INSPIRE
INTERACTIVE NASA SPACE PHYSICS
IONOSPHERE RADIO EXPERIMENTS

The INSPIRE Journal

VOLUME 26 SPRING 2022

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And to all who submitted articles and content for inclusion.

COVER IMAGE (James Webb Space Telescope): *While the purpose of this image was to focus on the bright star at the center for alignment evaluation, Webb's optics and NIRCam are so sensitive that the galaxies and stars seen in the background show up. At this stage of Webb's mirror alignment, known as "fine phasing," each of the primary mirror segments have been adjusted to produce one unified image of the same star using only the NIRCam instrument. This image of the star uses a red filter to optimize visual contrast.*
Credits: NASA/STScI

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INSPIRE'S LEGACY
Dr. William (Bill) W. L. Taylor was a leader in the field of space science education and public outreach. He co-founded and was president of INSPIRE, one of the pioneering successes in NASA Sun Earth Connection Education. NASA Goddard Space Flight Center honored the late William W. L. Taylor with an *Excellence in Outreach in Science* Award for his accomplishments.

CO-FOUNDER/EMERITUS
William E. Pine

IN MEMORIAM
Kathleen Franzen, President 2005 – 2010
Jack Reed, INSPIRE Board Member 1992 – 2009
Jim Ericson, INSPIRE 1st Vice President 1981 – 2006

MISSION
The INSPIRE Project Inc. is a non-profit scientific, educational corporation whose objective is to bring the excitement of observing natural and manmade radio waves in the audio region to high school students. Underlying this objective is the conviction that science and technology are the underpinnings of our modern society, and that only with an understanding of science and technology can people make correct decisions in their lives, public, professional, and private. Stimulating students to learn and understand science and technology is key to them fulfilling their potential in the best interests of our society. INSPIRE also is an innovative, unique opportunity for students to actively gather data that might be used in a basic research project.

– William W. L. Taylor and William E. Pine, Co-Founders

In 2009, The INSPIRE Project expanded its STEM educational programs to provide scholarships and internships to educators, middle/high school students, and university students to ensure the next generation of space science and technology explorers.

From the Editor/Program Manager

SAVE THE DATES
Annular Solar Eclipse (10/4/23)
Total Solar Eclipse (4/8/24)
In this issue, eclipse photographer Gordon Telepun shares his "tricks" for taking great photos *(see page 22)*.

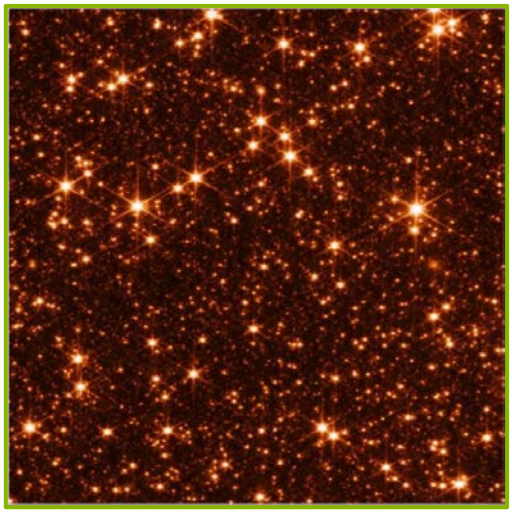
Eva Kloostra

For thirty-three years, The INSPIRE Project has engaged students of all ages in Science, Technology, Engineering and Mathematics (STEM) by bringing the excitement of observing natural and manmade radio waves in the audio region. To date over 3,900 INSPIRE Very Low Frequency (VLF) radio receiver kits have provided students worldwide a hands-on opportunity to experience the sounds of space firsthand. INSPIRE's VLF-3 kit continues to be incorporated in middle/high school science curricula and university programs both nationally and internationally. In this issue, Marcelo Lago Araújo discusses developing and promoting hands-on educational radio astronomy in places where radio frequency interference prevails *(see page 14)*.

In 2009, INSPIRE expanded its STEM programs to include the William W.L. "Bill" Taylor Memorial Scholarship and NASA Goddard Space Flight Center Internship for undergraduate students in Washington DC. For middle/high school educators and students, INSPIRE created the Space Academy Scholarship program. Recipients participate in the U.S. Space & Rocket Center's week-long space camp programs in Huntsville. INSPIRE has awarded 167 STEM scholarships/internships to date. In this issue, past educator and student recipients share their recent endeavors *(see page 26)*. This spring, American University's Community Voice Lab made a documentary about 2013 Space Academy alumni Jacqueline Fernandez-Romero, Principal at LAYC Career Academy in DC who attended Space Academy when she was a science teacher at the school. To watch the inspirational 10-minute film, *Transformer of Souls*, visit: https://youtu.be/DrKPioyHF6M.

Jacqueline (2nd from left) with her fellow 2013 Space Academy educators and INSPIRE Board Member, Rick Chappell.

When INSPIRE's Space Academy program launched in summer of 2009, I accompanied the first scholarship recipient to Huntsville, Alabama to photograph the weeklong workshop. INSPIRE's late executive director, Kathleen Franzen, asked our Chief Technical Advisor, Dennis Gallagher of NASA Marshall Space Flight Center (MSFC), if he would arrange a tour of MSFC for me, which he generously did. It was one of the most exciting days of my life! I toured the Lunar Impact Lab where I also had the opportunity to hear the sounds of space firsthand on INSPIRE's VLF receiver. In the International Space Station Payload Operations Integration Center, I got to experience an ISS crew training facility and watched as MSFC controllers communicated live with the ISS crew. Finally, I toured the X-ray and Cryogenic Facility (XRCF) which had just received a James Webb Space Telescope (JWST) mirror to be tested. Honestly, I had no idea what was done in that facility and had not heard of the JWST prior to that day. In 2011 when all testing was complete, NASA released the following: *Completed at the X-ray and Cryogenic Facility (XRCF) at NASA's Marshall Space Flight Center in Huntsville, Ala., a ten-week test series chilled the primary mirror segments to -379 degrees Fahrenheit. During two test cycles, telescope engineers took extremely detailed measurements of how each individual mirror's shape changed as it cooled. Testing verified each mirror changed shape with temperature as expected and each one will be the correct shape upon reaching the extremely cold operating temperature after reaching deep space. "Achieving the best performance requires conditioning and testing the mirrors in the XRCF at temperatures just as cold as will be encountered in space," said Helen Cole, project manager for Webb Telescope mirror activities at the XRCF. "This testing ensures the mirrors will focus crisply in space, which will allow us to see new wonders in our universe."* This issue of the *Journal* includes an article about the James Webb and the research team that will survey the stars, star clusters, and dust that lie within 19 nearby galaxies *(see page 4)*. For over a decade after my first trip to Huntsville, I anticipated the launch of the James Webb Space Telescope. When it successfully launched on December 25, 2021, it was my best Christmas present ever!



The above image was obtained by the FGS/NIRISS instrument on the James Webb Space Telescope. The Fine Guidance Sensor (FGS) allows Webb to point precisely, so that it can obtain high-quality images. The Near Infrared Imager and Slitless Spectrograph (NIRISS) part of the FGS/NIRISS is used for first light detection, exoplanet detection and characterization, and for exoplanet transit spectroscopy. FGS/NIRISS has a wavelength range of 0.8 to 5.0 microns.
Credits: NASA/Canadian Space Agency

On behalf of the Board of Directors, thank you for your continued support of The INSPIRE Project's mission and STEM programs; and we hope you enjoy the 2022 *Journal*. Never Stop Exploring ~ Eva

Capturing All That Glitters in Galaxies with NASA's James Webb Space Telescope

An international research team will survey the stars, star clusters, and dust that lie within 19 nearby galaxies.

Editor: Rob Garner
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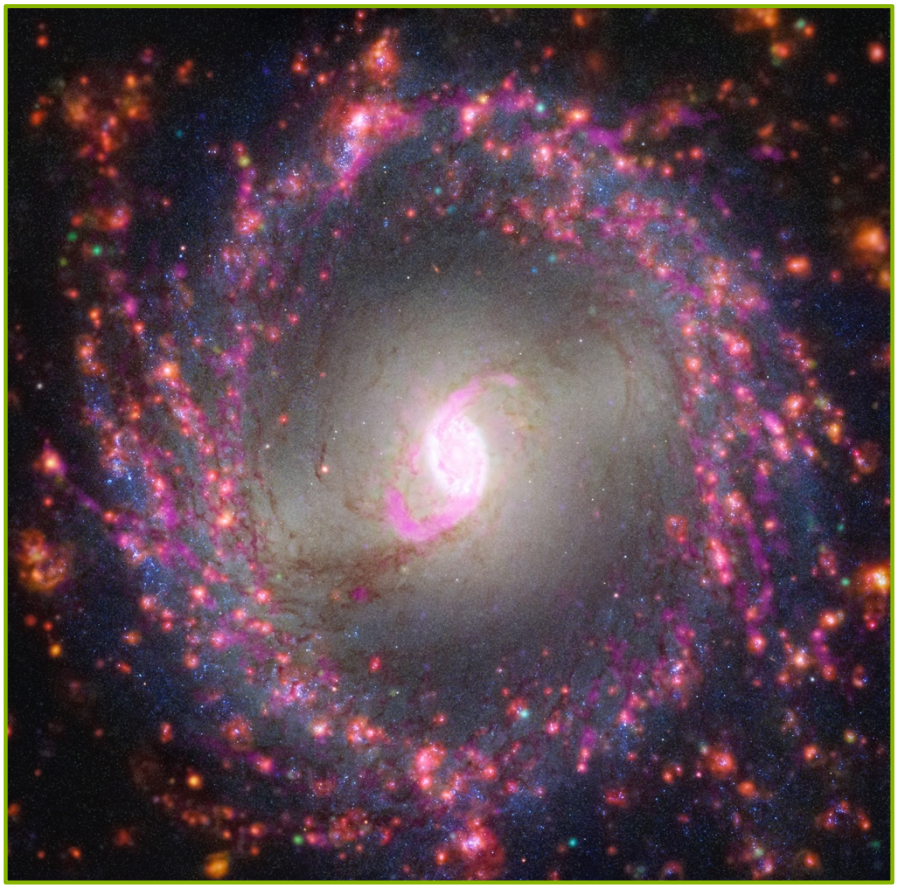


This image of spiral galaxy NGC 3351 combines observations from several observatories to reveal details about its stars and gas. Radio observations from the Atacama Large Millimeter/submillimeter Array (ALMA) show dense molecular gas in magenta. The Very Large Telescope's Multi Unit Spectroscopic Explorer (MUSE) instrument highlights where young massive stars illuminate their surroundings, set off in red. The Hubble Space Telescope's images highlight dust lanes in white and newly formed stars in blue. High-resolution infrared images from the Webb Space Telescope will help researchers identify where stars are forming behind dust and study the earliest stages of star formation in this galaxy. *Credits: Science: NASA, ESA, ESO-Chile, ALMA, NAOJ, NRAO; image processing: Joseph DePasquale (STScI)*

Spirals are some of the most captivating shapes in the universe. They appear in intricate seashells, carefully constructed spider webs, and even in the curls of ocean waves. Spirals on cosmic scales – as seen in galaxies – are even more arresting, not only for their beauty, but also for the overwhelming amount of information they contain. How do stars and star clusters form? Until recently, a complete answer used to lie out of reach, blocked by gas and dust. Within the first year of operations, NASA's James Webb Space Telescope will help researchers complete a more detailed sketch of the stellar life cycle with high-resolution infrared-light images of 19 galaxies.

The telescope will also provide a few key "puzzle pieces" that were missing until now. "JWST touches on so many different phases of the stellar life cycle – all in tremendous resolution," said Janice Lee, Gemini Observatory chief scientist at the National Science Foundation's NOIRLab in Tucson, Arizona. "Webb will reveal star formation at its very earliest stages, right when gas collapses to form stars and heats up the surrounding dust."

Lee is joined by David Thilker of the Johns Hopkins University in Baltimore, Maryland, Kathryn Kreckel of Heidelberg University in Germany, and 40 additional members of the multi-wavelength survey program known as PHANGS (Physics at High Angular resolution in Nearby GalaxieS). Their mission? Not only to unravel the mysteries of star formation with Webb's high-resolution infrared images, but also to share the datasets with the entire astronomical community to accelerate discovery.

THE RHYTHMS OF STAR FORMATION

PHANGS is novel, in part, because it brought together more than 100 international experts to study star formation from beginning to end. They are targeting galaxies that can be seen face-on from Earth and that are, on average, 50 million light-years away. The large collaboration began with microwave light images of 90 galaxies from the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile. Astronomers use this data to produce molecular gas maps to study the raw materials for star formation. Once the Very Large Telescope's Multi Unit Spectroscopic Explorer (MUSE) instrument, also in Chile, came online, they obtained data known as spectra to study later phases of star formation of 19 galaxies, particularly

after star clusters have cleared nearby gas and dust. The space-based Hubble Space Telescope has provided visible and ultraviolet light observations of 38 galaxies to add high-resolution images of individual stars and star clusters.

The missing elements, which Webb will fill in, are largely in areas of the galaxies that are obscured by dust – regions where stars are actively beginning to form. “We’re going to clearly see star clusters in the hearts of these dense molecular clouds that before we only had indirect evidence of,” Thilker said. “Webb gives us a way to look inside these ‘star factories’ to see the freshly assembled star clusters and measure their properties before they evolve.”

The new data will also help the team pinpoint the ages of stellar populations in a diverse sample of galaxies, which will help researchers build more accurate statistical models. “We’re always putting the context of the small scales into the big picture of galaxies,” explained Kreckel. “With Webb, we’ll trace the evolutionary sequence of each galaxy’s stars and star clusters.”

Another important answer they’re seeking involves the dust surrounding the stars, within the interstellar medium. Webb will help them determine which areas of the gas and dust are associated with specific star-forming regions, and which are free-floating interstellar material. “This couldn't be done before, beyond the nearest galaxies. It will be transformative,” Thilker added.

The team is also working to understand the timing of the star-formation cycle. “Timescales are critical in astronomy and physics,” Lee said. “How long does each stage of star formation last? How might those timelines vary in different galaxy environments? We want to measure when these stars free themselves from their gas clouds to understand how star formation is disrupted.”

This image of spiral galaxy NGC 1300 combines multiple observations to map stellar populations and gas. Radio light observed by the Atacama Large Millimeter/submillimeter Array (ALMA), represented in yellow, highlight the clouds of cold molecular gas that provide the raw material from which stars form. Data from the Very Large Telescope’s Multi Unit Spectroscopic Explorer (MUSE) instrument is represented in red and magenta, capturing the impact of young, massive stars on their surrounding gas. Visible and ultraviolet light captured by the Hubble Space Telescope highlights dust lanes in gold and very young, hot stars in blue. High-resolution infrared images from the Webb Space Telescope will help researchers identify where stars are forming behind dust and study the earliest stages of star formation in this galaxy.
Credits: Science: NASA, ESA, ESO-Chile, ALMA, NAOJ, NRAO; image processing: Alyssa Pagan (STScI)

SCIENCE FOR ALL

These Webb observations will be taken as part of a Treasury program, which means they are not only available immediately to the public, but they will also be of broad and enduring scientific value. The team will work to create and release data sets that align Webb’s data to each of the complementary data sets from ALMA, MUSE, and Hubble, allowing future researchers to sift through each galaxy and their stellar populations easily, toggling on and off various wavelengths – and zoom into individual pixels of the images. They will provide inventories of different phases of the star-formation cycle, including regions of star formation, young stars, star clusters, and local dust properties.

This research will be conducted as part of Webb’s General Observer (GO) programs (https://www.stsci.edu/jwst/science-execution/approved-programs/cycle-1-go), which are competitively selected using a dual-anonymous review system, the same system that is used to allocate time on the Hubble Space Telescope.

The James Webb Space Telescope is the world's premier space science observatory. Webb will solve mysteries in our solar system, look beyond to distant worlds around other stars, and probe the mysterious structures and origins of our universe and our place in it. Webb is an international program led by NASA with its partners, the European Space Agency (ESA) and the Canadian Space Agency (CSA).

To learn more about the James Webb Space Telescope, visit: https://www.nasa.gov/mission_pages/webb/main/index.html

2022 NASA DC Space Grant Consortium Student Research Competition

This second annual competition held in February 2022 was sponsored by the NASA District of Columbia Space Grant Consortium (DCSGC), one of 52 members of a national network known as "Space Grant," which encompasses more than 1,200 universities and organizations in every state, the District of Columbia, and Puerto Rico. The Space Grant Program is administered by NASA. The DCSGC offers DC university students opportunities for internships, fellowships, and scholarships, as well as research opportunities. It's all part of NASA's overarching mission to increase public knowledge, support educators, and attract and retain students to pursue STEM advanced degrees and careers. "For American University which serves as the lead institution of the Consortium in the District of Columbia, it provides opportunities to students to have authentic research experiences while supporting NASA missions in science and space technology," says Nathan Harshman, AU Professor of Physics and DCSGC Director. "One goal of the program is to broaden the pipeline of students prepared for joining the NASA workforce. The DCSGC also provides matching support to professional development activities to outreach and education projects and programs that build community and excitement around NASA missions."

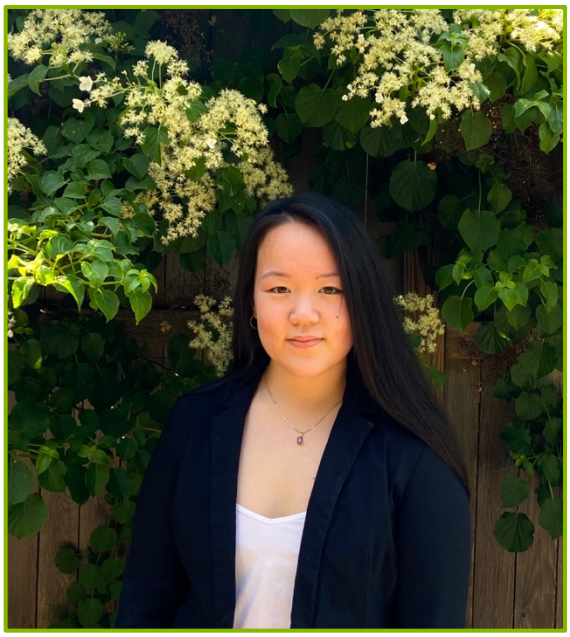
This year, students presented their research posters remotely by making videos and posting them on YouTube. Below are some of the exciting research projects students are working on at DC colleges and universities.

INSPIRE is an affiliate member of the DCSGC which helps to fund many of its educational STEM programs.

FIRST PLACE: Effects of Melatonin Against Western-Diet Induced Hippocampal Dysfunction

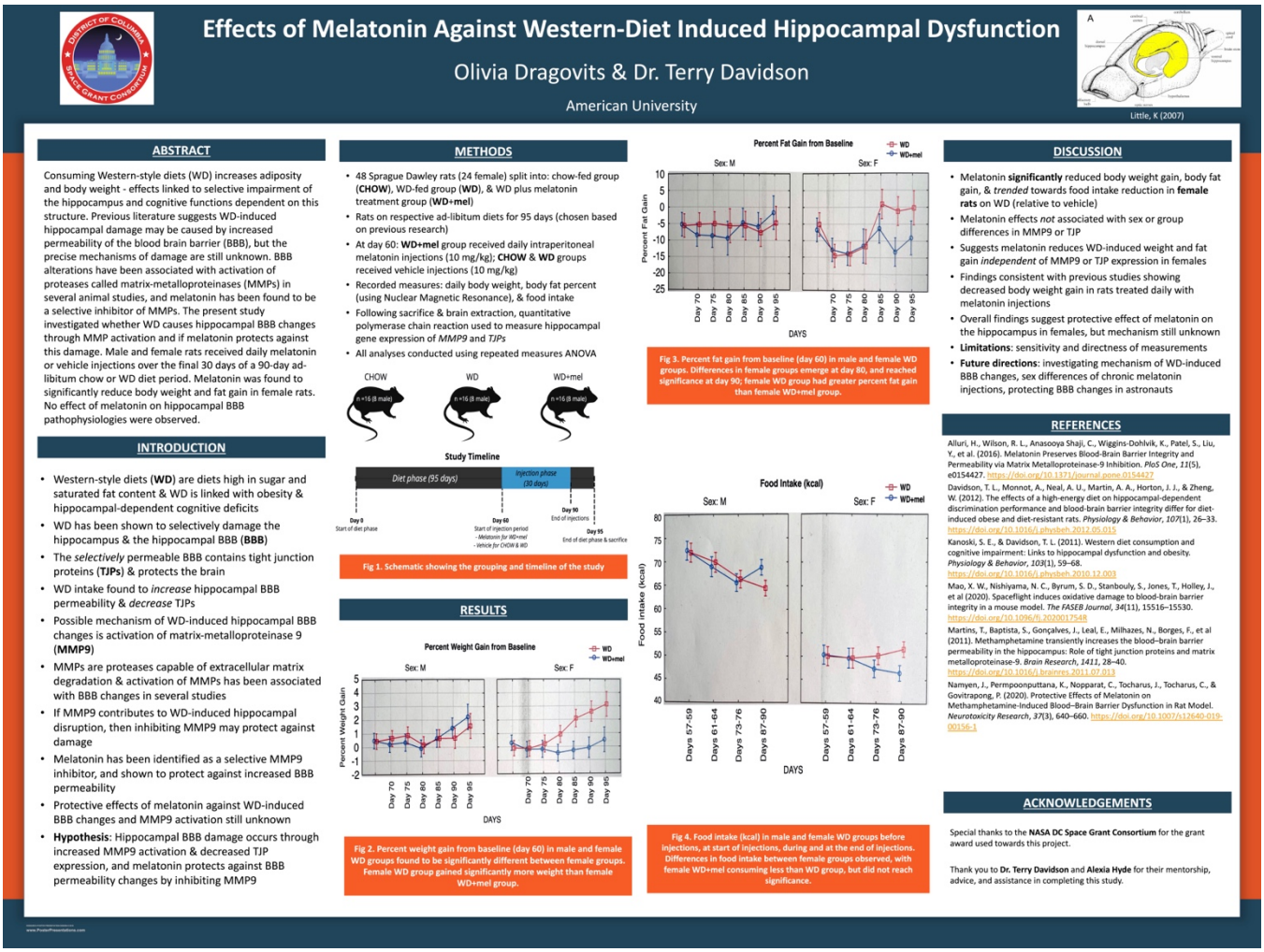
Olivia Dragovits, American University (Senior)

For as long as I can remember, I've been extremely interested in the brain and how it works. Our brains, through billions of interconnected neurons and specialized regions, allow us to explore the world, form memories, and learn through experiences (among other things). Once I reached college, my curiosity and passion about the brain led me to major in neuroscience at American University. As I dove further into my studies on the brain, I discovered that I was also interested in the many ways that our brains can become damaged – disrupting the complex functions it is capable of. For this reason, I found an incredible opportunity to do research in Dr. Terry Davidson's lab at American University. Dr. Terry Davidson's research focuses on a brain region called the hippocampus, which has well-established roles in learning and memory. Specifically, the lab researches how consuming high-fat and high-sugar diets (called Western diets) harm this part of the brain, and disrupt its functions, which leads to outcomes such as obesity and cognitive decline. Dr. Davidson's mentorship allowed me to learn about his research, help to run studies in the lab, seek possible explanations for the results we found, and participate in amazing opportunities. One of these opportunities was researching and designing my own study. Eventually, I applied to the NASA DC Space Grant Consortium to receive a grant that would fund my study. Thanks to the NASA DC Space Grant Consortium I was awarded a research grant and was able to conduct the study in the lab throughout the summer.



Olivia Dragovits, senior neuroscience student

The goal of my research project was to further investigate the mechanism of how Western diets damage the hippocampus, and whether using melatonin would help protect against this damage. Previous research has shown that Western diet consumption may promote damage to the hippocampus by disrupting the blood-brain-barrier (BBB). The BBB is a selectively permeable membrane responsible for maintaining homeostasis in the brain, providing nutrients to the brain, and protecting the brain from neurotoxic substances. However, the integrity of the BBB has been found to be much lower in rats consuming a Western diet (meaning, the permeability of the BBB increases). This means that its protective functions are disrupted, and brain structures can be impacted by this disruption. One possible way to explain this BBB disruption is through a protease (an enzyme) called matrix-metalloproteinase 9 (MMP9), which is capable of degrading the extracellular matrix. In several animal studies of brain injury and disease (such as ischemia, methamphetamine-use, and diabetes), increased levels of MMP9 have been associated with increased BBB permeability (and decreased BBB integrity). For this reason, my study investigated whether Western diet consumption also causes BBB disruptions through activating MMP9s. Previous studies have also identified melatonin as a selective MMP9 inhibitor. If hippocampal-BBB disruption occurs through MMP9, then inhibiting MMP9 is a potential target for protecting against this damage. Therefore, my study also investigated whether melatonin was capable of protecting against Western diet-induced hippocampal damage.



Olivia's poster on the study presented for the NASA DC Space Grant Consortium Student Research Competition

To investigate these questions, my study used rats. It was hypothesized that hippocampal BBB damage occurs through increased MMP9 activation, and that melatonin protects against BBB permeability changes by inhibiting MMP9. Three groups of rats were split into groups: one group eating a regular chow diet (CHOW), one group eating a Western diet (WD), and a third group also eating a Western diet and treated with melatonin (WD+mel). For 90 days, the rats were maintained on their diets. However, after 60 days of diet-exposure, the treatment phase began. During this phase, the WD+mel group began receiving daily injections of melatonin, which would continue over 30 days. The other two groups received vehicle injections, which contained everything in the melatonin injection except melatonin. Throughout the study, the rats' body weight, body fat, and food intake were measured. Once the study ended, the rats' brains were analyzed for MMP9 expression.

We found that female rats treated with melatonin had significantly less body weight gain than female rats on the Western diet who were not treated with melatonin. For body fat gain, there was a similar finding. However, these differences were not found between male rat groups. For food intake, female rats treated with melatonin consumed less food (in kilocalories) than female rats who were not treated with melatonin – however, this difference was not found to be significant. Finally, for the brain measures, no significant differences in MMP9 expression levels were found between groups or sex. These findings suggested that melatonin protected against Western diet-induced body weight and fat gain, but these effects were independent of MMP9 expression levels. In future studies, the sex differences found in this study, possible behavioral effects of melatonin treatment, and the mechanism of Western diet-induced BBB changes should be investigated. I certainly hope to further investigate the effects of Western diet on the hippocampus, and the possible uses or effects of melatonin treatment.

Following this study, I was able to participate in the NASA DC Space Grant Consortium student research competition. This was another great opportunity, in which I learned how to put a research poster together, the best way to present it, and how to relay my research to others. I am extremely grateful to the NASA DC Space Grant Consortium for providing so many wonderful and educational experiences and allowing me to conduct my own study. I couldn't have done so without the wonderful mentorship, support, and advice from my lab – including my principal investigator (PI) Dr. Terry Davidson, and Alexia Hyde. These experiences allowed me to deeply engage with my passions and have set the foundations for a lifelong career in science! *To view Olivia's presentation, visit: https://youtu.be/nX79VZvE35k*

SECOND PLACE: **Ashley Bastin, American University (Senior)**

Ashley could not submit her research as it is ongoing and confidential. Below is a brief summary.

The research I was able to conduct on the NASA Space Grant Consortium Summer Fellowship revolved around the gene-to-gene interactions crucial to floral development in Arabidopsis thaliana. Through analyzing specific organ-forming genes, I was able to show that there is interaction present in select gene activity domains, as well as motifs that are critical to the interaction occurring at all. This research has broader applications in developmental biology, as well as stem cell biology, and is promising as civilization moves toward agriculture in new frontiers.

THIRD PLACE: In-Situ Temperature Measurement Using Carbon Nanotube Yarn Monofilament Composite Sensors

Tannaz Tayyarian, Catholic University (PhD candidate)

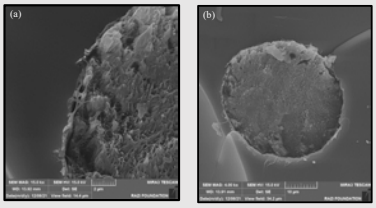
In-Situ Temperature Measurement Using Carbon Nanotube Yarn Monofilament Composite Sensors

T. Tayyarian[1], O. Rodríguez-Uicab[1], J. L. Abot[1]

[1] Department of Mechanical Engineering, The Catholic University of America, Washington, DC 20064, USA.

Introduction

Carbon nanotube yarns (CNTYs), continuous fiber-like materials comprised of carbon nanotube (CNT) bundles in their cross-section area, may be great candidates for development of in-situ sensors for structural health monitoring (SHM) due to their significant sensitivity to temperature and strain, small size, light weight, and high electrical and thermal conductivity. The piezoresistive properties of CNTYs make them attractive candidates in applications such as strain sensors. CNTYs can be integrated into thermosetting polymer composites and used as in situ sensing elements for stress build-up and damage monitoring. Potential applications of CNTYs include flexible electronics, artificial muscles, flexible touch screens, electrical energy storage, and strain sensors. A less explored potential use of CNTYs is as a temperature sensor relying on the temperature-dependent relationship of the CNTY's electrical resistance. This thermoresistive properties of CNTYs make them attractive candidates for development of self-sensing smart structures for thermal stresses and implementation of the next generation of nanocomposite thermistors.



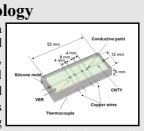
SEM images of CNTY monofilament composites at (a) 15000x and (b) 4000x magnification.

Research Objective

This study aims to investigate the thermoresistive behavior of the embedded CNTY in a polymeric matrix towards the fabrication of a temperature sensor with increased sensitivity, flexibility, and low hysteresis that is commensurate with conventional thermistors.

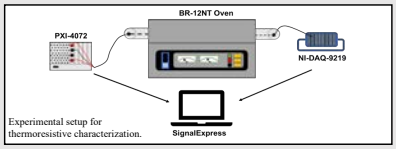
Materials and Methodology

The CNTY used in this study was fabricated from a vertically aligned CNT array at Nanoworld Laboratories (Cincinnati, OH). Derakane Momentum, Methyl ethyl ketone peroxide, MEKP, with nominal concentration of 0.9 wt.% and cobalt naphthenate and CoNap, with concentration of 0.6 wt.% were used as the as the vinyl ester resin (VER), crosslinking initiator and promoter, respectively.

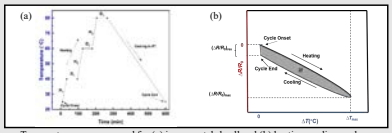


Schematic of the fabricated sample.

Four electrical copper wires were secured across a polyvinyl chloride (PVC) mold at the mid center of the mold to measure the electrical resistance (R) of the CNTY using four-point probe measurement technique. 1.65mL of premixed VER was poured into the mold and cured at room temperature (RT~25°C) for 4 hours followed by post-curing at 140°C for 1 hr.

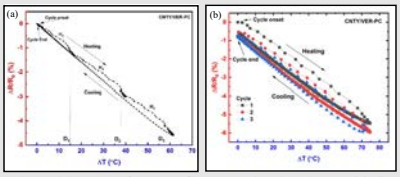


Electrical resistance was measured by connecting the copper wire electrodes to a NI PXI-4072 impedance-capacitance-resistance (LCR) digital multimeter card, mounted on a PXI-1033 chassis. The temperature (T) was measured using a K-type thermocouple connected to an NI-9219 universal analog input module mounted in a NI cDAQ-9178 chassis. The resistance and temperature were simultaneously recorded at 1 Hz using SignalExpress software.



Temperature programs used for (a) incremental-dwell and (b) heating-cooling cycles.

Experimental Results



Thermoresistive response of CNTY monofilament composites using (a) incremental-dwell temperature program and (b) heating-cooling cycles above RT to 100°C.

Thermoresistive parameters calculated at heating-cooling cycles					
Material	$\beta_H \times 10^{-4}$ [°C^{-1}]	$\beta_C \times 10^{-4}$ [°C^{-1}]	$(\Delta R/R_0)_{max}$ [%]	$(\Delta R/R_0)_{res}$ [%]	H_N [%]
CNTY/VER-PC	−8.20±0.21	−7.93±0.06	−5.91±0.07	−0.20±0.09	12.49±1.4

Thermoresistive characterization of CNTY monofilament composites was performed under incremental-dwell and heating-cooling cycles in order to measure the thermoresistive sensitivity of the monofilament composites. A negative and linear thermoresistive sensitivity of~ −8.05 was observed during heating and cooling sections. CNTY/VER-PC has a great potential for self-sensing of temperature and thermal curing stresses in high-performance materials such as ships, naval vessels and aircrafts.

Conclusions and Future Work

CNTY/VER-PC composites shows a good linearity and low hysteresis when exposed to varying temperatures. Additional experiments were conducted to further evaluate the practical implementation of the investigated nanocomposites as thermistors.

Acknowledgement

NASA DCSGC, the Department of Mechanical Engineering at The Catholic University of America

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I am a PhD candidate in Mechanical Engineering at The Catholic University of America. I was so thankful for the opportunity to present my research in the NASA Space Grant Consortium presentation contest, in which I won third place. One of my research projects is about the development of temperature-sensing smart structures using carbon nanotube yarns (CNTYs) relying on the coupling between the temperature and the electrical resistance of the yarn. This coupling phenomenon makes them attractive candidates for integrated in-situ, self-sensing, of thermal stresses and temperature in high performance vehicles and structures including aircraft, ships. Figure1 shows the image of a single CNTY.

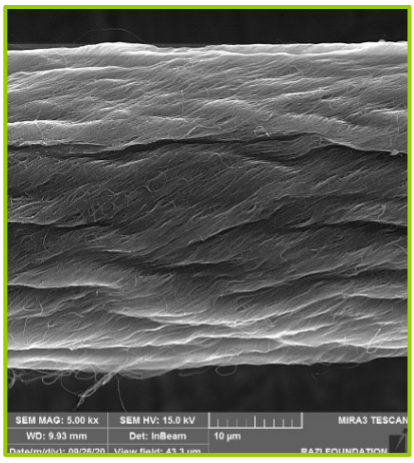


Figure 1. Scanning Electron Microscopy of a single CNTY at 5000x

CNTYs are hierarchical fiber-like materials comprised of thousands of carbon nanotubes (CNTs) in their cross-section. Due to their small size, light weight, and high electrical conductivity, they can be integrated into structures without changing the integrity of the host material and be used as piezoresistive sensors. A less explored potential use of CNTYs is as temperature sensors. The variation of their electrical resistance with temperature (thermoresistivity) is quantified by a metric known as temperature coefficient of resistance (TCR), which is obtained as the slope of the fractional change in the electrical resistance of the yarn over the temperature range. In order to measure the TCR values, the CNTY was embedded into a vinyl ester resin cured at room temperature followed by post-curing at 140 °C for 1 hr in order to form a monofilament composite. The composite was subjected to heating-cooling cycles above room temperature RT (~25 °C to 100 °C) cycles while their electrical resistance was simultaneously measured using a four-point probe measurement technique. Figure 2a represents the heating-cooling cycles of three continuous cycles. A negative and quasilinear TCR with an average value of -7.9×10^{-4} °C $^{-1}$ was obtained at heating-cooling sections. The negative thermoresistivity of CNTYs could be explained by quantum mechanics mechanisms such as fluctuation-induced tunneling (FIT) and the variable range hopping (VRH). The maximum change in electrical resistance was $(\Delta R/R_0)_{max} = -5.94\%$. The residual change in resistance yielded a small value of $(\Delta R/R_0)_{res} = -0.13\%$ after each cycle.

The average of TCR was further used to convert the change in the electrical resistance of the CNTY monofilament composites to temperature readings. The temperature readings were compared to that of a commercial thermocouple in order to evaluate the fidelity of the CNTY monofilament composites as temperature sensors. Figure 2b shows the representative graphs of the temperature measured by the reference thermocouple and calculated temperature based on the average TCR. It is observed that readings of the CNTY monofilament composites show a good reproducibility of the temperature measurements of the reference sensor.

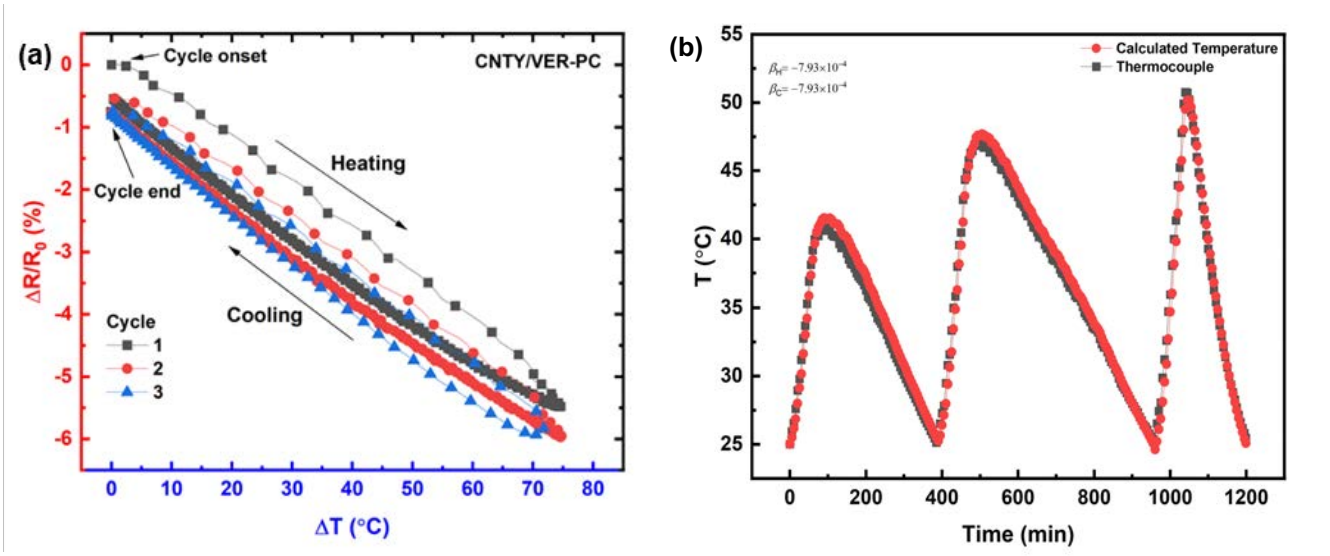


Figure 2. (a) Thermoresistive characterization of CNTY monofilament composites during heating-cooling cycles; (b) Temperature readings of the CNTY monofilament composites commercial thermocouple.

To view Tannaz's presentation, visit: https://youtu.be/n0Cb1y1xsQU

Detecting Dopamine and Beta-Phenylethylamine with Electrodes Using Fast-Scan Cyclic Voltammetry (FSCV)

Kalliopi Mereos, American University (Senior)

About the student:

My name is Kalliopi Mereos and I am a senior at American University. I am a neuroscience major on the premed track, and I minor in psychology. I joined the Dr. Zestos Lab in fall 2020 and have enjoyed every moment of the research. In summer 2021, I was fortunate and very grateful to receive the DC Space Grant.

I got to spend lots of time further observing the effects of dopamine and beta-phenylethylamine (beta-PEA) at different concentrations while being mentored by Dr. Zestos. The goal of this study was to compare dopamine to its metabolite beta-PEA and determine if there is concentration dependence with the neurochemicals.

Abstract:
Fast-scan cyclic voltammetry (FSCV) is a method used to measure a variety of neurochemicals and other biomolecules with the use of carbon fiber microelectrodes (CFMEs). Dopamine and phenylethylamine (PEA) are the neurochemicals measured in this study. Dopamine is an important endogenous catecholamine that serves as a neurotransmitter and an autocrine or paracrine agent. Moreover, in this study, dopamine is detected as a standard to β-PEA since it is easily metabolized by FSCV and the waveform is more comprehendible. Beta-PEA has not been well studied, especially since it is more difficult to measure with FSCV. Therefore, with more focus brought to it, it can be studied to further advance its role in the brain and other scientific advancements.

Figures:

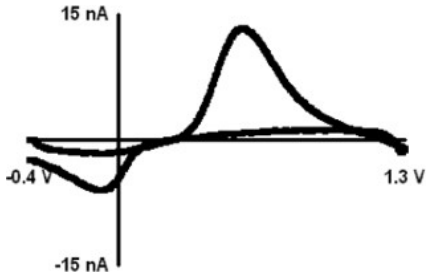


Figure 1. This figure shows the appropriate cyclic voltammogram (CV) for a dopamine curve.

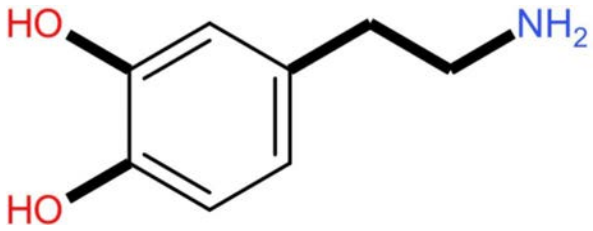


Figure 2. The figure above shows a dopamine molecule. It consists of two hydroxyl groups, an amine group, and benzene.

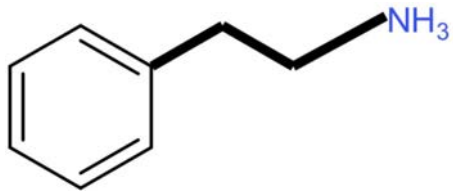


Figure 3. This figure shows the molecule for phenethylamine. It is a metabolite of dopamine. It has a similar structure but without the hydroxyl groups.

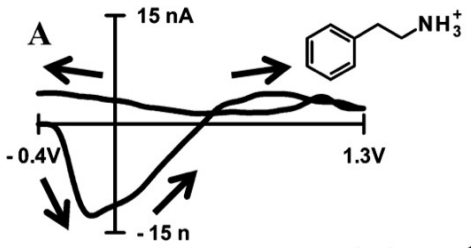


Figure 4. This figure shows the appropriate waveform of beta-PEA, which is different from dopamine.

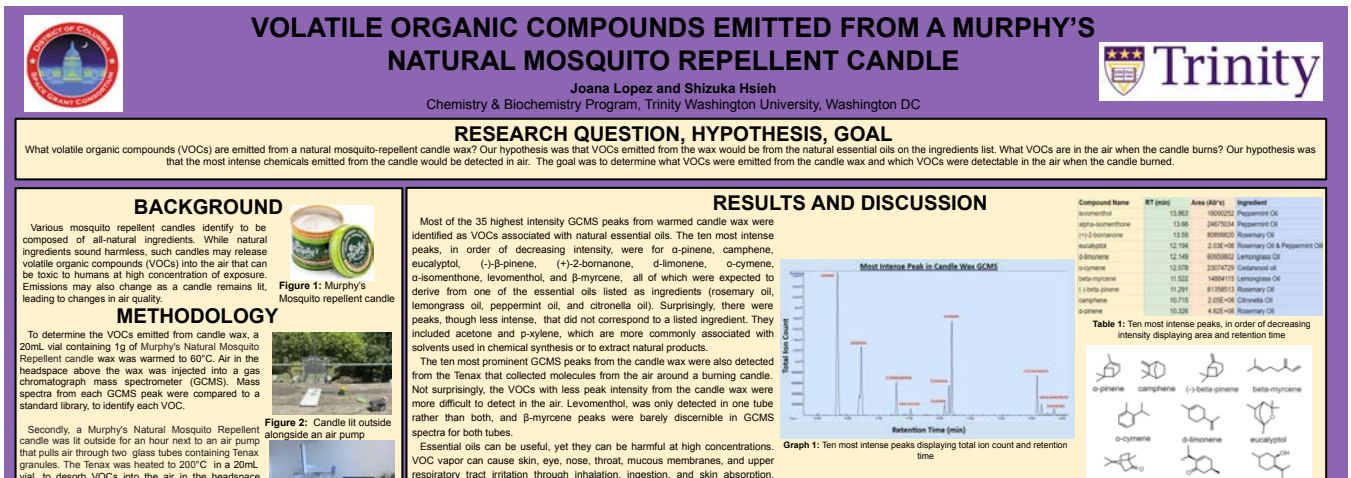
Learn more about the study:
The first link posted below gives more detail about the research project. The second link provides a poster of the project that includes the abstract, introduction, figures, and further implications.

1) https://youtu.be/O_NmIpOaBDA
2) https://create.piktochart.com/output/57457250-nasa-research-poster

HONORABLE MENTION: Volatile Organic Compounds Emitted from a Murphy's Natural Mosquito Repellent Candle

Joana Lopez, Trinity Washington University (Senior)

I am a senior at Trinity Washington University, with a major in Biology and a minor in Chemistry. During the summer of 2021, I had an incredible opportunity to conduct research along with my mentor Dr. Shizuka Hsieh. My research began by understanding how volatile organic compounds (VOCs) can be harmful to humans at a certain exposure despite being derived from natural sources. Our research aims to answer a few questions; what VOCs were emitted from a Murphy Natural Mosquito Repellent candle and whether all VOCs derived from the listed ingredients of the candle or if there were any additional unnatural chemicals not listed? And, what VOCs were detectable in the air when the candle was burning? A 20 mL vial containing 1g of warm candle wax was analyzed by GCMS (gas chromatography-mass spectrometry), the list of the VOCs emitted was examined for chemicals known to come from the listed ingredients. To detect VOCs in the air around the burning candle, air was pumped through a tube containing an adsorbent material, Tenax, for an hour. The exposed Tenax was placed in a 20mL vial, which was warmed, to get VOCs to desorb into the GCMS for analysis. Some of the detected VOCs were also present from unexposed Tenax and an empty vial, assumed to have not come from the burning candle. Most of the high-intensity GCMS peaks from the warmed candle wax corresponded to compounds known to be in different natural essential oils, with a couple of surprise exceptions of acetone and p-xylene. The most prominent peaks, in order of decreasing intensity, were identified as alpha-pinene, camphene, eucalyptol, (-)-beta-pinene, (+)-2-bornanone, d-limonene, alpha-isomenthone, o-cymene, levomenthol, and beta-myrcene. Each is known to be extracted from at least one of the essential oils listed as a candle ingredient. The same compounds were also detected in the air around the burning candle. Overall, even VOCs derived from natural ingredients can be harmful to humans by inhalation, ingestion, and skin absorption, at high enough concentrations. To determine the level of exposure of VOCs in the presence of the burning candle, future studies will need to determine the concentration level of each VOC extracted from the air surrounding the burning candle.



As I came to the end of my research internship, I can see how science is a subject that is always evolving and growing and how my interest in science continues to grow. During each lab, I was taught something new that will benefit me as I continue my education in the STEM field. As an attentive person, I have always been interested to learn more about topics that are passionate to me. During the eight weeks, I have grown more as a researcher, maturing my skills of leadership, theoretical thinking, communicating, and time management. My experience will allow me to continually see how science works in the real world with the help of others' experience and knowledge. Working along with my mentor, Dr. Shizuka Hsieh has been a pleasure. Thank you, DC Space Grant Consortium for funding my research and to INSPIRE for allowing me to share my experience. *To view Joana's presentation, visit:* https://www.youtube.com/watch?v=muVpm6nBZRs&t=59s

Using Carbon Fiber Microelectrodes to Detect Cortisol

Michelle Hadad, American University (Senior)

I am a Health Promotion major from McLean, Virginia. In summer 2021, I received a scholarship from the NASA DC Space Grant Consortium (AU STEM Summer Student Award) and had the opportunity to continue research in the Zestos Lab in the Chemistry Department at American University (AU). The goal of my project is to use Fast Scan Cyclic Voltammetry (FSCV), to detect cortisol using Carbon Fiber Microelectrodes (CFMEs) and collect data using fast scan cyclic FSCV through the High-Definition Cyclic Voltammetry (HDCV) software.

Cortisol is the molecule that regulates the body's response and management of stress through its release from the adrenal glands during "life threatening" or dangerous situations (fight or flight). It increases blood pressure and blood sugar to fuel muscles to escape a threatening situation. Although cortisol can manage these stressful situations, it is common to observe high cortisol levels physiologically. It is associated with digestive issues, hypertension, infertility, etc., and can lead to chronic illnesses such as heart disease. The need for studying cortisol arises from its physiological importance on how to manage stress more effectively to prevent such diseases. To study its behavior, FSCV with CFMEs quickly detect changes of biomolecule concentration.; Therefore, it can quickly detect the flux of several neurotransmitters and hormones in the brain. In the laboratory, buffer mimics cerebrospinal fluid through the preparation of artificial cerebrospinal fluid (aCSF). Therefore, we dissolve cortisol, cholesterol, and other biomolecules in aCSF to mimic its presence in the brain. To perform experiments, CFMEs', are utilized since they are highly sensitive due to their surface oxide groups where cationic neurotransmitters adsorb. Biomolecules such as cortisol can be electrostatically attracted to these groups and adsorb onto the surface of the electrode, which allows them to be measured. Cortisol is an important, but challenging molecule to detect. By utilizing FSCV and CFMEs,' we can create a sensor for these compounds and differentiate their cyclic voltammogram (CV's), from one another. This will ultimately allow us to learn more about their physiological importance in vivo and ex vivo.

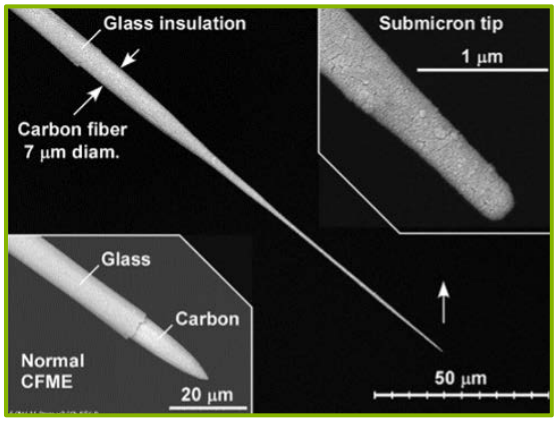


Figure 1: Scanning Electron Microscope (SEM) image of a carbon electrode under high magnification

Using CFMEs' (Figure 1), I was able to measure different concentrations of cortisol from 10μM to 40μM (Figure 2). Electrodes had to be cut under the microscope to a protruding length of approximately 100 microns before FSCV testing with cortisol (Figure 3). Different measurements of concentrations were collected on an analysis software where CV graphs, I vs T graphs and color plots were recorded and compared. I was able to detect cortisol from 10_μM to 40_μM and displayed similar behavior to dopamine: current was dependent on cortisol concentration. Although current increased as concentration increased, at 30μM, cortisol was not detected. This may be due to error with dilution or experimental error. However, data is promising and with more precision with experimental methods, we can determine if cortisol is truly current dependent.

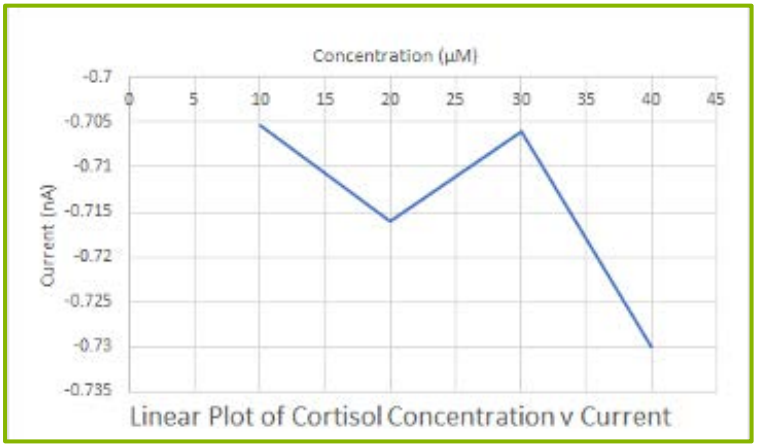


Figure 2: Linear Plot graph of cortisol concentration versus current

Figure 3: Electrode preparation – Michelle cutting carbon fiber microelectrode under the microscope

During my 8 weeks, I attended weekly conference meetings which have furthered my curiosity in the STEM field. Overall, my summer was very impactful with the support of my lab group and the funding for my project. I am very appreciative of the opportunity that I have been given to further my research with neurochemicals.

To view Michelle's presentation, visit: https://youtu.be/EnIEKoZjU4Q

Dopamine Detection Using Fast Scan Cyclic Voltammetry

Nadine Hadad, American University (Sophomore)

Dopamine is a neurotransmitter that plays a role in how one feels pleasure, known as the “feel-good” hormone. It is a very important part of the brain’s reward system since it impacts mood, muscle, sleep, the ability to store recall information, concentration, appetite, and self-control. Detecting and understanding the effects that dopamine has on the body is critical to understand due to its importance. If there is an imbalance of dopamine in the brain, a person cannot function optimally or normally. To study dopamine in the body, fast scan cyclic voltammetry (FSCV) is used to detect changes in the concentration of neurotransmitters. The goal of using this system is to better understand the effects of the different concentrations of neurotransmitters overall. In this study, dopamine is observed using carbon fiber microelectrodes (CFMEs), to detect the neurotransmitters dissolved in and aCSF (artificial cerebrospinal fluid) buffer, which mimics cerebrospinal fluid, and observe its behavior in the brain. Therefore, using FSCV and CFMEs can help detect these neurotransmitters in vivo and learn more about their impact on overall brain function.

FSCV was used to test the neurotransmitter, dopamine, using CFMEs (electrodes) by performing various experiments such as varying the concentration, stability, and scan rate. The polymer coating on the CFME is used to increase the sensitivity of the electrode to the neurotransmitter. The triangular waveform that is specific to Dopamine scans from -0.4V to 1.3V at a scan rate of 400 V/s. The concentration experiments consisted of creating serial dilutions of dopamine starting with 1.0 micromolar up to 100.0 micromolar. The next experiment performed was the stability experiment where the electrode was tested for a four-hour period of time. Every hour within the four hours, tests would be performed to observe if the electrode has been stable by injecting a specific concentration of dopamine. The scan rate experiment varied the different scan rates from 50 to 500 V/s, while normally the scan rate is 400 V/s for the dopamine waveform. After completing the Concentration Experiments for Dopamine, it was found that Dopamine is concentration-dependent at CFMEs, and increasing peak oxidative current corresponds to higher concentrations.

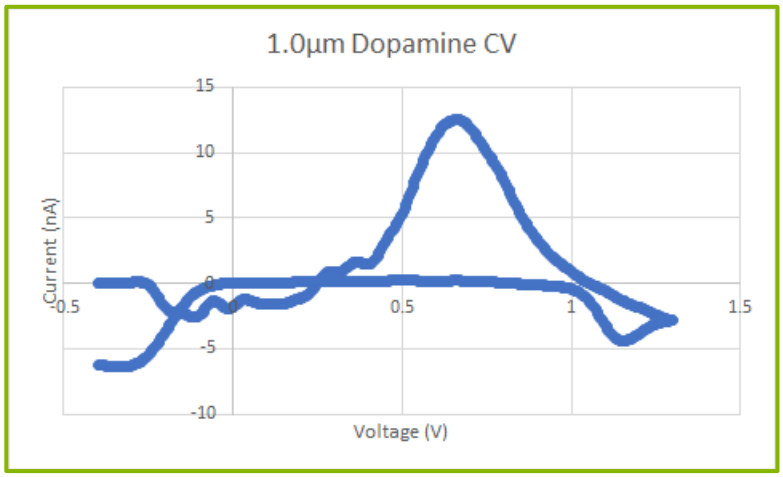
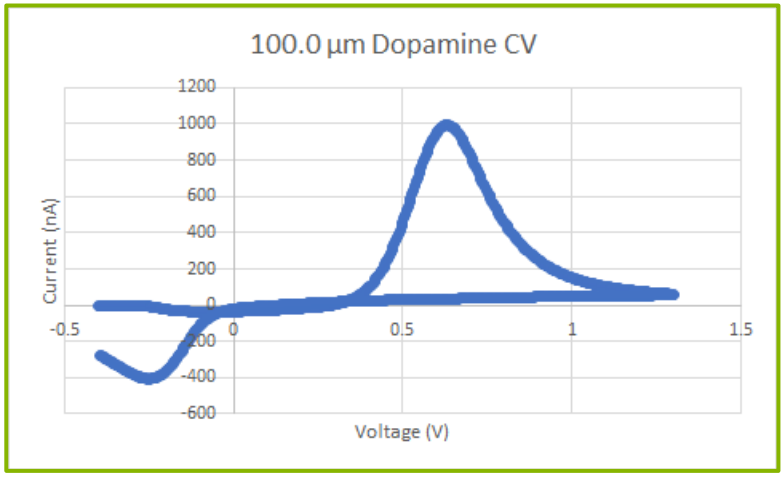


Figure 1 & 2: Dopamine at 1.0 micromolar to 100.0 micromolar – showing as the concentration increases, the current increases

As the concentration increases, the current increases. The Current versus Time graph traces correspond to how current relates to the injection times for Dopamine. The current is also proportional to the concentration. The possible causes of error can be the electrode being cut too short or being too long, which would have potentially produced varied results. The amount of Dopamine pushed during each run through the experiment would affect the Current versus Time graphs. Lastly, inaccurate measurements of the serial dilutions would affect the concentration results. Moving forward, we are planning to continue to optimize the overall experiment by repetition as well as moving forward on working with other molecules such as Cortisol. The enhanced detection of these biomolecules will help us further understand their physiological roles.



To view Nadine’s presentation, visit:
https://www.youtube.com/watch?v=eIc_n_U2XPk

A VLF-3 Station in a RFI Environment: Promoting Radio Astronomy for Education

Marcelo Lago Araújo (Bahia, Brazil)

Editor's Note: Marcelo wrote and submitted the article in English, which he is currently studying to be his second language. Portuguese is his first language.

ABSTRACT

How to investigate natural VLF emissions in places where RFI (radio frequency interference) prevails? One of the first recommendations for VLF researchers is to stay away from power lines. For me, this is a difficult rule to follow, living in Salvador, the capital city of the state of Bahia in Brazil. Two years ago, in the critical period of the COVID-19 pandemic, it became more difficult to go outside my town. For this reason, I started to think what kind of experimental radio astronomy I could do at home, using the receivers I already have. My station is composed by SDR receivers, some antennas, the Radio JOVE and the INSPIRE VLF-3. Some of these resources I used in my master's degree in teaching Astronomy, so my goal is also related to develop and promote educational radio astronomy, a hands-on STEM approach.

GETTING STARTED

If in the past, picking up Sun radio emission was intended by some researchers, for example, like Sir Oliver Lodge tried, as J. S. Hey describes in his book, *The Radio Universe* [1], on the other hand, in late 1800´s attempts, receivers weren't sensitive enough to do the task. Fortunately, with 1930's receivers, Jansky identified thunderstorms and Milky Way emissions, inaugurating Radio Astronomy. Now, we have the technology to build very sensitive devices at a low cost. It is possible to create and apply educational activities, with hands on approach, such as The INSPIRE Project's VLF receiver.

Figure 1: When the VLF-3 kit arrived in 2015, I began to build it right away.

One day in 2015 before going to work, I listened on the FM radio a call to a master's degree in Teaching Astronomy at UEFS (Feira de Santana State University, here in Bahia, Brazil), MPAstro program [2]. After approved, I already knew Radio Astronomy was my main interest. I talked about my ideas with my advisors, professors Germano Guedes and Marildo Pereira, who gave me the green signal to continue. MPAstro program is heavily focused in developing educational products and Radio Astronomy offers a rich field to do that. Soon, my first online searches showed me The INSPIRE Project and Radio JOVE. It was perfect to my needs, to have experience with the subject. Help teaching Physics to high school or even college students, with a STEM approach, was my goal.

I ordered some books and the two kits. The VLF-3 receiver was the first to arrive and, I must say, I was really excited when opened the box (Figure 1). I soon started placing the well-organized electronics components on the PCB. I have been working as telecom technician since 1988. At first, for a big telecom company, for almost sixteen years. Now, since 2005, I am still working with telecommunications, but in a federal government agency called Anatel. So, I have some skills to build the kits and successfully test them.

That said, well, the first time I turned the VLF-3 on, I must confess, I thought I did something wrong. The noise the receiver sent to the headphones was loud. It surprised me, even knowing that the 60 Hz electric RFI would be a challenge. Everything in the kit assembling was fine, I could confirm. The first tests outside my home, I did in a small farm, near Salvador city, to try to record "Sferics" at last. I also tested the receiver during my classes at MPAstro, in the Antares Observatory area (maintained by UEFS). Figure 2 shows the open area behind the observatory, where I was searching for a spot with less interference. With their high sensitivity, the VLF-3 helped me to identify and mitigate RFI near the Radio JOVE, when I started

to use that receiver too. From 2015 to 2017, these receivers helped me in my research. I could better understand the radio astronomy fundamentals and write about it, proposing some educational products to high school students.

RADIO ASTRONOMY AND EDUCATION

Being a graduate in Pedagogy who has some skills with electronics, I was able to be sure about the relevance electromagnetism has to our society. Studying it from a STEM perspective, with meaningful learning, adopting some methodology proposed by Novak and Gowin [3], with hands on activities, I think it could be relevant to the students.

Between 2016 and 2017, I presented some lectures in public spaces and schools to assess how teachers and students reacted to the educational products I was creating. When explaining what radio astronomy is, I often was with the Radio JOVE and VLF-3 receivers with me, as Figure 3 shows.

Since I began using the VLF receiver, I was worried about the undesired noises received. Those are the RF that are all day around us. Not only created by artificial sources, but generated by natural processes, like lightning. As an educational perspective, we can realize that the Earth is also kind of astronomical radio source. Other worlds could have similar behavior within their atmospheres and magnetospheres, we could suppose. This opens a fascinating field of research, possibilities to study and use this knowledge. Because of this, I think the VLF-3 receiver could encourage teachers and students with STEM subjects.

Figure 2: Here I am in 2015 conducting one of the first VLF-3 field tests. The two wires: one as ground connection (left) and antenna (right). This place is at Antares Observatory area (don't panic with some pre-historic animals in the background near the power lines).

Figure 3: On October 4, 2017, my advisor Dr. Marildo Pereira (UEFS/BA) and I talked to physics students about Radio Astronomy, "On the radio astronomy waves" ("Nas Ondas da Radioastronomia", Semana de Física da UEFS). Some educational prototypes(from the left): an artisanal MW receiver, a simplified "Hertz Experiment", pictured I am holding (and on the screen) the VLF-3 receiver, and on the table is the "Pulsar Simulator".

THE VLF-3 STATION

Trying to minimize undesirable signals, I remembered the Stanford SuperSID, VLF receiver [4], that uses a loop antenna, and I decided to see if it was possible to have a similar loop with the VLF-3. Known for their directional pattern, loop antennas maybe could help me to observe natural emissions from my balcony and, as it worked, I thought to suggest this setup to be used in schools too.

Figure 4 shows my VLF station main components: the loop antenna, the VLF-3 receiver, a Sony digital recorder, a laptop with Radio-SkyPipe and Spectrum Lab software. From the station on the balcony of my apartment, there are several TV and FM transmitter antennas around it. Where I tested it, the RFI is intense and it's almost impossible to discriminates natural VLF signals from artificial ones, with a telescopic antenna.

Figure 4: My VLF station main parts: loop antenna, receiver, headphones, audio recorder, and the laptop with Radio-SkyPipe and Spectrum Lab Software.

Due to the COVID-19 pandemic, since 2020 I have been using the station inside a building with the loop antenna. With this setup, Figures 5 and 6, the tests allowed me to record some natural VLF radio emission.

Figure 5: A cloudy sky in the background. The loop antenna with red wire, the digital recorder, with headphones and data cables on the left, and the VLF-3 turned on.

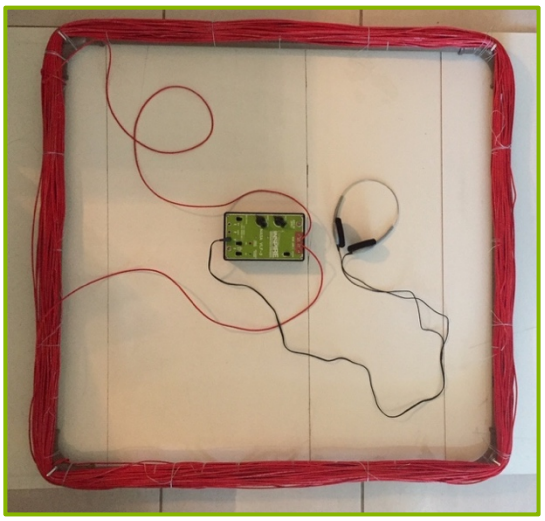


Figure 6. More station details: a 0,9m (~3 feet) loop antenna, the receiver, and headphones.

STORMS OVER THE HORIZON

According to INPE/ELAT (National Institute for Space Research/Group of Atmospheric Electricity), Brazil is one of the most lightning affected countries in the world, with more than 70 million registered discharges [5]. This is an interesting scientific fact that justifies using educational resources like the INSPIRE VLF-3.

Recently from my balcony towards the northwest, I could see distant clouds and lightning, Figure 7. At the same time, I recorded the radio frequency with the VLF-3. Interestingly, not all lightning I saw was also registered as noises by the receiver. Others were perceived as Sferics, with little frequency dispersion. With the loop antenna, I try to choose the best orientation to pick up the RF signal. In some Sferics, the energy spectrum seems to be concentrated in the 5 to 10 kHz band. This is compatible with the information I found on the INPE/ELAT page, "in the frequency domain, the fields have a maximum intensity around 5-10 kHz for ground lightning and around 100-200 kHz for cloud lightning" [6]. This may explain why the discharges perceived with the light of distant lightning did not always coincide with the Sferics recorded with the VLF-3.

Figure 7: A screen capture from my smartphone during a storm near Salvador/BA, in the northwest direction, from the VLF station on my balcony. To the left, distant clouds, and lightning. To the right, some radio and TV towers.

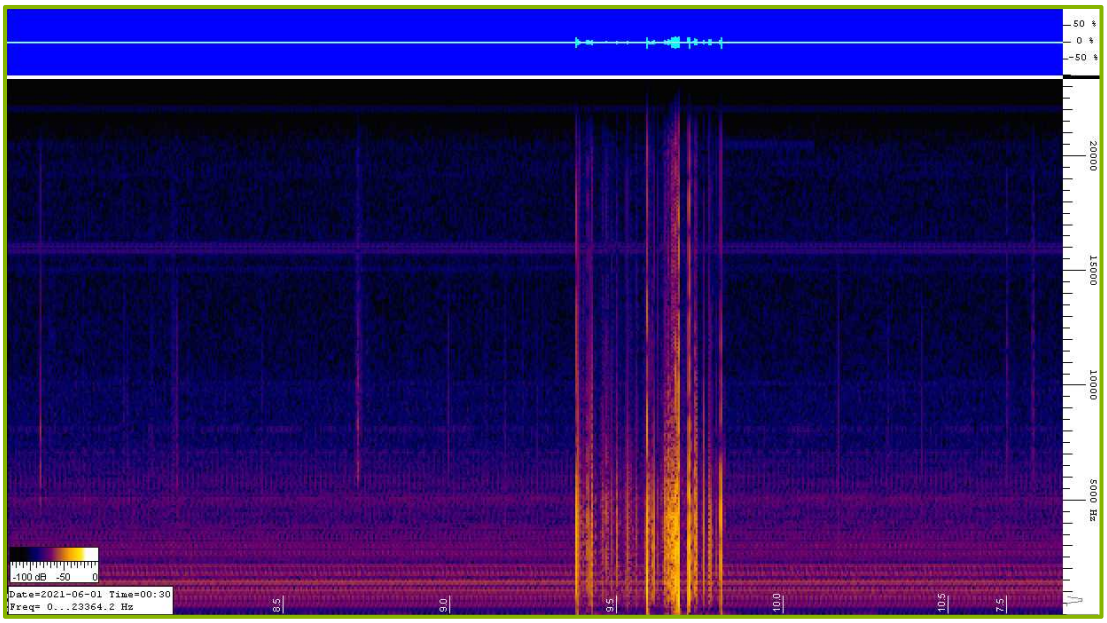


Figure 8: Analyzing nearby Sferics with the Spectrum Lab. It covers almost the entire band; it seems stronger below 10 kHz and frequency didn't seem to disperse.

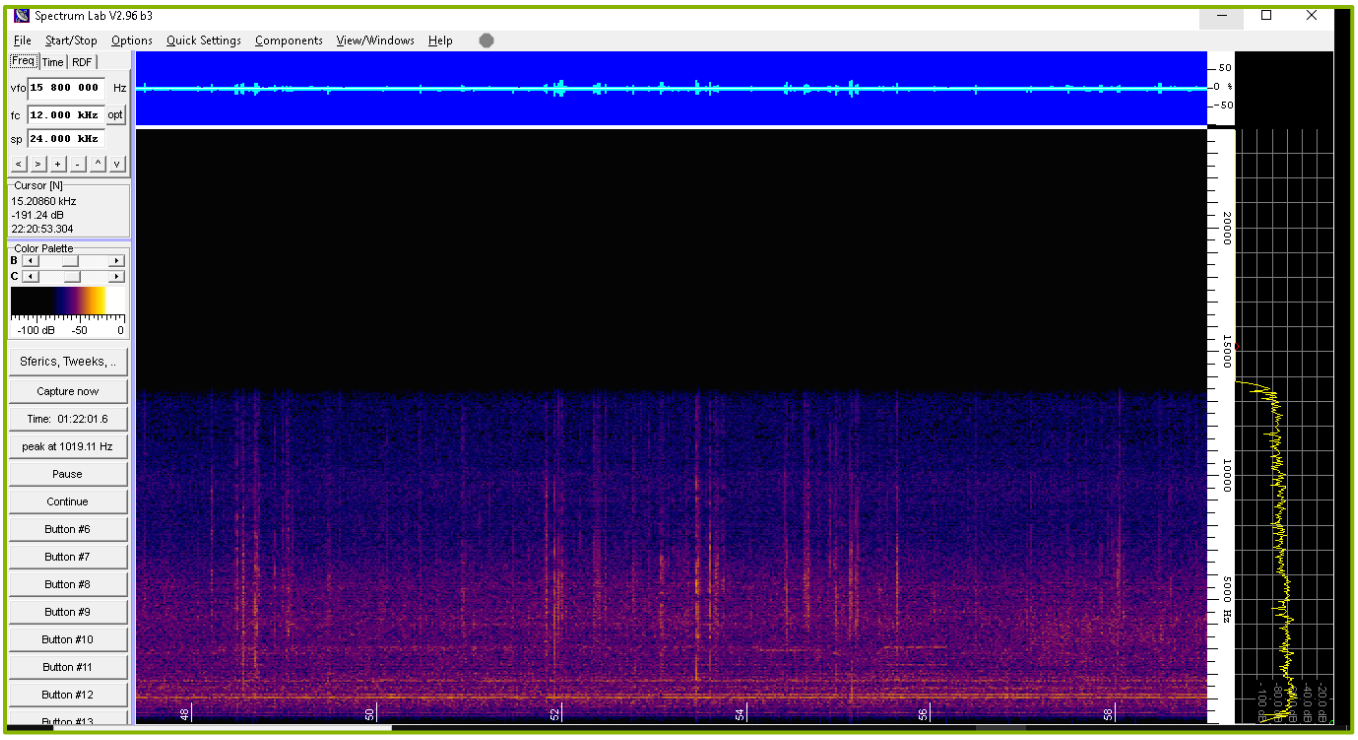


Figure 9: Analyzing some distant Sferics with the Spectrum Lab. Despite the RFI, it is possible to identify.

Even with the high RFI incidence, I could identify at least Sferics and maybe a few Tweeks, Figures 8 and 9. To see the context of storms, I used INPE/ELAT real-time lightning map, Figure 10.

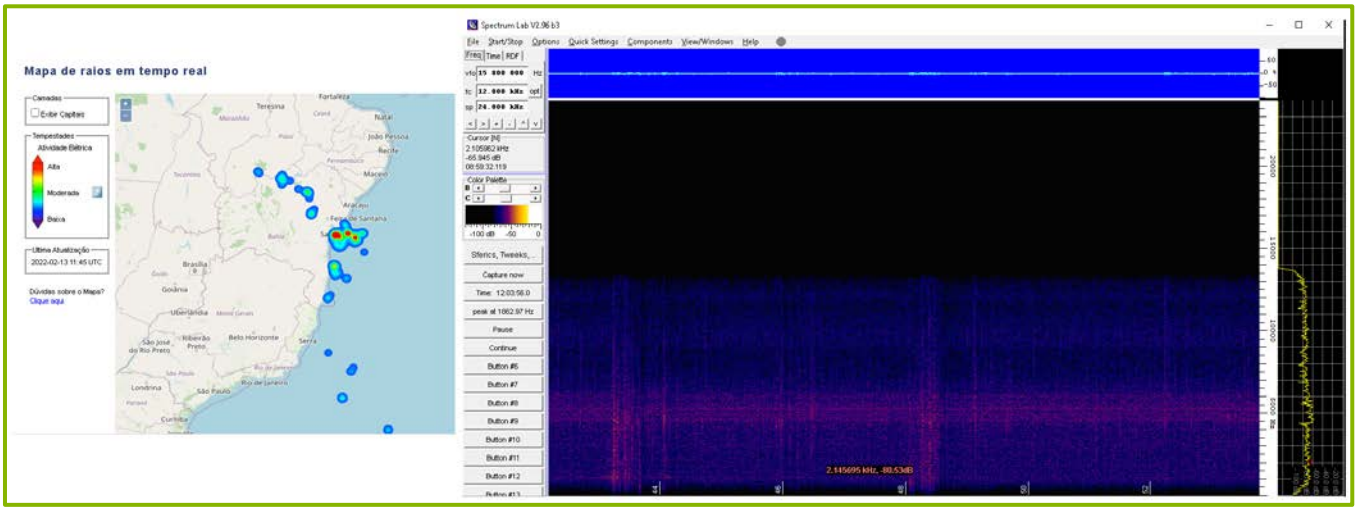


Figure 10: A thunderstorm near Salvador, while writing this article, as INPE/ELAT map shown. It was possible to register it, despite the RFI.

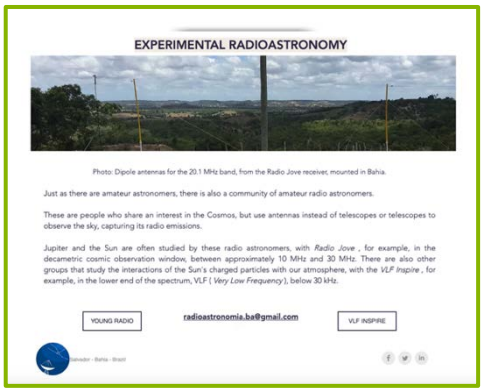
SPREADING EXPERIMENTAL RADIO ASTRONOMY

Confident to propose this approach (with the loop antenna) to other teachers, in July 2021 at the National Physics Teaching Symposium, the XXIV SNEF [7], I presented my experience using the VLF-3, for an online audience of professors and students, Figure 11. I think that, with the loop antenna, it is possible to try observations in school environments, staying in protected places, to observe nearby storms [8].

To view the presentation on the SNEF YouTube channel (in Portuguese), visit: https://www.youtube.com/watch?v=AzZ86QgdQcU

Figure 11: VLF-3 presentation in July 2021 on SNEF YouTube channel.

I maintain a webpage about experimental radio astronomy (in Portuguese with English translation available): https://www.radioastronomia.pro.br/. It was created in 2016 as part of my master's degree project [9]. I also recently created a YouTube channel: https://www.youtube.com/channel/UCjik9lYUxdMDRmFKQwhinMA. These are ways in which I continue to publicize, promote, and explain the use of such receptors, what are the precautions, difficulties, rewards and what is expected to observe with Radio Astronomy.



POSSIBILITIES AND PERSPECTIVES

Since I've been using the VLF-3, I never had the opportunity to record natural emission from a place far from the nearby powerlines RFI. I know this is an inconvenience for radio astronomy research, even experimental. Using the loop antenna was a good decision and I could rediscover the strangeness of all that noises in Very Low Frequency around us. It wasn't possible yet to record Whistlers in such environment. Anyway, I think that with the setup described here, others could promote this experimental research, especially in high school classes. New communication technologies are crucial, some people don't even realize how their tech devices works. It's always time for us to disseminate scientific knowledge of natural phenomena, which for many is completely unnoticed. Therefore, I will continue to promote The INSPIRE Project whenever possible. Opening the door to new perspectives, I think it would be an interesting idea to consider the creation of a network of experimental VLF receivers that could operate in real time, publishing data over the Internet. For example, with the recent volcanic eruption in the Pacific, which was followed by numerous lightning strikes, could the VLF receivers detect a change in the pattern of Sferics, Tweeks and Whistlers?

About Marcelo Lago Araújo

Marcelo Lago Araújo has a degree in Pedagogy from UNEB (Universidade do Estado da Bahia/BA/Brazil), and a master's in Astronomy Teaching from UEFS (Universidade Estadual de Feira de Santana/BA/Brazil). In his master's dissertation, proposes educational products about electromagnetism and radio astronomy for high school students (hands-on STEM related activities). He was advised during his master's degree by professors Dr. Germano Pinto Guedes and Dr. Marildo Geraldête Pereira (Department of Physics/UEFS). Currently, Marcelo continues researching radio astronomy and education, maintains a website about this subject, and works as a technician at ANATEL, the Brazilian telecommunication agency.

This photo was taken on December 21, 2017 after Marcelo received his master's degree at UEFS. From left to right: Dr. Germano Pinto Guedes (advisor), Marcelo, Jonas Lima Araújo (Marcelo's father), and Dr. Marildo Geraldête Pereira (advisor).

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INSPIRE Educational STEM Programs

College / University Scholarships

Dr. William W.L. "Bill" Taylor Memorial STEM Scholarship

Scholarship Awards: Up to $4,000 per recipient
Application Deadline: Ongoing

In honor of INSPIRE's co-founder Dr. Bill Taylor, The INSPIRE Project with its partners at the District of Columbia Space Grant Consortium and other science and technology organizations established this STEM (Science, Technology, Engineering, Mathematics) scholarship to help ensure our next generation of scientists and explorers. Undergraduate/ graduate and high

school seniors who are majoring in a STEM discipline and are currently or will be attending a Washington DC college or university are encouraged to apply.
Apply online at: http://theinspireproject.org/default.asp?contentID=5

Eligibility Requirements

All applicants must meet the following requirements and submit the required documents as outlined below:

- US citizenship
- Be registered as a full-time student in good standing at a Washington DC college or university
- Must be majoring in a STEM (Science, Technology, Engineering, Mathematics) discipline
- Submit current transcript
- Submit two letters of recommendation with at least one from a teacher or faculty member
- Submit a 300 to 500 word essay discussing how this scholarship award will help you advance in STEM disciplines and the positive impact it will have on your future career plans

College / University Internships

NASA Goddard Space Flight Center Summer Internship Program

Summer Internship Awards: $7,300 Undergraduate Students / $9,000 Graduate Students
Internship Session: Early June – Early August (10 weeks, full-time)
Application Period: November – February (see NASA website for dates)
Fall and Spring semester internships also available

NASA Goddard Space Flight Center aerial photo courtesy of NASA

With support from the District of Columbia Space Grant Consortium and other partners, The INSPIRE Project offers paid full-time summer internships at NASA Goddard Space Flight Center.

Internship Description

NASA summer internships are educational hands-on opportunities that provide unique NASA-related research and operational experiences for undergraduate and graduate students. The internships integrate participants with career professionals emphasizing mentor-directed, degree-related, real-work task completion. During the 10-week summer internship, participants engage in scientific or engineering research, development, and operations activities. Through these internships, participants engage in scientific or engineering research development, and participants leverage NASA's unique mission activities and mentorship to enhance and increase their professional capabilities and clarify their long-term career goals. Upon completion of internships, recipients are required to submit an article on his or her research project for inclusion in *The INSPIRE Journal*.

Eligibility Requirements

- US citizenship
- Minimum 3.0 GPA on a 4.0 grading scale
- Applicants must be enrolled full-time in a degree-granting course of study appropriate to NASA's long-term professional workforce needs
- INSPIRE summer internship applicants must be undergraduate or graduate students enrolled at a Washington DC college or university

Applicants must complete the required NASA internship application which includes a letter of recommendation and current college or university transcript.

For more information and to apply, visit the NASA internship website:
https://intern.nasa.gov/
Note: After completing online NASA internship application, please email: info@theINSPIREproject.org, so INSPIRE can confirm receipt of your application with NASA.

Middle & High School STEM Educators

Kathleen Franzen Memorial Space Academy for Educators Scholarship Program*

Full Scholarships for Weeklong Summer STEM Program at the U.S. Space & Rocket Center in Huntsville, Alabama

The INSPIRE Project teamed up with the U.S. Space & Rocket Center, District of Columbia Space Grant Consortium, Washington Space Business Roundtable, and other partners to offer Washington DC middle and high school teachers and administrators full scholarships to attend Space Academy for Educators in Huntsville. The weeklong program during the summer includes authentic astronaut training simulators and activities developed to promote learning in a classroom setting. Curriculum includes NASA content and is correlated to the Next Generation Science Standards (NGSS). Trainees in Space Academy for Educators can earn 45 professional development hours and educators get access to a shared website with lesson plans, networking opportunities, and tips to adapt many of the workshop activities to individual class environments. Workshop topics/activities include: Engineering Design Challenges, Rocket Construction, Math Workshops, Living and Working in Space, Orion Spacecraft, Space History and Mars & the Moon. Teachers participate in Low Earth Orbit (LEO) and Mars Missions, simulate walking on the moon and working in the frictionless environment of space on astronaut simulators and weather permitting, spend an afternoon at Aviation Challenge simulating parachute landings and helicopter rescues in the water.

Space Academy for Educators full scholarships include:

- Round-trip airfare from Washington DC to Huntsville
- Six nights lodging and meals
- Program materials, flight suit, T-shirt and USSRC exhibit ticket
- Transportation to/from the airport in Huntsville

Apply online at: https://theinspireproject.org/default.asp?contentID=7

Middle & High School Students

Space Academy for Students Scholarship Program*

Full Scholarship for Weeklong Summer STEM Program for Washington DC Area Middle & High School Students at the U.S. Space & Rocket Center in Huntsville, Alabama

The INSPIRE Project teamed up with the U.S. Space & Rocket Center, Washington Space Business Roundtable and other sponsors to offer full scholarships to Space Academy in Huntsville, Alabama for Washington DC area high school and middle school students. Space Academy is an action packed 6-day program for students world-wide to participate in classroom, laboratory and training focused on space science and space exploration. Space Academy encourages teamwork, problem solving, communication skills and self-confidence. Students take part in astronaut-style training and simulations, as well as STEM activities to ensure our next generations of space science and technology explorers!

Space Academy for Students full scholarships include:

- Round-trip airfare from Washington DC to Huntsville *(INSPIRE chaperone accompanies students)*
- 5 Nights lodging and meals at the U.S. Space & Rocket Center
- Program materials, flight suit, T-shirt, team patch, and photos
- Transportation to/from the airport in Huntsville

Apply online at: http://theinspireproject.org/default.asp?contentID=19

** NOTE: Due to the pandemic, the Space Academy for Educators and Students programs have been temporarily suspended for summer 2022. INSPIRE hopes to resume both programs in summer 2023.*

Special Thanks to The INSPIRE Project's Program Sponsors, Supporters and Volunteers

NASA | District of Columbia Space Grant Consortium | Washington Space Business Roundtable
U.S. Space & Rocket Center | International Launch Services | Space Ad Agency | Fisher Space Pen

2022 William Taylor Scholarship Recipient Reports on NASA Johnson Space Center Spring Internship

Malaya Moon

NASA JSC x Firefly Aerospace Blue Ghost Lunar Lander

Growing up, I would always hear the saying, “The sky’s the limit.” However, my time at Howard University and as a NASA intern has shown me that if I shoot for the stars, then the sky can be nothing more than the ground beneath me. As I am now officially finished with my third year as a Computer Science major at Howard University, I know the younger me is proud of the accomplishments I achieved over the past three years. This year I had the opportunity to take on my third NASA internship at Johnson Space Center (JSC) as a Commercial Lunar Payload Services (CLPS) Intern. As an intern in the CLPS program, I was able to gain first-hand experience of a practical industry standard engineering design process at Firefly Aerospace in Austin, Texas.

The main purpose of my project is to implement various tests that will ultimately prepare for a successful lunar lander launch. The goal of my project is to curate and present data that will be used as preliminary insights for future Blue Ghost lunar lander testing. The significance of my efforts will be a vital part of having success in early stages of the assembly, integration, and testing of the lander. From the Mars Perseverance rover to now, the Blue Ghost lunar lander, my internships with NASA have been a childhood dream come true.

My time at NASA JSC and Firefly Aerospace has allowed me to step outside of my world of solely computer science and into a world of all things engineering and beyond. My most memorable moment of this internship is getting to help conduct some tests on the moon surface simulator at the testing facility. My diverse experiences have allowed me to gain insight into multiple STEM-focused disciplines.

I’m very grateful to have received the 2022 William Taylor Memorial Scholarship. As a first-generation college student, I believe it is important to have a great foundation of support financially and academically. This scholarship will help me with alleviating the financial stress that comes with attending college. I will now be able to focus on turning my dreams into reality. I will continue to extend the limits of my own endeavors in the hope of inspiring and creating space for the next generation of trailblazers. Thank you INSPIRE for your continued support of my academic and career journey.

About Malaya Moon

Malaya Moon is a rising senior at Howard University majoring in Computer Science. Malaya’s accomplishments include being a Black Females Moving Forward (BFF) in Computing Scholar, Howard University Leadership Scholarship Recipient, Military Order of the Purple Heart Leadership Award Recipient and a member of the Upsilon Pi Epsilon International Honor Society for Computing and Information Disciplines. Malaya's involvement on campus includes Co-Founder of the Google Developer Student Club Howard University Chapter, Association of Computer Machinery, National Society of Black Engineers, National Society of Collegiate Scholars, Howard’s Army ROTC program, and Howard’s Georgia Club. This summer she will be a cyber futures intern at MITRE. Her passion for STEAM is the foundation of the legacy she is creating as she takes on the world one step at a time.

How to Photograph a Total Solar Eclipse: Six Simple Steps for Success

Dr. Gordon Telepun (foxwoodastronomy@gmail.com)

All photographers preparing to image their first eclipse stress out over the details. I know that I did preparing for my first solar eclipse in 2001. Eclipse photography is unlike any other “nature” photography. You have one opportunity to be successful, it’s difficult to achieve focus, it requires special filters, perfect timing, and there is no way to practice in advance. So yes, it is stressful. I have successfully imaged five solar eclipses and I simplify the process by breaking it down into six easy steps and teaching a couple of tricks.

Step 1 – Choosing a Solar Filter Type

All commercially available solar filters are safe for eclipse photography and block 99.9% of the incoming light. There are three that are commonly used: metalized glass (different brands), Thousand Oaks Optical SolarLite Film, and AstroSolar Baader Film (OD 5). Each has different light transmission characteristics. I strongly recommend metalized glass solar filters. Their light transmission behavior works with a wide range of camera setups with different focal ratios enabling mid-range camera settings of ISO and thus allowing shutter speeds that can properly expose all parts of the solar eclipse. This will be explained later.

Figure 1. Images of the full solar disk using the same telescope camera setup at 1/200s, ISO 200, and f/10. The left image is a balanced exposure through a Seymour Solar glass filter. The center image is taken through SolarLite film which passes 3 stops less light, making the image too dark. The right image is taken through Baader film which passes 2 1/3 stops more light, making the image too light.

Step 2 – Using a Solar Filter Properly

You buy a glass solar filter with an aluminum frame having an internal diameter about 1/4” to 1/2" larger than the outside diameter of your lens or telescope. Then you pad the inside of the aluminum frames with self-stick felt. You want the solar filter to be snug enough to stay in place, but easy to remove and replace without jarring your gear and ruining your alignment.

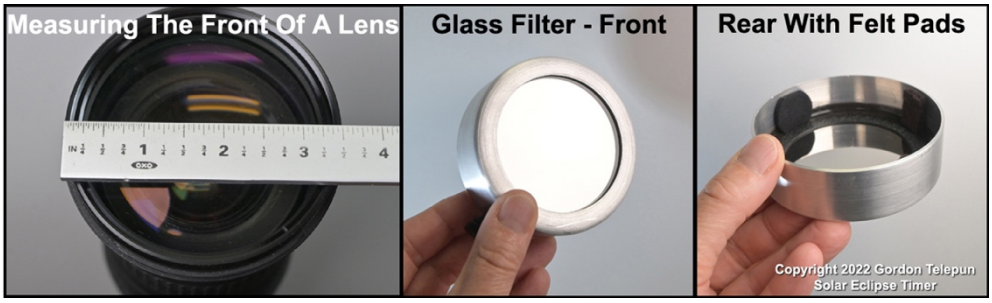


Figure 2. How to measure, buy, and pad an aluminum-framed glass solar filter.

The second reason you want the aluminum frame to have space is for the situation when the back of the solar filter is acting like a mirror and sending a reflected image down the optical system causing a ghost image. The ghost image can ruin your partial phase images. When this occurs introducing a slight angle to the filter will send the ghost image to the side of the optical system.

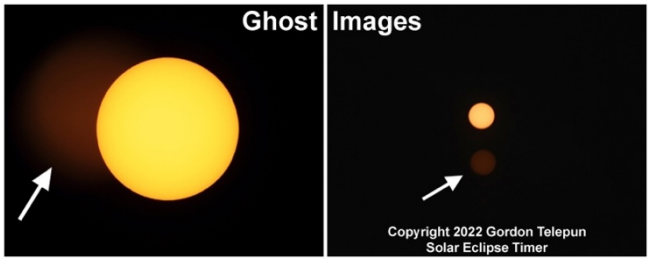


Figure 3. Ghost images are caused by reflections off the rear surface of the glass solar filter being direct down the optical system.

Figure 4. A slightly larger solar filter with felt padding allows for introducing a slight angle to the filter, if needed, to remove a ghost image.

Step 3 – Focal Length, Crop Factor, and Image Scale

Amateur photographers may already have what they need in their camera bags. I am an advocate of trying to use the camera gear you already own for eclipse photography. Modern DSLR cameras with high-density megapixel sensors can take very detailed images. You can do quite well with a camera system that is achieving an "effective" focal length of 600 to 800mm. The "effective" focal length refers to how your system, lens plus the camera, is actually imaging. With a full-sized image sensor, the focal length of the system is what the lens reads in millimeters. With a small-sized image sensor (APS-C) a multiplying crop factor is introduced. With Nikon cameras, you multiply the printed lens focal length by 1.5x. With Canon cameras, you multiply the printed lens focal length by 1.6x. For example, a 500mm lens on a Nikon APS-C sensor is working at an "effective" focal length of 750mm (500mm x 1.5x). The decision about focal length is important due to image scale. You want the Sun's diameter to be large enough in your pictures to see details, but not so large that you cut off the outer corona filaments. Therefore, an "effective" focal length between 600mm and 800mm works well. With a 750mm effective focal length you will have approximately 2 1/3 solar diameters of space on each side of the eclipsed Sun horizontally and 1/1/2 solar diameters of space on the top and bottom.

Figure 5. When this lens is zoomed all the way out, the 2x extender and the 1.5x crop factor make the system work at 900mm. This system would be best used at a focal length of 750mm. This would be achieved by taping down the zoom barrel at the 250mm setting.

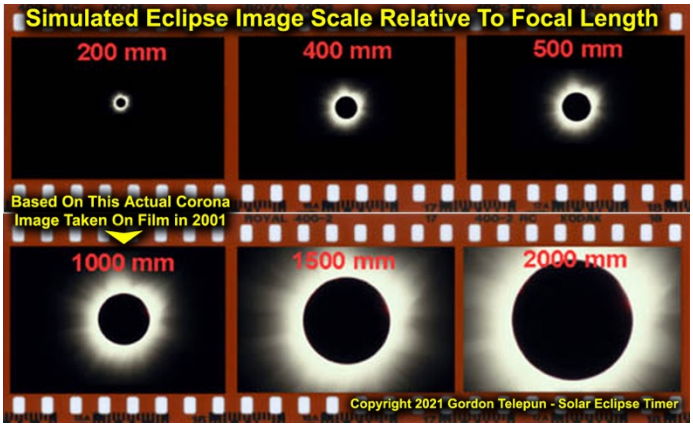


Figure 6. With modern DSLR cameras, imaging long filaments of the corona is possible. In the above figure, the 1000mm picture is used for the basis of the scale, and that picture was taken with slide film in 2001.

Step 4 – Setting Proper Exposure Settings

There is only one thing in eclipse photography that you can practice before the eclipse and that is taking exposures of the full solar disk through a solar filter. This step is the basis for how I teach the first trick of eclipse photography based on my experience with using glass solar filters. The trick starts by using your camera gear to take a range of exposures of the full solar disk. Your lens and camera determine your f/stop. Depending on your f/stop you will pick an ISO setting, somewhere between 200 and 800. The only thing you will vary is the shutter speed. Take images with a range of shutter speeds and choose the shutter speed that gives you a properly exposed full solar disk image. This means the image has a bright center, but stays yellow, and is not overexposed to white. If there are sunspots on the Sun the exposure must show them. And the limb of the Sun must show the natural limb darkening. Here is the trick: I know from experience that if you have a properly exposed full solar disk image through a glass solar filter, that shutter speed with your gear will expose for the inner corona when the filter is not over the lens. Do you see how important this concept is? You have an understanding of how your setup is going to capture light to image the corona without ever having the chance to practice imaging the corona!

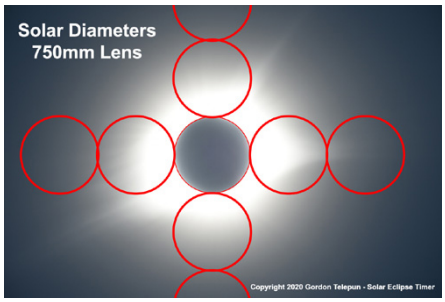


Figure 7. An overexposed image of the corona from 2017 shows the length of the filaments at 750mm measured in solar diameters.

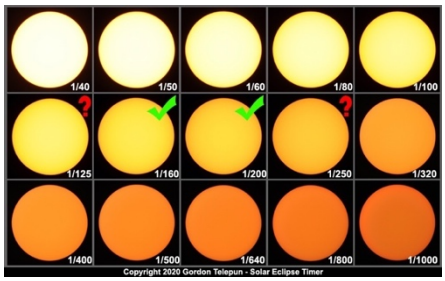


Figure 8. From this palette of solar disk exposures, all taken at f/10 and an ISO of 200, the shutter speeds of 1/160s and 1/200s have the best exposures (green checkmarks). You use this exposure for all partial phase images except for the last slim crescent before totality and the first slim crescent after totality.

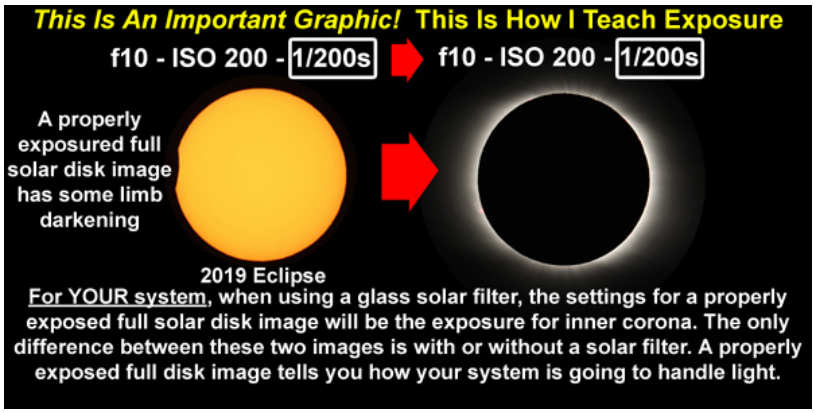


Figure 9. This is "trick #1." If you have a properly exposed full solar disk image, your system will expose for inner corona when the solar filter is not in place.

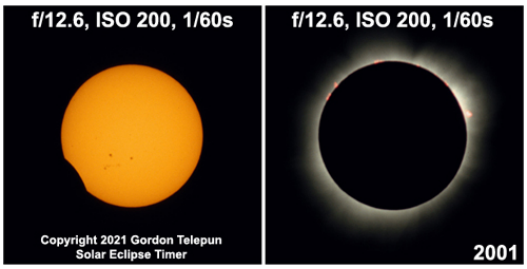


Figure 10. Example with the 2001 eclipse with slide film. The only thing that changed between these two images is that the corona image does not have the solar filter on the lens. Full solar disk image settings expose for inner corona.

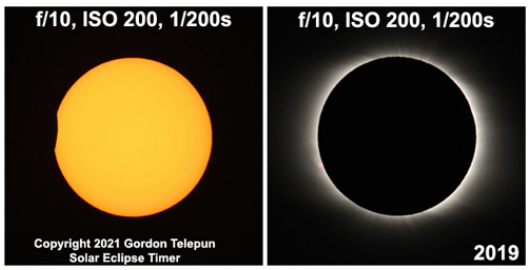


Figure 11. Example with the 2019 eclipse with a digital camera. The only thing that changed between these two images is that the corona image does not have the solar filter on the lens. Full solar disk image settings expose for inner corona.

There are two adjustments you can make if you want a brilliant, big diamond ring. One adjustment is to use a 2 stops faster shutter speed to allow more light. The other adjustment is to start imaging for diamond ring earlier, when there is more photosphere exposed. My standard recommendation is to pull your solar filter and start imaging 20 seconds before second contact. But you could start imaging safely at 30 seconds, or even 40 seconds, before second contact and the first diamond ring exposures would be bright. Some may be overexposed, but then you pick the exposure you like the best.

Step 5 – Exposure for the Diamond Ring, Baily's Beads, and Chromosphere

The second trick is to use what you know about the light gathering ability of your system without the solar filter to choose the diamond ring, Baily's beads, and chromosphere shutter speed. This imaging comes before second contact, before you will do corona imaging. I know from experience that the shutter speed you should use starting with the diamond ring phase will be 2 stops to 2 ½ stops faster than what you determined was the shutter speed for your full solar disk image.

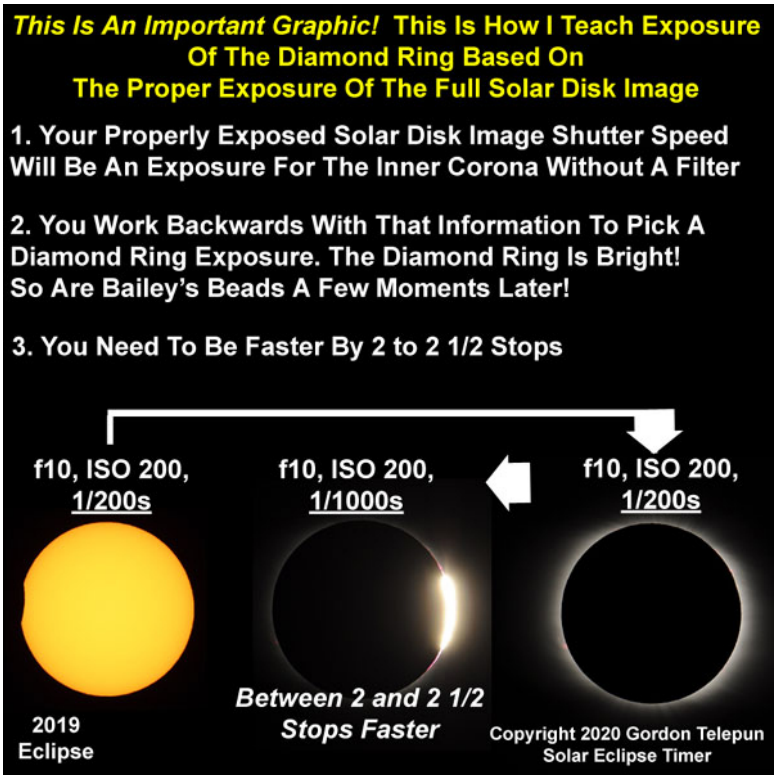


Figure 12. The diamond ring and Bailey's beads are bright. Some people prefer an overexposed diamond ring, while others prefer a tight and smaller diamond ring. Shutter speeds need to be fast to delineate Baily's beads.

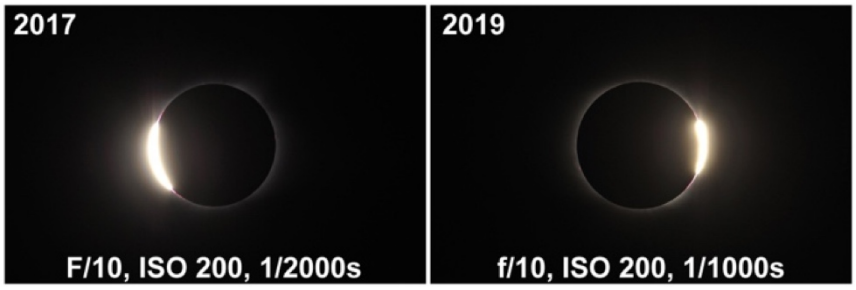


Figure 13. The variables that affect either of these two images from being more brilliant are the shutter speed and how far in advance of second contact the image was taken. The 2019 image (right) used a shutter speed of 1/1000s and could have been more brilliant, but the image was taken too late, approximately 10 seconds before 2nd contact.

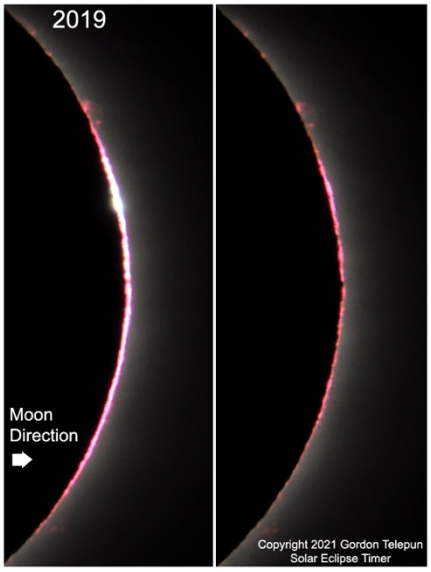


Figure 14 (far right). The left image shows the final Baily's bead and the right image shows all chromosphere. These images are about eight seconds apart. These are taken at the same settings as the 2019 diamond ring, f/10, ISO 200, 1/1000s.

Step 6 – Corona Imaging Simplified

The tricks explained in steps 4 and step 5 take the mystery out of imaging the corona. At second contact you will be imaging the chromosphere at a fast shutter speed. When second contact occurs you just need to take images at progressively slower shutter speeds, 1/3 to 1/2 stop at a time, to a slow speed of about 2 seconds or 3 seconds. This will give you a beautiful set of

bracketed corona images. From this set, you can pick the best single exposure that has a balance between the over-exposed inner corona and nice outer corona filaments. Or you can use multiple exposures to learn the techniques of high dynamic range processing (HDR).

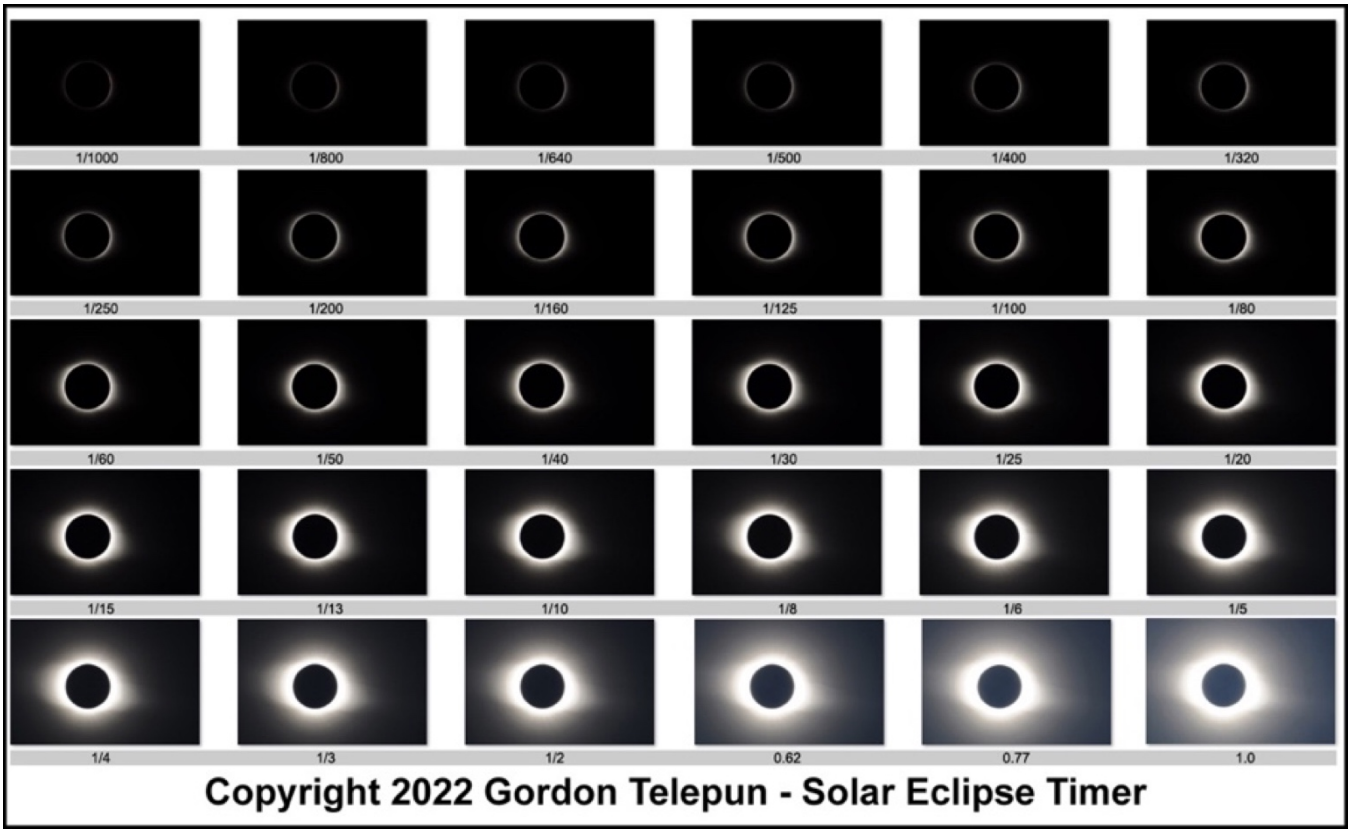


Figure 15. A range of corona exposures starting with the diamond ring shutter speed and ending with an exposure of one second.

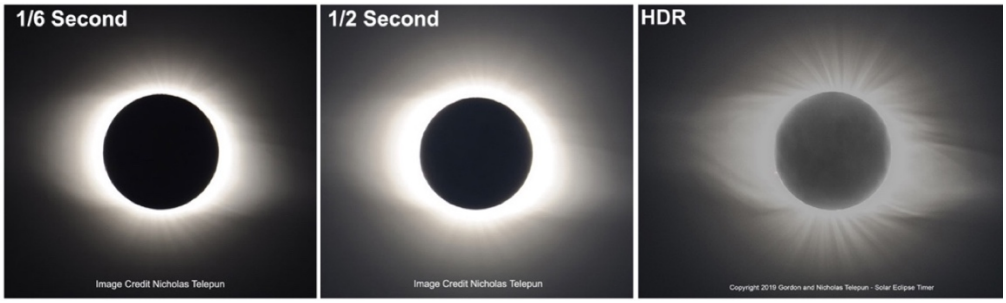


Figure 16. From your palette of corona images, you can pick a single exposure that you prefer. But the corona has a wide range of brightness. So, as you choose longer shutter speeds to see more corona filaments you get an overexposed inner corona. The techniques of high dynamic range processing allow the exposure of the corona to be more balanced.

Summary

These six steps take the mystery out of planning eclipse photography if 2024 will be your first total solar eclipse. This article discusses the gear, but then you must also be prepared for the crucial timing of the events. You must practice! You must know your gear thoroughly! The minutes before second contact are very exciting and you can get distracted. Two additional words of advice: 1) Take time to look at totality with your eyes. 2) If you have an equipment malfunction just before second contact or during totality, give up on the gear and enjoy the eclipse. This is not the time to try to troubleshoot equipment problems.

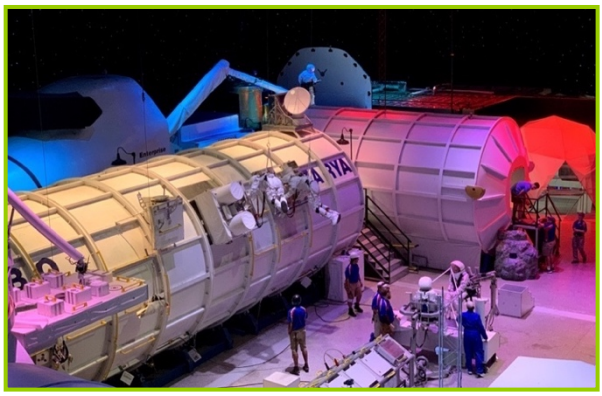
About Dr. Gordon Telepun and his book "Eclipse Day – 2024 and More!"

Dr. Gordon Telepun is a plastic surgeon who lives in Alabama. He is an expert eclipse photographer, eclipse educator, and the developer of the mobile app Solar Eclipse Timer which is designed so he can be your personal guide and photography assistant through the stages of an eclipse. It was used with great success for the eclipses in 2017, 2019, 2020, and is ready for the next United States eclipse in 2024.

In preparation for the 2024 eclipse, he recently published a comprehensive ebook on how to enjoy, observe and photograph a total solar eclipse called "Eclipse Day 2024 & More! How to enjoy, observe, and photograph a total solar eclipse." This article is based on excerpts from that book. Information about his app and book is available on his website: http://www.solareclipsetimer.com.

Kathleen Franzen Memorial Space Academy Scholarship Program

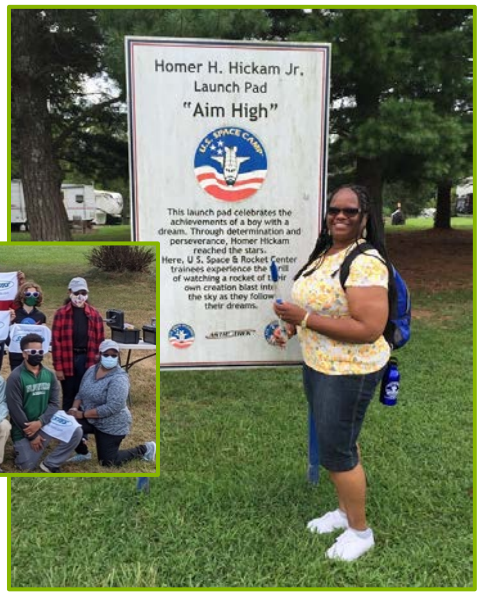
INSPIRE Space Academy Educator and Student Alumni Report on Recent Endeavors



During the past 13 years, 39 educators and 70 students have been awarded full scholarships to participate in this week-long educational STEM program for middle and high school educators and students held at U.S. Space & Rocket Center (USSRC), NASA's official Visitor Information Center for Marshall Space Flight Center, in Huntsville, Alabama. The action-packed week includes 50+ hands-on STEM activities and experiments. Aside from astronaut training, the Space Academy for Educators program includes intensive classroom, laboratory and training focusing on space science and exploration activities developed to promote learning in a classroom setting and equips teachers with knowledge, activities, and materials to excite, engage and attract students to STEM disciplines. Year after year in INSPIRE's annual educator survey, 100% of Space Academy for Educators STEM scholarship recipients (still teaching) utilize materials and knowledge acquired via the Space Academy program directly impacting approximately 2,800 students. Special thanks to INSPIRE's sponsors including the Washington Space Business Roundtable, District of Columbia Space Grant Consortium, Patriots Technology Training Center, and private donors for their support and inspiring our next generation of space scientists and explorers. Due to the pandemic the program is suspended until summer 2023. Below are a few updates from INSPIRE's past of educator and student alumni.

Robin Houston, Educational Administrator and Volunteer STEM Coach (2015 Space Academy & 2017 NASA Solar Eclipse Team)

I am an educational administrator for my local school district by day and a STEM enthusiast evenings and weekends. As a coach for our 100% volunteer non-profit STEM education organization, I enjoy sharing fun hands-on activities with middle and high school students. This year, my daughter and I piloted a model rocket competition we are collaborating with the National Society of Black Engineers Aerospace SIG to rollout as a national program Fall 2022.



The FIRE Rocket Challenge is designed engage underrepresented youth by providing instruction and expeirences that will aid them in transitioning to successful participation in other national and international rocket/aerospace-themed competitions. The program aims to provide students with opportunities to become problem-solvers, STEM proficient, and confident they have "the right stuff" to become leaders in the aerospace industry. Given our organizations longevity as a leader in preparing pre-college-aged students to pursue degrees and careers in STEM fields successfully, the rocket program is a "go for launch" with the intent of being a catalyst for developing the next generation of rocket scientists!

Jacqueline Fernandez-Romero, Ph.D. Principal LAYC Career Academy (2013 Space Academy)

I'm happy to report that August 16, 2022 will be my 10 year work anniversary at the LAYC Career Academy. I began the journey with Career Academy as a founding Science teacher and STEM Coordinator. I'm now completing my 3rd year serving the Career Academy staff and students as their Principal.

This year we have established a GREAT partnership with American University (AU) in which some of our students will be able to be mentored in STEM as well as have the opportunity to learn more about college and careers. Through AU Community Voice Lab I was able to share part of my life story in a short documentary regarding the work I do with students in Washington DC.
To view the American University Community Voice Lab documentary, visit: https://youtu.be/DrKPioyHF6M.

Kiera Drew (High School Sophomore) – 2017 Space Camp

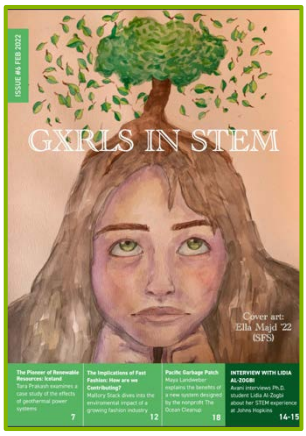
In March of 2021, I was selected as a participant in the W.E.B. Dubois Scholars Institute Advanced Learning Academy through Princeton University. Because of the pandemic, it was a fully virtual program consisting of three major tracks: applied mathematics, biomedical engineering and technology, and medical science. I got into my first choice which was biomedical engineering and technology, which correlated to my dream occupation. I was so excited when I found out that I was accepted into this specific facet of the program! Over the course of three individual weekends in three months, I learned so much about what exactly biomedical engineering is, what it entails, the various disciplines involved, and the future of biotechnology. One of my favorite activities was studying the applications of nature in the field of biomedical engineering. We worked in groups to research and present our findings into a solution that could be applicable for everyday life. My group researched the proboscis (the mouth device) of a mosquito and how it can be used as an alternative to needles, which can be intimidating for many people. I loved how interactive the sessions were within our Friday night STEM challenges, videos we were tasked to watch in order to gain more knowledge about the subjects, discussions my classmates and I would have about the topics, and group presentations that allowed everyone to learn from each other. I was so glad that I had this wonderful opportunity, and I look forward to participating in more events with the W.E.B. Dubois Scholars Institute in time ahead. You can find more information at https://www.duboisscholars.org/.

Kiera with her GE Healthcare and DMV NSBE Jr STEM competition winning trophy

During April of 2021, I participated in a STEM product lifestyle virtual case study competition. Hosted by GE Healthcare and DMV NSBE Jr, I was able to learn more information from professionals in a variety of fields about their experiences as people of color in the vast discipline of engineering as well as gaining exposure to the engineering life cycle as pre-college scholars. In addition to obtaining knowledge from subject-matter experts, students were grouped into teams and challenged to work on a solution to the given problem. This task was to create a software application that would grant field engineers the opportunity to service ventilators from their own homes due to the circumstances of the Covid-19 pandemic. My partner and I divided up the tasks and got to work as soon as we were given our assignment. We conducted Zoom meetings on weekdays and the weekends to update each other on our progress since we were in different states. This made everything more organized and easier to understand the pace at which we were working as a group. Although it was discouraging at times due to members leaving the original group and competing for the first time with someone who I had never met, my partner and I won the competition! As a team, we discovered the attributes of perseverance, flexibility, and communication that can be applied to multiple areas of our lives. Who knew that I would have found my ideal teammate who lives in Missouri through this amazing opportunity?

In summer of 2021, I joined my school's VEX robotics team- the Robotic Runners. We are an all-girls team of hard-working individuals united by our end goal of achieving as much as we can in our collective season. Initially, there were three teams, A, B, and C, and everyone on the teams were divided up into various roles. These included builders, drivers, and programmers. I serve as a builder, and my tasks consist of brainstorming ideas for our robot, researching possible additions to the robot, and executing designs for local competitions. Although it was my first year participating, I learned so much from my fellow team members who had been on the team since their freshman year, consisting of lessons of persistence, dedication, and teamwork. I was grateful to have these people along with those who became my friends along the way to support me in this great commitment. I also learned about the importance of documenting our work along the way throughout the development of our designs. Eventually, our teams narrowed down from three into two, making it much easier for everyone to be in a more organized manner. Throughout our last season, the team I was on won the sportsmanship award along with an invitation to the state championship, which would allow teams to qualify for VEX Worlds. Despite not making it to the world championships, I remain proud of our team and how far we have come while resisting setbacks and discouragement. I am looking forward to our next season!

Recently, in the winter of 2021, I had my first article published in *Gxrls in STEM* magazine. This publication makes it its mission to highlight writing featured only by female-identifying along with non-binary individuals. This specific magazine issue was on the topic of sustainability, and my article was about environmental injustice. I am very passionate about writing, and I am so glad that I got to share this love with the readers of this amazing magazine. I have another article in the works for their spring issue, so look forward to seeing that soon!



Currently, as I am transitioning away from my sophomore year in high school, I have been in the process of applying for internships and volunteer opportunities to strengthen my STEM experience and portfolio. I have applied for the ASPIRE internship through Johns Hopkins, Ag Discovery through USDA, Summer STEM camp through the U.S. Naval Academy, and a bioethics internship through STEMcx. So far, I have gotten a notification of acceptance from the Ag Discovery program! I will find out my application status for the other opportunities in May of 2022, so I am excited to see what the future has in store for me!

Charis Houston (Junior, Capitol Technology University)
2015 & 2017 NASA Solar Eclipse

Wrapping up my junior year and heading towards my senior year, I've had many new opportunities. Since May 2021, I have held the position as a Mission Operations intern at Northrop Grumman. I have learned a lot about the behind-the-scenes work to make sure satellite missions are successful both before and after launch.

As co-founder of the FIRE Rocket Challenge, I was able to help expand student exposure to principles of Aerospace Engineering and careers. I value the importance of giving back, especially with the multitude of opportunities I have had in the past, such as Space Academy and the 2017 Solar Eclipse. The rocket challenge is scheduled to launch nationwide in Fall 2022. I am also coaching a team of high school students participating in the RockOn 2022 workshop that features a sounding rocket payload experiment.

Bryce Stephens (Freshman, Tuskegee University)
2015 & 2017 NASA Solar Eclipse

Hello again, I am Bryce Stephens, a former Space Camp student through The INSPIRE Project in 2015. I am just finishing my freshman year of college at Tuskegee University as an Aerospace Engineering major. In the past year, I have completed my summer internship at NASA Goddard, where I designed and planned the use of a frame to use with the OSAM-1 Satellite during testing to stop the contamination of the spacecraft. I worked with various NASA engineers and scientists to interface this frame with other parts and assemblies that were simultaneously being worked on at NASA Goddard. During my freshman year of college, I acquired a lot of knowledge in engineering and mathematics, which helped to build on and fill in the gaps in knowledge I already knew. In addition to my classes, I took part in the DOD-AERIC Research group at Tuskegee, which contains various teams focused on different projects to help support the DOD and further our experience in engineering fields. I am part of the UAV Platform research team, where we worked to construct an autonomous drone platform that could be mounted to vehicles and be used in various situations. I am the primary drone operator on the team, so I was able to obtain my remote pilot's license to help support my role. I gained hands-on experience during construction, designing using Computer-Aided Design (CAD) programs, and developing technical reports that can be submitted to Army archives and scientific journals. This summer, I will be working as an intern at Electra.aero in Manassas, Virginia to help develop a solar-powered glider. I am excited to see what the future holds and to gain more experience.

Evan Valentine (8th Grade, Milton Hershey School) – 2017 Space Camp

In summer of 2021, I received a Lindsey Vonn Foundation scholarship to Aviation Challenge as it was not in our family budget, and I really wanted to go after attending Space Academy with INSPIRE! The Aviation Challenge in Huntsville, AL (an aviation summer camp) took place over a period of 5 days and involved a series of activities that required me to work well in a team. My team name was "Reaper" and my code name was "Pain". The Aviation Challenge was super fun and it kept me super fit! During the challenge, I learned a lot about airplanes and how they work. I have always wanted to do fighter jet simulators and I finally got to do it at the camp! I really enjoyed learning about Rear Aspect, which is when you get behind the enemy's aircraft to fire. I enjoyed the Helicopter Lift Simulator, which simulated being rescued by a helicopter from a raft, requiring me to swim across the lake and back. I also enjoyed the Field Training exercise with my team, where we simulated getting data from an enemy base – it was really challenging! I also had fun doing less strenuous activities, like walking around the Huntsville Space and Rocket Center museum, where I got a few souvenirs. At the end of the program we each received an Aviation Challenge Badge, of which I am very proud. I made a lot of friends at the program and we still keep in touch! Since I want to be an aerospace engineer when I grow up, this experience was very helpful!

Justice Flora (Freshman, Penn State University) – 2016 & 2017 NASA Solar Eclipse

Throughout my first year at Penn State there were many times where I struggled in my first year from Calculus, Chemistry and Physics which are the core classes every STEM major takes. While difficult, I used the resources I had available to fight and try my best to succeed in a climate where people like myself are not meant to. Being a part of exclusive programs, being involved on campus and engaging in fun but enriching activities were crucial to my success during my first year.

The Millennium Scholars Program (MSP) at the Pennsylvania State University is an exclusive program for underrepresented students pursuing STEM degrees. Every year a new cohort of about 35 to 40 students enter the program together and participate in a summer bridge program the allows the cohort to experience the rigorous coursework of a STEM student including math, chemistry, physics, and coding in addition to creating connections within your cohort and the program staff. My cohort, Cohort 9 proved to be a strong, diverse, and motivated group of scholars as we were prepared to excel before arrived at University Park in the fall. It is hard to say that I would be doing well at Penn State without MSP, and I am truly grateful for the strong foundation and support system this program has surrounded me with.

Justice pictured far left (above) and center (below) at Penn State with other Millennium Scholars

In addition to Millennium Scholars Program, I am also in the Schreyer Honors College, which is one of the top public university Honors Colleges in the world. Schreyer offers an endless support network in addition to an endless list of resources and a commendable level of academic integrity for scholars to excel. Through Schreyer I have experienced exclusive honors courses such as Rhetoric and Civic Life, Math 140, and 141 which have allowed me to be more successful in a concentrated learning environment.

To conclude, I have truly enjoyed my first year at Penn State. With the addition of making any new friends, learning more about myself and the community I am involved in, taking the next step in my professional life, and the help of the Millennium Scholars program, Schreyer Honors College, Navigators program, NSBE (National Society of Black Engineers), and the Paul Roberson Cultural Center I have a village of positivity and success around me that I am extremely grateful for.

Joshua Simpson (Senior, College of New Jersey)
2013 & 2017 NASA Solar Eclipse

I am preparing for graduation and majored in Public Health. During the past year, I have recognized my talent and interest in ultimate frisbee. It is a competitive field sport where two teams play 7 versus 7 to see who can score the most points. Recently, I was acknowledged for my skills by club-level players in a local league and several representatives from different teams asked if I would like to play for them. I was even approached by a captain for one of the upcoming Disc Diversity showcases, which are essentially ultimate frisbee games played by the best ultimate frisbee players in the nation. Who knows, maybe I will go Pro someday!

Christian Jenkins (High School Senior) – 2016 & 2017
NASA Solar Eclipse

I am currently a senior at John F. Kennedy High School in Silver Spring, Maryland. I will be graduating on June 14, 2022. I am a member of the National Honor Society and the Leadership Training Institute. I am also an EagleScout. In the fall of 2022, I will attend the University of Maryland College Park studying Kinesiology and Psychology.

Natural Radio & VLF Group

Formerly Yahoo VLF Discussion Group Visit: https://groups.io/g/VLF

Shawn Korgan, Founder/Group Moderator & Mark Karney, Group Administrator/Moderator

The Natural Radio & VLF Group, formerly the Yahoo VLF Discussion Group, was founded by Shawn Korgan in 2001. It is a discussion group dedicated to those who enjoy monitoring radio frequencies in the VLF (very low frequency) radio spectrum (3-30 kHz) and the surrounding radio frequencies. We listen to the amazing Natural Radio sounds created by planet Earth such as whistlers, chorus, tweeks, risers, sferics and hiss on simple VLF receivers (Whistler Receivers). This is a form of radio astronomy. You can listen to beautiful bird-like sounds created by the northern lights on your whistler receiver while watching them at the same time! Or hear an incoming solar flare impact our planet's ionosphere and magnetosphere in real time! Listen to distant lightning's metallic ring during nighttime hours. Study sprites and jets and learn about Space Weather. Discuss VLF receiver designs. Some members monitor Military and Government and VLF stations to assess the effects of solar activity on the ionosphere. Others experiment with transmitting on certain VLF frequencies.

Become a member today by simply sending an email to: VLF+subscribe@groups.io from the e-mail account you wish to have subscribed to the Natural Radio & VLF Group. Membership is open to anyone interested in any aspect of VLF. We encourage new members to visit our website at https://naturalradiolab.com/ for introductory information to the world of Natural Radio listening. *Please note that we conduct our discussions within the bounds of proven science. Discussions of fringe science, speculative science and conspiracy theories are considered off-topic and out of place on this forum.*

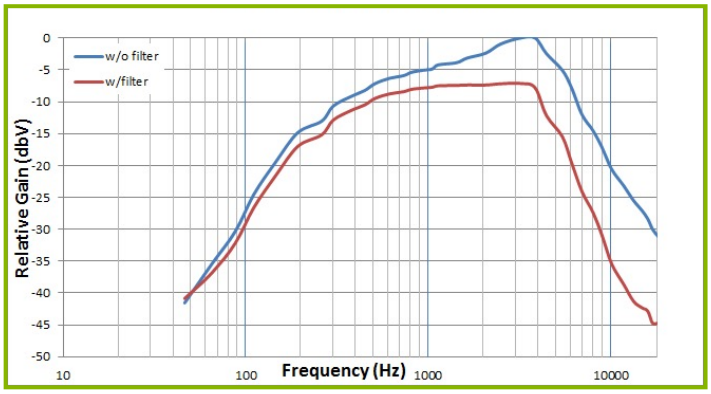
INSPIRE VLF-3 Receiver Notes

Dennis Gallagher, VLF Receiver Chief Technical Advisor

For 33 years, the INSPIRE Very Low Frequency (VLF) radio receiver kit has been designed with one underlying goal – to educate students of all ages about the sounds of space through hands-on experience. Building one's own electronic device is a step forward to opening the world of scientific exploration and showing that this complex world is made up of many simple components working together. (Did you know the VLF-3 receiver kit has 114 parts?) The receiver's features include an internal battery / external battery connection and stereo audio plugs for listening to the VLF signals between 300 Hz up to 15 kHz – antenna not included.

VLF Questions from INSPIRE VLF-3 Receiver Users

What is frequency range that can be observed?
See the two curves for the INSPIRE receiver's measured frequency response, one with the high pass filter switched out and one switched in. With the filter "out" the frequency range is roughly 100 Hz to 15,0000 Hz. One would have to determine the noise floor for the receiving location as a function of things like nearby power line and power supply noise before knowing the frequency range that could be observed.



INSPIRE VLF-3 Receiver Frequency Response Curve

What type of antenna do you recommend using with the INSPIRE VLF receiver?
The faceplate includes two interfaces for an antenna. One is a BNC connector and the other a two-screw terminal plate, one for signal and the other for a ground wire. The antenna can be as simple as an insulated wire tossed over a tree limb, for example. I have used a field setup where I run a wire up through 18 foot (6 meter) high triplet of PVC pipes connected end to end that I slide onto a metal rod hammered into the ground. I have a ground wire connected to the rod. A copper grounding rod works well in our wet soil around here in the southeast USA. I leave the sleeve coupling between PVC pipes with only friction fitting so they can be disassembled for transport. When the BNC connector is used, it is usually for a telescoping antenna with integral BNC connector. That makes it pretty portable. Most BNC mount antennas are made with a load coil to improve operation at high frequencies. For VLF signals the load coil neither helps nor hinders its use. The receiver is designed so that a 6-foot (~2 meter) antenna is sufficient. There is a gain control for the "data output", a microphone-level audio output, that can be adjusted to make use of a wide range of antenna lengths. Too high a volume setting will result in feedback squeal. A separate high-quality ground is recommended regardless of the antenna employed, which would be connected to the ground screw terminal on the terminal block.

After setting up the VLF receiver, what software should I use?
I use Spectrum Lab (https://www.qsl.net/dl4yhf/spectra1.html), but there are several packages available, and some operating systems can capture sound. The receiver is sensitive up to about 15 kHz so recording with a sample rate of 48 kHz is plenty. This software can record audio and display it as amplitude as a function of time or as frequency versus time with the amplitude color coded.

Share Your VLF Observations in *The INSPIRE Journal*

The INSPIRE team invites you to share your VLF observations with our readers. Describe your experience, including any comments that relate to carrying out your field observations. Field photographs and spectrograms are welcome components along with a short bio and photo to accompany your submission. All submissions are reviewed prior to publication.

Thanks to INSPIRE VLF Chief Technical Advisor Dennis Gallagher

Dr. Dennis Gallagher is a Senior Researcher in the Heliophysics and Planetary Science Branch at NASA Marshall Space Flight Center and serves as INSPIRE's Chief Technical Advisor. Dennis answers VLF kit users' technical questions. He has been actively involved with the organization since it was founded in 1989.

VLF Online Resources

NATURAL RADIO & VLF DISCUSSION GROUP
(Formerly Yahoo Discussion Group)
https://groups.io/g/VLF

VLF GRAPH CONVERSION SOFTWARE
Spectrum Lab: http://www.qsl.net/dl4yhf/spectra1.html

VLFrxTools: http://abelian.org/vlfrx-tools

LOCAL TIME TO UTC CONVERSION
http://www.worldtimeserver.com/current_time_in_UTC.aspx

To Purchase an INSPIRE VLF-3 Receiver Kit and Download Assembly Instructions & Observation Forms
http://theinspireproject.org/default.asp?contentID=3

INSPIRE VLF-3 Kit Questions
CustomerService@TheINSPIREProject.org

INSPIRE Journal VLF Observations/Article Submissions:
Editor@TheINSPIREProject.org


Photo courtesy of
Tony Bateman (Finland)

INSPIRE VLF-3 Radio Receiver Kit Ordering Information

INSPIRE VLF-3 Radio Receiver Kits can be ordered online at:
www.TheINSPIREProject.org

INSPIRE accepts purchase orders for multiple kit orders. Discounts are available for non-profit organizations utilizing kits STEM curriculums.

For more information email: CustomerService@TheINSPIREProject.org

Invest Today for the Exploration of Tomorrow

In 2009, The INSPIRE Project expanded its STEM educational programs to provide scholarships and internships to educators, middle/high school students, and university students to ensure the next generation of space science and technology explorers. INSPIRE's team is comprised of dedicated board members and advisors who volunteer his/her time to make it possible for INSPIRE to continue fulfilling its expanded mission of providing students the resources to pursue study in STEM disciplines. If you would like to make a life-changing gift, please visit: www.TheINSPIREProject.org.
Donations are tax-deductible.

For more information about individual and corporate giving opportunities or volunteering, please contact INSPIRE Program Manager:
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Photo: Karin Edgett, 2017 NASA Solar Eclipse Team (Austin Peay State University, Clarksville, TN)

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