Fellowship Application Information

Type: GRAD

Project Title: Interactions Between Iodine and Thermionic Emitting Insert Materials for the Design of Hollow Cathodes

Abstract: Hall thrusters and gridded ion engines require the use of a hollow cathode to ignite the plasma inside the thruster and neutralize the emitted plume. The most common propellant used for electric propulsion devices is xenon, but its scarcity and expense elicit the need for an alternative. Iodine is similar in atomic mass and first ionization energy to xenon. Additionally, it's stored diatonically as a solid three times the density of xenon. Whereas xenon feed systems require a pressurized vessel, iodine's solid storage allows for a smaller propellant feed system. Iodine is a halogen and therefore reactive, but there is little data regarding the interactions between iodine and materials used in space applications. This data is necessary to evaluate the possibility of using iodine as a propellant. This will require extensive research into the interactions between diatonic iodine and hollow cathode insert and construction materials at the molecular level.

Fellowship Application Information

Type: GRAD

Project Title: Empirical modeling of CMEs using near-Earth ionic measurements

Abstract: Coronal Mass Ejections (CMEs) are highly energetic eruptions occurring at the sun. As a CME is released, the plasma experiences heating, expansion and acceleration; however, the physical mechanism supplying the heating in the corona still remains uncertain. Previous work has found that ions in the expanding ejecta reach a distance where the rapidly decreasing density overcomes the ionization timescale rendering the charge states fixed beyond that point. This property makes them a good indicator of thermal conditions in the corona, where the plasma likely receives most of its heating. We propose to model this so-called ‘freeze-in’ process in Earth-directed CMEs using our ionization code to empirically determine temperature, density and velocity along its trajectory. The models are constrained to ‘frozen-in’ ionic abundances detected near the Earth. The CME properties generated will be used to estimate an energy budget and heating rate to compare with a variety of proposed heating mechanisms.

Fellowship Application Information

Type: GRAD

Project Title: Sleep in Space: Sleep Restriction, Nuerovascular Control, and Orthostatic Intolerance

Abstract: Before sending humans on extended missions to Mars and beyond, NASA must better understand the potential physiological consequences of prolonged microgravity. Chronic sleep restriction is well-documented in spaceflight, and is a potential contributor to dysfunction of the cardiovascular and autonomic nervous systems in microgravity. Critical mission days are often characterized by severe sleep restriction (2-3 hours of sleep) or even 24-hours of sleep deprivation (i.e., total sleep deprivation). The laboratory of my graduate advisor has shown that total sleep deprivation results in altered baroreflex function in women, which could increase the risk of post-flight orthostatic intolerance in female astronauts compared to male astronauts. Because a Mars mission will consist of both male and female astronauts, it is important to understand if detrimental factors such as chronic sleep restriction and/or total sleep deprivation have different impacts across sexes. This could be crucial in developing effective and sex-specific countermeasures.

Fellowship Application Information

Type: GRAD

Project Title: Investigating the Relationship Between Volcanic Sulfur Dioxide Concentrations and Human Population and Land Use Changes through Geographic Visualization

Abstract: Volcanic SO2 emissions have been shown to be detrimental to human and environmental health, but their association with changes in population and land use is poorly known. This project will investigate the relationships between satellite measurements of SO2 column, human population, and land use between 2005 and 2016. By developing an ArcGIS and Python programming toolkit and utilizing the NASA datasets from the Ozone Monitoring Instrument, Gridded Population of the World, and Land Cover Dynamics, we will create a time series of maps visualizing human exposure to volcanic SO2 emissions. These maps will be analyzed at several time points to identify geographic areas at risk for SO2 exposure; observe changes in SO2 concentrations, population, and land use; and draw conclusions about these relationships. This research has implications for public health, economic development, and geological and environmental sciences, and can contribute to the understanding and development of a more sustainable Earth.

Fellowship Application Information

Type: GRAD

Project Title: The High Energy Plasma Environment at Saturn and Relation to Interchange Injections by Planetary Longitude

Abstract: The Cassini spacecraft routinely observed interchange injection events while orbiting Saturn from 2004-2017. Interchange injection events are thought to initiate from a Rayleigh-Taylor like instability sourced from Saturn's rapid rotation (period ~10.8 hours) and dense plasma population outgassing primarily from Enceladus. Interchange mixes dense water plasma from Enceladus with highly energetic hydrogen plasma from further into the magnetosphere. We propose to evaluate interchange occurrence rates and particle pressure against Saturn planetary longitude. The planetary longitude system is based off the periodic nature of radio emission from Saturn's atmosphere (Saturn kilometric radiation). The longitude system undergoes long-term changes dependent on Saturnian season. We propose to build off of our recently completed statistical evaluation of interchange injections to evaluate the high-energy (3-220 keV) intensification of interchange by longitude. This will answer: how are interchange events distributed in Saturn longitude and does this affect the distribution of energetic plasma within the middle magnetosphere?

Fellowship Application Information

Type: GRAD

Project Title: Reaction Mechanisms for the Degradation of Trace Organic Contaminants Through Advanced Oxidation Processes

Abstract: Trace amounts of known and emerging organic pollutants are raising concerns about nation's water because of the uncertainty of human health impact and the lack of management plans. Conventional water treatment techniques are insufficient to remove these trace organics, particularly to the levels necessary for water reuse scenarios. Advanced oxidation that utilizes highly reactive hydroxyl radicals has been proposed as a method of treatment, yet the mechanisms of target organic compounds degradation remain greatly unknown. Through the coupling of experimental and theoretical investigations this work will provide a validated elementary reaction kinetic based model. This model can then be used for the preliminary design and the process assessment for advanced oxidation systems in wastewater reclamation processes and at the international space station and manned long-distance space aircraft water recovery systems.

Fellowship Application Information

Type: GRAD

Project Title: Mapping the Co-distribution of Mercury and Polychlorinated Biphenyls in Michigan Upper Peninsula Lakes

Abstract: Mercury and polychlorinated biphenyls (PCBs) are ubiquitous pollutants globally; a four-year national survey of lakes and reservoirs for persistent, bioaccumulative, and toxic (PBT) chemicals in fish detected both chemicals in all the fish samples collected1. It is well-known that mercury2 accumulates in muscle tissue and has neurodevelopmental and cardiovascular effects, and that PCBs3 affect cardiovascular health as well as neurological development and accumulate in fatty tissue but their synergistic relationship is an unknown. The objectives for this project include assembling a database of lake characteristics that have been shown to predict mercury and PCBs in Michigan's Upper Peninsula (MUP) lakes, extending current maps of individual pollutants to include lakes in which they have not been directly measured by using existing statistical relationships between lake characteristics and contaminant concentrations, and evaluating patterns in the co-distribution of the pollutants to inform human health applications such as risk assessments.

Fellowship Application Information

Type: GRAD

Project Title: The Origin of an Archean Batholith- Michigan's Upper Peninsula

Abstract: For over a century the geologic community has debated over the origin of granite. There are two accepted models that are both known to occur on Earth. The first involves generation of new granitic crust through magma generation in the mantle. The second involves melting of old crust. In addition, more recent crustal growth models suggest that most new granitic crust formed >2.5 Ga, and has since transitioned into production of granite by recycling of old crust. In contrast, the Southern Complex of the Upper Peninsula Michigan is 4-2.5 Ga and has been interpreted to have formed primarily by melting of old crust. In this project, we will use U-Pb dating and oxygen isotope ratios of zircon to determine whether or not the granite formed primarily from the mantle or by recycling of old crust. This result will also be used to test recent models of crustal evolution on Earth.

Fellowship Application Information

Type: GRAD

Project Title: Cold water therapy as a recovery intervention during spaceflight operations

Abstract: There are a number of scenarios in which astronauts may face thermoregulation challenges during spaceflight operations (e.g. exercise, extravehicular activity, emergency egress). Increases in body temperature are known to hinder performance during prolonged physical activity. Cold water therapy may serve as a recovery intervention to attenuate fatigue within the muscle and the brain (sensation of fatigue). This study will be the first to investigate the association between prefrontal cortex activation, muscular performance, and psychological variables when using cold water therapy as a recovery intervention. These results will help guide the use and development of liquid cooling garments being used by NASA. MSGC support will help me complete my doctoral dissertation related to thermoregulation and exercise performance. Moreover, I will develop a better understand of the role of the prefrontal cortex in tolerating or terminating fatiguing exercise.

Fellowship Application Information

Type: GRAD

Project Title: Space Weather Propagation in the Inner Heliosphere

Abstract: This research aims to improve space weather modeling and space environment awareness by investigating the structure and dynamics of the plasma and magnetic fields of Interplanetary Coronal Mass Ejections (ICMEs) as they propagates out through the heliosphere. ICMEs are massive ejections of solar plasma and energy resulting from magnetic reconnection near the surface of the Sun. This research will model the expected observational signatures of ICMEs, such as heavy ion properties and suprathermal electron (SE) pitch angle distributions (PADs), given various magnetic field topologies and solar wind plasma conditions. This research will analyze signatures of Solar Energetic Particles (SEPs) to study their interaction with ICMEs and the heliospheric magnetic field through related in-situ plasma and SE measurements. The heliosphere is a natural laboratory to study plasma transport processes, particle acceleration, wave-particle interaction and plasma dynamics, driven by the Sun’s magnetic field.

Fellowship Application Information

Type: GRAD

Project Title: Frogs in a Climate Changing World: Toxic Effects of the Biological Pesticide, Bacillus thuringiensis israelensis, on North American Frog Larvae

Abstract: Earth's changing environment poses complex challenges for sensitive amphibian species, including increased exposure to biopesticides. Temperature and rainfall increases due to climate change have increased the prevalence of mosquito-transmitted diseases, and has led to an increased demand for mosquito control treatments. As an alternative to highly toxic chemical pesticides, the biopesticide, Bacillus thuringiensis israelensis (Bti), has increased in use to treat habitats where mosquito larvae develop. These are the same aquatic environments where frog larvae development occurs. There are few studies evaluating the effects of Bti exposure on amphibians, and no published work has investigated the sublethal effects of Bti in North American frogs. In accordance with NASA's Objective 2.2 to address the challenges of environmental change, this research will study the acute toxicity, genotoxicity and cellular effects of Bti on larval development in Michigan frog species to understand the impact of increased commercial Bti usage on aquatic ecosystem health.

Fellowship Application Information

Type: GRAD

Project Title: Use of Structure from Motion (SfM) Photogrammetry to Evaluate Fluvial Substrate

Abstract: Degradation to fluvial habitat due to accumulations of fine sediment has significant implications for resident biota and in-stream processes, as well as downstream aquatic and terrestrial habitat. As new technologies are developed there are questions regarding how best to address the restoration of rivers. Recently, Structure from Motion (SfM) photogrammetry has become an increasingly useful tool to assess the physical structure of aquatic and terrestrial systems due to the ability to rapidly collect high resolution data that would otherwise be costlier and time consuming to gather. This project will evaluate the applicability of using SfM photogrammetry to quantify fluvial substrates in regards to stream habitat restoration in the Salmon Trout River. The data will assist in the assessment of critical brook trout spawning habitat restoration as well as will add to validation of this novel technique for quantifying fluvial landscapes.

Fellowship Application Information

Type: GRAD

Project Title: Radio Emission from V5666 Sgr

Abstract: We report on the observations and analysis of radio emission of V5666 Sgr. Multi-frequency observations of this nova over many epochs, using the Karl G. Jansky Very Large Array, have allowed us to study the temporal behavior of its radio emission. By fitting the radio light curve to various models, that assume the radiation is dominated by thermal bremsstrahlung emission, we will ultimately derive the mass, density profile, and kinetic energy of the ejected material. These values will be compared to theoretical predictions, which historically have been inconsistent.

Fellowship Application Information

Type: GRAD

Project Title: Investigating Radio Wave Reflection caused by Plasma Sheaths

Abstract: A communication blackout problem occurs when a vehicle reenters Earth's atmosphere from orbit. The high-speed collision of the vehicle with the atmospheric molecules ionizes the gas and causes a plasma sheath to form in front of the vehicle. This plasma sheath can cause communication problems between the vehicle and the ground control, and in extreme cases can lead to a total loss of communication. Multiple theoretical solutions to this problem have been proposed, such as using high-frequency waves or Raman scattering, but currently there have been very few experimental tests. This project will attempt to measure how high-frequency waves affect the transmission efficiency of radio waves through a plasma sheath.

Fellowship Application Information

Type: GRAD

Project Title: Habitat Use and Site Occurrence of the threatened River Redhorse sucker (Moxostoma carinatum) in the Grand River, MI, USA.

Abstract: The resiliency of our aquatic ecosystems hinges on our ability to protect the native species that reside there. The River Redhorse is one such example and populations have become low enough to warrant listing by the State of Michigan. Causes of decline include overfishing, habitat alteration, and lack of knowledge of basic life-history attributes. In order to aid its recovery we propose to (i) identify key spawning, nursery and overwintering habitat in the Grand River, (ii) identify habitat characteristics that can be applied throughout the River Redhorses range, and (iii) to use eDNA sampling to identify population clusters given that the species is notoriously difficult to capture. This project fulfills NASA's objective 2.2 by identifying the environmental impacts that are affecting a threatened species, and contributes to objective 2.3 by combining eDNA analysis and occupancy modeling to create a novel technique for assessing the occurrence of rare species.

Fellowship Application Information

Type: GRAD

Project Title: Real-Time Neuron Stimulation Device: Analog Electronics

Abstract: The Western Michigan University Neurobiology Engineering Laboratory has successfully applied pre-computed energy efficient current stimuli to biological neurons using a rack-based electrophysiology rig. The goal of this research is to miniaturize this system into a device that could form the basis of a medical device for neuron stimulation for neurological disease treatment, or support electrophysiology experiments. This work will focus on the analog electronics that will be required for this miniaturization. This research experience will have a profound impact on my professional development and will be the basis of my graduate thesis.

Fellowship Application Information

Type: GRAD

Project Title: An Automated Tool for repairing Average Recovery Time

Abstract: The problem of model repair focuses on revising a given program so it satisfies new properties while preserving its existing properties. The properties such as average response time require analysis of all program computations simultaneously to decide whether the program satisfies the specification or not. Therefore, the users need to know the computational techniques. We present Automated Tool for Repairing Average Recovery Time, a tool that is user-friendly and provides computation that is invisible from users to compute the time and repair a given program. The tool takes as input a program and returns a revised program and an average recovery time that satisfies the requirement. We expect the designers and researchers in the area of model repair computation to significantly benefit from the tool. Our designed to robust a system and improve reliability.

Fellowship Application Information

Type: GRAD

Project Title: The Effect of Hollow Cathode Oscillations on Magnetically Shielded Hall Effect Thruster instabilities and Pole Erosion

Abstract: Magnetically Shielded (MS) Hall Effect Thrusters (HET) which effectively eliminate wall erosion is the most recent advancement in HET technology. The effect of MS on other aspects of a HET is not fully understood. Recent performance characterizations of two MS HETs has unveiled operational instabilities in the most efficient operating envelope of HETs. Additionally, wear testing has shown a strong correlation between similar operating conditions and an increase in pole erosion which has been identified as the first source of wear failure for a MS HET.

I hypothesize that these two phenomena, pole erosion and operation instability, are driven by the oscillations of an axial, center-mounted hollow cathode. This research will investigate the hollow cathode oscillations by utilizing a High-Speed Dual Langmuir Probe (HDLP) to collect time-resolved measurements of the front and back of the hollow cathode along with optical pyrometry diagnostic tools while installed in a running MS HET.