use energy harnessed on site through solar panels. Data on energy usage, roof capacity, and geometry are implemented. Though great for disseminating 'solar potential' information to the public, they are limited in resources (people) to apply this project across the country; Columbus has been mapped but not Delaware.

This student will apply similar methodologies to generate a 'solar potential' for the entire campus area – building by building, to determine the ability for campus to be powered by solar energy, including the upfront costs and long-term savings. The student will use campus drones to generate high-resolution maps of campus buildings and apply a GIS-based methodology to calculate and analyze our OWU solar potential.

Submit the research proposal

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Summer Science Research Program
Ohio Wesleyan University

2021 Research Project Information Sheet

(Faculty information sheet)

Submission Deadline: 11 February 2021

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Chemistry, Surface Science

Specific title of research project

Surface Tension Studies of Monolayer Proxy Systems of Biological and Environmental Relevance

Faculty mentor supervising research

Name: __Dr. Bethany Rudd_____

Department: ____Chemistry_____

Campus phone: __740-368-3527_____

Email address: __barudd@owu.edu_____

Anticipated research dates (10 weeks):

Beginning: ____June 1, 2021_____

Ending: ___August 6, 2021_____

Requested number of students

one __X__

two _____

If requesting two students: Please indicate the rationale for requesting two students, including willingness to work with just one student if that is all that can be placed in your project.

N/A

Will this project be conducted in-person or remotely?

In-person only __X___

Remote only _____

Either in-person or remote _____
(to be decided upon after consultation with faculty mentor and student researcher)

Minimum qualifications of student researcher (be as specific as possible)

The student should have successfully completed general chemistry (CHEM 110, 111). Ideal candidates have proficiency in basic laboratory skills such as solution preparation and titration. This project will also involve data analysis using graphing software.

Description of the research project (one page maximum)

The overall goal of research performed in my lab is to understand the organization of surface-active species at the air-aqueous interface in both simple and complex systems of environmental and biological significance. Surface-active molecules (surfactants) self-assemble at the interface due to the intermolecular forces in their molecular structure. The hydrophobic portion of the surfactant forces the molecule to the interface, while the hydrophilic headgroup anchors the molecule to the surface due to its favorable interaction with water molecules.

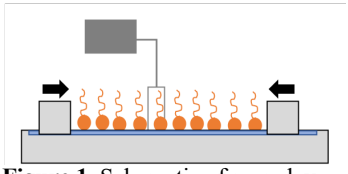

Figure 1. Schematic of monolayer compression in a Langmuir trough.

Pictured in **Figure 1** is a schematic of a Langmuir trough which allows for, among many things, the determination of surface tension as a function of molecular area of insoluble surfactants. Briefly, a lipid solution of known concentration is deposited dropwise onto a clean aqueous surface. As these surfactants are anchored to the surface via the hydrophilic headgroup, compression of the surface area via moveable barriers will result in changes in surface tension. Analysis of the data allows us to gain information on molecular ordering, including properties such as the compressibility of the film and the miscibility of mixed lipid systems. Static surface tension measurements (i.e. without compression) can also be conducted for *soluble* surfactants through alternative experimental configurations.

In the 2021 SSRP, students conducting research in my lab may choose to work on a project which most meets their interests. Below are brief descriptions of two possible project areas. Research in the Rudd lab is currently being done on both of these projects, so exact molecules, systems, etc. may change based upon the findings of current student research.

1. Organization of soluble surfactants in aerosol proxy systems

Sea spray and lake spray aerosols contain a surfactant contribution which significantly alters their physical and chemical properties.[1-4] The focus of this research project is to determine the critical micelle concentration (CMC) of various soluble surfactant systems of atmospheric interest. The CMC is an important benchmark for all surfactants and can be determined in a variety of ways (surface tensiometry, conductivity, voltammetry, etc.).[5] CMC measurements in this project will be determined through surface tension and conductivity measurements of surfactant solutions of short/medium chain (C_8-C_{12}) fatty acids and alcohols in both pure and binary systems to determine how the CMC of a mixed system compares to that of each individual surfactant system. Additionally, this project aims to quantify and interpret the effect of ion complexation on the CMC through the study of single fatty acid/alcohol systems with marine-relevant ions dissolved in the bulk subphases.

2. Interactions between monolayer membrane mimics and small organic molecules

When a drug interacts with a biological membrane, it alters the organization of the lipid molecules making up that membrane. In this project, students will study phospholipid Langmuir monolayers as simple model systems representing human biological membranes and/or lung surfactant. Studying simple Langmuir model systems allows us to obtain molecular-level information on the interactions between pharmaceutical drugs, hormones, etc. with the membrane which can be correlated to their physiological activity.[6-8] This is a newer project in the Rudd lab, so the identities of the small organic molecules which will be investigated with phospholipid monolayers are currently being determined through preliminary research. Students will utilize the Langmuir trough and Brewster angle microscopy, which allows for the imaging of aqueous interfaces, to study these systems.

References

[1]R. E. Cochran, O. Laskina, T. Jayarathne, A. Laskin, J. Laskin, P. Lin, C. Sultana, C. Lee, K. A. Moore, C. D. Cappa, T. H. Bertram, K. A. Prather, V. H. Grassian and E. A. Stone, *Environ. Sci. Technol.*, 2016, 50, 2477–2486. [2]N. W. May, J. L. Axson, A. Watson, K. A. Pratt, A. P. Ault, *Atmos. Meas. Tech.,* 2016, 9, 4311-4325. [3]T. H. Bertram, R. E. Cochran, V. H. Grassian, E. A. Stone, *Chem. Soc. Rev.*, 2018, 47, 2374-2400. | [4]S. M. Burrows, O. Ogunro, A. A. Frossard, L. M. Russell, P. J. Rasch and S. M. Elliott, *Atmos. Chem. Phys*., 2014, 14, 13601–13629. [5]K. Nesmerak, I. Nemcova, *Anal. Lett.,* 2006, 39, 1023–1040. [6]V. P. N Geraldo, F. J. Pavinatto, T. M. Nobre, L. Caseli, O. N. Oliveira Jr., *Chem. Phys. Lett.*, 2013, 559, 99-106. [7]C. Nunes, D. Lopes, M. Pinheiro, C. Pereira-Leite, S. Reis, *Pharm. Res.*, 2013, 30, 2097-2107. [8]M. D. Maximino, C. J. L. Constantino, O. N. Oliveira Jr., P. Alessio, *Appl. Surf. Sci.*, 2019, 476, 493-500.

Summer Science Research Program
Ohio Wesleyan University

2021 Research Project Information Sheet

(Faculty information sheet)

Submission Deadline: 11 February 2021

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)
Physics

Specific title of research project
Coupled Nonlinear Systems: The Physics of Josephson Junction Arrays

Faculty mentor supervising research

Name: _____Brad Trees_____

Department: ____Physics and Astronomy_____

Campus phone: _____3779_____

Email address: _____brtrees@owu.edu_____

Anticipated research dates (10 weeks):

Beginning: _____June 1_____

Ending: _____Aug. 6_____

Requested number of students

one __x___

two _____

If requesting two students: Please indicate the rationale for requesting two students, including willingness to work with just one student if that is all that can be placed in your project.

Will this project be conducted in-person or remotely?

In-person only _____

Remote only _____

Either in-person or remote _____x_____
(to be decided upon after consultation with faculty mentor and student researcher)

Minimum qualifications of student researcher (be as specific as possible)

Two years of physics and math: Physics courses: 110, 111, 280. Math courses: 110, 111, 210, 280.
One upper-level physics theory course preferred.

Description of the research project (one page maximum)

This project studies the effect of coupling two or more current-biased Josephson junctions (JJs), which are superconducting tunnel junctions, by means of linear or nonlinear circuit elements, *e.g.* a nanomechanical oscillator or another JJ, respectively. The focus is on two particular aspects of this coupling: the effect on synchronization of the voltage across the JJs, and the effect on tunneling and decoherence rates of each JJ when biased so as to operate as so-called phase qubits. *Classical and Quantum Synchronization:* Systems of limit-cycle oscillators show a wealth of interesting behaviors. For example, synchronization due to coupling of the oscillators has been experimentally observed in many systems in many scientific disciplines such as physics, chemistry, and biology. On theoretical grounds, the Kuramoto model, describing the dynamics of N globally-coupled oscillators of phase ϕ_i, angular velocity ω_i, and coupling strength K, $d\phi_i / dt = \omega_i + (K / N)\sum_{j=1}^{N} \sin(\phi_j - \phi_i)$, has provided important insight into the nature of a synchronization transition itself. JJ arrays, which have been theoretically linked to the Kuramoto model in certain geometries, are perhaps the quintessential nonlinear system for studying the causes and stability of synchronous behavior. Well-controlled, modern fabrication techniques allow the design of JJ arrays with precise geometries and junction parameters. The result is an exquisitely controlled "test bed" for the study of complex dynamical systems. This computational project involves the simulation of JJs coupled both to each other as well as to external loads that could result in synchronous time-dependent behavior of the junction voltages. For example, one goal is to determine if coupling a nanomechanical oscillator to a JJ array can result in stable synchronization of the junctions in the array. Such coupled nanomechanical-oscillator and JJ systems are currently of interest because of their potential use as quantum bits and because of the expanding expertise in fabricating high-Q mechanical oscillators on the microscopic scale. This project is highly suitable to undergraduates because the model for a current-biased JJ is analogous to that of a damped, driven, nonlinear pendulum, and the JJ can be treated in either a classical or quantum limit, depending on its size and other physical characteristics. For junctions in the classical limit, the pendulum analogy allows students to build up physical intuition about the behavior of single junctions. They can then focus on learning new physics based on how multiple junctions behave when coupled. Students with a stronger physics and mathematics background can study the synchronization of JJs in the quantum limit by learning about numerical techniques for solving the Schrödinger equation for an open system. Such a more challenging project is of considerable interest, since the phenomenon of quantum synchronization is still not well understood. The project involves a combination of analytical work and computation (Mathematica and Python, or Fortran).

Submit the research proposal

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