

**Proceedings of the 28th Annual Meeting
of the
NASA - Missouri Space Grant Consortium**



**Missouri University of Science and Technology
April 26-27, 2019**

Sponsored by

**The National Aeronautics and Space Administration
National Space Grant College and Fellowship Program**



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MISSOURI SPACE GRANT

CONSORTIUM



Preface

This 28th 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 26-27, 2019.

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. Joeletta Patrick, National Program Manager. It is my pleasure to thank the Affiliate Directors of the Consortium: Dr. Frank Feng, University of Missouri-Columbia; Dr. Travis Fields, 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 coordinating and directing Space Grant activities at their respective institutions. I would also like to thank our 2018-2019 Associate Directors: Dr. Vayujeet Gokhale, Truman State University; Drs. Mike Swartwout and Vasit Sagan, Saint Louis University; Dr. Dan Justice, Metropolitan Community College of Kansas City, and Mr. David Caples, Moberly Area Community College 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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**A Highly Specific Method for Rapid Capture and Detection
of *Escherichia coli* O157:H7
from *Lactuca sativa* Romaine Lettuce Samples**

**Nasruddeen Al-Awwal and Samira Mahdi
Cooperative Research Programs, Center of Nanotechnology
Lincoln University**

Advisor: Dr. Majed El-Dweik

Abstract

This proposed detection method is based on our laboratory's previous research to achieve rapid bacterial capture using highly specific protein-A coated immunomagnetic particles (**IMPs**). The study attempted combining specific bacterial-capture with rapid colorimetric-detection using sandwich enzyme-linked immune sorbent assay without bacterial elution. The result demonstrated a good response to low bacterial concentrations which allows for shorter sample enrichment and total actual testing time in less than one hour. The weak direct binding of the detection antibody to the magnetic beads have created a challenge by producing a false positive result to be addressed by further research for the optimization of detection methodology. The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference ($p = <0.001$). The maximum number of *E. Coli* O157:H7 that can get bonded to IMP is about 17,000 and the minimum concentration of bacteria that could be detected with this method is 7.4×10^{-3} CFU/ml.

Nasruddeen Al-awwal was born in Columbia Missouri and raised in Nigeria. He graduated from Usmanu Danfodiyo University Sokoto, Nigeria where he obtained his B.S. in Applied Chemistry. He earned his M.S. in Organic Chemistry from SRM University Kattankulathur, India and another M.S. in environmental science from Lincoln University, Missouri with emphasis on water quality. Nasruddeen, is now in his second year PhD. in Natural Resources at the University of Missouri Columbia with emphasis in Soil Sciences. He wants to stay in the field of research and academia and continue to impact to the community.

Samira Mahdi, born and raised in ancient city of Kano, Nigeria. Samira received her first master's degree in Environmental Science from Cyprus International University and she is currently working on another master's degree in integrated Agricultural Systems at Lincoln University.

Spyder FANG: Functional Attitude Determination and Control System for NanoLaunch Guidance

Jacey Allen

Missouri University of Science and Technology

Research Mentor: Dr. Jonathan Jones

NASA Marshall Space Flight Center

Abstract

An attitude determination and control system (ADCS) is a system used in launch vehicles and satellites to provide pointing control and stability in the pitch, yaw, and roll axes. The goal of this project is to integrate various attitude control components, including cold gas thrusters, solid rocket motors, and the avionics package, AVA, into a complete attitude control system. These parts will work together in order to de-spin the launch vehicle, point it in a desired direction, and then spin it back up for stability. The cold gas thrusters will initially be fired using a LabVIEW program. When the students are ready to connect AVA, they will utilize a MATLAB laser tracking software to verify that the attitude data from AVA is reliable. The testing of the attitude determination and control system will be performed on a spherical air bearing in order to simulate a zero-friction environment. By the end of the project, the students will have a fully functional attitude determination and control system working in the test environment.

Jacey Allen is originally from Roanoke, Texas, but spends most of the year in Rolla, Missouri. Currently, she is a junior studying aerospace engineering at Missouri University of Science and Technology and also plays on the varsity softball team which competes in the NCAA Division II Great Lakes Valley Conference. Her life goal is to work at NASA to help humans reach and inhabit other planets, like Mars, to ensure the survival of the human race beyond Earth's capacity.

Investigating a Graphene Membrane for the Purification of Nitrates and Phosphates in Drinking Water

Emmanuel Babalola
Cooperative Research, Center of Nanotechnology
Lincoln University Missouri

Advisor: Dr. Majed El-Dweik

Abstract

Pollution caused by water eutrophication has become a global environmental concern in recent years. It is caused by the high concentration of nutrients in water, mainly Nitrates and Phosphates, which is mainly due to the fertilizer runoff from agricultural areas, as well as poor disposal of industrial and domestic wastewater into the environment. Consumption of high concentration of these pollutants from drinking water can lead to various health problems including blue-baby syndrome in infants. Several methods have been established to remove these nutrient pollutants from water due to its negative impacts on human health and environment. Most common and efficient methods are chemical method (Electrocoagulation, MAP, chemical precipitation technique), Physio-chemical method (Crystallization, Polymer hydrogels technique), and Bio-electrochemical denitrification method. However, these methods require high electricity usage and are not cost effective. The major aim of this research project is to develop and establish a cost-effective method to remove nutrient pollutants from the drinking water sources utilizing nanotechnology tools. Water samples will be collected from various water sources across the state of Missouri and will be compared with pure drinking water, and the pure water spiked with various concentrations of nitrates and phosphates as a positive control. The graphene oxide coated membrane or sieves will be developed and optimized for the establishment of an efficient nano-filtering method. Development of a cost effective and efficient water purification method can significantly improve the availability of pure drinking water to people in developed and developing countries.

Emmanuel Babalola is currently a graduate student at Lincoln University of Missouri. He hails from Nigeria and had most of his schooling in Nigeria with a Bachelor of Science degree in human Anatomy and a Master of Philosophy degree in Public Health. He has a passion for Environmental science and its role on human health.

**Geochemistry of the Lazufre Volcanic Complex:
Determining the Geometries and Processes
of the Magmatic Sources in the Andean Central Volcanic Zone**

**Brooke Benz and Madelaine Stearn
Department of Geography, Geology, and Planning
Missouri State University**

Advisor: Gary Michelfelder, Ph.D.

Abstract

The Central Andes in South America contain many active volcanoes and volcano complexes due to constant subduction producing extrusive rocks varying in composition. The Lazufre Complex, Chile-Argentina border, consists of two Pleistocene volcanic centers, Lastarria and Cordon del Azufre, erupting medium- to high-K, calc-alkaline andesite and dacite lava flows and domes. Whole-rock K-Ar dates of lavas from Cordon del Azufre place the most recent eruptions at 0.6-0.3 Ma \pm 0.3 Ma. The most recent eruptive activity at Lastarria has been dated at ~0.5-0.1 Ma. Major- and trace- element data of plagioclase and pyroxene show homogeneous compositions between the centers, which is consistent with whole rock major and trace element compositions. The primary composition of the pyroxenes are augite and diopsides for cpx and hypersphene for opx and the primary composition of the plagioclases are An₃₅₋₇₈. REE diagrams show the samples enriched in Eu and La, and depleted in Yb. The overall trend of trace elements in feldspars is linear, which suggests magma mixing. The Fe-Ti oxide thermo-oxybarometric, and cpx and cpx-liquid thermobarometric models were used. Initial temperatures and pressure calculations of both centers range from 970-1070°C and 60-700 MPa, respectively. Detailed investigation of plagioclase textures alongside crystal size distribution analyses provide evidence for magma mixing as a major pre-eruptive process. Distinct magma storage zones are suggested, with a deeper zone at mid crustal levels (>20 km depth), a second zone at shallow-crustal levels (10-15 km depth) and several magma storage zones distributed throughout the uppermost crust at <10 km depth.

Brooke Benz is a first-year master's student at Missouri State University in the Geography, Geology, and Planning Department. She completed two bachelor's degrees at Missouri State University in 2018 in Geology and Wildlife Conservation and Management. She has presented research at the Geological Society of America's annual meetings in Seattle, Washington (2017) and Indianapolis, Indiana (2018). Ms. Benz is from Ironton, Missouri, and a high school graduate from Arcadia Valley High School. Her career aspirations are to be a field volcanologist at the Nordic Volcanological Center, but realizes that goal is unattainable, so really is striving to make over \$35,000 a year. Her lifelong aspiration is to have a field cat that goes hiking and helps with sample collection wherever she goes.

Visualizing the Critical Dynamic Events of Carbon Nanocomposites Augmented Reality Tools

Chad Brewer and Taylor Kuttenkuler
Missouri State University

Advisors: Dr. Razib Iqbal and Dr. Ridwan Sakidja

Abstract

Purpose of the study is to construct Augmented Reality tools that can be used for materials science education to educate topics related to the dynamics in nanomaterials. Researchers used the Unity Game Engine to visualize the reactions between Carbon Nanocomposites and Oxygen molecules. After the development of the atomistic models and the initial development in Unity, the application is able to be installed on the Microsoft HoloLens for augmented reality development.

Chad Brewer is originally from Charleston, Arkansas. He is a Senior Computer Science major at Missouri State University and also holds a BA in Sociology and an AA in Criminal Justice. Chad is currently involved with one independent research project: Visualizing the Critical Dynamic Events of Carbon Nanocomposites Using Low Cost Wearable Virtual Reality Tools. This project will end with an IEEE published paper that will hopefully land him a career either involving Virtual Reality applications or software development.

Taylor Kuttenkuler is originally from California, Missouri. He is currently a Junior Computer Science major at Missouri State University and may possibly pursue a minor in Cybersecurity. Taylor is currently involved with one independent research project: Visualizing the Critical Dynamic Events of Carbon Nanocomposites Using Low Cost Wearable Virtual Reality Tools. While not attending school, Taylor works as intern in the Information Technology Department of the Missouri Department of Employment Security. He is hoping to use the experience gained from this project to further widen his knowledge of software development and his future career.

Stellar Spectroscopy of the Star Forming Region IC 1805

Justin Bryan¹ and Matthew Wentzel-Long¹

¹Department of Physics and Astronomy, University of Missouri – St. Louis

Advisor: Dr. Bruce Wilking

Abstract

In this paper we observe 2294 sources in the star cluster IC 1805 inside the HII region W4, and of those, spectral type over 1300 stars that are candidates for mid-infrared excesses as observed by the Spitzer Space Telescope. Wavelength regions observed were from 3900Å-9100Å with a resolution of 5Å. Criterion for spectral classifications such as line features and luminosity indicators are outlined for this study. Individual H-R diagrams of IC1805 are created for infrared excess sources, x-ray sources, and proper motion members. We have found 60 sources with mid-infrared excesses that will be further modeled in part of understanding the influence that hot O and B stars have on their disks.

Justin Bryan was born in St. Louis, MO and raised in a small town called High Ridge, thirty minutes south of St. Louis. He obtained his Associate's in Arts from St. Louis Community College-Meramec in 2016 then transferred to UMSL. Justin will be graduating this May with a B.S. degree in physics with an emphasis in astronomy and a mathematics minor. Justin has served as the student director of the Richard D. Schwartz observatory for the past 2 years. He plans to continue his studies in graduate school with intentions of becoming a professor and engaging in public outreach of the sciences. In his free time, he enjoys playing the drums, golfing, fishing, and playing with his dog Apollo.

**Investigation of Solid-State LiPON Thin Films
Grown by Pulsed Laser Deposition for Application as an Electrolyte**

**Thomas Callaway
Missouri State University**

Advisor: Dr. Saibal Mitra

Abstract

Lithium phosphorous oxy-nitride (LiPON) is a solid state material with good lithium ion (Li⁺) conductivity. Modern lithium batteries use liquid electrolytes as the source for Li⁺ ions. Batteries often fail due to dendritic shorts or thermal runaway reactions. One way to mitigate these problems is to switch to solid-state electrolytes such as LiPON. For this project, the growth of LiPON films on pristine soda-lime glass is investigated. LiPON and tungsten oxide (WO_x) thin films were grown using pulsed laser deposition (PLD). WO_x were grown for the purpose of testing the LiPON as an ion source in an electrochromic device. Using a target of lithium phosphate (Li₃PO₄), films deposited are while varying the nitrogen reactor pressure and substrate temperature. Two sets of films were prepared. One set was as-deposited and the other underwent post-deposition annealing. The LiPON films were studied systematically as a function of deposition parameters using x-ray diffraction (XRD), scanning electron microscopy (SEM), and energy dispersive spectroscopy (EDS). It was found that the LiPON films grown with the highest nitrogen pressure contained the highest concentration of Nitrogen. WO_x thin films tested well for use as electrochromic material.

Thomas Charles Callaway was born and raised in Bolivar, Missouri. Thomas worked his way Ozarks Technical Community College earning his associate's degree. Transferring to Missouri State University and a mere two years, he would graduate with as a Bachelor of Science in Physics. Continuing his education at Missouri State University, he is currently working a Master's in Materials Science. Continuing to make modern devices more environmentally friendly and economically viable is his career goal.

Characterization of Massive CANDELS Galaxies

Cody Ciaschi
University of Missouri-Kansas City

Advisor: Dr. Daniel McIntosh

Abstract

Our currently-accepted model of the universe presents the hierarchical growth of galaxies through major galaxy merging. However, the importance of major merging at $z > 1$ has yet to be determined. Competing theories and observations suggest non-major merging hierarchical processes, such as clump migration and violent disk instabilities, may play a key role in the development of spherical bulges and the assembly of massive galaxies. In order to aid in the determination of merger rates at redshifts $z > 1$, we search for massive $\log(M) > 9.7$ galaxies hosting tidal features, hallmark signatures of major mergers, in a sample of 10043 GALFIT model subtracted (residual) images at redshifts $1 < z < 3$. We characterize the residual structures and fit quality issues in the GALFIT model for each galaxy in our sample, providing valuable information about the accuracy of the related catalogs, as well as the incidence of major mergers and other interesting substructure (e.g. spirals, disks, clumps, etc.) in the sample.

Cody Ciaschi has been doing research with Dr. Daniel McIntosh and the Galaxy Evolution Group at the University of Missouri-Kansas City since the beginning of summer in 2017. He is currently a third year master's student and hopes to finish his Master's degree by the end of the spring 2019.

North American Detrital Zircon Age Domains and Sediment Dispersal Patterns

Jordan Cruzan
Missouri State University

Advisor: Dr. Matthew McKay

Abstract

Determining sediment source to sink relationships and sediment pathways using provenance geochronology requires constraints on the distribution of age domains that may serve as sediment sources. Current age domain maps are largely based on ages of crystalline basement that underlie geologic provinces, which fails to characterize the observed distribution of zircon components that may be sourced from crystalline basement and recycled into successive sedimentary deposits. To investigate the distribution of zircon age components across the North American continent, U-Pb zircon datasets from publically available repositories (www.geochron.org; Canadian Geochronology Knowledgebase) along with collected samples were compiled to construct age domain contour maps that display the relative distribution of zircon age components across North America. Relative proportions of user-defined age components display the spatial extent of detrital zircon age components and provide insight into sediment dispersal through time in North America. Generated models delineate single source areas, multicomponent regions, and sediment mixing zones that contain numerous zircon age components to better characterize potential sediment sources for provenance identification.

Jordan Cruzan is a Springfield native and senior at Missouri State University. He is currently in the College of Natural and Applied Sciences and is pursuing a degree in geology with a minor in geospatial sciences. Jordan is also a member of Theta Chi fraternity, has been a member of the dean's list for multiple semesters, and has held various positions within his fraternity. He hopes to be able to use the skills he learned through his college career to benefit society as a whole. He feels as if communication is one of his greatest strengths and it is his desire to use this strength to be a bridge between the scientific community and the general population. There is often a divide between these two groups especially when the topic discussed is climate change or natural resource management. Jordan would love to be able to speak and write on behalf of the scientific community to limit that divide and promote understanding between these two groups.

Studies of van der Waals Interactions of an Important Earth and Interstellar Molecule: O₂

Amanda Duerden, Frank Marshall, and Nicole Moon
Missouri University of Science and Technology

Advisors: Dr. Garry S. Grubbs and Dr. Richard Dawes

Abstract

As O₂ complexes are of fundamental importance to atmospheric chemistry and astrochemistry, methods for collecting and resolving their radiowave/microwave rotational spectra are discussed. Methods include collaborative construction of approaches to deal with spin-spin splitting involved with open shell complexes of this type, both spectroscopically and computationally. To this end, rotational spectra of several O₂ complexes have been experimentally observed on a broadband CP-FTMW and narrowband FPC-FTMW instrument, some for the very first time. Observation of such complexes by their rotational spectra in other regions of the electromagnetic spectrum will involve accurate prediction of transition occurrence, even at high resolution. The work elaborated within, therefore, serves as a precursor and foundation to continued collaboration towards a generalized approach for the treatment of these challenging systems.

Amanda Duerden is in her second year of graduate studies in the Chemistry Department at the Missouri University of Science and Technology. Her current research interest includes experimental and theoretical physical chemistry, with a focus on van der Waals complexes.

Characterizing the Residual Substructure of Massive CANDELS Galaxies: V Using Machine Learning to Identify & Quantify Feature Similarity

Rubyet Evan

In collaboration with Osiris Hines (UG), Kameswara Bharadwaj Mantha (PhD candidate),
Andrew Pepper (UG), Scott Thompson (UG) Luther Landry (MS candidate),
and Cody Ciashi (MS candidate)

Department of Physics and Astronomy
University of Missouri-Kansas City

Research Supervisor: Professor Daniel H. McIntosh

Abstract

Constraining the specific physical processes at play in the assembly of massive galaxies during the peak epoch of galaxy development ($1 < z < 3$) remains difficult. Hierarchical processes like merging and rapid gas accretion are predicted to transform the appearance of galaxies, and different evolutionary processes may produce unique but faint and transient signatures in the morphological substructure of galaxies. To facilitate the identification and further analysis of plausible hallmark indicators of merging, we visually characterize the H-band (WFC3/F160W) single Sersic, model-subtracted “residual” images (van der Wel et al. 2012)¹ of 10,000 massive galaxies ($\log(M_{\text{stellar}}/M_{\text{sun}}) > 9.7$) spanning $1 < z < 3$ in the five CANDELS fields. We classify these residual images according to two criteria: (1) the quality of the model fit to the galaxy; and (2) the qualitative nature of the residual flux, both objective, and subjective. To repeat our characterization process on data sets from future surveys and calibrate them against synthetic mock observations from the VELA hydrodynamic simulations, we develop a Convolutional Neural Network (CNN) based classification system. To identify CANDELS galaxies hosting structurally similar tidal features, we use Scale Invariant Feature Transform (SIFT) and NeuroEvolution of Augmenting Topologies (NEAT). Using these machine learning techniques, we hope to calibrate the qualitative shapes of tidal features to the intrinsic properties of simulated merging systems (e.g., merger time step, stellar-mass ratio). We aim to use these calibrations as a first step to map the empirical high-redshift merging systems over cosmic time.

Rubyet Evan grew up and lived in Kansas City for most of his life after moving from Bangladesh. This is now his third year as an undergraduate student majoring in Physics with an Astronomy Emphasis and Mechanical Engineering. He’s been doing research with Dr. Daniel McIntosh and the Galaxy Evolution Group at the University of Missouri-Kansas City since the summer of 2017. He’s also a mentor and previous scholar of the ‘A Bridge to the Stars’ program also under the supervision of Dr. Daniel H. McIntosh. He is also the current Treasurer of the Society of Physics Students (SPS) chapter at UMKC and takes part in creating small-scale research projects for their chapter. Outside of university work, his biggest activity is mentoring the FIRST Robotics Team from Lincoln College Preparatory Academy (of which he is a former member). For the future, he plans on undertaking engineering research and continuing astronomy research to eventually work on research that encompasses both fields.

Application of the Hydrocode Modeling to Model Low-Angle Terrestrial Impacts

Daniel Fishbein, Devon Romine, and Greg Luckey
Missouri State University

Advisor: Dr. Ridwan Sakidja

Abstract

Purpose of the study is to model low-angle impacts of asteroid-like bodies colliding with the ground and the effect on surrounding areas. This project dealt with the low angle impact of asteroids. LAMMPS (Large-scale Atomic/Molecular Massively Parallel Simulator) was used with the SPH (Smooth Particle Hydrodynamics) library to model low-angle impact of an asteroid colliding with the earth's crust especially with a low angle impact found in the Weaubleau structure in Ozarks [1]. The SPH is grid-free technique, using significantly less computing power for large scale models and allows for modeling fluid or solid dynamics with complex geometry. This model provides a visualization of the impact and disbursement of particles after impact. The modeling of this project looked at the various effects of changing the mass of the meteor and the mass of the layers of the ground. An application of this research is to further the understanding of an iteration of a meteor impact.

Daniel Fishbein is originally from Barrington New Hampshire. He is a Junior physics major at Missouri State University. Daniel is currently involved with 2 research projects with Dr. Ridwan Sakidja: Application of the Hydrocode Modeling to Model Low-angle Terrestrial Impacts and Molecular Dynamic Simulations to Study Tunnel Barrier Layer Formation in Ultra-Thin Film Alumina. Daniel hopes to pursue a PhD in physics and use this degree to research plasma or fusion development.

Devon Romine is from Southeast Missouri. He is currently pursuing a bachelors in graduate prep physics and will be going on to seek a PhD in either computational quantum mechanics or high energy particle theory.

Greg Luckey is originally from Belleville, Illinois. He is a senior in Materials Science. Greg is currently involved with Hydrocode Impact modeling with Dr. Ridwan Sakidja and Dr. Kevin Evans. He is also involved in Data Mining using AI with Dr. Sakidja. He plans to continue in the private sector after graduation.

Implementation and Testing of Inverse Kinematics on Robotic Arm

Carter Franz

**Research Advisors: John Rakoczy and Levin Guillermo
NASA Marshall Space Flight Center**

Abstract

COSIE (Coronal Spectrographic Imager in the Extreme ultraviolet) is a proposed solar tracking ISS imaging payload that will help bridge the theoretical gap between the physics of the low corona and the heliosphere. This scientific instrument requires high pointing accuracy on the order of arcseconds. The instrument is mounted onto a three revolute joint robotic arm in order to track the roll, pitch, and yaw motion of the Sun. The goal of this project is to construct a prototype model of the robotic arm and implement the proposed analytical inverse kinematics algorithm. In robotics, the inverse kinematics problem is solving for the set of joint angles that achieve the desired end effector location and/or orientation. In this case, orientation is the focus. Depending on the configuration, multiple sets of joint angle solutions may exist. Due to the complexity of robotics, typically iterative methods are used to solve for the joint angle solution sets. However, in this case, an analytical solution exists. A small robotic arm representative of the full-size hardware was constructed. The inverse kinematics algorithm, originally in MATLAB/Simulink, was converted into C in order to interface with the motors. This C software was implemented on a Windows 10 PC and microcontroller, and serial communication between the two was established, allowing the motors to be directly controlled by the inverse kinematics algorithm. Testing the inverse kinematics on a physical system will allow the validity and accuracy of the analytical solution to be verified.

Carter Franz is from Houston, Texas and is currently a graduating senior in Aerospace Engineering from Saint Louis University in Saint Louis, MO. Carter will be attending the University of Texas in Austin in the fall to begin his PhD in Aerospace Engineering with a focus on Orbital Mechanics. After graduating, he hopes to work in mission and trajectory design for deep space missions. He believes that humanity can become an interstellar species in his lifetime and wants to help make that happen.

**Analyzing Multi-Band Properties of Tidal Features
in the Nearby Universe ($z < 0.08$) with SDSS**

Logan Fries

**In Collaboration with Kameswara Mantha (PhD candidate)
Department of Physics and Astronomy
University of Missouri-Kansas City**

Research Supervisor: Professor Daniel McIntosh

Abstract

A novel way to analyze tidal interactions is presented to analyze the optical color of tidal features from a set of visually selected mergers in the SDSS from Weston et al. 2017¹ ($M_{\text{stellar}} \geq 10^{10} M_{\odot}$, $z \leq 0.08$) to gain new insights into the nature of these dynamical encounters. Gravitational interactions between massive galaxies are predicted to produce tidal features during the first close pericentric passage and the final merging phases. Hallmark tidal features are used by many studies to quantify the rate of major galaxy-galaxy merging. A new tidal extraction and quantification method by Mantha et al. in prep was employed to SDSS g and r-band images that are first analyzed using GALFIT to remove a symmetric galaxy radial light profile. The color was used to estimate the stellar mass of each tidal feature. The color of the galaxy and of the tidal features was used to learn whether the interactions are quiescent or star-forming according to the urz color-color plane. The tidal feature mass will be compared with predictions from merger simulations to constrain the mass ratio of the progenitors. Ultimately, a new tidal feature metric will be employed to the analysis of larger samples.

Logan Fries is a senior studying astrophysics at the University of Missouri-Kansas City. He is from Lee's Summit, Missouri and wishes to eventually get a Ph.D. in astrophysics and continue doing research.

Pulsation Modes of sdB Star PG0850+170

Yadira S. Gaibor
Missouri State University

Advisor: Dr. Mike Reed

Abstract

Subdwarf B stars are blue stars with thin hydrogen shells which allow observation of their helium burning core. From previous analyses we know that some of them are pulsators, this means they have variable light output. These oscillations can be studied through asteroseismology in order to analyze the interior structure and provide additional constraints to current stellar evolution models. We use Kepler space telescope data to study PG0850+170, also called HZ Cnc, and present a preliminary list of periodicities our analyses have detected. We search for rotationally induced frequency multiplets and period spacings to provide mode identifications and determine a rotation period. This star is known to be in a binary system and its companion could be either a white dwarf or low-mass main sequence star. Our final analysis could further constrain the companion star's characteristics.

Yadira Gaibor is a sophomore at Missouri State University. She is studying Physics with an emphasis in Astronomy/Astrophysics. After graduation, she hopes to enroll in an astrophysics graduate program.

A Computational Study of Sleep, Synchronization, and the Hemispheres of the Brain

Tera Glaze
University of Missouri - St. Louis

Advisor: Sonya Bahar, Ph.D.

Abstract

Sleep has been a major area of study since the mid-18th century, yet it still poses a challenge as scientists continue to unravel more aspects of this essential function. One of the largest hurdles provided by sleep is understanding what is happening inside the brain while it snoozes. Many experimental studies and computational models have been dedicated to this mystery, from EEG recordings to unihemispheric sleep models. The model presented here aims to provide a step forward in understanding sleep in the brain, which will aid in further development of vital studies, such as treatments for sleep disorders and support for sleep in difficult environments. This model utilizes Huber-Braun and Hindmarsh-Rose neurons, placed in two groups that represent different regions of the brain. One region is sleep promoting, and the other is wake promoting. They will inhibit one another, while receiving input from the circadian drive. In the expanded version of the model, the regions are split into two interacting hemispheres. Analysis of the synchronization of neurons in each region has shown the levels of synchronization in each region having a reciprocal relationship dependent upon the time of day. This may reveal an interesting relationship between the synchronization index, time of day, region of the brain and number of neurons per region. Future work includes more analysis of the two-hemisphere version of the model and possibly adding in a region representing orexin and/or a region for REM sleep.

Tera Glaze is from Joliet, Illinois. She is working on her PhD in the Department of Physics and Astronomy at the University of Missouri – St. Louis. Her research centers around studying neurons and their behavior via computational models. She presented her research on Neural Chimeras at the Experimental Chaos and Complexity Conference in Banff, Canada in May of 2016, and published said research in *Chaos* the same year. She will be presenting at the SIAM conference in May this year. Her goal is to finish her dissertation and publish another paper in the next year.

Computational Fluid Dynamics Analysis of Inverted Multi-Element Airfoils in Ground Effect

Michael M. Grabis
Washington University in St. Louis

Advisor: Dr. Ramesh K. Agarwal

Abstract

Formula SAE cars are formula-styled racecars designed to race on an autocross circuit. The autocross circuit is mostly comprised of turning sections as well as a limited amount of straight sections for passing. Highly competitive cars in the competition feature aerodynamic devices to generate negative lift for the. This negative lift, or downforce, increases the amount of traction between the racecar's tires and the ground, ultimately allowing the drivers to turn at faster speeds. Commonly used aerodynamic devices are a front and rear wing; the wing cross sections are defined by configurations of multiple 2D airfoils. This paper focuses on the systematic design of a Formula SAE specific front wing through the comparisons of high lift, inverted airfoils, in ground effect in order to maximize the negative lift generated. Five high lift, single element airfoils are studied at multiple angles of attack from which three superior airfoils are chosen and used in a second study for various heights above the ground. A final study aims at combining the single airfoils into a two-element airfoil configuration to further increase the negative lift generation.

Michael Grabis is from Willow Springs, Illinois. Michael completed an undergraduate degree in Mechanical Engineering at Washington University in St. Louis and is currently in his 1st year as PhD candidate in Aerospace Engineering at Washington University in St. Louis. He has spent significant time with the University's Formula SAE Team, with leadership positions ranging from the Aerodynamics and Body Lead to being the President of the team his senior year. Currently he beginning to conduct research on the topic of sonic boom mitigation for his PhD related research work.

**Prediction of Two-dimensional Diamond-Like Carbon Nitrides
with Extraordinary Mechanical Stiffness and Thermal Conductivities**

Yuan Dong, Chi Zhang, Melinda M. Groves, Min Meng, Jian Lin
Department of Mechanical & Aerospace Engineering
University of Missouri-Columbia

Advisor: Dr. Jian Lin

Abstract

In this work, two new types of structurally stable two-dimensional (2D) carbon nitrides were predicted using first-principle calculations. These structures were derived by extracting two adjacent atomic layers from a cubic diamond or hexagonal diamond structure and then unsaturated carbon atoms were replaced with nitrogen atoms. The formed 2D diamond-like carbon nitrides were named as 2D c-C₂N₂ and 2D h-C₂N₂. First-principle calculations on their structural stability, electronic, mechanical, and thermal properties were performed to reveal conductivity of a semiconductor with a direct band gap of ~ 4.43 eV for c-C₂N₂ and an indirect band gap of 3.70 eV for h-C₂N₂. In addition, their mechanical stiffness reached as high as 1.08 TPa for c-C₂N₂ and 1.06 TPa for h-C₂N₂, both of which were comparable to that of graphene. c-C₂N₂ showed a thermal conductivity of 70000 W/m·K while h-C₂N₂ had a thermal conductivity of 56000 W/m·K at 80 K. These values were several times those of graphene and diamond at the same temperature. This research provided theoretical perspectives for exploring novel 2D carbon nitrides with extraordinary properties. Once experimentally realized, they would open widespread applications in electronics, optoelectronics, heat management, and mechanical structures.

Melinda Groves is a senior from Barnett, Missouri, pursuing her BS in Mechanical Engineering at the University of Missouri-Columbia, with minors in Aerospace Engineering and Mathematics. She is a coauthor of three published works and plans to pursue a master's degree in engineering or business.

A Study on the Release of Parent Volatiles from Comet C/2015 ER61

Tyler James Hanke
University of Missouri - St Louis

Advisor: Dr. Erika Gibb

Abstract

The study reports measurements of five native (i.e., released directly from the comet nucleus) volatiles (H₂O, HCN, NH₂, C₂H₂, and NH₃) in comet C/2015 ER61 (PANSTARRS) on the Lcustom setting using the iShell at the IRTF Facility. The observation presented was done on April 17, 2017 while ER61 was outbursting. Using the Interactive Data Language, the raw data was reduced to obtain abundance ratios for water and other volatile species in C/2015 ER61. H₂O was identified to have an average production rate of $(1.39 \pm 0.059) \times 10^{29}$ molecules s⁻¹. On April 17, the average abundance ratios for the other volatile species were: HCN/H₂O = $(0.10412 \pm 0.01311)\%$, NH₂/H₂O = $(1.67231 \pm 0.26834)\%$, C₂H₂/H₂O = $(0.05830 \pm 0.01296)\%$, and NH₃/H₂O = $(0.84571 \pm 0.11836)\%$. Based on the results and comparisons with other comets, it was found that ER61 was depleted in C₂H₂ and HCN, at the average with other Oort Cloud Comets in NH₃ and slightly enriched in NH₂. These results are only for one date and about two weeks after C/2015 ER61 started to outburst, thus the data for April 17, 2017 has not been compared with a previous date when the comet was not outbursting, and the comet may have had sufficient time by April 17 to have lost a significant portion of its reserves of each targeted molecule. More data on other dates for C/2015 ER61 must be reduced for this study can make an accurate conclusion on the chemical composition of the comet.

Tyler James Hanke is a junior Physics student with the Physics Department at the University of Missouri - St Louis, located in his hometown of St Louis. Tyler Hanke is committed to understanding the natural laws of the universe and will soon begin to pursue graduate training after graduating in May 2020, with a career goal of becoming a researcher in academia, a national lab, or in the private industry.

**Enhancing Remote Sensing Research and Education in Missouri
through Workshops and UAS Sensor Technology**

Sean Hartling
Department of Earth and Atmospheric Sciences
Saint Louis University

Advisor: Dr. Vasit Sagan

Abstract

Remote sensing has major advantages as a mechanism for learning. Across Missouri, educational institutions, from K-12 to the collegiate level, engage in the scientific process to investigate environmental issues, such as water quality monitoring, invasive species, biodiversity conservation and other important environmental issues. Given the importance of remote sensing for natural resource assessment and environmental monitoring as well as economic decision making, attention should be given to strengthen those institutions in academic and technical assistance. This project aims to enhance school and student learning, including the public, through hands-on learning in their community. The main topics presented in this project are: 1) the integration of UAS and relevant sensors as a highly autonomous environmental survey tool and 2) demonstrating the utility of remote sensing and GIS for enhancing interdisciplinary research. These topics have been presented to a diverse audience of organizations, educators, students, and general public through multi-institutional research collaborations, technical workshops, and hands-on learning displays. The work ties to several NASA areas of emphasis: 1) authentic, hands-on student experiences in science and engineering, 2) environmental science and global climate change, 3) diversity of institutions, faculty, and students, and 4) the capacity of institutions to support innovative research infrastructure activities to enable early career faculty to focus their research toward NASA priorities. The main objective of this initiative is to promote a remote sensing community committed to creating, establishing and assessing innovative education research and theory and incorporating it into effective practice.

Sean Hartling is a PhD student in the Integrated and Applied Science (IAS) program with emphasis on remote sensing and GIS. He received his B.A. from Washington University in 2006 in St. Louis and a Graduate Certificate in Advanced Remote Sensing and GIS from Saint Louis University. His research focuses on storm damage forecasting for regional utility network using UAS/satellite remote sensing and GIS.

Adaptive Controller Development and Testing for the Steerable Cruciform Parachute

Shawn Herrington
University of Missouri – Kansas City
Advisor: Dr. Travis Fields

Abstract

Within the airdrop community there has recently been renewed interest in modifying minimally gliding and historically unguided parachute canopy shapes for use in precision guided systems. Cruciform shaped canopies have a unique combination of characteristics which make them ideal candidates for adaptation for precision guidance. Additionally, modifications to the basic cruciform shape may enhance the performance of such systems without substantially increasing cost or complexity. Building on an experimental methodology first used to study the basic cruciform design, determination of the dynamic characteristics of proposed modified cruciform canopies is to be conducted at the 20ft. Vertical Spin Tunnel (VST) at the NASA Langley Research Center (LaRC). In addition to providing data which can be used to determine the dynamic behavior of the bare canopy, the VST provides a unique venue for experimental gain tuning in the closed-loop configuration due to the unlimited virtual descent time. A compact experiment at LaRC will provide experimental data which could require weeks of expensive flight testing.

Shawn Herrington is a PhD. student in the Mechanical Engineering Department at the University of Missouri Kansas City. His research areas include development of guidance, navigation and control systems for autonomous aerial vehicles.

Spectral Energy Distributions of Control WISE-Selected Obscured AGNs

Lauren Higgins
University of Missouri – Kansas City

Advisors: Madalyn Weston and Professor Daniel McIntosh

Abstract

The infrared emission from galaxies poses a unique challenge to Astronomy. Contributions from both star formation and supermassive black hole growth (via active galactic nuclei; AGNs) need to be isolated to determine the relationship between these processes and galaxy morphology. The researchers used archival photometric data from the Galaxy Evolution Explorer (GALEX), the Sloan Digital Sky Survey (SDSS), the Two Micron All-Sky Survey (2MASS), and the Wide-field Infrared Survey Explorer (*WISE*) to construct spectral energy distributions (SEDs) of 55 non-merging, non-interacting WISE AGNs, originally selected as control galaxies in a previous study as galaxies lacking any noticeable signs of plausible tidal disturbance. The SEDs were constructed using *AGNfitter*, a publicly available SED-fitting code for galaxies hosting an AGN. The results indicate that 98% of control galaxies previously identified as *WISE* AGNs hosted an infrared AGN component through SED decomposition, thus verifying the original classification. This contribution is part of a larger project led by M. Weston. These SEDs will serve as the control sample for her Ph.D. dissertation research, focused on the relationships between merging galaxies, AGNs, and star formation. Ongoing work includes performing independent, aperture-matched photometry on the sample and gathering additional, longer-wavelength data to constrain star formation rates.

Lauren Higgins grew up in Kansas City, Missouri and is a non-traditional college student who began her 14+ year college journey as a Music Education Major. Now, she is majoring in Physics with an emphasis in Astronomy and minoring in Mathematics. She is the President and a founding member of Women in Science (WiSci), a UMKC Student Organization whose goal is to create a network of women and men promoting and supporting women in STEM fields. She will be studying the formation of the first stars this summer at The University of Texas – Austin. She wants to pursue a PhD. in either Particle Physics or Astrophysics and she wants to become a professor.

Characterizing the Residual Substructure of Massive CANDELS Galaxies: V Using Machine Learning to Identify & Quantify Feature Similarity

Osiris Hines

In collaboration with Rubyet Evan, Kameswara Mantha,
Luther Landry, Cody Ciashi, Andrew Pepper, and Scott Thompson
University of Missouri - Kansas City

Advisor: Dr. Daniel McIntosh

Abstract

Constraining the specific physical processes at play in the assembly of massive galaxies during the peak epoch of galaxy development ($1 < z < 3$) remains difficult. Hierarchical processes like merging and rapid gas accretion are predicted to transform the appearance of galaxies, and different evolutionary processes may produce unique but faint and transient signatures in the morphological substructure of galaxies. To facilitate the identification and further analysis of plausible hallmark indicators of merging, we visually characterize the H-band (WFC3/F160W) single Sersic, model-subtracted “residual” images of 10,000 massive galaxies ($\log(M_{\text{stellar}}/M_{\text{sun}}) > 9.7$) spanning $1 < z < 3$ in the five CANDELS fields. We classify these residual images according to two criteria: (1) the quality of the model fit to the galaxy; and (2) the qualitative nature of the residual flux, both objective, and subjective. To repeat our characterization process on data sets from future surveys and calibrate them against synthetic mock observations from the VELA hydrodynamic simulations, we develop a Convolutional Neural Network (CNN) based classification system. To identify CANDELS galaxies hosting structurally similar tidal features, we use Scale Invariant Feature Transform (SIFT) and NeuroEvolution of Augmenting Topologies (NEAT). Using these machine learning techniques, we hope to calibrate the qualitative shapes of tidal features to the intrinsic properties of simulated merging systems (e.g., merger time step, stellar-mass ratio). We aim to use these calibrations as a first step to map the empirical high-redshift merging systems over cosmic time.

Osiris (Courtney) Rhen Keiton Hines grew up in the Shawnee Mission School District. After graduating high school he enlisted into the United States Air Force where he served six years at Offutt Air Force Base as a Aerospace Ground Equipment specialist for the E4-B Presidential Support Mission. He completed a Bachelors of Science in Music Production from Full Sail University before beginning his undergraduate studies in Physics and French. He is currently in his third year of study at the University of Missouri-Kansas City to graduate Spring 2020 after which he plans on attending graduate school. He is the 2018-2019 president of the Society of Physics Students (SPS) for the UMKC chapter, and is leading a project to build a hydroponic system and report how air quality is affected. He plans to partake in research with the Physics and Astronomy department during his remaining time at UMKC and after graduation aims to join a graduate program to work on Neural Interfacing and Prosthesis.

Effects of Stenosis Geometry on Flow in Arteriovenous Fistula Patients

Jeff Krampf

**Department of Mechanical Engineering & Materials Science
Washington University in St. Louis**

Advisors: Drs. Ramesh Agarwal & Surendra Shenoy

Abstract

This focus of this study is to understand the relationship between the fluid properties present in and the geometric parameters of stenoses developed in end-stage renal disease (ESRD) patients, after creation of an arteriovenous fistula (AVF). Stenosis is the leading cause of failure in AVF creation and maturation. A fistula is meant to provide an access point for hemodialysis treatment necessary for ESRD patients, but large failure rates in fistula creation and maturation cause reoccurring problems for patients and a disproportionately high amount of spending on ESRD patient care. In the United States alone, ESRD patients account for 1% of the Medicare patient population, but the Centers for Medicare & Medicaid Services spent \$35.4 billion, 7.2% of the 2016 Medicare budget on their treatment (United States Renal Data System, 2018 Annual Report). This study uses CFD to simulate blood flowing through venous stenoses of varying lengths and initial flow conditions. Computational modeling allows for specific control of geometric conditions as well as simple generation of resulting properties, such as wall shear stress, that are difficult to acquire in vivo. For this study, five different geometric models were constructed to represent straight vascular segments with varying lengths of stenosis. The data collected here shows under which flow conditions different stenosis geometries can result in a failed fistula, as well as under which conditions the stenosis alone will not prevent the fistula from providing the required flow for dialysis treatment.

Jeff Krampf is a Ph.D. candidate in Mechanical Engineering at Washington University in St. Louis. Originally from Belleville, IL, Jeff received his B.S in Mechanical Engineering from Missouri University of Science & Technology in 2011. After which, he worked as a process engineer at the Naval Reactors Facility on the Idaho National Lab before returning to St. Louis to work as a performance contract engineer. Jeff returned to academic work at WashU in 2015, where he completed his M.S. in Mechanical Engineering in 2017 and plans to complete his Ph.D. this year.

Characterizing Residual Substructures of Massive CANDELS Galaxies: III Investigating Plausibly Tidally-Disturbed Systems in the Non-Star-Forming Population

Luther Landry
University of Missouri - Kansas City

**In collaboration with Kameswara Mantha, Cody Ciaschi, Osiris,
Scott Thompson, Andrew Pepper, and Rubyet Evan**

Research Supervisor: Professor Daniel McIntosh

Abstract

Constraining the specific physical processes at play in the assembly of massive galaxies during the peak epoch of galaxy development ($z \sim 2$) remains difficult. Hierarchical processes like merging and rapid gas accretion are predicted to transform the appearance of galaxies. Different processes may produce faint and transient morphological substructures that are more readily identified using single Sersic, model-subtracted “residual” images. To facilitate the analysis of these substructures, we characterize the HST/WFC3 H-band (F160W) residual images of 10,000 CANDELS galaxies with $\log(M_{\text{stellar}}/M_{\text{sun}}) > 9.7$ and redshifts $1 < z < 3$ from van der Wel et al. 2012. We catalog two flags for each galaxy: (1) the descriptive characteristics of the residual flux, and (2) the quality of the Sersic model fit. We find that 22% of this sample populates the non-star-forming region of UVJ space; of these, 91% have only a faint residual or no residual at all. However, 4% of these non-star-forming galaxies host highly asymmetric residuals plausibly associated with major mergers. We present preliminary results on how these galaxies populate different multivariate parameter spaces to attempt to distinguish whether or not these objects are plausible examples of high-redshift gas-poor (so-called dry) merging or rapid quenching.

Luther Landry is an MS candidate in astronomy at the University of Missouri - Kansas City. Originally from Nixa, MO, he received a BA in philosophy from William Jewell College in 2007. That was not a good year to graduate with a degree in philosophy. In 2016, he decided to go back to school pursue his childhood love: physics and astronomy. He now collaborates with UMKC’s Galaxy Evolution Group to help better understand the role of major mergers in galaxy evolution.

Adapting Molecular Dynamics Hydrocode to Simulate Large Scale Oblique Impact Structures

Greg Luckey and Devon Romine
Missouri State University

Advisors: Dr. Ridwan Sakidja and Dr. Kevin Evans

Abstract

Purpose of the study is to create a 3-dimensional virtual model of an oblique meteor impact using the physical evidence from the Weaubleau impact structure in Missouri. Researchers employed molecular dynamics simulation software (LAMMPS) to create the model. Classical computational models of high energy impacts rely of a mesh-based system in this project Smoothed Particle Hydrodynamics (SPH) was used to create the model.

Greg Luckey is originally from Belleville Illinois. He is a senior in Physics/Materials science. He is researching Computational modeling of oblique impacts with Dr. Ridwan Sakidja and Dr. Kevin Evans. He is also involved with an ongoing research project with Dr. Sakidja on employing AI techniques to mine creep data for ab initio calculations. He hopes to continue his work in the private sector focusing on data analysis and Artificial Intelligence.

Devon Romine is from Southeast Missouri. He is currently pursuing a bachelors in graduate prep physics and will be going on to seek a PhD in either computational quantum mechanics or high energy particle theory.

**Design and Development of Plasma Sources
for Laboratory Investigations of Plasma-Material Interactions**

**David Lund
Missouri University of Science and Technology**

Advisor: Dr. Daoru Han

Abstract

The design and development of a plasma source is being conducted to further advance the technology and knowledge to establish a permanent base on the Moon. Plasma source components have been researched and purchased. Once arrived, the source will be assembled and calibrated/characterized. Also, research on constructing different types of measurement probes to measure various plasma conditions is happening. Future experimentation includes using lunar dust simulants to test various situations involving plasma and dust interactions as well as simulating natural solar wind conditions.

David Lund grew up as a military child traveling the country and world before settling down near Fort Leonard Wood, Missouri. He is currently a senior in Mechanical Engineering at Missouri University of Science and Technology, graduating May of 2019. He will be pursuing a Ph.D. in Aerospace Engineering starting Fall of 2019 at Missouri University of Science and Technology. His research interests include extraterrestrial environments and space exploration. He wants to continue his research under Dr. Han because his projects are especially appealing. Their research will continue to work with high-fidelity particle simulation codes and experimentation in a large vacuum chamber to simulate the complex space environment (solar wind plasma, photoelectrons, dust, etc.). His career aspiration is to become involved with space projects at NASA or related space technology companies.

**Major Merger History of Massive Galaxies since $z\sim 3$:
Calibrating Close-Pair Observability Timescales using SAMs**

Kameswara Bharadwaj Mantha
University of Missouri – Kansas City

Research Supervisor: Dr. Daniel H. McIntosh

Abstract

The role of major mergers in galaxy evolution remains a key open question. Major merger rate estimates based on galaxy-galaxy pairs, non-parametric morphological metrics, and subjective visual classifications often disagree with each other and with theoretical predictions, especially at redshifts $1 < z < 3$. The primary reason is that there is a gap in our understanding of the observability timescales of galaxy-galaxy pairs and of hallmark tidal interaction signatures. To help resolve this issue, we are systematically analyzing state-of-the-art galaxy formation and evolution simulation data to calibrate these observability timescales. For pairs, we measure the major pair ($<4:1$ stellar-mass ratio) fraction evolution during $1 < z < 3$ among massive galaxies ($M_{\text{star}} > 1E10 M_{\text{sun}}$) from the mock CANDELS survey lightcones generated by the SAMs and find varying trends: SantaCruz SAMs (strong), Carnegie and SAGE SAMs (weak), and the UniverseMachine (UM; no evolution). Following the methodology by Snyder et al., we calibrate the UM close-pair fractions to their corresponding intrinsic merger rates within each model and find that the close-pair observability timescale (T_{obs}) evolves with redshift as $T_{\text{obs}} = 2.2 (1+z)^{-1.6}$ Gyr. These calibrations will enable us to robustly constrain the major merger history of massive galaxies since $z\sim 3$.

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, 229th, 231, and 233 AAS meetings, and at the 36th ASI meeting. He is currently an Ph.D. 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.

Oxygen Saturation Control for Premature Infants During Feeding Using Automatic Control

Lydia Meyer
University of Missouri

Advisor: Dr. Roger Fales

Abstract

Infants born prior to 32 weeks' gestation and/or weighing less than 1500 grams at birth frequently receive supplemental oxygen to improve their short-term and long-term health outcomes. Maintaining a safe arterial oxygen saturation level (SpO_2) is critical when supplemental oxygen is administered. The SpO_2 level is regulated by adjusting supplementary oxygen (FiO_2) delivered via a high-flow nasal cannula for the population of infants which are the focus for this research. The ideal SpO_2 level of the infant lies within a range that depends on gestational age and several other factors, which are determined by the infant's physician. For example, in this population of infants, some infants have an ideal SpO_2 range of 91-99 percent oxygen saturation. Current neonatal intensive care unit (NICU) practices administer supplemental oxygen through a nasal cannula attached to an oxygen blender for the infants who are the subjects of this research. The blender dispenses air with supplemental oxygen ranging from 21 percent oxygen in air to 100 percent oxygen. Nurses manually adjust the oxygen blender to keep the infant's SpO_2 level within the desired range. The nurse can view a display of the SpO_2 on a bedside monitor which also produces alarm notifications when the patient is outside of the desired range of SpO_2 . The automatic oxygen control system receives information from a pulse oximeter. The nurse or the controller will then adjust the FiO_2 levels based on the SpO_2 data. Many factors may influence the SpO_2 levels of premature infants and can cause a premature infant's oxygen level to desaturate or noticeably decrease to below 80 percent. According to existing literature, feeding the premature infant poses challenges to maintaining safe SpO_2 levels. The automatic controller has been utilized several times in a clinical trial in which the premature infant is fed frequently. Data from the trials, conducted in both automatic and manual modes, has been analyzed to compare the efficacy of oxygen control in automatic mode to manual mode before, during, and after feeding the premature infant.

Lydia Meyer is a senior mechanical engineering major at the University of Missouri-Columbia. Meyer is originally from Jefferson City, Missouri. Meyer has conducted research on automatic control since May 2016 and has presented her research at the Mizzou Undergraduate Research Forum, Chancellor's Address, Undergraduate Research Day at the Capitol, and the MOSGC Annual Meeting in 2018. Meyer has interned at the National Renewable Energy Laboratory (NREL) in Golden, Colorado, where she developed an energy estimation framework for modeling the energy usage of vehicles between pairs of origins and destinations. Meyer plans to spend the summer of 2019 as an intern at NREL. In this internship, she will conduct research on the effects of evaporative cooling on combustion phasing and emissions from internal combustion engines. Meyer plans to attend Colorado School of Mines to earn a PhD in mechanical engineering after graduating from the University of Missouri-Columbia.

Shock Tube Experimentation Utilizing Advanced Diagnostics to Study an Impulsively Accelerated Multiphase Cylinder

John B. Middlebrooks
University of Missouri

Advisor: Dr. Jacob A. McFarland

Abstract

Shock driven multiphase instabilities (SDMI) are unique physical phenomena that have far-reaching practical applications in engineering and science. The instability is present in high energy explosions, scramjet combustors, and supernovae events. The SDMI arises when a multiphase interface is impulsively accelerated by the passage of a shockwave. Complex particle-to-gas coupling is the driving mechanism of the SDMI. Particle effects such as lag, aerodynamic breakup, and mass, momentum and energy exchanges with the gas all contribute to the development of the instability. An experiment has been developed for studying the SDMI at our shock tube facility. A multiphase interface is created and flowed into the shock tube where it is accelerated by the passage of a planar shockwave. Dynamic imaging of the interface was used to analyze the flow morphology. The effects of Atwood number (particle seeding), particle size, and a secondary acceleration of the interface were examined providing a mostly qualitative analysis of the flow. Non-intrusive flow visualization techniques such as Particle Image Velocimetry and Planar Laser Induced Fluorescence were used to obtain quantitative measures of multiphase effects. Measurements of particle lag distance, carrier and dispersed phase velocity, and vorticity were made. The experimental set up and findings will be discussed in detail.

John B. Middlebrooks, St. Louis MO, Current MS student in Mechanical and Aerospace Engineering, University of Missouri, University of Missouri Ronald E. McNair Scholar, Missouri Space Grant Fellow, wishes to continue his education in the area of Thermal-Fluids sciences through course work and research.

Uranium-Lead in Zircon Age Date Analysis of Salmon River Ash Tuffs, Idaho

**Tessa Mills
Missouri State University**

Advisor: Dr. Matthew McKay

Abstract

The Cascade Volcanoes of the Western United States were formed due to the collision of smaller tectonic plates such as the Juan de Fuca, Explorer, and Gorda Plates subducting underneath the North American Plate starting in the Mesozoic leading to the area consisting of mainly metamorphic rocks. The associated volcanoes erupted pyroclastic debris that can be found in the North Western United States, including Western Idaho. These ashes are exposed along the Salmon River, located in the Riggins quadrangle, and the Rapid River located in the Heaven's Gate quadrangle, as well as exposed in road cuts along roads leading to the Heaven's Gate Fire lookout.

Six samples were collected from this area. Age estimates of the ash tuffs will be concluded from U-Pb geochronology from zircon grains removed from the samples. Determination of the age of zircon formation will help to estimate the time frame of the eruption the grain originated from. We hypothesize that the data will correlate to previously known eruptions of volcanos from the Cascade Arc and will help us attribute the ashes to a specific volcano.

Tessa Mills comes from the small town of Cleveland, Missouri, and is currently a senior in the Geology, Geography and Planning Department at Missouri State University. She is majoring in Geology with a minor in Art and is a part of the Honors College at MSU and the Vice President of Events for the student chapter of American Association of Petroleum Geologists. Tessa hopes to continue her education by attending Grad school at MSU and then get a job working with the National Parks Department.

An Introduction to Nonlinear Behavior and its Applications

Lauren Parker
University of Missouri – Columbia

Advisor: Dr. Frank Feng

Abstract

Disc springs, or springs with a conical shape, are often used in industry due to their unique geometry and nonlinear qualities. This paper examines the nonlinear behavior of such a disc spring through simulations using SolidWorks, in which the bottom edge of the spring is fixed and a force is applied to the topmost edge. The stress, strain, and displacement of both the spring as a whole and the topmost edge are examined. The results of this study support the suggestion that disc springs behave in a nonlinear manner, and these findings are illustrated with various graphs produced by SolidWorks. This paper seeks to provide a basic, introductory explanation of nonlinear dynamics and behavior, and more research will be conducted in order to gain a more thorough understanding of the theory behind and applications of this behavior.

Lauren M. Parker is a junior at the University of Missouri - Columbia studying Mechanical and Aerospace Engineering with minors in Mathematics and Spanish. She plans to work as a Process Engineer Intern with Textron Aviation during the summer of 2019, and will pursue a career in the aerospace field upon graduating in December 2020.

Characterizing Residual Substructures of Massive CANDELS Galaxies

Andrew Pepper

Key Intern - GALFIT Residual Analysis Team (GREAT)

University of Missouri Kansas City

Advisor: Professor Dr. Daniel McIntosh

Abstract

Constraining the specific physical processes at play in the assembly of massive galaxies during the peak epoch of galaxy development ($1 < z < 3$) remains difficult. Hierarchical processes like merging and rapid gas accretion are predicted to transform the appearance of galaxies, and different evolutionary processes may produce unique but faint and transient signatures in the morphological substructure of galaxies. To facilitate the identification and further analysis of plausible hallmark indicators, we visually inspect single Sersic, model-subtracted “residual” images of high-redshift objects. We characterize the H-band (WFC3/F160W) residual images of 10,000 galaxies with $\log(M_{\text{stellar}}/M_{\text{sun}}) > 9.7$, H-band mag < 24.5 and spanning $1 < z < 3$ in the five CANDELS fields from van der Wel et al. 2012. We classify these residual images according to two criteria: (1) the quality of the model fit to the galaxy; and (2) the qualitative nature of the residual flux, both objective (e.g., underfit centers, clumpy or patchy substructure), and subjective (e.g., plausible tidal features, spiral arms, disks). Analyzing these residual images and looking for key characteristics that exhibit signs of interacting galaxies is an important tool for understanding how our immediate neighboring galaxies are behaving, and how we can expect them to change over time. Furthermore, these classified residual images are excellent fodder to improve machine learning tools focused on constructing galaxy models. The primary motivation in assessing these residual images is to be able to accurately assess structures related to galaxy mergers and to identify GALFIT model related issues with the hope of improving our modelling method.

Andrew Pepper is an undergraduate researcher (senior) at the University of Missouri – Kansas City. He works with the distinguished Galfit Residual Analysis Team (GREAT) and could not be more proud of the work their team has done. He is from, and grew up in, St. Louis, Missouri, but he made his way across state for his collegiate career. Andrew is currently in the process of applying to graduate programs in the field of astrophysics, and aspires to find, classify, and analyze exoplanets and their planetary atmospheres.

Investigating Climate Impacts of Urbanization and the Potential for Cool Roofs to Mitigate Future Climate Change in Kansas City

Kyle Reed
Department of Geosciences
University of Missouri – Kansas City

Advisor: Fengpeng Sun

Abstract

An urban heat island (UHI) is a type of microclimate where the temperatures within cities are greater than those of surrounding rural areas due to human activity and physical properties of the urban area. This effect can cause the annual mean temperature within cities to be up to 3°C more than its surroundings. As the increasing trend in urbanization around the world continues, the UHI effect will continue to affect a greater number of people over time. One method that has been investigated as a way to mitigate the UHI phenomenon is to increase the albedo in cities, which would reflect a greater amount of solar radiation that is reflected away from urban surfaces compared to conventional materials (e.g. asphalt roads and dark shingles). In this study, we assess the impact of increasing the albedo within the Kansas City metropolitan area in order to reduce the UHI effect during a summer heat wave. Our results indicate that high albedo materials are a viable option for mitigating near-surface air temperatures in the Kansas City area.

Kyle Reed is currently pursuing a Master of Science in Environmental and Urban Geosciences at the University of Missouri – Kansas City. His research interests include climate modeling and the effects of urban land cover on local climate. Kyle is originally from Larned, Kansas, but has lived in the Kansas City area for the past 10 years. He holds prior undergraduate and graduate degrees from Fort Hays State University and the University of Kansas, respectively. Most recently, he graduated with a Bachelor of Science in Geography from the University of Missouri – Kansas City in the spring of 2018. After completing his schooling, Kyle would like to pursue a career in climate research.

Computational Investigations of Hydrous Andalusite Melts

Weston R. Renfrow

**Department of Physics, Astronomy, and Materials Science
Missouri State University**

Advisor: Professor Robert Mayanovic

Abstract

Water affects the viscosity of aluminum silicate melts. Beneath the earth's crust, magma is largely made up of aluminum silicates. Viscous magma is more eruptive and can be more dangerous. By simulating how water reacts when mixed with an aluminum silicate melt, we can build computational data of earth's volcanos and its mass distribution. By studying earth, we can learn about the habitable zone of similar rocky exoplanets and help us on our search for life in our universe. Currently, there are no studies about hydrous (i.e., with soluble water) silicate melt systems with sufficient data on the structure of the systems. With this study of dry and hydrous andalusite systems and many more like it we hope to gain enough data to better understand the molecular dynamics of these systems. These simulations are done by using LAMMPS and ReaxFF software which can estimate quantum mechanical reactions.

Weston Renfrow is from Overland Park, KS and is currently perusing a BS degree in Physics/Material Science with a Mathematics minor at Missouri State University. He hopes to either continue his education and pursue an advanced degree once he graduates, or find a career in the science field. This research has brought him a much better understanding of material science. The computer programs that he uses shows him a visual depiction of what is happening at the molecular level which would be impossible to view experimentally. This research has taught him how to use complicated computer software and write shell scripts using Unix. Weston enjoys working with computers very much and he hopes to continue on down the computational programming path in his future works.

Examination of Proverse Yaw in Bell-Shaped Spanload Aircraft

Jonathan Richter
McKelvey School of Engineering
Washington University in St. Louis

Advisors: Mr. Kevin Hainline & Dr. Ramesh K. Agarwal

Abstract

Recent developments in the bell-shaped lift distribution have shown the existence of proverse yaw control power via induced thrust at the wingtips which can fundamentally change aircraft design. With no need for vertical control surfaces, straight tapered flying wings are now possible vastly increasing efficiency and performance compared to traditional aircraft. In order to maintain stability and control, straight tapered flying wings require adequate proverse yaw control power. This paper investigated the connection between aircraft geometry and proverse yaw control power while applying the bell spanload.

By varying taper ratio, wing chord, wing length, twist distribution, and outboard wing control surface (OWCS) size, several relationships between aircraft geometry and proverse yaw control power are determined. Proverse yaw control power is a function of both increased lift within a region of upwash and the change in upwash caused by the increased lift. As the OWCS area increases due to larger chord lengths, proverse yaw control power increases. However, increasing the span fraction of the OWCS does not necessarily result in increased proverse yaw control power as it is tied to both the change in lift and upwash. Increasing the region of upwash via wing lengthening or twist distribution increases proverse yaw control power. The Biomimetic Aircraft with 10% more span 10% more twist has 16 times more proverse yaw control power than the original Biomimetic Vehicle. With this increase in proverse yaw control power, straight tapered flying wings are controllable through all necessary flight regimes.

Jonathan Richter, originally from Darien, CT, is currently a sophomore Mechanical Engineer minoring in Aerospace at Washington University in St. Louis McKelvey School of Engineering. Jonathan hopes to find an analytical solution to proverse yaw control power and integrate the efficient bell shaped spanload into other aircraft designs. After concluding his undergraduate studies, Jonathan wishes to pursue a doctorate degree in aeronautics.

Heterostructure of 2D Materials

Christopher Robledo
Missouri State University

Advisor: Professor Kartik Ghosh

Abstract

The 2D material HfS₂ is predicted to have a high electron mobility (1800 cm²/Vs), finite bandgap (1.2 eV), and reduced hysteresis curve. Unfortunately, there are no established fabrication processes to synthesize HfS₂ in a practical manner. Current methods of creating of these heterostructure materials is limited to mechanical exfoliation and chemical transport. Neither of these methods are practical enough to be considered established techniques. To fabricate HfO₂/HfS₂ heterostructures, on a single crystal of Silicon (400), it was grown using atomic layer deposition (ALD) at Air Force Research Laboratory (AFRL) and annealed at various temperatures. Then, sulfidised via hydrothermal process to produce a HfS₂ layer on top. HfO₂ was also grown on SiO₂ substrate using pulse laser deposition (PLD). Again, the oxygen on the top few layers was replaced with sulfur using the hydrothermal process similar to the first process. The 2D materials and their heterostructures were characterized using X-ray Diffraction (XRD), Raman spectroscopy, photoluminescence. Analysis of the parent samples and sulfidation technique is still ongoing. We hope to have the initial results of the sulfidation process analyzed by the end of April, as well as a more in-depth analysis of the annealing process.

Christopher Robledo is a Master of Science degree candidate in the Department of Physics, Astronomy, and Material Science at Missouri State University in Springfield, MO.

**Molecular Dynamics Simulations
of Anorthite-Melt-Water Interactions**

Devon T. Romine

**Department of Physics, Astronomy, and Materials Science
Missouri State University**

Advisor: Professor Robert Mayanovic

Abstract

This study is a continuation of ongoing research into hydrous albite melts, which was the first attempt at creating structural data of hydrous silicate melts. Anorthite is an aluminosilicate with Ca incorporated into it ($\text{CaAl}_2\text{Si}_2\text{O}_8$). Water dissolution into silicate melts, such as anorthite, plays an important role in modifying the nature of the melt and, thereby, its physical properties. This in turn has a direct bearing on many natural processes involving melts, such as the eruptive power of magmas and the transfer of mass in magmatic processes. The use of molecular dynamics simulations enables the study of water-melt interactions at the atomic scale, which is often difficult using experimental techniques. Such studies may potentially lead to a better understanding of the water cycle related to the plate tectonics of the Earth and on exoplanets. In terms of practical applications, there are considerable potential for use of the results from our studies in the field of construction, as a number concrete and window mixtures use silicates in their compounds. To this extent, large simulation-cell molecular dynamic calculations are being employed to try and make a detailed quantitative structural analysis of hydrous anorthite melt systems.

Devon Romine is from Southeast Missouri. He is currently pursuing a bachelors in graduate prep physics and will be going on to seek a PhD in either computational quantum mechanics or high energy particle theory.

Design of the Nanosat 8 Satellite Flight Software

Joseph Schulte
Missouri University of Science and Technology

Advisor: Dr. Henry Pernicka

Abstract

The purpose of this project is to develop the higher-level flight software for the Nanosat 8 satellite project. For the flight code to be operational it needs to be able to communicate with the various subsystems of the satellite, and parse sensor data to be sent to the Guidance, Navigation, and Control algorithm. The flight code also needs to divide the workload of gathering data so as to not overload a single thread of the CPU on the flight computer. This paper elaborates on how some of the higher level flight code for the Nanosat 8 satellite project operates

Joseph Schulte is from Vienna, MO, and is a sophomore in Computer Engineering at the Missouri University of Science and Technology in Rolla, MO. Ever since he watched a tutorial on how to build a computer, he has been extremely fascinated by how computers work; which led him to pursue an education in computer engineering. Joseph's dream job would be developing hardware drivers.

**Pumice Compositions and Mineral Chemistry of Bimodal Pumice
Erupted from Lascar Volcano, Central Volcanic Zone, Chile**

**Madelaine Stearn
Department of Geography, Geology, and Planning
Missouri State University**

Advisor: Dr. Gary Michelfelder

Abstract

Lascar volcano is the most active volcano in the Central Volcanic Zone of the Andean Cordillera, with 36 Holocene eruptions and a VEI 4 event in April, 1993. We do not fully understand the processes behind Lascar's activity, as it has not been consistent throughout time. Lascar volcano has cyclic behavior, meaning it has cycles of dome growth, eruption, and then subsidence; additionally, the vent migrates between stages. Interestingly, the style of eruption and composition is unique for each stage. The first stages of activity were mostly effusive eruptions, which transitioned into pyroclastic flows. Lascar's contemporary eruptions are almost exclusively explosive. We hypothesize that eruptions caused by magmatic rejuvenation will retain diverse chemical signatures and prevent crustal assimilation, whereas slower rates of magma intrusion resulting in regional magma body formation will result in more homogeneous geochemistry.

Madelaine Stearn is originally from Redmond, Washington State and received her Bachelors of Science in Geology from Central Washington University in Ellensburg, Washington. She is currently working on her Masters of Science in Geology at Missouri State University in Springfield, Missouri. Her degree focuses on volcanology in South America. She aspires to one day work at the Cascade Volcano Observatory working on the volcanoes she grew up with.

Spyder Third Stage Design

**Lauren Bassler¹, Andrew Janecek-Oiler², Matthew Schoffelmeer³,
and Alexander Strenfel⁴**

**Research Advisors: Pat Lampton, Timothy Kibby, and Jonathan Jones
NASA-Marshall Spaceflight Center**

Abstract

Currently, it is very expensive to launch small payloads into low earth orbit, and “piggyback” rides on large payload launches are difficult to obtain for the average CubeSat builder. UP Aerospace Inc. has contracted NASA to aid in the development of a four stage, solid-fueled launch vehicle intended to send a 6U CubeSat (16 lbs.) to low earth orbit for a reasonable price, on demand. The purpose of this project was to characterize, design, and optimize the third stage motor. First, the optimum launch profile and the resulting motor characteristics were determined using industry design tools. To deliver the needed performance while minimizing inert mass, the motor will feature a composite case construction and additively manufactured components. Using these determined characteristics and materials decisions, the team designed and optimized the motor’s case and propellant grain geometry, insulation thickness, and nozzle assembly. The team also designed the propellant casting and composite wrapping tooling, and delivered CAD models of all components.

Alexander Strenfel is a graduate student at Missouri University of Science and Technology, and will be graduating December of 2019 with his Masters in Aerospace Engineering with a focus on propulsion. His hometown is Van Buren, MO, known for its river tourism. He worked with NASA and UP Aerospace in an internship to design a solid rocket motor for an upper stage rocket. This rocket, the Spyder, will be UP Aerospace’s first access to orbit rocket. He is a member of Missouri S&T’s Liquid Rocket Design Team where he helps design liquid bi-propellant rocket engines, and he is also the head of the team’s plumbing sub-team. He led the design and manufacturing of a sleeve valve to be used by the team for toggling propellant flow. Alex has a strong passion for rocketry and has a dream of one day working with NASA to expand mankind’s horizons to space.

1. University of South Alabama
2. University of Wyoming
3. The Pennsylvania State University
4. Missouri University of Science and Technology

Evaluation of Various RANS Turbulence Models for Predicting the Drag on an Ahmed Body

Bryce Thomas
Washington University in St. Louis

Advisor: Dr. Ramesh K. Agarwal

Abstract

The focus of this paper is on simulation of flow past an Ahmed body with a rear slant angle defined to be 25° . Reynolds-Averaged Navier-Stokes (RANS) equations are solved concurrently with various turbulence models using the finite-volume method. The turbulence models utilized in this paper are the k-epsilon standard and realizable models, k-omega shear stress transport (SST) model, Spalart-Allmaras (SA) model and the wall-distance free (WDF) Wray-Agarwal model (WA2018). A pressure-based solver in the ANSYS Fluent CFD software package is used for the computations. A range of linear eddy viscosity turbulence models are employed, and the results are compared in terms of computation time and ability to predict accurately the drag coefficient of the Ahmed body. Simulation conditions are obtained from the experimental wind tunnel data along with the Ahmed body model geometry. Computational results show that k-epsilon realizable, k-omega SST and WA models yield values closer to the experimental data with the WA model requiring less simulation time per iteration. The variation in computational results is primarily due to wall-boundary layer treatment differences between various turbulence models.

Bryce Thomas is an undergraduate junior from Allen, Texas studying mechanical engineering at Washington University in St. Louis. His turbulence modeling research is conducted at WashU's computational fluid dynamics laboratory. Additional research conducted by Bryce includes the analysis and design of formula style racing radiator ducting.

Characterizing Residual Substructures of Massive CANDELS Galaxies: I Visual Characterization Process

Scott Thompson
University of Missouri - Kansas City

Advisor Dr. Daniel McIntosh

Abstract

Constraining the specific physical processes at play in the assembly of massive galaxies during the peak epoch of galaxy development ($z \sim 2$) remains difficult. Hierarchical processes like merging and rapid gas accretion are predicted to transform the appearance of galaxies. Different processes may produce faint and transient morphological substructures that are more readily identified using single Sersic, model-subtracted “residual” images. To facilitate the analysis of these substructures, we characterize the HST/WFC3 H-band (F160W) residual images of 10,000 CANDELS galaxies with $\log(M_{\text{stellar}}/M_{\text{sun}}) > 9.7$ and redshifts $1 < z < 3$ from van der Wel et al. 2012. We catalog two flags for each galaxy: (1) the descriptive characteristics of the residual flux, and (2) the quality of the Sersic model fit. I will describe the rigorous system we designed to characterize the CANDELS residual images. A detailed decision tree with definitions was created and used as the method to visual characterization. This decision tree provided a step by step process with the intention of providing and maintaining detailed information with maximum objectivity and minimal subjectivity. The classifications were filtered through a validation process in which two specialists would either agree with the classification and include into catalog; or disagree and galaxy would be re-classified. This validation process filtered and provided optimal accuracy in the description of the visual characterizations. Finally, the step of adding flags to the visual characterizations for the catalog involved combining subsets into shared repeated patterns and creating a descriptive label with definitions such as `ufitLwc_aoHSB`, `XH`, and `tidal_plaus_LSBtail`.

Scott Edward Thompson was born in the small town of Festus, south of St. Louis, Missouri. He has truly found his passion in life with astronomy, research, and the pursuit of understanding our universe. He is a non-traditional student, returning after several years of working in retail and free-lancing with his graphic design background. Scott was managing a print shop for a retail chain which he had been at for eight years when he decided he wanted to achieve more in life and needed a change. He started taking pre-calculus at a community college and kept taking more classes until he was ready to apply to the University of Missouri – Kansas City, UMKC. He has spent the last two years attending college full time and has worked very hard to overcome obstacles and put him in the position to be able to do that. He has dedicated what time he has outside of his classes to do research and is on course to graduate in Spring 2020. Scott’s goal is to continue his education and earn his PhD in Astronomy.

Characterizing the Circumstellar Disks of IC 1805

Matt Wentzel-Long
University of Missouri – St. Louis

Advisor: Dr. Bruce A. Wilking

Abstract

This study investigates the properties of the young, circumstellar disk-bearing stellar population of the open cluster IC 1805. 60 candidate disk-bearing stars were identified using spectral energy distributions (SEDs) which utilized dereddened photometry the following surveys: Pan-STARRS PS1, 2MASS, AllWISE, and Spitzer. Several disk properties of this population are then estimated using Markov-chain Monte Carlo optimization, which fits a simple disk model to the measurements given their respective errors. Environmental effects from the massive OB-type stars of the cluster on the young disk-bearing population are then examined using empirical cumulative distribution functions and estimates of the disk fraction of the population as a function of photoevaporative flux. Preliminary results indicate that photoevaporative flux is not significantly affecting the evolution of the disk-bearing population.

Matt Wentzel-Long was born and raised in St. Charles, MO. After attending St. Charles Community College for two years, and developing a liking for physics and mathematics, he moved to Salt Lake City, UT, where he went on to receive a Bachelor of Science in Mathematics and Physics in 2014 from Westminster College. He then returned to St. Louis where he now attends the University of Missouri St. Louis. In the spring of 2016, he received his Master of Science in Physics, and completed his Comprehensive Exam this past February. He has been married to his amazing wife Melanie since 2017, who will receive her PhD in Economics this May, and this Fall become an Assistant Professor of Economics at the College of Wooster in Ohio!

Spectral Energy Distribution Analysis of *WISE*-Selected Obscured AGNs

Madalyn E. Weston
University of Missouri – Kansas City

Advisor: Dr. Daniel H. McIntosh

Abstract

The connection between merging galaxies and active galactic nuclei (AGNs) is widely debated in the literature. Central to this debate is the simultaneous presence of star formation (SF) and AGNs, which emit light at similar wavelengths. Dust produced during SF can also obscure an AGN. Therefore, disentangling SF and AGN activity in these systems is key to understanding the major merger-induced growth of stellar mass and central supermassive black holes. In this ongoing research, spectral energy distribution (SED) analysis is used to quantify the amount of SF and AGN activity in a sample of merging and control (non-merging, non-interacting) galaxies, identified in a previous study to host an infrared (*WISE*) AGN. The researchers compiled SEDs for four merging galaxies and 55 control galaxies using the publicly-available SED-fitting code *AGNfitter*. The results indicate that 98% of control galaxies previously-identified as *WISE* AGNs host an infrared AGN component through SED decomposition, thus verifying the original classification. Ongoing work includes performing independent, aperture-matched photometry on the sample and gathering additional, longer-wavelength data to constrain star formation rates.

Madalyn E. Weston is from Independence, Missouri. She completed her Bachelor of Science degree in Physics at the Missouri University of Science & Technology in 2012, and her Master's degree in Physics from the University of Missouri – Kansas City in 2015. She is currently a Ph.D. Candidate in Physics and Education at UMKC, with an intended completion of May 2020.

Hot Jupiter Observations in Search of Transit Timing Variations

Shania Wolf

**Department of Physics, Astronomy, and Materials Science
Missouri State University**

Advisor: Dr. Mike Reed

Abstract

Exoplanets have been discovered using transit surveys such as those by the Kepler missions and ground-based sky surveys such as HATNet and WASP. 4,000 planets orbiting stars other than the sun have been discovered, but little is known. Using Baker Observatory's CDK20, transits for several targets in hopes of discovering Transit Timing Variations (TTVs) have been observed. These variations in the start and end times of the transit may be indicative of an additional object in the system, positioned at such an angle so that it would not be observed in transit.

Five nights of data on five targets were obtained between Fall 2018 and Spring 2019: Hat-P-16b, Hat-P-28b, WASP-1b, WASP-12b, WASP-60b. A total of over 20,000 images covering five transits were acquired. At this point, the collection of data on the same transit over a significant enough span of time to determine a Transit Timing Variation has not been achieved. This is the ultimate goal as research continues.

Shania Wolf is a Junior in the Department of Physics, Astronomy, and Materials Science at Missouri State University in Springfield.

K2 Observations of UY Sex

Matthew Yeager
Missouri State University

Advisor: Dr. Mike Reed

Abstract

This paper presents the asteroseismic analysis of the subdwarf-B star UY Sex (PG 1047+003) using K2 Campaign 14 data. UY Sex was a known p-mode pulsator prior to its observations by *Kepler* with 20 previously-detected pulsation frequencies. After processing the K2 data, Fourier analysis was used to extract 86 p-mode frequencies, recovering all 20 previously known frequencies. Ten rotationally induced multiplets were found, four of which have the same ~ 1.05 μHz splitting as previous work on UY Sex, while another six were found to have a ~ 0.5 μHz splitting between components. This new smaller splitting means that UY Sex is a slower rotator than previously determined, with a period of 22 days. Overtone spacings of $l=1$ and 2 p modes multiplets were found to be ~ 1000 , ~ 945 μHz , respectively, agreeing with model predictions.

Matt Yeager is a Senior at Missouri State University studying in the Physics, Astronomy, and Materials Science Department. His major is Physics with an emphasis in Astronomy/Astrophysics.

Inspiring and Educating Students at the High School and College Level Through Participation in Robotics Competitions

Edgar Cerna, Maricarmen Garcia, Sacdiya Sayid, and Dominic Torre
Metropolitan Community College of Kansas City

Advisor: Dr. John Daniel Justice

Abstract

This report contains research, introductions, and personal statements about FIRST Robotics, diversity, and the relationship between colleges and high schoolers conducted by the Metropolitan Community College and Penn Valley campus early college academy high schoolers. Beginning in the spring of 2017, they formed a team of six students in their second year of college and under the guidance of Professor Dan Justice, they began to experiment with the FIRST robotics starter kits. This continued into the summer as they worked on creating and programming a robot that could compete in the previous season FIRST Tech Challenge (FTC) - Velocity Vortex. At the start of the fall semester of 2017, the students formed a partnership with the Early College Academy (ECA). College students began to mentor and learn alongside the high school students as they prepared for the new season of FTC. Everything from setting up the workspace, designing, programming, building and competing were shared learning experiences. Penn Valley engineering students interacted with the team and learned about the robotics equipment, preparing them to be mentors for other teams in the future. The team advanced from the local competitions, winning an Innovate Award for one of their designs, and reached the semi-finals at the state championship in Rolla, Missouri. Their plans for the rest of the year and summer are to recruit and educate incoming members for the next season.

Edgar Cerna is a sophomore college student at Metropolitan Community College – Penn Valley, and, being a part of the Early College Academy, a senior in high school. He plans to major in Computer Science. He has received awards from MCC for his contributions to Computer Science & Surgical Technology. He's set to graduate in May and will transfer to Park University.

He loves creating anything involving software, especially robots. There are certain imperfections in robots that need to be accounted for while programming and this is something he loves. This gives him the ability to account for and correct those imperfections in the software, making it run as if there were no issues. Robotics is just the start, now he would like to pursue software development as a career

Maricarmen Garcia is a freshman student at Metropolitan Community College – Penn Valley, she currently plans to major in Mechanical Engineering. She has always had a great interest in how things work and loves working with different tools and machines. She is really interested in transferring to UMKC or to Missouri S&T her sophomore year.

Maricarmen has always had a great interest in Robotics, in her senior year of High School at North Kansas City High School, she was on the Robotics Team at the beginning of the year and did a lot of great work and helped as much as she could. When she started at Penn Valley last year, she heard about a great opportunity to be a college mentor in the Early College Academy Robotics team. Since then, she has helped her team as much as she could and has bonded with every one of her teammates. She has enjoyed the process and cannot wait till next year to do the same, with a lot more focus and great energy.

Sacdiya Sayid is a full-time student at Penn Valley Community College. She is a part of the Early College Academy which enables her to be a college student her last two years of high school. Sacdiya attended Lincoln College Preparatory Academy since 6th grade and has demonstrated academic excellence. She has maintained 4.0 all through her academic career. Sacdiya has always excelled at math, taking advanced coursework at a young age. She currently is learning and thriving in her STEM classes.

She joined the Robotics team in hopes of understanding engineering processes. Sacdiya will earn an Associate's of Arts degree this semester and will transfer to UMKC for a Bachelor's in Electrical and Computing Engineering at UMKC starting this Fall. The FTC robotics team has allowed her to flourish in a team environment with other high school students trying to work on a common goal as well as mentors to help achieve that goal. Sacdiya is also very involved in the community. She has acquired 80 hours of community service through tutoring and mentoring others in the community.

Dominic Torre is a sophomore college student at Metropolitan Community College – Penn Valley, and, being a part of the Early College Academy, a senior in high school. He currently plans to major in chemical engineering, and minor in German Literature and Linguistics. He tutors through Calculus II in the math tutoring lab at Penn Valley. He is set to graduate in May, and will transfer to Missouri S&T.

Dominic has spent his entire life doing lots of volunteer work. As long as he can remember, it has been a part of his life. He still volunteers twice a month or more and has attained over 100 hours of service every year for five years and counting. Robotics has been an interest of his for quite some time now, especially since many of his friends have been doing it for a long time, and when the opportunity to participate in a team presented itself, he could not refuse. After last year, he was more than ready to put a lot more focus onto it this year.

Dan Justice joined MCC in 1995 as a district-wide engineering instructor, a position he still holds. As engineering coordinator, he schedules engineering classes across the MCC district, designs curriculum and works with area universities maintaining articulation agreements. He holds a Bachelor's degree in Aerospace Engineering from Missouri S&T and a Master's and Ph.D. in Aerospace Engineering from the University of Texas at Austin.

In addition to his teaching load, Dr. Justice helped create and maintain scholarship programs for underrepresented minority and women engineering students. He continuously has been an early adopter and trainer of faculty in a wide variety of distance education methods and technologies. Outside of MCC, he has worked as an adjunct instructor in mechanical engineering at UMKC, a mini-Baja car enthusiast, and a FIRST robotics coach, mentor and judge for several local robotics competitions.

Liquid Fuel Rocket Design Team

Amy Costa and Nicholas McCracken
Missouri University of Science and Technology

Advisor: Dr. Jillian Schmidt

Abstract

The Missouri S&T Rocket Design Team liquid division is researching and designing a regenerative cooled, liquid powered rocket engine that will be used in the Base 11 Space Challenge competition to reach an altitude of 100 kilometers. The team has designed a rocket that is 30 feet tall, 16 inches in diameter, and outputs 2,500 pounds of thrust that can reach 150 kilometers. The rocket was designed by establishing base parameters for the engine and adding different parameters for each subsystem that would work with the engine design. From there, research into manufacturing began and further finalization on and simulation testing was performed.

Amy Costa – President

Amy is a senior in Psychology at Missouri University of Science and Technology and is expecting to graduate in May 2020. Amy plans on continuing her education through graduate work in behavioral neuroscience, where she eventually wants to work with trauma patients. Amy is also involved in Chi Omega and undergraduate research in her department. In her free time, Amy enjoys training dogs for service and therapy purposes and hanging out with her dogs.

Nicholas McCracken – Vice President

Nick is from Kansas City, Missouri and is currently pursuing an Aerospace Engineering degree as well as a Mechanical Engineering degree from Missouri S&T. He is currently in his 4th year of schooling in a 5 year program. He has been involved with AIAA, the Solid Rocket Design Team, the Liquid Rocket Design Team, and the Mars Rover Design Team. Nick plans to work towards a propulsive system emphasis and hopes to work on new types of rocket propulsion systems that could one day propel humanity to distant planets.

Maxwell Geiger - Chief Engineer

Max is from Sandy, Utah and is a 3rd year Aerospace Engineering student, with a minor in Electrical Engineering. He has also been involved with IEEE and the Formula SAE team. Max will be working with Spirit Aerosystems this summer, and hopes to continue on to graduate school with a focus on control systems.

Alexander Strenfel - Plumbing Lead

Alex is a graduate student at Missouri University of Science and Technology, and will be graduating December of 2019 with his Masters in Aerospace Engineering with a focus on propulsion. His hometown is Van Buren, MO, known for its river tourism. He worked with NASA and UP Aerospace in an internship to design a solid rocket motor for an upper stage rocket. This rocket, the Spyder, will be UP Aerospace's first access to orbit rocket. He is a member of Missouri S&T's Liquid Rocket Design Team where he helps design liquid bi-propellant rocket engines, and he is also the head of the team's plumbing sub-team. He led the design and manufacturing of a sleeve valve to be used by the team for toggling propellant flow. Alex has a strong passion for rocketry and has a dream of one day working with NASA to expand mankind's horizons to space.

Stephen Rippee - Engine Lead

Stephen is a freshman in Aerospace engineering from Kansas City, Missouri. In high school, Stephen was deeply involved in FIRST robotics, which is where he learned most of his technical and soft skills. Although he takes a particular interest in space and especially propulsion, his ultimate goal is to apply himself in a way that requires teamwork and deep critical thinking.

Andrew Hauck – Electronics Lead

Andrew Hauck is a fourth year Electrical Engineering student from Saint Louis, MO. He plans to graduate with a bachelors in May 2020. Andrew hopes to go on to do electrical design work for the aerospace industry. He enjoys music and playing guitar in his free time.

Miner Aviation

**Alexander Fangman, Zachary Gerding, Evan Guyett,
Annika Highley, Donnita Johnson, and Thomas Ziervogel
Missouri University of Science and Technology**

Advisors: Drs. Walter Eversman and Warner Meeks

Abstract

The Missouri S&T Miner Aviation Design Team is creating a radio controlled aircraft that must complete four missions and fit specifications as set by competition rules. The team has finished an aircraft that can take off in 10 feet, fit in a 2x3 ft box with an 8-foot wingspan, mount and rotate a radome, and carry and release 4+ attack stores. The team will take its design to the AIAA Design/Build/Fly on April 11-14, 2019, in Tucson, AZ, to compete against 112 other teams. The aircraft was designed by defining desired aerodynamic characteristics and adding restrictions such as thrust available and weight. From there, an aircraft was created and tested. The aircraft was then improved upon and completed.

Alex Fangman - Propulsion Lead

Alex is a senior majoring in Aerospace Engineering. He plans to attend graduate school with a focus in hypersonics. Alex is from Saint Joseph, Missouri. Besides being a part of Miner Aviation, Alex also plays on S&T's club tennis team. His hobbies include playing piano, hiking, and watching the Food Network.

Evan Guyett - Design and Manufacturing Lead

Evan is from Plattsburg, Missouri and is a junior in Aerospace and Mechanical Engineering. He hopes to work in the design side of the aerospace industry after getting his bachelor's degree. Evan has interned at Spirit AeroSystems and will be interning for Scaled Composites this summer. Outside of design team work he likes to compete in Aeromodelling competitions hosted by the National Free Flight Society (NFFS) and the Academy of Model Aeronautics (AMA).

Zachary Gerding - Structures Lead

Zachary is a senior in Aerospace Engineering from Kansas City, Missouri who hopes to work on structural and stress analysis after graduating. As the Structures lead, he works on obtaining properties for materials being considered for the aircraft and performing stress analysis on the aircraft model using finite element analysis

Annika Highley - President

Annika is a 4th year student expecting to graduate in 2020 with her bachelors in aerospace engineering. This summer she is interning at Northrop Grumman in San Diego and is applying for DOD secret security clearance in order to pursue a career in highly classified work with Northrop Grumman's defense sector in order to protect our nation's military. On campus, Annika is a member of the Society of Women Engineers and off campus loves to play guitar, write music, hiking (a lot), and amateur photography.

Donnita Johnson - Chief Engineer

Donnita is from Hermann, Missouri and is a 3rd year student in Aerospace and Mechanical Engineering at Missouri University of Science and Technology. She is involved with AIAA and the Society of Women Engineers. She is also a student pilot who hopes to get her private pilot certification. She hopes to continue on to graduate school with a focus on hypersonics. She then hopes to pursue a career in hypersonics and defense aviation.

Thomas Ziervogel - Vice President/Aerodynamics Lead

Thomas enjoys golf, watching the Office, and joking around with friends. He is an Aerospace Engineering major and hopes to get his bachelors in 2019 and Masters in 2020. Thomas is also involved with other on campus organizations as an officer in AIAA and very involved in the Sigma Pi Fraternity.

**Mars Rover Design Team
System Acceptance Review
University Rover Challenge 2019**

**Andrew Rausch, Matthew Lowe, Téa Thomas, and Emily Bruns
Missouri University of Science and Technology**

Advisors: Drs. Smitty Grubbs and Melanie Mormile

Abstract

The members of the Mars Rover Design Team (MRDT) at Missouri University of Science and Technology have designed and fabricated a next-generation Mars rover, Valkyrie, over the past nine months in pursuit of their vision “Today. Tomorrow. Forever.”. Though the team’s primary mission is to compete at the 2019 University Rover Challenge (URC), the team is also dedicated to developing the technical expertise of its members and inspiring others to explore the universe. Valkyrie was developed through the collaboration of the team’s six technical and two non-technical subteams - Drivetrain, Electrical PCB, Ground Support Systems, Manipulators, Science, Software, Finance, and Public Relations - each vital to the overall success of the team at URC.

Andrew Rausch is a Senior pursuing a BS in Mechanical Engineering from Missouri University of Science and Technology. He grew up on a farm in Monett, MO, and is currently the Chief Executive Officer of the Mars Rover Design Team. Andrew intends to use his degree and experience to change the world for the better by creating intelligent and efficient machines which improve the way humanity interacts with the universe.

Matthew Lowe is currently a Junior at Missouri University of Science and Technology pursuing a degree in mechanical engineering. He lives in Katy, Texas and came to S&T for the design teams. I am currently the Chief Technical Officer of the Mars Rover Design Team. With his degree, Matt hopes to work for NASA to make rovers.

Téa Thomas is the Chief Financial Officer of the Missouri S&T Mars Rover Design Team. She is a junior from Lee’s Summit, Missouri majoring in business and management systems. She will also be minoring in IST, studio art, and marketing. Téa is also the College of Arts, Sciences, and Business Chair for the Student Council and is a Chi Omega. After graduation, Téa plans to eventually work at NASA, SpaceX, or Boeing.

Emily Bruns is the Chief Administrative Officer for Missouri S&T’s Mars Rover Design Team. She hails from Fenton, a small town near St. Louis. She is in her final semester of studying economics and hopes to attend University of Missouri-St. Louis for her master’s degree in clinical mental health counseling. She intends to specialize in eating disorders, or addiction. Emily has a passion for mentoring students, having advised over 45 students through her on-campus job, extracurriculars, and volunteer positions.

Autonomous Flight in a Restricted, Indoor Environment

Innocent Niyibizi | Piotr Pogorzelski | Christopher O'Toole | Logan Thomure
Multirotor Robot Design Team
Missouri University of Science and Technology

Advisor: Dr. K. Krishnamurthy

Abstract

This report details our complete aerial robot's hardware and software design, from our current progress to our goals for the near future. Throughout the year we have discovered more optimal manufacturing processes, such as laying our own carbon fiber, as well as a more effective approach to completing task such as autonomous flight. With these findings we are ready to compete in the 2018 competition year for the International Aerial Robotics Competition.

Innocent Niyibizi: Innocent is currently a junior in the Computer Science department at Missouri S&T. His hometown is St. Louis, MO and his biggest career goal is to design and develop software systems that have high impact. He has been on the team for a little under three years and through his contributions, he has been able to provide more of an impact with each year.

Piotr Pogorzelski: Piotr is currently a senior in the Computer Engineering department at Missouri S&T. Originally from St. Louis MO, his greatest career aspiration is to improve unmanned aerial systems through advancement of electrical and data communication systems. He has been a member of the team for approximately two years and plans to continue developing systems for Multirotor.

Christopher O'Toole: Christopher is currently a junior in the Computer Science department at Missouri S&T. His hometown is Springfield, MO and his biggest career goal is to advance the field of computer vision as well as machine learning augmenting current solutions to more specific and advanced use cases.

Logan Thomure: Logan is currently a graduating senior in the Mechanical and Aerospace department at Missouri S&T. His hometown is St. Louis, MO and he is planning to obtain a masters in aerospace engineering with a focus in space crafts.

Missouri S&T Satellite Research Team

Missouri University of Science and Technology

Advisor: Professor Henry Pernicka

Abstract

The primary purpose of the Missouri S&T Satellite Research Team (M-SAT) is to develop new small satellite technologies that are tested in low Earth orbit (LEO) with smallsats designed, fabricated, and tested by Missouri S&T students, faculty, and staff. The design/build/fly process is complex, bringing concepts and ideas to reality for completion of flight-worthy satellites. Team members of M-SAT come from varying majors and academic levels. The team mimics industry practices in an academic interdisciplinary environment with assistance from faculty and staff.

Anna Case - MR & MRS SAT Program Manager

Anna, a Kansas City native, is a junior in electrical engineering at Missouri S&T. She is currently the program manager for the MR & MRS SAT satellite and has previously presented work at MOSGC on software defined radios. Anna is an undergraduate research assistant at the Applied Microwave Nondestructive Testing Lab (amntl) and will stay at Missouri S&T to complete a graduate degree. This summer, she will be working at Sandia National Labs on special communication systems.

Alex Reynolds - MR & MRS SAT Chief Engineer

Alex Reynolds is a senior in aerospace engineering at Missouri S&T. Currently, he serves as Chief Engineer of the NS-8 MR and MRS SAT Mission, and is actively involved in undergraduate research for Professors Henry Pernicka and Serhat Hosder. Upon graduation, he plans to attend graduate school at the University of Texas at Austin.

Thomas Ziervogel - APEX Program Manager

Thomas Ziervogel is a senior in Aerospace Engineering at Missouri S&T from Columbia, MO. He currently has the pleasure of serving as the Program Manager for the APEX mission of M-SAT and has been actively involved in the S&T campus' chapter of AIAA. He will be returning to Missouri S&T this following year to begin his Master's Degree, also in Aerospace Engineering. His interests in aerospace include propulsion, supersonic flight, and hypersonic flight and he would love to make a career out of one of those topics once he finishes his Masters. He hopes to one day be able to look back on his career and point to an advanced aircraft or spacecraft system knowing that he helped design or build it.

Kyle Craft - APEX Chief Engineer

Kyle Craft was born in Jefferson City, MO. He began at Missouri S&T in the fall of 2016 and is currently a junior in Aerospace Engineering. He is currently the deputy Chief Engineer of the APEX mission. His interests include GNC of proximity operations for spacecraft and interplanetary exploration missions. After graduation next spring he plans on pursuing a Masters in Aerospace Engineering.

Collin Steele - M³Program Manager

Collin Steele is a senior in Aerospace Engineering minoring in Computer Science at Missouri S&T. He currently serves as Program Manager of M-SAT's M³ mission. He plans to graduate with a Ph.D. in Aerospace Engineering. Once he completes graduate school he plans to go into industry and work to make the world a better place.

Joshua Burch - M³Chief Engineer

Joshua Burch is a Ph.D. student in the Aerospace Engineering department at Missouri S&T. His research is centered on non-mechanical vectoring of plasma plumes for electric spacecraft propulsion. He currently serves as chief engineer for M-SAT's M³ cubesat mission, graduate advisor for Tau Beta Pi, and president of Sigma Gamma Tau. He was raised in Knob Noster, Missouri and wants to apply his knowledge to accelerate human interplanetary space exploration.

Solid Fuel Rocket Design Team

**Usman Bajwa, Amy Costa, Ryan Dover, Kayla Ford,
Caleb Graham, Josh Lewis, and Ryker Travis
Missouri University of Science and Technology**

Advisor: Dr. Warner Meeks

Abstract

The Solid Rocket Design Team is building the largest rocket the campus has ever seen. This year's rocket is 15 feet 2 inches, weighs 109 pounds, and will reach over 10,000 feet apogee. The current payload is the most advanced the team has ever attempted, it is a reaction control system designed to counteract the spin of the rocket during flight. The rocket will fly in June of 2019 at Spaceport America in New Mexico competing against 122 teams from around the world.

Usman Bajwa - Propulsion and Recovery Lead

Usman is a senior in Aerospace and Mechanical Engineering at Missouri University of Science and Technology and is expecting to graduate in May 2020. He has worked as a test and integration engineering intern with General Atomics and will be working as a propulsion design intern with Ursa Major Technologies this summer. Usman is hoping to pursue a career in propulsion engineering after he graduates. Previously, he served as the publicity chair for Tau Beta Pi, the secretary for Sigma Gamma Tau, and the Electronics Lead for the Liquid-Fuel Rocket Design Team. Outside of school, Usman likes to cook, play video games, is building a rocket to obtain a Level 2 rocketry certification through the Tripoli Rocketry Association, and he holds an amateur radio license.

Amy Costa - President

Amy is a senior in Psychology at Missouri University of Science and Technology and is expecting to graduate in May 2020. Amy plans on continuing her education through graduate work in behavioral neuroscience, where she eventually wants to work with trauma patients. Amy is also involved in Chi Omega and undergraduate research in her department. In her free time, Amy enjoys training dogs for service and therapy purposes and hanging out with her dogs.

Ryan Dover - Vice President

Ryan is a senior in Aerospace Engineering at Missouri University of Science and Technology who is expecting to graduate in May 2020. Ryan plans on working in Rolla over the summer to improve team structure and complete several launches. In his free time, Ryan likes to play video games and tennis. He is also building a rocket to obtain a level 2 certification. After graduation Ryan hopes to get a job in design and manufacturing engineering.

Kayla Ford - Chief Engineer

Kayla is a 5th year senior in Aerospace and Mechanical Engineering at Missouri University of Science and Technology. She will be working with United Launch Alliance after she graduates in May 2019. Kayla has worked as a propulsion testing intern at United Launch Alliance, a design intern at Spirit AeroSystems, and as an advanced manufacturing co-op at Harley Davidson. Kayla is also involved in other organizations on campus such as the Road Safety Day Committee Chair of Riders' Society, a member of the Missouri S&T Satellite Research Team, and an alum of Kappa Delta. Off campus, Kayla likes to hike, ride her motorcycle, travel, and fly. She is also currently building a rocket to obtain a Level 2 rocketry certification through the Tripoli Rocketry Association.

Caleb Graham - Experimentation Lead

Caleb is a 3rd-year Aerospace and Mechanical Engineer. This is his 3rd year on the Solid Rocket Design Team and he is the only team member with his Level 3 certification. Currently he is the first team payload lead that is developing unique and creative payloads to be used in various rockets. Away from the rocket team, he designs and builds his own rockets. Eventually he plans on doing his own space shot rocket to be launched out of the black rock desert. Caleb plans on being employed in the Department of Defense or in the Space Industry developing Launch Vehicles.

Joshua Lewis - Design and Manufacturing Lead

Josh is a Missouri University of Science and Technology graduating senior in Aerospace Engineering from Hermann Missouri. He joined the Solid Fueled Rocket Design Team 4 years ago and has led both the Propulsion sub team and Design and Manufacturing sub team. Josh is also a founding member of both the Liquid Fueled Rocket Design Team and the first Plumbing and Integration sub team lead. He has worked a Manufacturing Engineering Co-op at Parker Hannifin in Washington Missouri and Manufacturing and Design Intern at Pratt & Whitney for commercial and military jet engines in Hartford Connecticut. After graduation, Josh is planning on starting work as a Design and Manufacturing Engineer at Collins Aerospace, formerly known as UTC Aerospace Systems.

Ryker Travis - Electronics Lead

Ryker is a 2nd-year student expecting to graduate in 2020 with bachelor degrees in Aerospace and Mechanical Engineering, with a minor in Computer Science. Ryker plans on taking several summer classes over the upcoming summer, after attending the team's annual competition at Spaceport America. After graduating, Ryker plans to enter the workforce and work on a Master degree at the same time.

SLUAV AUVSI Competition Team

Saint Louis University
Matthew Dreyer, Sarah Plunkett, Chalmers Benson, Josh Kemper

Advisor: Dr. Srikanth Gururajan

Abstract

Saint Louis University's AUVSI team SLUAV has been preparing for 2019 AUVSI SUAS competition. The team's main objective was to improve the performance and capabilities of the UAV, named *The Enola Gray (TEG)*, from previous years' design while meeting all of the mission requirements. The team consists of undergraduate students majoring in various disciplines including aerospace, mechanical, electrical, computer engineering, as well as in computer science, and business. The wide knowledgebase and skillset of the team provided a comprehensive toolset to improving the UAS. *TEG* is a 23-pound aircraft with a 10ft. wing-span, low-wing design, and, its' payload has been designed to complete the mission requirements while being modular. The main improvements this year include faster communications speeds, stable autonomous flight, reliable image capture, and newly introduced image classification. At this year's competition, the team expects *TEG* to complete numerous missions.

Matthew Dreyer, from Kirkwood, MO, is majoring in Aerospace Engineering and is the Team's Captain. Matthew plays on SLU's Club Baseball Team.

Sarah Plunkett is a Mechanical Engineering major from New Berlin, WI, and is the team's Structures Lead. Sarah enjoys knitting and crocheting.

Chalmers Benson is an Electrical Engineering major from Memphis, TN, and is the team's Communications Lead. Chalmers owns a pet horse.

Josh Kemper is an Aerospace Engineering major from Fenton, MO, and is the team's Communications Lead. Josh plays Percussion Instruments

The Argus-02 and DORRE Cubesat Missions for Demonstrating AI Networks in Space

**Jeffrey Kelley, Celia Taylor-Puckett
Space Systems Research Laboratory
Saint Louis University**

Advisors: Dr. Michael Swartwout, Mr. Keith Bennett, Dr. Kyle Mitchell

Abstract

The Space Systems Research Laboratory (SSRL) at Saint Louis University is currently developing two cubesat missions for space research on the field of on-orbit intelligent data processing. The first mission, Argus-02, is a 1U cubesat equipped with an imager and an onboard artificial intelligence (AI) agent known ARES. One of the key difficulties encountered on deep-space exploration missions is that the quantity of available data far exceeds the capacity of a spacecraft to transmit back to Earth. ARES is designed to reduce this scientific impediment by using AI to determine which data is most significant before transmitting to the ground. After being ejected from the International Space Station (ISS), Argus-02 will use its imager to observe natural events, such as cloud formations and aurora, and then data about the most interesting events. The continuation of this research is SSRL's second mission, known as the Distributed Observation Reasoning and Reaction Experiment (DORRE). Using the knowledge gained from the Argus-02 mission, DORRE will continue characterizing on-orbit intelligent data processing and explore the viability of a distributed network in space using ARES. An important distinction between the Argus-02 and DORRE missions is the network aspect of DORRE. Nominally, the network will consist of two identical spacecraft which will be deployed simultaneously, two ground telescope platforms, and other computational nodes. Similarly, DORRE will be observing Earth-based weather phenomena, specifically lightning, and the Moon.

Jeffrey Kelley is a junior undergraduate student studying Aerospace Engineering in the Parks College of Aviation, Engineering and Technology at Saint Louis University. He grew up in Prairieville, Louisiana, and graduated from Catholic High School of Baton Rouge before coming to Saint Louis. He is currently serving as program manager for the Argus-02 mission within the Space Systems Research Lab and hopes to eventually find employment in the space industry.

Celia Taylor-Puckett is sophomore undergraduate study Aerospace Engineering in the Parks College of Aviation, Engineering and Technology at Saint Louis University. She grew up in Lawrence, Kansas and graduated from Bishop Seabury Academy. Celia is currently serving as program manager for the DORRE mission within Saint Louis University's Space Systems Research Lab.

**Enhancing the Multidisciplinary Astrobiology
Research Community at Truman State University**

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. A total of four students (three supported directly) and two faculty members from the Biology and Physics departments participated in research activities sponsored by this project. One of these students was selected from the Astrobiology Seminar class taught in spring 2018 on the basis of her interest, aptitude, availability and performance to participate in astrobiology research in summer 2018. We are currently in the process of setting up a soil model experiment that aims to approximate the temperature gradient of a tidally locked planet. By seeding microbial life in the “twilight zone” and monitoring how the soil’s temperature gradient changes over time, we hope to refine our experimental setup and to provide a foundation for future work. In addition, students are involved in designing and distributing fliers and posters to increase awareness about the field of Astrobiology, about the Astrobiology opportunities at Truman State, and about various NASA-exoplanet missions such as Kepler, TESS, and JWST.

Michael Gill is a senior Biology major at Truman State University. He was born and raised in St. Louis, Missouri, where at a young age, he developed a passion for science. His other passions include music, politics and service. He plans to attend medical school in 2020 where he hopes to specialize in emergency medicine.

Payton Sullivan is a sophomore Biology major and Environmental Studies minor Student at Truman State University She loves nature photography and hiking.

Elsa Palumbo is a high school senior from Kirksville, Missouri. An aspiring astrophysics researcher, she is especially excited about exoplanetology and astrobiology. When not studying at home or at Truman State University, she loves stargazing, reading, translation, and squeezing in the occasional Star Trek.

Noah Anderson is a sophomore Physics major who attends Truman State. Noah enjoys learning more about the universe and the way it works. He plans to pursue a PhD in Physics.

Faculty Biographies

Carolina Sempertegui is an assistant professor of Microbiology at Truman State University. She earned her Master's in Public Health at Ohio University and Ph.D in Molecular and Cell Biology in 2011 and 2012 respectively. Dr. Sempertegui's laboratory has been focused on the study of cellular responses to UV radiation, using *Saccharomyces cerevisiae* as microbial model.

Vayujeet Gokhale is an associate professor of Physics at Truman State University. He earned his BSc. in physics ('96) and MSc. in nuclear physics ('98) from the University of Bombay, followed by a PhD in astronomy from Louisiana State University. The Gokhale group is interested in identifying and observing exoplanets in transiting systems, and studying habitable zones around low mass stars.

Light Pollution in Kirksville

Jordan Goins¹, Ashley Herdman¹, James Tompkins^{1,2} & Emily Wren¹

Advisors: Dr. Vayujeet Gokhale¹ & Mr. David Caples²

¹Truman State University, ²Moberly 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, and near Anderson Mesa in Flagstaff, Arizona. Students used light sensors to track the amount of light projected towards the sky at various locations on campus, the University farm, at Missouri conservation department (about 5 miles S of Kirksville), and at Anderson Mesa (about 15 miles S/SE of Flagstaff, Az). 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 Kirksville city management to begin the process of installing ‘dark sky reflectors’ (light shields) on poorly designed university and city light fixtures. In 2017-18 students successfully obtained internal funding through the ‘Funds Allotment Council’ and the ‘Environmental Sustainability Fee Committee’ (\$3000 + \$2500) to install ‘warmer’ lights and light shields on outdoor lights across the Truman State campus. This year (2019-20), we have received an additional \$3500 from the ‘Funds Allotment Council’ to do the same. Additionally, students continue to increase awareness about light pollution as part of the outreach program during the weekend shows at the *Del and Norma Robison Planetarium* at Truman State University. This includes handing out light pollution related brochures and showing a 6-minute ‘*Losing the Dark*’ planetarium documentary produced by the *International Dark Skies Association*.

Jordan Goins is a senior at Truman State University. She will be graduating in May of 2019 with a BA in Biology and minors in Environmental Studies and Astronomy. Jordan plans to pursue further education in the field of Microbiology and Immunology.

Ashley Herdman is a sophomore biology student at Truman State University. She has an interest in soil microbiology and is pursuing a career in research. Ashley is very passionate about environmental health and would like to work to reduce pollution and contamination throughout her education and professional career.

Emily Wren is a junior at Truman State University. She studies biology and is on the pre-physicians-assistant track. Emily loves traveling, coffee shops, and outdoors. In the future, after pursuing a career as a PA, she would love to become a nature photographer and travel the world.

James Tompkins is a MACC student recently accepted into the University of Missouri's computer science program. He loves figuring out how everything works and is pursuing a career in software development.

Faculty Biographies

David Caples is an Assistant Professor of Mathematics at Moberly Area Community College. He has a Masters-degree in mathematics from the University of South Dakota with an emphasis in computational mathematics. Prior to his seven years of teaching, he worked as a computer consultant in St. Louis for ten years completing projects at AT&T, Union Pacific, and Monsanto. When away from the classroom, he enjoys backpacking, camping and reading.

Vayujeet Gokhale is an assistant professor of physics at Truman State University. He earned his BSc. in physics ('96) and MSc. in nuclear physics ('98) from the University of Bombay, followed by a PhD in astronomy from Louisiana State University (2007). Dr. Gokhale loves the night sky and National Parks, and dreams of becoming an astronomy park ranger at the Arches National Park in Utah.

Mizzou SURF's *Tigris Maris*

James Kane, Alexandra Crump, Gary Vomund, and Jack Murphy
University of Missouri – Columbia

Advisor: Dr. Josiah A. Bryan

Abstract

Mizzou Students' Underwater Robotics Foundation (SURF) has designed, manufactured, and built an autonomous underwater vehicle (AUV) capable of performing a variety of underwater tasks. AUV's have many real-life applications from marine biology studies to oceanography to space exploration. Mizzou SURF's AUV, named *Tigris Maris*, has been designed and built in a two-year time frame. This technical report discusses the initial concepts, final design, and manufacturing of the submarine as well as electronics/software, testing, and optimization of the AUV. The Mizzou SURF team has spent hundreds of hours working on the design and manufacturing of the AUV. Some fluid dynamic analysis has been conducted, the results of which have been used to make the AUV as hydrodynamic as possible. Various forms of testing have been done to optimize the design as well. With all these studies, Mizzou SURF has built an efficient and well-performing AUV.

James Kane is a senior in Mechanical in Engineering with a minor in Aerospace. He grew up in St. Louis, MO. He is currently serving as President of Mizzou SURF, and is also a past Vice President of the Mizzou chapter of ASME. He has interned at Afton Chemical Company as a mechanical engineer, and at Roeslein & Associates as a Process and Energy engineer. He hopes to work in the aerospace industry after graduation in May of 2019, and someday obtain his Masters.

Lexi Crump is a junior in Mechanical and Aerospace Engineering at the University of Missouri. She grew up in Rolla, MO. She currently serves as the treasurer of SURF and the former secretary of SURF. Lexi has interned at Textron Aviation as a Process Engineering and Robotics intern and will intern at Textron Systems this summer as a Mechanical and Design Engineer for their AUV team. During her college career, she also has served as secretary of ASME, a member and leader in Alpha Chi Omega sorority, as well as a member of Residential Life leadership. She hopes to one day receive her Master's in Business Administration and lead the nation in robotics and automation advancement.

Gary Vomund is a sophomore in Mechanical engineering at the University of Missouri. He grew up in St. Paul, Missouri, just outside of St. Louis. He is currently the secretary of SURF as well as the treasurer of ASME. Gary has interned with Patriot Machine, which is an aerospace manufacturing company in St. Charles, Missouri. There he worked on CNC machines manufacturing parts for primarily Boeing and Lockheed Martin planes. Gary also will be interning with Boeing this upcoming summer as a structural engineer. He hopes to continue interning with Boeing and receive a job offer upon graduation.

Jack Murphy is a junior in Information Technology at the University of Missouri. He is from Columbia, Missouri. He is currently the webmaster and head of software development of SURF, and a member of the Sigma Phi Delta Engineering Fraternity, Beta Omicron Chapter. He is currently on the hunt for an internship that will make good use of his skills. He spends his free time working for the University of Missouri Telecommunications Department working as a cable technician. He hopes to find a job doing software development as soon as possible.

**A Bridge to the Stars High School-to-College Pipeline:
Overcoming the STEM Engagement Deficit in URMs and Low-Income Students**

Jaime S. Arnold (Development Intern)

2019 Mentors: Arnold, J., Biggerstaff, J., Carmack, C., Denny, K., Hines, O., Merritt, J.

2018 Mentors: Arnold, J., Evan, R., Hays, S., Higgins, L., Hines, O., Jennings, D.

Department of Physics & Astronomy

University of Missouri – Kansas City

Supervisor: Professor Daniel H. McIntosh

Abstract

A Bridge to the Stars (ABtS) is a pioneering high school-to-college pipeline that actively engages urban 10th and 11th grade students from all backgrounds. It allows these students to dive into a high-impact exposure to science through innovative experiential learning with Professor McIntosh in a first-year astronomy course at UMKC, a public urban research university. Since 2012, this program has helped show students who traditionally do not identify with high-tech careers that they can succeed in a university setting – a promising way to build confidence and to help fortify positive STEM aspirations during the critical bridge between high school and college. To date, ABtS has awarded 73 (13 in 2019) scholarships and 27 (6 in 2019) mentoring internships. Remarkably, the overall scholar performance is equivalent to that of 700 UMKC students enrolled in the same courses over 9 semesters. Owing to substantial improvements in the recruitment and application processes, the number of recent applications and new scholarships has risen dramatically. Among past scholars, 90% passed their course satisfactorily with an average grade of 80%. Participation in the program has been nearly three-quarters female or transgender, 87% students of color, and the vast majority low-income. Long-term tracking of former scholars shows positive attitudes regarding ABtS and persistence in STEM aspirations at promising rates based on small-number statistics. Our long-term mission is to see urban colleges and universities adopt similar pipelines in all STEM disciplines. As such, we provide a summary of the innovations that have led to the rapid increase in urban high-school student participation in the ABtS pipeline over the last two years. Programs like ABtS are a key step to overcoming the national deficit in Under-Represented Minorities (URMs) and low-income STEM majors, and diversifying the high-tech workforce.

Jaime S. Arnold grew up in Weatherby Lake, Missouri and went to the Park Hill School District. Now she is continuing her education at the University of Missouri - Kansas City where she is in the process of getting two degrees and one minor: Bachelor of Science in Physics with an Emphasis in Astronomy, Bachelor of Science in Biology and a minor in Chemistry. She is the Vice President of two organizations on campus: WiSci (Women in Science and STEM) and SPS (Society of Physics Students). In SPS she is leading a project to build a hydroponic system to test air quality and a display particle accelerator with one of her fellow mentors. Jaime's aspirations include research in both the Biology department and the Physics and Astronomy department as well as advancing her education after she completes her undergraduate degrees. Her ideal career would utilize the breadth of her eclectic educational background, making Astrobiology an exemplary fit.

Osiris (Courtney) Rhen Keiton Hines grew up in the Shawnee Mission School District. After graduating high school he enlisted into the United States Air Force where he served six years at Offutt Air Force Base as an Aerospace Ground Equipment specialist for the E4-B Presidential Support Mission. He completed a Bachelor's of Science in Music Production from Full Sail University before beginning his undergraduate studies in Physics and French. He is currently in his third year of study at the University of Missouri-Kansas City to graduate Spring 2020 after which he plans on attending graduate school. He is the 2018-2019 president of the Society of Physics Students (SPS) for the UMKC chapter, and is leading a project to build a hydroponic system and report how air quality is affected. He plans to partake in research with the Physics and Astronomy department during his remaining time at UMKC and after graduation aims to join a graduate program to work on Neural Interfacing and Prosthesis.

Jessica Merritt is a freshman in the Environmental Science program at UMKC. She is getting a minor in Geographic Information Systems and is involved in Women in Science, Fossil Free UMKC, and the Student Environmental Coalition. She plans to go into environmental consulting for private industries in order to minimize the global warming impact of American businesses. In her free time she enjoys blogging, going home to Lawrence, KS, pottery, and being social. She discovered the ABTTS program in her first semester and was incredibly excited for the opportunity to work within her field and support local youth. Jess is passionate about climate change, education, politics, and her two pet Corgis.

Katie Denny resides in a small town south of Kansas City in Cleveland, Missouri and is currently a junior in astrophysics at the University of Missouri-Kansas City. She wishes to pursue a graduate degree and career in planetary science and exoplanet research. Her extracurricular activities include a high school mentoring program called A Bridge to the Stars, a physics club called Society of Physics Students, and a group that offers support for women in science called Wi-Sci.

Cody Carmack is a Junior in the Honors College at the University of Kansas City. Growing up in Lee's Summit, Missouri, she has been living in Kansas City for 2 years now for school and work. Carmack is a Psychology major with an emphasis in Criminal Justice, and hopes to pursue a career in law one day. She is interested in defense law, and plans on studying to become a Trial Consultant. Until graduation, she is a full-time Honors student, works a part time job, participates in A Bridge to the Stars mentorship, and volunteers weekly at a local animal rescue center. Carmack enjoys school and the other activities she is a part of, and is excited to see what the future holds.

Jerrah Biggerstaff grew up in Kansas City, Missouri. She is a Junior majoring in Physics with an emphasis in Astronomy at the University of Missouri - Kansas City where she also participates in Summer Undergraduate Research for the Galaxy Evolution Group.

University of Missouri-St. Louis Astronomy Outreach Program

Kyra Chappell and Augusto Puig
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 nine groups. The nine groups had a total of 400 students. With our new partnerships and recent upgrades, the program can further develop several alternative shows in an attempt to appeal to a broader audience.

Kyra Chappell 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 Physics with emphasis in Astronomy and minors in Computer Science and Mathematics. She hopes to continue her academic career in graduate school and pursue a graduate degree in Astrophysics.

Augusto Puig is a freshman undergraduate in the Department of Physics and Astronomy at the University of Missouri-St. Louis. He is working towards a B.S. in Physics with focus on Engineering. He hopes to continue his life in academia in grad school and pursue a graduate degree in Nuclear Engineering.

Black Holes: Astrophysics' Final Frontier

Professor Marco Cavaglià
Physics Department
Missouri University of Science and Technology

Abstract

In a 1966 episode of Star Trek the original series, the starship Enterprise encounters a "black star", what we now call a black hole. At the time that episode was aired, black holes were just a mathematical curiosity derived from Einstein's Theory of General Relativity, and many physicists were doubtful of their existence. Fifty years later, we have physical evidence of the existence of countless black holes in the universe. Thanks to giant laser antennas and the largest network of radio telescopes ever built on Earth, we can measure the warping of space-time due to black hole collisions, as well as take pictures of supermassive black holes residing at the center of far-away galaxies. Today, we will explore the mysterious world of black holes, learn how they warp space-time, and discover how they shake the very fabric of the universe the across billions of light years. Buckle up and get ready to go where no one has gone before!

Marco Cavaglià is Professor of Physics at the Missouri University of Science and Technology. A native of Italy, he earned a Ph.D. in Astrophysics at the International School for Advanced Studies in Trieste. Before joining the faculty at Missouri S&T, he held positions as Assistant Professor, Associate Professor and Professor at the University of Mississippi in (2004-2018).

Previously, he held positions as research scientist at Tufts University, the Albert Einstein Institute in Germany, the University of Beira Interior in Portugal and the Massachusetts Institute of Technology, and was Lecturer at the University of Portsmouth, UK. During his career, Dr. Cavaglià authored over 200 publications in peer-reviewed journals and was the recipient of several research awards. His scientific interests are in gravitational physics, astrophysics, theoretical physics, and education and public outreach. Dr. Cavaglià has been a member of the Laser Interferometer Gravitational-Wave Observatory Scientific Collaboration (LSC) since 2007. Cavaglia has more than 20 years' experience in management and administration of scientific units, having served from 2012 to 2017 as Assistant Spokesperson of the LSC, an organization of over one thousand scientists from over 80 institutions across 17 countries. From 2008 to 2012 he was founding chair of the LSC Education and Public Outreach Group and from 2012 to 2015 he was founding chair of the LSC Diversity Group. He is a member of the American Physical Society and the International Astronomical Union and has recently been elected senior member of the LIGO Academic Affairs Committee of the LSC and co-chair of the LSC Burst Source Working Group.