Proceedings of the 26th Annual Meeting of the NASA - Missouri Space Grant Consortium

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NASA - MISSOURI SPACE GRANT CONSORTIUM
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MISSOURI SPACE GRANT CONSORTIUM

Preface

This 26th volume of our annual conference proceedings contains the abstracts of technical research reports that were written and presented by graduate, undergraduate, and high school students supported by the NASA-Missouri Space Grant Consortium. The complete reports can be found on the enclosed CD. The primary purpose of our program is to prepare students to contribute to nation's workforce in areas related to the design and development of complex aeronautical and aerospace related systems, as well as the in-depth study of terrestrial, planetary, astronomical, and cosmological sciences. This goal is being achieved by mentoring and training students to perform independent research, as well as supporting student-led engineering design team and scientific research group activities. This year's meeting was held at the Missouri University of Science and Technology on April 21-22, 2017.

The Missouri Consortium of the National Space Grant College and Fellowship Program is sponsored by the National Aeronautics and Astronautics Administration and is under the direction of Dr. Lenell Allen, National Program Manager. It is my pleasure to thank the Affiliate Directors of the Consortium: Dr. Frank Feng, University of Missouri-Columbia; Dr. Dan McIntosh, University of Missouri-Kansas City; Dr. Bruce Wilking, University of Missouri-St. Louis; Dr. Ramesh Agarwal, Washington University in St. Louis, Dr. Majed Dweik, Lincoln University of Missouri, and Dr. Mike Reed, Missouri State University, for their outstanding merit in directing and coordinating Space Grant activities at their respective institutions. I would also like to thank our Associate Directors: Dr. Vayujeet Gokhale, Truman State University, and Dr. Mike Swartwout, Saint Louis University, for their contributions in coordinating, advising, and mentoring student research training at their institutions this past year. Most of all, the student authors are to be commended for preparing and presenting their research reports with a high degree of quality and making this year's meeting an outstanding success.

I hope you find the wide variety of student research presented herein interesting and informative.

Sincerely,

Dr. S. N. Balakrishnan, Director
NASA-Missouri Space Grant Consortium
NASA-EPSCoR Missouri

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Banquet Presentation

Detection and Determination of Nutrient Pollutants: Their Effect and Mitigation Using Nano-Technology

Nasruddeen Al-Awwal and Ethan Eynard
Cooperative Research, Center of Nanotechnology
Lincoln University, Jefferson City, Missouri
Advisor: Dr. Majed Dweik

Abstract

Detection as a method for determining the presence of a chemical or biological agent is a vital function within the domain of environmental monitoring and remediation. This study uses Colorimetry and Ion Chromatographic methods to detection and determines the presence of nutrient pollutants (NPs), nitrates and phosphates that are applied commonly as fertilizers throughout American Midwest agricultural zones. Nutrient pollution occurs primarily as a result of fertilizer runoff in which nutrients are displaced from the site of application and carried into nearby rivers and streams with an increase in the concentrations of nitrogen and phosphorus which poses a high risk to both animals and humans health. Such runoff is carried downstream and has since been established among research agencies to be leading cause behind the oxygen deflation in the Gulf of Mexico leading to eutrophication. Due to high concentrations of biogenic compounds occurred in both agricultural catchments and residential drainages, significant focus has been put forth by management and research communities alike to develop enhanced methods of filtration to counteract nutrient pollution Detection of nutrient pollutants will serve as an underlying component of the study's role in exploring the prospects of nanofiltration as a means for extracting nutrient pollutants from surface water. Going by the Holm-Sidak method, the differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference ($P = <0.001$).

Link to Full Paper

Nasruddeen Al-awwal was born on 23rd August, 1983 in Columbia, Missouri, USA. He graduated from Usmanu Danfodiyo University Sokoto, Nigeria where he obtained his B.Sc. in applied chemistry. He taught A-level Chemistry at College of Arts, Science and Remedial Studies Kano, Nigeria. He later went to India in order to advance his studies where he obtained his MS Organic Chemistry from SRM University Kattankulathur, India. He is currently working on another masters degree in Environmental Science at Lincoln University, Missouri with emphasis on water quality. He planned to proceed ahead for his PhD. Nasruddeen wanted to stay in the field of research and academics and continue to impact to the community.

Ethan Eynard works as a research assistant through the Department of Nanotechnology at Lincoln University of Missouri. He is a dual degree-seeking student, majoring in English creative writing and environmental science. In his first year, he has focused his research on the issue of field nutrient runoff, its impacts in the terrestrial and aquatic communities exposed, as well as new methods for detecting nutrient pollutants in the environment. Raman Spectroscopy is his most recent focus for research on this issue.

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Yellow Supergiant Project

Kelly K. Alvarado
Missouri State University
Advisor: Dr. Robert S. Patterson

Abstract

All findings including data collected, images taken, and/or any other form of data found and used were learned through procedures with IRAF and CCD photometry. The purpose for the data was for the use of determining the variability of yellow supergiant star candidates we chose with the use of SIMBAD. Within these stars, should they have contained the characteristic of variability, the next objective of the study was to determine if those stars showed periodicity. Once stars were determined to have both, the next step in the procedure was to generate light curves.

Link to Full Paper

Kelly Alvarado is a sophomore at Missouri State University majoring in Cell and Molecular Biology in the Department of Biomedical Sciences. She also has two minors in Astronomy and Chemistry. Kelly is from a small town called Wheaton, MO, and has made the Dean's List for the past three semesters since attending MSU; and is a Multicultural Leadership Scholar and Honors College student.

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Periodogram Comparison

Adolfo Cancino
Missouri State University
Advisor: Dr. Peter Plavchan

Abstract

This project is to compare the three periodogram algorithms offered on the Exoplanet Archive periodogram service. A periodogram looks for repeating signals in a time-series measurements, like how the brightness of a star varies over time. The three algorithms are called: Lomb-Scargle, Box-fitting Least Squares (BLS), and Plavchan. The Exoplanet Archive uses the Lomb-Scargle algorithm by default, but users may change the algorithms and parameters in the results page. The project is focused on a simulated data set of 6,144 different time-series, each with injected signals with different sets of parameters. This data set is divided up into four different groups. These groups include time-series injected with a repeating transit signal and a sinusoidal signal, two sinusoidal signals, two transit signals, and two triangle (saw-tooth) signals with different periods, amplitudes and phases. The results from the periodogram algorithms indicate actual detections of the injected periodic signals, non-detections, and random data. The purpose is to figure out which periodogram algorithm works the best. The experiment will also help to find what algorithms and combination of parameters gives off false detections or which sets parameters do not produce an accurate detection for the given algorithm.

Link to Full Paper

Adolfo Andrès (Andrew) Cancino was born in Cushing, Oklahoma, but has moved around his whole life due to his father's military career. He is a senior at Missouri State University pursuing two majors: Mathematics and Physics with an emphasis in Astronomy. He is part of the math honors society Kappa Mu Epsilon and graduated with an associate of arts with a 4.0 GPA and honors recognition. Andrew will be attending UT Austin this summer (2017) for the TAURUS program and plans to continue to go to school for higher education with the goal of attaining a doctorate in either physics or mathematics. Andrew aspires to one day work for NASA or other government agency.

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Vibration System Reaction to Impact

Jared Carrier
University of Missouri
Dr. Frank Feng

Abstract

The research discussed in this report discusses a model for energy production using vibrations. By placing a vibrating plate in line with a stationary plate and alternating the positioning, one can create a variable capacitor to generate energy. The model that this report analyzes is the use of an instantaneous force on a vibrating plate to create higher output amplitudes. The higher the output amplitudes are, the greater amount of energy the variable capacitor can produce. The focus of this study is to sustain contact with a vibrating plate and a stopping block at a frequency lower than the systems resonance. If frequency lower than resonance can produce amplitudes greater than those at resonance, the system will be a success. An experiment was made to test this contact system and conclude the existence of a sustained contact period and a higher magnitude output amplitude. The system was also modeled using a MATLAB code for greater understanding of reactions to different inputs. The results from the experiment show the existence of a sustained contact period and high output amplitudes. The modeling code has been successful in its purpose, but must still be analyzed further to better understand the system.

Link to Full Paper

Jared Carrier is currently a senior Mechanical Engineering student at the University of Missouri. Columbia has been his home for the past 3.5 years, but before that, he lived in Swansea, IL. Upon graduation, he hopes to continue his interest in vibrations by becoming an Acoustical Engineer. Music has been a major inspiration in Jared's life, so combining it with engineering seemed like a great idea.

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Examination of the Effect of Riblets using the Spalart-Allmaras RANS-LES Model Progress Report

Jason Chau
Missouri University of Science and Technology
Advisor: Dr. Lian Duan

Abstract

The goal of this project was to determine the effectiveness of riblets in decreasing skin friction and drag using efficient methods. Direct Numerical Simulation (DNS) modeling, while accurate, is both time and resource intensive. To counteract this, the goal was to conclude if a Reynolds Averaged Navier Stokes-Large Eddy Simulation (RANS-LES) model could be used as a substitute. A RANS-LES model uses fewer resources and requires less time to conduct. Rough accuracy achieved by a RANS-LES model comparable to DNS would allow a time savings in calculations and a quicker determination in riblet effectiveness. Current progress has examined a clean flat plate at a Mach number of 2.5 to match the inlet skin friction coefficient presented by Duan and Choudhari.

Link to Full Paper

Jason Chau is a senior undergraduate student at Missouri S&T and will earn bachelors in Aerospace and Mechanical Engineering. Jason came to Rolla from his hometown of Springfield, Missouri, and intends to go into industry, though he is considering possible post-graduate studies.

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Extreme Ultraviolet Coronagraph Pointing Mechanism

Anthony G. Chen, William C. Chlanda, Ian L. Gwaltney, Benjamin H. Litwack
NASA MSFC Space Hardware and Robotics Academy
Principal Investigator and Mentor: Dean Alhorn

Abstract

The team developed a prototype pointing mechanism for the Coronal Spectrographic Imager in the Extreme Ultraviolet (COSIE) mission. This mechanism is designed for deployment on the International Space Station and will point an extreme ultraviolet coronagraph at the sun. The team demonstrated the device's motion tracking capability within a sufficient angular range to track the sun while onboard the station, as well as stowing, deployment, and manual operation capabilities. The mechanism is a triaxial robotic arm, with one axis for deployment and two axes for tracking. It tracks a slow-moving light source using input from a sun sensor mounted on the end of a coronagraph mockup. This prototype is built half-scale and consists of materials and components needed to operate within a 1-g Earth gravitational environment. It is intended as a proof-of-concept, and both its hardware and software are designed and integrated by this team since no previous prototype exists. Continued future development includes testing of scientific instruments and flight-capable hardware.

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Searching for Frequency Multiplets in the Pulsating Subdwarf B Star PG 1219+534

John Crooke, Ryan Roessler
Missouri State University
Advisor: Dr. Mike Reed

Abstract

Subdwarf B (sdB) stars represent the stripped cores of horizontal branch stars. Pulsating sdB stars allow us to probe this important stage in evolution. Thanks to Kepler data, we now know that sdB star rotation periods are long; on the order of tens of days. This explains why they were not measured using ground-based follow-up data, which typically only spanned a week or two. Azimuthal pulsation degeneracies are removed by rotation, and so by detecting pulsation frequency multiplets, we can determine pulsation modes and apply constraints to models, which tell us stellar structure. We need ground-based observations as Kepler did not detect many p-mode pulsators, but almost exclusively g-mode pulsators. The shorter-period p-modes occur in hotter sdB stars, and so we need these to measure the pulsation dependence across the horizontal branch. During 2015, we observed PG 1219+534 (hereafter PG 1219), a known p-mode pulsator, over several months using our local 16-inch robotic telescope. Here we report preliminary results of processing those data to search for pulsation multiplets.

Link to Full Paper

John Crooke is a junior at Missouri State University studying in the Physics, Astronomy, and Materials Science Department. His major field of study is Physics and he is pursuing the Astronomy/Astrophysics track. After graduation, he hopes to attend graduate school and earn a doctorate degree in astronomy and pursue a career focusing in extragalactic astronomy.

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Preliminary Work in Low-Fidelity Analysis of Hypersonic Vehicles

Cole P. Deegan

Missouri University of Science and Technology
Advisor: Dr. Serhat Hosder

Abstract

To reduce the time and cost of hypersonic vehicle design, low-fidelity engineering methods can be used to gain rough estimates of important parameters early in the design process. A Matlab program was written in order to understand the aerodynamic and aerothermodynamic properties of a planetary entry capsule of a sphere-cone geometry. The aerodynamics of this geometry were analyzed using pressure predictions methods such as the Newtonian Method, and Modified Newtonian Method using both a calorically perfect gas (CPG) assumption and thermo-chemical equilibrium gas (TCE) assumption. A no-skip ballistic atmospheric entry analysis using a density-altitude model was completed to understand the trajectory of the capsule starting from a specified altitude and velocity. Aerothermodynamic properties were analyzed using stagnation point heating analysis based on normal shock wave analyses using CPG and TCE assumptions. This low-fidelity model could be coupled with mid to high fidelity models in order to create a much faster and cheaper overall design process for hypersonic vehicles, without losing the accuracy provided by high-fidelity simulations.

Link to Full Paper

Cole Deegan was born and raised in Kansas City, Missouri. He is currently a senior undergraduate student studying Aerospace Engineering at the Missouri University of Science and Technology. He has been part of two undergraduate research projects in his time at Missouri S&T, has served as Vice President of the Aerospace Engineering honor society, Sigma Gamma Tau, and has been on the Dean's List for each semester of enrollment. Cole plans to continue his education and is pursuing a doctoral degree in Aerospace Engineering at Missouri S&T.

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Augmented Reality Applications for Carbon-Based Nanocomposites

Nick Delamora and Brittany Porter
Department of Physics, Astronomy, and Materials Science
Missouri State University
Advisor: Dr. Ridwan Sakidja

Abstract

We have been able to generate AR 2D and 3D models for components of carbon-based nanocomposites by utilizing AURASMA code, MAYA 3D-mech code and supporting molecular visualization codes. We found that for C60-C240 pairings, a strong C-C bond can be created which may improve the thermal conductivity of the nanocomposites. We found that the abundance of pentagon tiles and the curvature compatibility between two carbon-based molecules are essential to establish a good chemical bond.

Link to Full Paper

Nick Delamora is from Springfield, Missouri, and is currently pursuing his Bachelors of Science degree in Mathematics and Bachelors of Science degree in Computer Science at Missouri State University. He hopes to pursue a career in software development and use his information technology skills to collaborate on many future projects. His experiences range from technical troubleshooting to building a web application to modeling molecules with AR and scripting movement for VR using software such as Maya, Unity, and Aurasma. Nick values education and will continue to further his studies as well as continue to develop his abilities.

Brittany Porter is from Kansas City, Missouri, and is currently pursuing her Bachelor of Science degree in Sociology at Missouri State University. Brittany is minoring in Mathematics and Computer Science and plans to pursue these subjects more in the future.

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Transit Timing Variation and Exoplanet Demographic Studies

Shannon Dulz
Missouri State University
Advisors: Dr. Mike Reed and Dr. Peter Plavchan

Abstract

This paper summarizes ongoing work on two exoplanet research projects. The first utilizes Kepler light curves of known exoplanets to search for transit timing variations. Transit timing variations could indicate an additional non-transiting planet. The second study involves an exploration of the current state of exoplanet demographics for the purpose of generating a simulated synthetic planet population which matches observed trends. This synthetic planet population will contribute to a simulation to determine if a ground-based radial velocity survey can effectively choose targets for a space-based direct imaging mission such as NASA's WFIRST.

Link to Full Paper

Shannon Dulz is a senior undergraduate at Missouri State University from Kirkwood, Missouri. She has a double major in Physics and Mathematics. In the fall, she plans to begin a Ph.D. program focusing on Astronomy.

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Design and Computational Fluid Dynamics Analysis of an Idealized Modern Wingsuit

Maria E. Ferguson
Washington University in St. Louis
Advisor: Dr. Ramesh K. Agarwal

Abstract

The modern wingsuit has been the subject of few scientific studies to date; the prevailing design process remains the dangerous "guess-and-check" method. This study employed the commercial CFD flow solver ANSYS Fluent to solve the steady Reynolds Averaged Navier-Stokes equations with several turbulence models. The computational fluid dynamics (CFD) results provided information on the flow about a wingsuit designed with an airfoil cross section and relatively large planform with aspect ratio 1.3 at a Reynolds number of 5.5×10^6. The CFD simulations were performed using the k-kl-ω Transition turbulence model for the 2D Gottingen 228 airfoil and with the Spalart-Allmaras turbulence model for the 3D wingsuit. Although the lack of experimental data available for the wingsuit flight makes the true CFD validation difficult, the results for the 3D wingsuit were analyzed and compared to the 2D airfoil, for which the computations were validated against the data from the airfoil/wing management software Profili 2.0. The Gottingen 228 airfoil had a maximum lift coefficient of 1.97 and a stall angle of 13°. The wingsuit had a maximum lift coefficient of 2.73 and reached a stall angle of 48°, which is higher than that of the 2D airfoil due to the 3D planform and induced drag. The computational results indicate that the wingsuit as designed shows promise and could likely perform well under typical wingsuit flying conditions.

Link to Full Paper

Maria Ferguson is a Master's of Aerospace Engineering candidate in the department of Mechanical Engineering and Materials Science at Washington University in St. Louis. She graduated with honors with a Bachelor of Arts from Saint Mary's College and a Bachelor of Science in Mechanical Engineering from Washington University in 2016 through the Dual Degree program. Hailing from Napa, California, she hopes to secure a position as an Aerodynamics Engineer in industry after graduation and one day fly her own wingsuit.

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Block Copolymer Nanostructures Templated Metal Nanostructures for Optical Applications

Calbi Gunder
Missouri State University
Advisor: Dr. Mahua Biswas

Abstract

With the rise in emerging technologies in the field of optoelectronics, fabrication of plasmonic, and photonic nanomaterials becoming imperative. This research demonstrates a method for fabricating gold (Au) nanodots using block copolymers (BCPs) nanostructures as a template. These Au nanostructures are very attractive for application in the field of optical devices. This fabrication procedure known as BCP lithography is a promising, simple, low cost route, which has already shown great promise in the microelectronics industry in large scale. Polystyrene-block-poly (2-vinylpridine) (PS-b-P2VP) BCPs inverse spherical micellar nanostructures was fabricated first using a spin casting method for making the template, followed by fabrication of gold nanodots using solution process method. A brush layer of Monohydroxy terminated Polystyrene was deposited before the BCP casting to study any effect of surface modification. In this study, Au nanodots was fabricated successfully from the selective deposition of Au precursor only in the P2VP nanomicelles domain of the BCPs. It is also concluding that the surface modification due to the presence of Monohydroxy terminated Polystyrene brush layer, is probably contributing the slight shape deformation of the Au nanodots.

Link to Full Paper

Calbi Gunder is currently a graduate student in materials science at Missouri State University. In the fall of 2016, he obtained his Bachelor's degree in physics with an emphasis in engineering and applied physics along with a minor in mathematics. He spent his childhood in Stockton Missouri and his current aspirations include finishing his masters degree along with getting a doctorate in nanotechnology.

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MICRONERVA: Guiding Techniques for an Automated Telescope Array

Ryan Hall
Missouri State University
Advisor: Dr. Peter Plavchan

Abstract

MICRONERVA (MICRO Novel Exoplanet Radial Velocity Array) is a project designed to measure spectroscopic radial velocities with a system of 8 inch CPC Celestron telescopes. Our goal is to show that MICRONERVA has the effective light gathering power of a single, larger telescope for a lower cost. Light from each telescope is centered and focused on the entrance of a single mode fiber. Then, multiple fibers from multiple telescopes are combined at the exits of the fibers and sent through to one spectrograph. Focusing on more specific aspects of my project, this paper discusses the various programs and techniques that will allow individual telescopes to guide on targets. Each telescope must constantly keep starlight centered on the entrance to its single mode fiber for the time needed to obtain the spectrum. This will maximize the amount of light coupled into the fiber and sent to the spectrograph. The process of guiding will be done with the use of SBIG, ST-I guide cameras. The hardware is controlled using Python commands and the ASCOM and MaxIm DL drivers. The ability to guide on a target, with sufficient accuracy, is a crucial step that will determine the viability of the MICRONERVA project.

Link to Full Paper

Ryan Hall is a current Junior level student at Missouri State University from the town of Rogersville, Missouri. He is in the Physics, Astronomy, and Material Science department working on his Bachelors of Science degree. Upon graduation, he is planning to receive a Major in Physics with a Minor in Computer Science. After this, he plans to further his education by continuing on to a Doctoral program in Astronomy.

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Enclosed UAS Facility for Flight Algorithm Testing and EUS Main Propulsion System Monitored Conditions

Aaron J. Hensley
Missouri University of Science and Technology

Research Mentors:
David Teare and Gregory Miller
NASA Marshall Space Flight Center, Huntsville, AL, 35812

Bradley Biehn
Jacobs ESSSA, Huntsville, AL, 35806

Abstract

Two distinct assignments were given during the summer internship period. A concept study for an outdoor Category I Unmanned Aircraft System (CAT I UAS) Test Facility is performed. The facility is to provide an air space volume that allows UAS flight testing to be performed under a less restrictive set of operational requirements, responsibilities, and procedures. The concept study will include the user and design requirements that the facility will be expected to meet, along with the possible site locations at Marshall Space Flight Center (MSFC) or Redstone Arsenal. The MSFC CAT I UAS requirements, responsibilities, and procedures are documented in MPR 7900.2 and supporting documents. Definition and approval of the test facility CAT I UAS requirements, responsibilities, and procedures is not a part of this study. Work is also performed analyzing Exploration Upper Stage architecture and determining Mission and Fault Management monitored conditions of the main propulsion system during flight of the SLS Block 1B configuration. Different hypothetical failure modes of the main propulsion system are discussed along with the reason behind the failures and the recommended actions that should be taken in each case.

Link to Full Paper

Aaron Hensley is from Warrensburg, MO, and is a first-year Aerospace Engineering Master of Science degree candidate in the Department of Mechanical and Aerospace Engineering at the Missouri University of Science and Technology. He hopes to one day have a career in the space exploration field and believes the development and innovation of space exploration technologies not only benefits the expansion and advancement of humanity in space, but also for the Earth and its residents. He believes that deep-space missions will discover new and exciting things about the universe that humans had not known before, and wants to be part of the generation that pushes the boundaries. Aaron would like to eventually work for NASA and help to continue their dedication to science and exploration for the benefit of all mankind.

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Developing a Non-Destructive Evaluation Technique using Resonance Ultrasound Spectroscopy

Annemarie Hoyer
University of Missouri – Columbia
Advisor: Dr. Gary L. Solbrekken

Abstract

Resonant Ultrasound Spectroscopy (RUS) is conventionally used to determine material properties of elastic bodies. At the University of Missouri – Columbia, research is being done to draw parallelisms between the amplitudes of the peaks in the frequency response results to that of contact pressure. To prove that contact pressure is proportional to the amplitude results of RUS, contact resistance measurements were conducted on several samples that are an assembly of two hollow aluminum tubes. The analysis will show that reduced thermal resistance indicates higher contact pressure, which will lead to higher amplitude readings in RUS.

Link to Full Paper

Annemarie Hoyer is from Columbia, MO and is pursuing her doctorate degree in Mechanical Engineering at the University of Missouri – Columbia, under Dr. Gary Solbrekken. Her field of study is thermo-mechanical analysis and specifically, her current research includes irradiated material characterization. After graduation, she would like to pursue a career in R&D, utilizing skills learned in research and working at Oak Ridge National Laboratory and Northrop Grumman, Inc. Annemarie will be graduating May 2017.

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Deep Space Drug Shielding

Hannah Kim
Missouri University of Science and Technology
Advisor: Dr. Sutapa Barua

Abstract

Space medications help prevent astronauts from being ill and provide acute treatment in medical emergency situation for them to fulfill the primary goal of a successful long duration space mission: maintaining astronauts' health in a unique, isolated, and extreme space environment. However, recently, National Aeronautics and Space Administration (NASA) have reported a shorter shelf life of space medications caused by chronic ionizing radiation and space medications' long term efficacy in space became questionable. Hence, to help extend the space medications' stability and protect pharmaceuticals from the indirect radiation damage, Trolox, free radical scavenging antioxidant, were bio-conjugated with PLL (Poly-l-lysine) on the surface of drug encapsulated PLGA (Poly-lactic-co-glycolic acid) nanoparticles (NPs) using carbodiimide crosslinking chemistry. In this study, Melatonin, a sleep aid medication used in International Space Station (ISS), was chosen as a model drug. Radiation induced hydroxyl radicals, highly reactive free radicals, will be oxidized by Trolox before it could react with the pharmaceuticals in PLGA-PLL-Trolox composites' core. The mean size of PLGA-PLL-Trolox composites were 491.3 ± 33.09 nm with zeta potential value of 26.4 ± 10.18 mV. A successful conjugation of PLL-Trolox on the surface of melatonin encapsulated PLGA NPs were determined by FT-IR and H^1-NMR analysis. Hydroxyl radical scavenging capacity assay (HOSC) was performed to test Trolox's free radical quenching ability. These results suggest a new molecular approach to shield pharmaceuticals from indirect radiation damage using antioxidant conjugated biocompatible polymer.

Link to Full Paper

Hannah Kim is a senior majoring in Biological Sciences with minor in Biomedical Engineering at Missouri University of Science and Technology. She was born in Rolla, Missouri and grew up in Gwang-ju, South Korea. Hannah believes helping people improve their health by preventing or curing diseases with medicines and vaccine means giving their quality life back. Hence, she hopes to contribute to biomedical engineering research field for a healthier and happier world. Her research interests include nanoparticle synthesis for drug delivery, microbiology, and genetic engineering. Hannah also loves music as much as she loves science, which lead her to join Missouri S&T Symphony Orchestra as first violin.

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Modernization of CFD Code for Petascale Computing Platforms

Ryan Krattiger
Missouri University of Science and Technology
Advisor: Dr. Lian Duan

Abstract

This paper updates the progress towards the modernization of computational fluid dynamics (CFD) codes for use on petascale computing platforms. Effort has been made to improve cross-platform compatibility utilizing the CMake build system as well as structural considerations for threading and system specific tuning. The CMake build system has been introduced to the in-house direct numerical simulation (DNS) code HyperWENO and was successfully used to remove the need to manage multiple makefiles for building the same project, thus stream lining code deployment on multiple petascale supercomputers, including the SGI ICE machine Pleiades at NASA Advanced Supercomputing Division, the IBM Blue Gene/Q machine Mira at the Argonne Leadership Computing Facility, and the Cray XE6 machine Blue Waters at the National Center for Supercomputing Applications. The introduction of CMake also allows for command line options to be used to dynamically choose which libraries and features should be built into the code being tested. Progress has also been made to improve thread-level parallelization with OpenMP by suggesting code changes to isolate bottlenecks into unified loop structures. Ongoing and future work includes the introduction of a hybrid MPI-OpenMP parallel structure, an additional dimension of domain decomposition, and automated unit/regression testing.

Link to Full Paper

Ryan Krattiger was born and grew up in McFarland, Wisconsin, about five minutes south of Madison. Currently he is pursuing his Masters in Aerospace Engineering at Missouri Science and Technology. Graduating with honors with a BS in Aerospace Engineering, he continued work under Dr. Duan into a Master's Program, which is being completed remotely. Professionally, Ryan has worked as a developer intern at Forte Research Systems, and is currently employed full time as a HPC Engineer/Developer at Convergent Science (CS). At CS he is working on improving design and performance of their CFD solver, Converge. It is his goal to continue to work in CFD in the capacity of using and growing his knowledge of computer science, fluids, and numerical modeling to create solvers that scale to the larger and increasingly complex problems looking to be solved by researchers and industry.

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C/2002 T7 (LINEAR) Chemical Composition Study

Arianna Laurent
University of Missouri St. Louis
Advisor: Dr. Erika Gibb

Abstract

High-resolution, near-infrared spectroscopic observations of Comet C/2002 T7 were first performed on May 3-9, 2004 at the NASA Telescope Facility (IRTF) on Mauna Kea, Hawaii with the Cryogenic Echelle Spectrometer (CSHELL). Data were reduced and provided is the data from three settings one from May 3rd and two from May 9th. Ammonia (NH_3) and carbonyl sulfide (OCS) were detected on May 9th. This research is part of a continuing data reduction process for comet T7 to characterize the overall composition of volatiles in comets and to use comets to understand how volatiles were distributed through the early solar system.

Link to Full Paper

Arianna Laurent is an undergraduate physics student approaching the end of her junior year at the University of Missouri St. Louis. Currently she does not plan on continuing with the research aspect of the physics field, but is interested in pursuing a career in secondary education in the subjects of physics or mathematics.

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Torlon Coating of Ni-MOF 74 and UTSA-16 on Corning Cordierite Substrates and Their CO2 Adsorption Capabilities

Shane Lawson, Harshul Thakkar, Amit Hajari, and Xin Li
Department of Chemical & Biochemical Engineering
Missouri University of Science and Technology
Advisors: Dr. Ali Rownaghi & Dr. Fateme Rezaei

Abstract

It has been previously shown that metal-organic-frameworks (MOFs) can be effectively coated on monolithic structures and functionalized to perform large scale gas separation processes. Although the earlier process showed promising results, the loading of the UTSA and Ni-MOF 74 powders onto the substrates was only ~52 wt% for Ni-MOF 74 and ~55% for UTSA-16(Co) [1] respectively. In addition, the CO2 capacities deceased for both of these materials from the powders alone. This new process, which involves pre-seeding premade powder onto the monolithic surfaces using 3 wt% Torlon, improves upon the result from the previous experiment. Whereas the earlier loading was 52 wt% for Ni-MOF 74 and 55 wt% for UTSA-16, the new loading has been tested to be a maximum of ~126 wt% for Ni-MOF 74 and a maximum of ~123% for UTSA-16. In addition, the substrates treated with this new method have shown improved CO2 capacities with similar kinetics to that of the earlier method

Link to Full Paper

Shane Lawson is from Collinsville, Illinois and is a senior in Chemical Engineering at the Missouri University of Science and Technology. He has currently published two papers and is working on a third. Once Shane graduates this semester, he plans on pursuing his PhD and hopefully, someday working for NASA.

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Symmetry Breaking Bifurcation of a Cylinder in 2D Flow

Zachary Lipira
University of Missouri
Advisor: Dr. Feng

Abstract

The flow about a circular cylinder placed within a channel is studied numerically in order to examine the lift forces on the cylinder for Reynolds numbers below the onset of unsteady flow. To further simplify the numerical computations, the cylinder is fixed in a two-dimensional channel flow while the eccentricity of the cylinder and the cylinder diameter to channel height ratio are varied. This problem has often been studied in fluid mechanics because of its possible applications and because of its inherent complexities that are caused by the flow being confined between two plate boundaries. There have been many numerical simulations conducted for a cylinder in a two-dimensional channel flow, but none have explained well under what conditions the lift force on a fixed cylinder transitions from being stable to destabilizing. The goal of this report is to identify during which steady-state flow regimes a cylinder will experience stabilizing lift forces and how the lift forces transition to destabilizing as the inlet flow varies.

Link to Full Paper

Zack Lipira is from St. Joseph, MO, and started attending the University of Missouri in the fall of 2010 as a student in the Mechanical and Aerospace Engineering program. As an undergraduate, he gained familiarity with computer programming and computation fluid dynamics and contributed on a research project that focused on the aeroacoustics of rotor blades. After graduating in 2014, Zack attended one semester of graduate school at the University of Missouri while serving as a teaching assistant for a MATLAB programming syntax and algorithm design course. Following that semester, Zack took a full-time job in industry as a Process and Robotics Engineer in a 2k injection molding plant in Kansas City, MO, where he was primarily responsible for programming PLCs and interfacing them together with Keyence camera systems. In addition to that, Zack helped integrate machines together over a machine data network which allowed for continual monitoring of all of the processes in the plant while collecting data to optimize plant metrics and process parameters. At the start of 2017, Zack reenrolled in graduate school at the University of Missouri and started working towards a M.S. degree in Mechanical and Aerospace Engineering.

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Are Galaxy Major Mergers Frequent at Early Cosmic Time?
Critical Data-Theory: Tension and Plausible Selection Bias

Kameswara Bharadwaj Mantha
University of Missouri – Kansas City
Advisor: Dr. Daniel H. McIntosh

Abstract

Major galaxy-galaxy merging is expected to be important in the development and growth of massive galaxies (stellar mass $[M^S] > 2x10^{10}\ M_\odot$) over the cosmic history, but especially during early times according to the simulations based on cosmological expectations. We test this prediction by measuring major merger rate of massive galaxies over the past 11 Billion years ($0<z<3$) based on major ($1<M^S_1/M^S_2<4$) galaxy-galaxy pairs in close proximity from Cosmic Assembly Near-Infrared Deep Extragalactic Legacy Survey (CANDELS) and Sloan Digital Sky Survey (SDSS). We find that major merger rate increases from z~0 to z = 1.0-1.5, then turns over and decreases towards z=3, which is in good agreement with previous studies up to z~1-1.5 but is in critical tension with those predicted by simulations at z>1.5. One of the plausible reasons for this tension is that stellar mass ratios (M^S_1/M^S_2) might be a biased tracer of major merging owing to an increasing cold gas content (total baryonic mass M^B) of galaxies towards cosmic high-noon (z~2-4). Leveraging the exclusive CANDELS cold gas information from Popping et al., for the first time, we find observational evidence that stellar mass ratio selection excludes major mergers that are significant according to the total baryonic content of the galaxies ($M^S_1/M^S_2>4$ but $M^B_1/M^B_2<4$), implying that previous estimates of major merger rates might be an underestimate.

Link to Full Paper

Kameswara Bharadwaj Mantha was born in 1992 in Warangal, India. Upon graduating from high school, he completed his Bachelors in Electronics and Communications Engineering at K. L. University. To pursue his interest in Astronomy, he joined the Galaxy Evolution Group (GEG) in the Department of Physics and Astronomy at University of Missouri – Kansas City. He is a student member in the American Astronomical Society (AAS) and Astronomical Society of India (ASI), and has presented his research at 227th and 229th AAS meetings. He is currently an iPhD candidate with Dr. Daniel H. McIntosh, scheduled to graduate in early 2020, after which he plans to pursue a career as a Post-Doctoral research scientist.

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University of Missouri-St. Louis Astronomy Outreach Program

Tianna McBroom and Andre Whittaker
University of Missouri-St. Louis
Advisors: Dr. Bruce Wilking and Dr. David Horne

Abstract

The University of Missouri-St. Louis (UMSL) is proud to offer the Astronomy Outreach Program through the Department of Physics and Astronomy, with funding provided by the NASA-Missouri Space Grant Consortium. The program is geared towards fifth through seventh grade students and aims to stimulate critical thinking and encourage student's interest in space, astronomy, and engineering. It consists of a planetarium presentation, and a classroom presentation that includes demonstrations of science related activities. Great improvements have been made to the program due to a remodel of the UMSL planetarium in the summer of 2015, as well as a partnership with the Challenger Learning Center established in 2016 which provides simulated space missions in addition to the planetarium and classroom demonstrations. The program hosted a total of twelve groups, comprised of sixteen planetarium presentations, and eleven classroom demonstrations. The twelve groups had a total of 304 students. The program will also be hosting another group before the MOSGC Spring meeting which will consist of eight planetarium presentations, and about 200 students. With our new partnerships and recent upgrades, the program has the opportunity to further develop several alternative shows in an attempt to appeal to a broader audience.

Link to Full Paper

Tianna McBroom is a junior undergraduate in the Department of Physics and Astronomy at the University of Missouri-St. Louis. She is working towards her B.S. in General Physics. She hopes to continue her academic career in graduate school and pursue a PhD in materials physics.

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Computational Fluid Dynamics Simulation and Optimization of 69-Degree-Delta Wing Model in Supersonic Flow

James Mitchell
Washington University in St. Louis
Advisor: Dr. Ramesh Agarwal

Abstract

Computational Fluid Dynamics simulation and optimization of a 69-degree-delta wing model under supersonic flow condition is conducted. The steady compressible Reynolds Averaged Navier-Stokes (RANS) equations are solved using the commercial CFD flow solver ANSYS Fluent. The CFD simulations are compared with the experimental data. After simulation results were validated against the AIAA sonic boom workshop provided data, a genetic algorithm was used to optimize the delta wing to minimize the pressure disturbance or sonic boom signature. The NASA code s-boom is used to study the propagation of sonic boom form high altitude of nearly fifty thousand feet to the ground. The temperature effects on the sonic boom propagation are studied; it is concluded that they have little effect considering all the temperature variations throughout the year.

Link to Full Paper

James Mitchell is currently enrolled at Washington University in St. Louis in the B.S/M.S. program in Aerospace Engineering program as a graduate student. He is from Spokane Washington and has future aspirations of working in the aerospace and defense industry in rocket propulsion.

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A Rapid and Sensitive Detection Method for *Escherichia coli* 0157:H7 in Water

Grace Mobley
Center for Nanotechnology
Lincoln University of Missouri
Advisors: Mohamed Alalem and Majed El-Dweik

Abstract

Escherichia coli 0157: H7 is a pathogenic species of bacteria that induces symptoms of vomiting, stomach cramps, and bloody diarrhea. This strain is the most predominate of pathogenic E. coli strains. Cases of infection progressing past typical symptoms and causing the potentially fatal hemolytic uremic syndrome (HUS) play a role in the 2.2 million yearly deaths caused by water disease worldwide. The Center for Disease Control estimates that 73,500 cases of infection occur annually in the Unites States, costing roughly $480 million per year. The objective of this research was to develop a protocol for detection using Immuno Magnetic Separation techniques in conjunctiaon with ELISA testing, effectively reducing the time and cost of detection while maintaining necessary sensitivity. The protocol can be summarized in 6 steps: 1) coat protein A magnetic beads with primary antibody, 2) addition of water sample, 3) add enzyme labeled detection antibody, 4) add substrate, 5) photograph sample, 6) determine spectrophotometry values. In this procedure, color change in the sample is indicative of a positive result, confirming the presence of *E. coli* 0157:H7. Results showed that bacterial concentrations were indicated by a respective variation in color opacity relative to the bacterial concentration, which was quantitatively characterized via a portable optical detection platform. While the EPA's current detection method takes 40-55 hours, this protocol can be completed in just 6 hours. Faster and more cost effective methods, such as this protocol have the potential to significantly reduce the number of people affected and lighten the economic burden caused by *E. coli* 0157: H7.

Link to Full Paper

Grace Mobley was born in Jefferson City, Missouri. She received her Bachelor's Degree in Biology from Lincoln University, followed by readmission to Lincoln University for their Master's program in Environmental Science. Additionally, she is currently employed as an assistant researcher for NASA at Lincoln University. Grace aspires to work in extension and outreach, connecting under-serviced and under-informed populations to the information and resources they need to improve their health and standard of living within their communities.

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On-Orbit CubeSat Performance Validation of a Multi-Mode Micropropulsion System

Bradyn Morton & Shannah Withrow-Maser
Missouri University of Science and Technology
Advisor: Dr. Henry Pernicka

Abstract

Small satellite missions open the testing ground of space to a wide range of diverse missions. NASA has indicated that these satellites will be a "paradigm shift for NASA and the larger space community." Currently, most of these missions cannot support a propulsion system due to size and mass constraints, however, research being performed at the Missouri University of Science and Technology may soon change that. The Missouri S&T Satellite Research team is in the process of preparing two satellites that will validate a multi-mode micropropulsion system developed in collaboration with the Missouri S&T Aerospace Plasma Lab. Unique challenges to these missions include packaging the propulsion system and validating its performance on-orbit. Methods of thruster validation being researched include comparison of on-orbit pressure and temperature data to ground models and performance of orbit/attitude changing maneuvers combined with the orbit/attitude determination algorithms to validate the performance from a guidance, navigation, and controls perspective using Gauss' variational equations.

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Development and Testing of a 100mn GPROP CubeSat Propulsion Module

Alex J. Mundahl: Missouri S&T
Jonathan V. MacArthur: Iowa State University
Morgan D. Ruesch: Utah State University
Shyamal J. Patel: University of Texas at El Paso
2017 Propulsion Academy
NASA - Marshall Space Flight Center

Research Mentors: Chris Burnside and Kevin Pedersen
AST, Liquid Propulsion Systems
NASA - Marshall Space Flight Center

Abstract

NASA Marshall Space Flight Center is sponsoring efforts to develop technology for integrating a high-performance, low-hazard monopropellant into Cubesat platforms. The program focuses on a "green" monopropellant GPROP as an alternative to the widely used Hydrazine monopropellant. Being markedly less hazardous than Hydrazine, GPROP is attractive due to easier ground processing and storability. While research has been conducted on the characterization of the propellant itself, to date, a fully integrated propulsion system has yet to be tested. NASA is coordinating their monopropellant efforts with the United States Air Force to develop a 100 mN 1U Cubesat module that will utilize the GPROP monopropellant. A hot-fire test of this system will demonstrate the readiness of "green" monopropellant use in future spacecraft propulsion systems.

Link to Full Paper

Alex Mundahl is originally from Bloomington Minnesota. He attended Missouri University of Science and Technology for his undergraduate degree in Aerospace Engineering, and completed his undergraduate studies in May 2016. The following summer he was the team lead for the Green Monopropellant Propulsion group of the Marshall Space Flight Center's Propulsion Academy. In August 2016, Alex started pursuing his doctorate degree in Aerospace Engineering, researching possible new ionic liquid monopropellants for a Multi-Mode Propulsion System. After he finishes his studies, Alex wants to research and optimize potential propulsion concepts that will help advance mankind's abilities in space exploration.

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Application of the Quadratic Constitutive Relation to Various Turbulence Models in OpenFOAM

Hakop J. Nagapetyan
Washington University in St. Louis
Advisor: Dr. Ramesh K. Agarwal

Abstract

The goal of this paper is to analyze the accuracy of various eddy-viscosity turbulence models with the Quadratic Constitutive Relation (QCR) compared to the traditional linear Boussinesq relation used in modeling the turbulent stresses in computing vortical and mildly separated flows. QCR is added to the one-equation Spalart-Allmaras and Wray-Agarwal models, and the two-equation Shear-Stress-Transport k-ω model. OpenFOAM is used as the flow solver. These three models with the addition of QCR are employed to predict the subsonic flow past a flat-plate, flow in a 2D lid-driven cavity, subsonic flow over a backwards facing step, subsonic flow past an NACA 4412 airfoil and supersonic flow in a square duct. Numerical results using the linear Boussinesq relation and QCR for eddy viscosity are compared to the available experimental data. For the case of supersonic flow in a square duct described in this paper, the turbulence models utilizing QCR for eddy viscosity showed improved accuracy compared to the results from linear Boussinesq relation based eddy viscosity.

Link to Full Paper

Hakop Nagapetyan is currently a PhD student in Aerospace Engineering in the Department of Mechanical Engineering and Materials Science at Washington University in St. Louis. He received BS from Case Western Reserve University and MS from Washington University in St. Louis.

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Simulating Radial Velocity Precursor Surveys for Target Yield Optimization in Future Direct Imaging Missions

Patrick Newman
Missouri State University
Advisor: Dr. Peter Plavchan

Abstract

Future direct imaging missions such as WFIRST, HabEx, and LUVOIR aim to catalog and characterize Earth-analogs around nearby stars. With the scope and expense of these missions, the exoplanet yield is strongly dependent on the frequency of Earth-like planets, and the a priori knowledge of which stars specifically host suitable planetary systems. Ground-based radial velocity surveys can potentially perform the preselection of direct imaging missions at a fraction of the cost of a blind direct imaging survey. We present the first phases of simulations of such a survey. We consider multiple telescopes, including their locations, weather conditions, observation time limitations, and instrument sensitivities. Multiple target selection optimization algorithms are considered. From this, we generate realistic measurement frequencies, qualities, and RV precision. We intend to next inject and recover the masses and orbital parameters of real and simulated planets, estimating the effectiveness and optimizing the yield of a precursor radial velocity survey.

Link to Full Paper

Patrick Newman is a Master's student at Missouri State University's Physics, Astronomy, and Material Science department, and works under Dr. Plavchan.

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Water Assisted Liquefaction of Lignocellulosic Biomass by ReaxFF MD Simulations

Sean C. Rismiller
Department of Mechanical & Aerospace Engineering
University of Missouri - Columbia
Advisors: Dr. Yuan Dong and Dr. Jian Lin

Abstract

Lignocellulosic biomass can provide a cheap renewable source of combustible fuel and organic reagents. Current pyrolysis processes allow for conversion of lignocellulosic biomass to these products, however the feed biomass must be extensively dried and the resulting chemicals are highly oxygenated which impedes their use as fuel and presents storage difficulties. Hydrothermal liquefaction is an alternative process that carries out the pyrolysis reaction in water, eliminating the need for drying while allowing for extraction of lower-oxygen products. In this work ReaxFF MD simulations were performed to study the role of water in the liquefaction of cellulose and lignin and compare to 'dry' pyrolysis reactions. Reaction indicators such as aromatic ring structures and chemicals, as well as ratios of oxygen and hydrogen to carbon in fuel molecules are investigated. Preliminary results suggest an acceleration of the pyrolysis reaction by water, as well as influence on final products. Further investigation is to be conducted regarding the role of water in formation of aromatic products such as phenols, and additional deoxygenation of fuel molecules.

Link to Full Paper

Sean Rismiller is a junior student at the University of Missouri-Columbia in the Department of Mechanical Engineering. He started undergraduate research as a freshman to get more involved at the university and has second-authored a work in simulating the formation of laser-induced graphene on commercial polymers. He seeks to continue his research in school and eventually make a career in energy or further cutting-edge work.

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Virtual Reality Applications for Carbon-Based Nanocomposites

Chris Robledo and Matt Yeager
Department of Physics, Astronomy, and Materials Science
Missouri State University
Advisor: Dr. Ridwan Sakidja

Abstract

A new VR app by utilizing UNITY code and other molecular visualization codes that can be used to visualize carbon-based nano composites has been developed. This study found sp3 three-dimensional C-C bonds can be generated with certain types of pairings between these carbon nanomaterials and creating a linkage may help enhance the overall thermal property of the composites.

Link to Full Paper

Christopher Robledo is from Springfield. MO, and is currently pursuing his Bachelor's Degree in Physics at Missouri State University. Christopher hopes to pursue a career in the Applied Physics/Engineering field after graduation.

Matthew Yeager is from Springfield, Missouri, and is currently working towards his Bachelor's Degree in Applied Physics at Missouri State University. Matthew has always been fascinated with space exploration, so in the future he hopes to use his degree to pursue a career in the space industry.

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Radial Velocities of Young Stellar Objects in the Rho Ophiuchi Infrared Cluster

Lindsey Rodgers
University of Missouri-Saint Louis
Advisor: Dr. Bruce Wilking

Abstract

Observations of young stellar objects provide valuable insight into the mechanisms of formation and evolution of multiple-star systems, circumstellar disks, and planetary systems. The Rho Ophiuchi molecular cloud is a star forming region containing approximately 300 young stellar objects. Previous studies of young clusters in Rho Ophiuchi have produced strong evidence that many young stellar objects have significantly higher velocity dispersions than the dense prestellar cores from which they formed. It is suspected that stellar encounters may contribute to the increasing velocity dispersions of these young stars. High resolution data for 15 young stellar objects were retrieved from the ESO CRIRES archive and an additional 11 were collected during observations using the CSHELL spectrograph on the NASA Infrared Telescope Facility. The near-infrared high-resolution spectroscopy permitted by these instruments allow accurate radial velocity determinations for deeply embedded Class I and flat spectrum young stellar objects. Focusing on several prominent absorption lines from the CO bandhead at $\lambda > 2.29$ μm, radial velocity determinations were made by measuring the Doppler shift between these sources and synthetic spectra with similar characteristics.

Link to Full Paper

Lindsey Rodgers is a senior Physics major from St. Charles, Missouri studying at the University of Missouri-Saint Louis with an emphasis in Astrophysics and a Mathematics minor. She is the student director of the campus observatory, president of the Physics and Astronomy Club, and Peer Mentor in the Pierre Laclede Honors College. Her interest is in observational astronomy, particularly stellar formation and evolution. After completion of her undergraduate program she plans to obtain a Ph.D. in Astrophysics and hopes to pursue a career in academia.

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Investigation of Multi-Fidelity Modeling for Hypersonic Vehicle Analysis and Design

Mario Santos
Missouri University of Science and Technology
Advisor: Dr. Serhat Hosder

Abstract

The ability to analyze and design hypersonic vehicles accurately and with minimal computational cost is essential to NASA's success in space exploration. Multi-fidelity analysis can achieve this goal by using information from both low-fidelity models and high-fidelity models to create a model with the accuracy of the high-fidelity model but with the computational cost comparable to the cost of a low-fidelity model. This study will investigate the use of multi-fidelity modeling in the analysis and design of hypersonic sphere-cone planetary entry capsule geometries, specifically the use of Kriging, Co-Kriging, Polynomial Chaos expansion, and Linear and Non-Linear space mapping techniques. The project is currently still in progress and to date has focused on the Co-Kriging prediction of the stagnation point heating in three-dimensional velocity, density, nose radius space. The low-fidelity model used is the Fay-Riddell correlation, and the high-fidelity model used is LAURA hypersonic CFD code of NASA LaRC. Three different high-fidelity model sampling schemes will be investigated for use with the co-kriging method: single Latin Hypercube scheme, estimated Root Mean Square Error scheme, and the Leave-One-Out Cross Validation scheme. Current study includes the results for the single Latin Hypercube scheme, showing that the multi-fidelity model is accurate when using 1000 low-fidelity points and 24 high-fidelity points, producing a model that has 1-3% error and 2-4% error when compared to Aero-capture and EDL test cases, respectively. The future work will include the investigation of the other sampling techniques, multi-fidelity methods, and performance criteria to assess the performance of multi-fidelity techniques applied to the analysis and design of hypersonic vehicles.

Link to Full Paper

Mario Santos, whose home town is Boston Massachusetts, is currently a first year Doctoral student at Missouri S&T where he also obtained his Bachelor's degree in Aerospace engineering. He is working with his advisor Dr. Serhat Hosder on robust analysis and design of hypersonic vehicles using surrogate modelling.

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Studying Stars: the Significance and Study of sdBV Stars

Alyssa Slayton
Missouri State University
Advisor: Dr. Mike Reed

Abstract

Asteroseismology is the study of stars using their vibrations (pulsations). Stellar pulsations are the only means to study stellar interiors and seismology has been successfully used to discern the interior structure of white dwarf and solar-like oscillations. Our interest is a fairly new class of pulsating stars known as subdwarf B (sdBV) stars. These are helium fusing stars between the red giant and white dwarf phases. Their insides include interesting physics which cannot be reproduced in Earth-bound labs. Our data were collected using the Kepler Space telescope as part of its extended (K2) mission. I will describe how we transform the raw satellite images into processed pulsation spectra.

Link to Full Paper

Alyssa Slayton is a senior attending Republic High School. She began working with Dr. Reed's research during fall of 2016 plans to continue this work next year when she begins attending Missouri State University to study physics and computer science. She intends to graduate and continue with her master's degree.

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The Dynamical State of a Young Stellar Cluster

Timothy Sullivan
University of Missouri-St. Louis
Advisor: Bruce A. Wilking

Abstract

The velocity dispersion of a young embedded cluster should reflect the initial conditions of star formation and the subsequent role of stellar interactions. Recent studies of prestellar cores indicate that stars should form in subvirial conditions, yet radial velocity dispersions of young, optically visible clusters already show significantly higher dispersions than the prestellar cores. The timing of stellar encounters in the early phases of formation is critical as it can affect the structure of circumstellar disks and the formation of planetary systems. We were recently granted telescope time on NASA's Infrared Telescope Facility (IRTF) in Hawaii and used an echelle spectrograph to obtain spectra for a number of deeply embedded young stellar objects (YSOs). We have been granted more time on the IRTF for April 2017. These sources, along with already published results for more developed YSOs, should give us a larger sample size to work with. We are using Markov-Chain Monte-Carlo simulations to analyze our data to find the most accurate values for these objects radial velocity, veiling, and vsini. Our goal is to investigate whether the most deeply embedded objects have lower velocity dispersions more comparable to prestellar cores.

Link to Full Paper

Timothy Sullivan was born in Kansas City, Missouri, and lived there before attending Truman State University for his undergraduate degree. He is currently in his fifth year in the graduate program at University of Missouri - St. Louis. Tim plans to earn his PhD in physics while doing astronomy and astrophysics research.

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Manufacturing and Characterization of Fiber-Reinforced Transparent Composites for Aerospace Applications

Gregory Taylor
Missouri University of Science & Technology
Advisor:f Dr. K. Chandrashekhara

Abstract

The most commonly used transparent material is glass, but traditional glass is heavy and structurally brittle. Some aerospace and military applications include aircraft canopies, vehicle windows, and facial visors. The development of transparent composites would allow improved performance in terms of transparency, strength, and low weigh. Matching the refractive index of a glass fiber fabric with a transparent polymer and demonstrating a working composite panel would be an innovative solution for aerospace applications.

The objective of this work is to manufacture and evaluate transparent composite panels for use in aerospace and military applications. Materials for the composite panels will include commercially available S-glass woven fabric and epoxy-based resin system. S-glass has higher strength, stiffness, and optical clarity in comparison with conventional E-glass fibers. The resin system will be manufactured at Missouri University of Science & Technology (Missouri S&T), and the resin system will be based on several commercially available epoxies to reduce cost. Composite panels will be manufactured with a high pressure injection and autoclave processing techniques to minimize void content and increase transparency. Performance evaluation will consist of transparency (clarity and haze) tests as well as tensile and impact mechanical tests. All testing will be performed according to ASTM standards.

Link to Full Paper

Gregory A. Taylor was born in Belleville, IL to Mark Taylor and Sharen Taylor. He received his Bachelors of Science degree in Aerospace Engineering in May of 2012 from Missouri University of Science and Technology and joined the M.S. degree program in Aerospace Engineering the following semester. He completed his M.S. degree in December 2014. He is currently enrolled in the Ph.D. program at Missouri S&T and expects to complete his work in 2018.

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Experimental and Computational Investigations of Hydrous Aluminosilicate Melts

Jesse G. Underwood,
Department of Physics, Astronomy, and Materials Science
Missouri State University
Advisors: Prof. Robert Mayanovic and Dr. Ridwan Sakidja

Abstract

Water dissolution plays an important role in modifying the physical properties of silicate melts, thereby directly impacting upon the eruptive power of magmas in volcanoes and the mass transfer associated with magmatic processes. Studies of water-melt interactions at the atomic level will lead to a better understanding of the water cycle and plate tectonics on Earth, which is useful to help constrain habitable zones of rocky exoplanets. At present, there are no detailed structural data of hydrous (i.e., with soluble water) silicate melts. We have made for the first time in situ high-energy x-ray diffraction measurements of a hydrous albite ($NaAlSi_3O_8$) melt at high temperatures and pressures. The measurements were made using our modified diamond anvil cell that enables in situ synchrotron x-ray scattering measurements of water+melt systems to high scattering angle conditions. Large simulation-cell molecular dynamics calculations are being carried out in order to make a detailed quantitative structural determination of the hydrous albite melt system.

Link to Full Paper

Jesse Underwood is from Rogersville, Missouri and is currently pursuing his BS degree in Physics at Missouri State University. Jesse plans to pursue an advanced degree in physics in the near future.

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Mathematical Modeling of Lunar Topographical Slant Range Altimetry

Kari C. Ward
Missouri University of Science and Technology
Advisor: Dr. Kyle J. DeMars

Abstract

Approximation of the lunar surface has been accomplished using spherical and ellipsoidal reference surfaces, spherical harmonic models, and topographical maps based on laser altimetry data. The modeling of a slant range sensor requires a lunar surface model and for the spherical and ellipsoidal reference surfaces, a closed form solution of the slant range measurement exists. However, these approaches are low fidelity and as a result, especially impractical at low altitudes. This research uses digital elevation maps of the lunar surface to create a topography based algorithm for modeling a slant range sensor. Using the position and pointing direction of the satellite, the complexity of the problem is reduced from a fully three dimensional space to a two dimensional interpolation. The result gives a slant range solution based on the actual topography data for the Moon as opposed to a general reference surface. The algorithm is tested and shows a clear improvement in solution accuracy over generalized surface models and increased precision with increased number of topographical map data points.

Link to Full Paper

Kari Ward received her undergraduate degree in Aerospace Engineering from Missouri University of Science and Technology and is currently pursuing a Masters in the same program. Her research areas of interest include topics in satellite guidance, navigation and control as well as orbit determination.

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Amateur Radio Small Satellite Communication System

Damon Wendt
Missouri University of Science and Technology
Advisor: Dr. Henry Pernicka

Abstract

The intent of this research was to develop a low-cost and reliable amateur communication system for small satellites. The system developed herein spans from the flight computer of the spacecraft to the ground station where the operators fly the satellite. The primary purpose of the system is for future use by academic level satellites. The system begins with a Raspberry Pi, which is a simple and reliable computer, as the flight computer of the spacecraft. A custom-built PCB houses the Atmel AVR ATxmega256A3BU microcontroller that drives the two AstroDev Li-1 radios mounted on the PCB. The Li-1 radios serve as a full-duplex transceiver capable of a data rate of 9.6 kbps. The antennas used in the system are two "Rubber Ducky" antennas that have a sufficient gain for a link with the ground station while still fitting in the tight envelope requirements of a small satellite. The system is currently being tested and will be flight ready within the year, following with a flight test in 2018 on a microsatellite deployed from the International Space Station.

Link to Full Paper

Damon K. Wendt is originally from Prairie Home, a small town located in the "middle-of-nowhere Missouri." Damon is a senior in Aerospace Engineering and Mechanical Engineering at the Missouri University of Science and Technology in Rolla, Missouri. Upon graduating in May 2017 Damon will leave the Midwest to join the workforce at Orbital ATK in Phoenix, Arizona to continue his goal of working in the space industry.

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Incidence of *WISE*-Selected Obscured AGNs in Major Mergers and Interactions from the SDSS

Madalyn E. Weston[1], Daniel H. McIntosh[1], Mark Brodwin[1], Justin Mann[1,2], Andrew Cooper[1,3], Adam McConnell[1], Jennifer L. Nielsen[1,2]
[1]University of Missouri – Kansas City
[2]University of Kansas
[3]University of North Carolina at Chapel Hill
Advisor: Daniel H. McIntosh

Abstract

We use the Wide-field Infrared Survey Explorer (WISE) and the Sloan Digital Sky Survey (SDSS) to confirm a connection between dust-obscured active galactic nuclei (AGNs) and galaxy merging. Using a new, volume-limited ($z \leq 0.08$) catalog of visually-selected major mergers and galaxy-galaxy interactions from the SDSS, with stellar masses above $2{\times}10^{10}$ M_{Sun}, we find that major mergers (interactions) are 5 – 17 (3 – 5) times more likely to have red [3.4]-[4.6] colors associated with dust-obscured or `dusty' AGNs, compared to non-merging galaxies with similar masses. Using published fiber spectral diagnostics, we map the [3.4]-[4.6] versus [4.6]-[12] colors of different emission-line galaxies and find one-quarter of Seyferts have colors indicative of a dusty AGN. The vast majority of mergers hosting dusty AGNs are star-forming and located at the centers of Mhalo<10^{13} M_{Sun} groups. Assuming plausibly short duration dusty-AGN phases, we speculate that a large fraction of gas-rich mergers experience a brief obscured AGN phase, in agreement with the strong connection between central star formation and black hole growth seen in merger simulations. We will use the WISE-selected AGNs (and AGNs selected by other methods) to perform SED analysis of mergers and interactions and dissect the SEDs to disentangle AGN and SF activity.

Link to Full Paper

Madalyn Weston was born in 1989 in Independence, Missouri. Upon graduation from high school, she completed her Bachelor of Science degree in Physics at the Missouri University of Science & Technology. She continued her education in the Department of Physics and Astronomy at the University of Missouri – Kansas City. She has represented UMKC at many conferences, including the 223rd, 225th, and 229th American Astronomical Society meetings and the WISE@5 Conference at Caltech in Pasadena, CA. She graduated with her Master of Science degree in Physics in May 2015. She is currently a Ph.D. student in Physics and Education at UMKC.

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Uncertainty Quantification of Turbulence Model Closure Coefficients in OpenFOAM and Fluent for Mildly Separated Flows

Isaac Witte
Washington University in St. Louis
Advisor: Ramesh K. Agarwal

Abstract

In this paper, detailed uncertainty quantification studies focusing on the closure coefficients of eddy-viscosity turbulence models for several flows using two CFD solvers are presented. Three eddy viscosity turbulence models are considered: the one-equation Spalart-Allmaras model, the two-equation Shear Stress Transport k-ω model, and the one-equation Wray-Agarwal model. OpenFOAM and ANSYS Fluent are used as flow solvers. Uncertainty quantification analyses were performed for subsonic flow over a flat plate and subsonic flow over a backward-facing step. In the case of flat plate, coefficients of pressure, lift, drag, and skin friction were considered to be the output quantities of interest. In the case of the backward-facing step, these quantities were considered along with the separation bubble size. Uncertainty quantification was conducted with DAKOTA using stochastic expansions based on non-intrusive polynomial chaos. The influence of the closure coefficients on output quantities was assessed using global sensitivity analysis based on variance decomposition. This yielded Sobol indices which were used to rank the contributions of each constant. A comparison of the Sobol indices between the turbulence models, flow cases, and flow solvers was conducted. Closure coefficients of interest are identified in the hope of aiding modelers in improving the accuracy of these turbulence models.

Link to Full Paper

Isaac Witte is a graduate student attending Washington University in St. Louis, from where he will graduate in May 2017 with a M.S. in Aerospace Engineering, a B.S. in Mechanical Engineering, and a Minor in Computer Science. Upon graduation, he is joining the Johns Hopkins Applied Physics Lab in Laurel, Maryland.

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VESCON CubeSat Mission: Demonstrating a Soft Contact Docking Mechanismfor Small Satellites

Krzysztof Bzdyk, Kathryn Clements,
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Abstract

This paper examines the VESCON small satellite mission, which shall characterize a soft-contact docking mechanism for small spacecraft. This mechanism shall serve as an alternative to the standard satellite docking mechanisms which often involve robotic arms and require very accurate pointing. Small satellites, often developed by university teams, may not have the budget or resources to be able to develop these complicated systems for docking. Moreover, VESCON aims to provide teams in such a situation with a viable alternative for missions involving docking. This paper details the development of this docking system, consisting of a docking mechanism, propulsion system, and an active attitude control system all developed by the authors. Also included is the development of necessary subsystems to support the VESCON mission. These sections include detailed attitude simulation and testing results, completed power and link budgets, a design for a modular structural chassis, and results and analysis of all collected test data necessary in the process. Test data is acquired from testing performed using in-house developed hovercrafts mounted with the VESCON docking mechanism.

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Cody Chlanda, a senior aerospace engineering student at Saint Louis University, hails from Joplin, Missouri. For the VESCON mission, he is responsible for the design, manufacture, and testing of the Power and RF Communications subsystems. Cody spent the summer of 2016 at Marshall Space Flight Center as a Research Associate for the NASA Space Hardware and Robotics Academy, and will be employed at Lockheed Martin Space Systems Company once he graduates.

Kate Clements is a senior aerospace engineering student from Glens Falls, NY. She is responsible for the Propulsion subsystem for the VESCON mission. In the summer of 2016, she interned at The Aerospace Corporation where she researched multipactor breakdown. In the summer before that, she characterized an impulsively driven plasma generator and its diagnostics through an NSF Research Experience for Undergraduates at Baylor University's Center for Astrophysics, Space Physics, and Engineering Research. After graduation, Kate will pursue graduate study in propulsion and combustion.

Nick Mercadante is a senior aerospace engineering student at Saint Louis University, from Fitchburg Massachusetts, and a proud graduate of Saint John's High School. Nick is the project lead of VESCON and in charge of the Attitude Determination and Control System. Nick has interned as a systems engineer at Raytheon during the summer of 2015, and as a space systems engineer at Orbital ATK over the summer of 2016. Upon graduating, he will join Orbital ATK in Dulles, VA as a systems engineer specializing in systems modeling and simulation of spacecraft.

Krzysztof Bzdyk is a senior aerospace engineering student at Saint Louis University from Downers Grove, Illinois. Krzysztof is the lead for the docking and separation system for VESCON, as well as the structures lead. He secured a NASA pathways internship position for the summer of 2016 at NASA Glenn Research Center as a propulsion engineer, where he intends to work after graduation from Saint Louis University. Immediately following his graduation from the undergraduate program at SLU, Krzysztof will peruse a masters degree in engineering at Saint Louis University which he intends to complete in one academic year.

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Enhancing the Multidisciplinary Astrobiology Research Community at Truman State University

Bria Berry, Nicole Fiore, and Nathan Scott
Truman State University
Advisors: Dr. Carolina Sempertegui-Sosa and Dr. Vayujeet Gokhale.

Abstract

Faculty and undergraduate students at Truman State University continued the activities of the Multidisciplinary Astrobiology Research Community and introduced new interdisciplinary educational opportunities for Truman students. A total of three students and two faculty members from the Biology and Physics departments are directly participating in research activities sponsored by this project. In addition, we opened up the 'Astrobiology Seminar class' to all students (not just directly supported students) and have increased enrollment to 10 students from a variety of science and non-science disciplines. We discuss astrobiology themed review papers during the seminar class, and devote a significant amount of time discussing short 'review projects' each student is involved in. These projects support the activities of the astrobiology research program at Truman, strengthen the Center for Astrobiology, and inspire students from a range of science and non-science disciplines to consider research opportunities and careers in science and astrobiology.

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Bria Berry is a fourth-year student at Truman State University with an anticipated Bsc. in biology ('17). She has a strong interest in microbial, immunological, and astrobiological studies. Currently, she is researching the effects of ultraviolet irradiation on *Saccharomyces cerevisiae*, which could be used to theorize how eukaryotic cells are affected by such radiation in space.

Nicole Fiore is a senior biology major at Truman State University and a member of the Gokhale research team, studying the habitability of exoplanets orbiting low mass stars. She will be enrolling in the University of Nebraska-Lincoln's PhD program in Biological Sciences, specializing in Genetics, Cellular, and Molecular Biology.

Nathan Scott is a Senior Biology student at Truman State University where he will graduate in May of this year with a Bachelor's of Science. He is interested in determining the viability of tidally locked planets around small mass stars for life.

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Light Pollution in Kirksville

Eric Hilker[1] & Steven Pankey[1]
Advisors: Dr. Vayujeet Gokhale[1] & David Caples[2]
[1]Truman State University, [2]Moberly Area Community College

Abstract

Faculty and undergraduate students at Truman State University and the Moberly Area Community College (MACC) participated in activities related to quantifying the light pollution in and around the Kirksville area in northeast Missouri. Students used light sensors to track the amount of light projected towards the sky at various locations on campus, the University farm, and at Thousand Hills State Park (about 5 miles W/NW of Kirksville). In addition, students used DSLR cameras to qualitatively capture the amount of light pollution by capturing long exposure tracked and untracked images of the night sky. Students have reached out to school administrators, the Truman State Physical Plant, and the local power company (*Ameren*) to understand the process of outdoor light and light fixture selection. In particular, the local power company is in the process of replacing broken fixtures and fluorescent lamps with more efficient LED lights. Students are reaching out to *Ameren*, to impress on them to install 'warmer' lights as against the currently favored blue/white LED lights that cause more light pollution and glare. Additionally, students have designed an outreach program to be tied in with the weekend shows at the *Del and Norma Robison Planetarium* at Truman State University, which includes handing out light pollution related brochures, a 6-minute '*Losing the Dark*' planetarium documentary produced by the *International Dark Skies Association*, and Q&A sessions with the audience.

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Eric Hilker is a student at Truman State University. He will be graduating this semester with his BSc. in Biology with minors in Astronomy and Chemistry. Eric is pursuing a career in medicine, with a interest in preventative medical research.

Steven Pankey is a junior undergraduate student of Mathematics and Physics at Truman State University. He joined his light pollution group lead by Professor Vayujeet Gokale, which aims to increase public awareness and quantify light pollution. Steven's activities in this group are focused around quantifying the effects light pollution on data collected using DSLR Photometry.

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A Bridge to the Stars Scholarship and Mentoring Program

Derrick Jennings (Spring 2017 Senior Bridge Mentor/Development Intern)
Lauren Higgins (Spring 2017 Bridge Mentor)
Rubyet Evan (Spring 2017 Bridge Mentor)
Yana Yen (Spring 2017 Bridge Mentor)
Department of Physics & Astronomy
University of Missouri – Kansas City
Supervisor – Prof. Daniel McIntosh

Abstract

This report covers the process of the Spring 2017 semester (FY2016) Bridge to the Stars scholarship and mentoring program set up by Prof. Daniel McIntosh at the University of Missouri – Kansas City and the results of the Spring 2016 semester (FY2015) Bridge to the Stars scholarship and mentoring program. Results from Spring 2016 (FY2015) semester are compared to all semesters of the Bridge program. The purpose of the program was to provide underrepresented minority high school students a chance to take a college level astronomy course, and gain an understanding of basic physics/astronomy principles, while also being introduced to college life. All scholars from Spring 2016 passed the Astronomy 150 course at UMKC. Spring 2017 semester (FY2016) is proceeding nicely with twelve scholars. The demographics of the twelve students who participated in the program varied widely. Three males, one Caucasian one African American and one Native American, as well as nine female students, one Hispanic, seven African American, and one Caucasian, participated in the A Bridge to the Stars program. Two students attended East High School; four attended Hogan Preparatory Academy, two attended University Academy, and four attended Grandview Sr. High School. Prof. Daniel McIntosh was assisted by development intern Derrick Jennings. This was the first time the program had a development intern and many parts of the program were updated. Some of which were orientation, mentoring sessions, and revamped application process because of this we had one of our largest semesters and hired four undergraduate interns at the University of Missouri – Kansas City for the 2017 Spring (FY2016) semester, Prof. Daniel McIntosh hired interns Derrick Jennings, Lauren Higgins, Rubyet Evan and Yana Yen to peer mentor the high school students. The interns were to attend class with the students, as well as meet outside for at least one hour each week. The weekly meetings outside of class would begin with an icebreaker followed by going over study material then going over slides from previous lecture ending with open discussion.

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Are There Martians in Australia? How Acid Saline Lakes Can Serve as a Mars Analog

Dr. Melanie Mormile
Missouri University of Science and Technology

Abstract

People have long wondered if there is life on Mars. With the confirmation of the presence of water on Mars, this question is seriously considered. The acidic saline lakes of Australia serve as analogs for previous bodies of water on Mars. Thus far, unique microbial communities have been found in all the lakes our team has studied. The microbial communities in these extreme sites can provide targets for the investigation of the possible presence of life on Mars.

Link to Full Paper

Dr. Melanie Mormile is an environmental microbiologist at Missouri University of Science and Technology who specializes in halophilic bacteria and has published extensively in this field. She holds two patents on the use of an haloalkaliphilic bacterium for biohydrogen production and a patent on the use of this organism to form propanediol from glycerol from biodiesel waste. She is one of a very limited number of researchers who have studied the microbial populations in both saline alkaline and saline acidic environments. She was interviewed by the BBC for inclusion on their Horizon episode “Oceans of the Solar System” covering the possibility of life elsewhere in our solar system. In addition, she was the initial Faculty Advisor for the Missouri S&T Mars Rover Design Team and continues to be its very proud main advisor.

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