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NASA - MISSOURI SPACE GRANT CONSORTIUM
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MISSOURI SPACE GRANT CONSORTIUM

Preface

This 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 technical 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 scientific research group and engineering design team activities. This year's meeting was held at the Missouri University of Science and Technology on April 24-25, 2015.

The Missouri Consortium of the National Space Grant College and Fellowship Program is sponsored by the National Aeronautics and Space Administration and is under the direction of Dr. Lenell Allen, National Program Manager. It is my pleasure to thank the Affiliate Directors of the Consortium: Dr. Mike Reed, Missouri State University; Dr. Frank Feng, University of Missouri-Columbia; Dr. Dan McIntosh, University of Missouri-Kansas City; Dr. Bruce Wilking, University of Missouri-St. Louis; Drs. William Smith and Ramesh Agarwal, Washington University in St. Louis, Mr. John Lakey, St. Louis Science Center, and Dr. Majed Dweik, Lincoln University of Missouri; for their outstanding merit in directing and coordinating Space Grant activities at their respective institutions. I would also like to thank our Associate Directors; Dr. Mike Swartwout, Saint Louis University, Dr. Vayujeet Gokhale, Truman State University, and Ms. Tasmyn Front, Challenger Learning Center of St. Louis, for their contributions in coordinating, advising, and mentoring student research and training at their institutions this past year. Finally, 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 a success.

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

Sincerely,

Dr. Dave Riggins, Director
NASA-Missouri Space Grant Consortium
NASA-EPSCoR Missouri

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Student Research

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Banquet Presentation

Dissipative Elastic Metamaterials and Their Potential Applications for Blast Wave Mitigation

Miles V. Barnhart
Department of Mechanical & Aerospace Engineering
University of Missouri, Columbia
Advisor: Dr. Guoliang Huang

Abstract

The field of elastic metamaterial research has seen a great increase in attention in recent years owing to their local resonance properties that can act to attenuate subwavelength elastic and acoustic waves. When considering their potential application for blast wave mitigation, a key shortcoming arises from the fixed band gap inherent in a non-dissipative elastic metamaterial. Because of this, passive non-dissipative elastic metamaterials would not be effective in the mitigation of blast waves which are broadband in nature. By including dissipative elements into the system, it is possible to optimize certain material properties in order to manipulate the location and range of the band gap over a broad frequency range. The key objective of this report in to investigate the shock wave mitigation performance of a dissipative elastic metamaterial represented by a multi-resonator, mass-in-mass-in-mass lattice, where each mass is connected by differing springs and dampers. By integrating dissipative material properties into the system, it is possible to adjust the location of the band gap there by making the metamaterial more suitable for wave attenuation over a broad frequency range. Dispersion relations of the lattice are initially derived and evaluated for a dissipative system providing a means for comparison of results to previously studied models. By adjusting and optimizing certain properties including mass ratios, spring stiffness, and damping coefficients it was possible to increase the size of the band gap thus increasing its potential effectiveness for blast wave mitigation.

Miles Barnhart grew up in Springfield Missouri where he attended Greenwood Laboratory School for his elementary and secondary education. He was active in research during his time at Greenwood and participated on two occasions as a finalist in the Intel International Science and Engineering Fair (ISEF). Miles received his B.Sc. degree in mechanical engineering from the University of Missouri, Columbia in May 2014 and worked as an undergraduate research assistant during his senior year. He is currently a graduate student at the University of Missouri, Columbia studying mechanical engineering. The main focus of Miles' research deals with the development of metamaterials that can be applied for acoustic/elastic wave mitigation. After graduating with his M.Sc. degree he hopes to go on to work in research and development for a national research lab or government agency.

Shock Generated Multiphase Hydrodynamic Instabilities

Wolfgang Justice Black
University Of Missouri: Mizzou Shock Tube Facility
Advisor: Jacob McFarland

Abstract

Multiphase flow is a common component within many engineering applications from fuel air mixtures in turbines, to slug and plug flows in oscillating heat pipes, to slurry flows that may occur in refrigeration or rapid freezing procedures. Many systems with multiphase flow experience complex accelerations in the form of shock waves, like jet engines or super novae. This paper presents simulations performed on a multiphase, multispecies system undergoing shock driven turbulent mixing. Simulations are performed using the Ares code, a high density hydrodynamics code developed at Lawrence Livermore National Laboratory. The particle package within the Ares code shows qualitative agreement with experiments and other simulations found within literature. This research, though in its infancy, is the initial step towards developing experiments for the Mizzou Shock Tube Facility as well as supporting future simulations with the long term goal of incorporating phase change into multiphase-compressible turbulence simulations.

Wolfgang Justice Black, is a first year Masters Candidate at the University of Missouri. He studies Mechanical Engineering with emphases in the Thermo-Fluids field. He is the first graduate student to work for and the main designer of the Mizzou Shock Tube Facility. Currently, he is a collaborator with Lawrence Livermore National Laboratory and this summer will be working at Los Alamos National Laboratory where he will continue to simulate multiphase particle systems and design the first experiments to be run within the Mizzou Shock Tube Facility. He aspires to earn his PhD, travel the world, and use science and technology to inspire practical change.

University of Missouri- St. Louis Astronomy Outreach Program

Alex Bretaña
University of Missouri- St. Louis
Advisor: Dr. Bruce Wilking

Abstract

The University of Missouri- St. Louis is proud to offer the Planetarium Outreach Program through the Department of Physics and Astronomy, with funding provided by the NASA-Missouri Space Grant Consortium. The program is geared for third through fifth grade students and aims to stimulate critical thinking and encourage student interest in space, astronomy, and engineering. It consists of a planetarium presentation and a classroom presentation with demonstrations and science related activities. Attendance numbers were low for this year's program, and efforts will be made to contact schools earlier in the academic year along with continuing to update the program to widen the audience and attract more groups: our projector is being upgraded in the summer of 2015.

Alex Bretaña is a junior undergraduate in the Department of Physics and Astronomy at the University of Missouri- St. Louis. He comes from Saint Peters, Missouri, and plans to obtain his Bachelor's Degree in General Physics.

Morphologically Disturbed Massive Galaxies: Nature and Evolution During 0.6 < z < 2.5 in the CANDELS UDS and GOODS-S Fields

Joshua S. Cook
University of Missouri-Kansas City, Kansas City, MO, United States
Advisor: Daniel H. McIntosh

Abstract

Merging is predicted to be an important process in the early and turbulent assembly of massive galaxies. These violent encounters heavily impact galaxy morphology and structure. As such, the evolution of morphologically disturbed systems may help constrain the relative importance of merging, the answer to which is largely debated especially at higher redshifts. Disagreements between studies regarding the role of galaxy mergers may be attributed to the various methods used to select mergers such as various quantitative selections and visual classifications based on different rest-frame wavelengths. Using a new comprehensive catalog of rest-frame optical visual classifications based on HST/WFC3+ACS imaging from the CANDELS, the nature and evolution of highly disturbed galaxies are examined within the UDS and GOODS-S fields. The sample is limit for completeness to high-mass objects ($M_{star} > 10^{10}$ M_{sun}) with redshifts between $0.6 < z < 2.5$. Most disturbed galaxies are star-forming and two-thirds have masses under $3x10^{10}$ M_{sun}. The number fraction disturbed galaxies increase modestly with increasing redshift from a few percent to ~15% at $z > 2$. One-third however appear to be neither interacting nor merging, rather they are isolated and visually disk-like. This may indicate that the different classification methods are preferentially selecting objects undergoing either different processes such as major-merging, minor-merging and violent disk instabilities, or different stages within the same process.

Joshua Cook received his B.S. in Physics with an emphasis in Astronomy from the University of Missouri-Kansas City in May 2014. He plans to apply for graduate school in Astronomy in the fall of 2015.

Observations of Five Yellow Supergiant Stars

Philip E. Crouse
Department of Physics, Astronomy, and Materials Science
Missouri State University
Advisor: Dr. Robert S. Patterson

Abstract

From September to November 2014 a collection of yellow supergiant stars was observed with the 14-in. telescope and Apogee Alta u77 CCD camera at the Missouri State University Baker Observatory. Once the images were calibrated, the brightness of the program stars was obtained using differential aperture photometry. To be certain of any variability in program stars, double stars presumed to be constant in brightness of like spectral class, were observed concurrently.

Philip Crouse is a senior student of Physics, Astronomy, and Mathematics at Missouri State University.

TEM Metrology with Oxygen Precipitates in Silicon

Jamie Roberts, Phil Fraundorf, David Osborn
University of Missouri- Saint Louis
Advisor: Phil Fraundorf

Abstract

Transmission electron microscopy (TEM) can uniquely characterize individual sub-micron defects in crystals, but statistical information about a collection of such defects requires extra work. Topics of particular concern are distinguishing volume-defects from surface-defects (since prepared-specimens are generally thinned to under a micron thick), measuring the volume of material surveyed and one's uncertainties therein, classifying individual defect types given only data from electron contrast mechanisms, and measuring individual defect properties like volume, composition, etc.. The authors explore the limits of this challenge by documenting a grid search for oxygen precipitate-related defects in Czochralski silicon for the electronics and photovoltaic industries. For this particular application, they take advantage of wedge-shaped ion-milled perforations for large amounts of thin area, abundant stacking faults on known habit planes to check against light-microscope color estimates of the perforation wedge-angle, and the fact that the defect types are generally recognizable via diffraction contrast while being tilted. So far, they find that plots of maximum defect size versus number density help to define the magnifications and time needed for a given accuracy, and that defect location maps superposed on thickness model maps can be used to check for volume versus surface correlation of the objects being counted. They expect these same tools (eventually in on-line form) will be important in studies of (non-crystallographic) nuclear particle track density, as well as for the study of nanocrystals in an amorphous support, even though the geometric and object-recognition challenges take a different form.

Jamie Roberts is a first year student in the graduate physics program at the University of Missouri- Saint Louis and holds a B.S. from the University in physics as well as a B.A. from the University of Wisconsin- Madison in International Relations. Upon graduation, she plans to pursue a career in material science and energy research. During her leisure time, she loves to learn new languages, travel, and dance.

Determining the Properties of an Infrared-Selected Sample of High-Redshift Galaxy Clusters

Bandon Decker
University of Missouri—Kansas City
Advisor: Dr Mark Brodwin

Abstract

As galaxy clusters the largest gravitationally bound objects in the universe, theirevolution over cosmic time is a very interesting area of research. To do thiseffectively it is necessary to have a large and unbiased sample of clusters to studyat high redshifts, but current surveys are biased toward high gas masses due tothe way the clusters are selected. We are constructing an infrared-selected catalogue of high-redshift clusters and will be determining the stellar and gas mass fractions for this sample of clusters that is not biased toward high gas masses. We have so far determined total masses for a dozen of our clusters and are working toward determining stellar and gas masses for those as well as expanding our sample.

Bandon Decker is an alumnus of Truman State University and has been a graduate student at the University of Missouri—Kansas City since the autumn of 2013. He has been working with MaDCoWS since the summer of 2014 and plans to earn his PhD in the next few years.

Observations to Constrain the Albedo of a Hot Jupiter

Shannon Dulz
Missouri State University
Advisor: Dr. Mike Reed

Abstract

We obtained 23 nights of data on the transiting hot-Jupiter exoplanet TrES-4b in 2014 to measure the day-side albedo. We obtained over 7,100 images in two filters covering 17 orbits. We have 78.2% phase coverage and the light curve reaches a precision of 0.0068 magnitudes in the r filter and 0.0098 magnitudes in the g filter. We estimated the precision necessary to measure eclipse depth to be 0.0012 magnitudes and have not reached this level of precision. We did, however, detect a transit of approximate depth 0.01 magnitudes agreeing with literature on TrEs-4b.

Shannon Dulz is currently a sophomore at Missouri State University. She is working on a double major with Physics and Applied Mathematics. After her undergraduate education, she plans to attend graduate school with the goal of a career in Astronomy research. Her hometown is Kirkwood, Missouri, near Saint Louis.

Additive Manufacturing of Polymers for Composite Tooling

Michelle Gegel
Missouri University of Science and Technology
Advisor: Dr. K. Chandrashekhara

Abstract

Additive Manufacturing (AM) is a process of joining materials to make objects from three-dimensional digital model data, usually layer by layer. AM allows flexible design and rapid creation of tooling at significant time and cost savings. The Fused Deposition Modeling (FDM) method uses wire-shaped thermoplastics as the build material. The FDM machine melts the thermoplastic feed wire before extruding the material from a nozzle and, in this manner, builds the part from digital model data. Composites are widely manufactured using techniques such as resin transfer molding and autoclave processes, in which elevated temperature and pressure are required to cure the part.

Manufacturing of complex composite parts requires molds. Currently metal molds are used which require additional machining to achieve the desired shape. As an alternative, FDM can be used to build polymer-based tooling by means of an automated build process. The use of FDM tooling for composites will allow the aerospace industry to save both time and cost on composite applications. Missouri S&T has recently acquired a FDM machine from Stratasys. The objective of this study is to evaluate the performance of this polymer tooling at elevated temperatures.

Michelle Gegel is currently a senior at Missouri S&T in the Mechanical Engineering Department. She is planning on attending graduate school after receiving her B.S. from Missouri S&T.

A Novel Approach to Large Aperture Astronomical Spectroscopy

Claire Geneser
Missouri State University
Dr. Peter Plavchan

Abstract

The goal of this project is to show that the combined light from four 8 inch telescopes is just as effective for radial spectroscopy as the light from a 16 inch telescope, at a much lower cost to the researcher. This paper analyzes the expense benefits of building and programming a robotic telescope array from four 8 inch CPC Celestron telescopes. The images are overlaid using single mode fiber optics, and the light is sent through a spectrograph to produce a single image of the star's spectrum. The system is built to imitate the same light gathering power as a 16 inch telescope, such as the Cassegrain reflector housed at Baker Observatory. Our model tests the pricing to search for exoplanets using the array for discovery by the Doppler spectroscopy technique. The results open possibilities to perform this research at a fraction of the former cost.

Claire Geneser is a student from the town of Mahomet, IL, currently enrolled in her Junior Year at Missouri State University. She is working on obtaining her Bachelors of Science in the Physics, Astronomy, and Material Science department. She plans to graduate with a Major in Physics, and Minors in both Astronomy and Mathematics. After graduation, she will continue to graduate school, in order to obtain a Masters in Astrophysics.

Plasma Plume Characterization of Electric Solid Propellant Microthrusters

Matthew S. Glascock
Missouri University of Science and Technology
Advisor: Joshua L. Rovey, Ph.D.

Abstract

Electric Solid Propellants are a potential option for propulsion because they are ignited only by an applied electric current. As a result, these propellants offer exciting capabilities such as on-demand throttling and re-ignition and are insensitive to accidental ignition by spark, impact or open flame. Further, when utilized in a microthruster and fitted with a proper power delivery unit, this propellant can be used in a mode similar to that of a traditional Teflon-fed Pulsed Plasma Thruster. In this work, the plasma plume created by electric solid propellant microthrusters is investigated using methods similar to prevalent PPT diagnostic strategies. Ion current density, plume velocity and shape, ionization fraction and plasma density of the plume are measured and analyzed.

Matthew Glascock is a first year graduate research assistant pursuing his doctorate degree in Aerospace Engineering at the Missouri University of Science and Technology. His research interests and expertise lie mainly in the field of Electric in-space propulsion and other future propulsion technologies. Matthew has publications with AIAA's Propulsion and Energy Forum and Journal of Propulsion and Power, and his career goals are to participate in research and development of advanced propulsion technologies in the Aerospace community.

Iodine Propulsion System Development and Testing

Matthew S. Glascock
NASA George C. Marshall Space Flight Center
Advisor: Kurt A. Polzin, Ph.D. and John W. Dankanich

Abstract

Iodine vapor has presented itself as a potentially advantageous alternative propellant for use in Hall-effect thrusters (HET's) owing to its ability to be stored as a solid at room temperature, the higher density of the stored propellant, and its comparable performance to the well characterized and state-of-the-art HET propellant, xenon. In this work a propellant loading system conceptual design is studied and tested. The system operation uses a temperature difference where crystalline iodine in one reservoir is sublimated by adding heat and deposited in a cooled target reservoir. Experimental observations noted undesired deposition in transfer lines, increased density of the delivered propellant solid, and purification of the delivered propellant. Recommendations for a CubeSat propellant feed system and tank fill system include heated transfer lines, high temperature differentials and gradients, and removal of relatively lower temperature stagnation points from the system.

Matthew Glascock is a first year graduate research assistant pursuing his doctorate degree in Aerospace Engineering at the Missouri University of Science and Technology. His research interests and expertise lie mainly in the field of Electric in-space propulsion and other future propulsion technologies. Matthew has publications with AIAA's Propulsion and Energy Forum and Journal of Propulsion and Power, and his career goals are to participate in research and development of advanced propulsion technologies in the Aerospace community.

Aerodynamic Shape Optimization Applied to Benchmark Problems

Joe-Ray Gramanzini
Missouri University of Science and Technology
Advisor: Dr. Serhat Hosder

Abstract

The main scope of this project is efficient aerodynamic shape optimization in the transonic flow regime using gradient-based and surrogate-based approaches. These techniques are demonstrated on two airfoil sections in the transonic flow regime. This paper will focus on the use on gradient based optimization, using an adjoint solver to determine the sensitivity derivatives needed for the optimization procedure. The Fully Unstructured Navier-Stokes 3D (FUN3D) code developed by NASA Langley was implemented as the computational fluid dynamic solver. The use of the Multidisciplinary Aerodynamic-Structural Shape Optimization using Deformation (MASSOUD), tailored for aerodynamics shapes, and Bandaid, free-form deformation, codes where used for the shape parameterization and deformation tools. The aerodynamic shape optimization approach includes several key components, including the set up of a computational domain, creating a parameterization of the aerodynamic shape, performing a sensitivity analysis, and deformation of the geometry. To study the optimization of aerodynamic shapes the AIAA Aerodynamic Design Optimization Group developed a series of test cases; his paper will focus on two of those cases, the inviscid modified-NACA 0012, and the viscous RAE2822 airfoil sections. The optimization process resulted in a drag reduction of 78.67% for the modified-NACA 0012 and 60.94% for the RAE2822, from their respective baseline base line solution.

Joe-Ray Gramanzini, originally from Kansas City Missouri, is a Candidate for a Master's of Science in Aerospace Engineering at the Missouri University of Science and Technology. Joe-Ray is currently studying in the fields of Aerodynamics, Computational Fluid Dynamics, and Aerodynamics Shape Optimization. Joe-Ray Graduated Magna Cum Laude with a Bachelors degree in Aerospace Engineering from Missouri University of Science and Technology 2012. As a graduate student he was awarded the ASME Graduate teaching award in 2013. Joe-Ray will be working as an Aerodynamics Engineer with an NAVAIR were he will start on his research for his PhD, with an emphasis in aerodynamic design, computational fluid dynamics, and thermofluids.

Plasma Theory for Undergraduate Education

Joseph B. Hakanson
Missouri University of Science and Technology
Advisors: Warner Meeks and Dr. Joshua L. Rovey

Abstract

These instructions will discuss both DC plasma theory as well as describe experiments that can be used for undergraduate instruction of DC plasma diagnostics. Experimental breakdown curves and Langmuir Probe curves will be obtained and studied with the use of a DC glow test article. Through the development of these experiments, the Missouri S&T Aerospace Plasma Laboratory (AP Lab) have experimentally achieved data that resembles theoretical models. From this, useful quantities can be obtained, such as breakdown voltage region (lower limit: $p*d$ = 0.2 Torr*cm), electron temperature (T_e = 1.4124 eV), etc. The results of the AP Lab have been included in this document for reference.

Joseph Hakanson is a Junior who is double majoring in Aerospace and Mechanical Engineering at Missouri University of Science and Technology. His hometown is St. Louis, Missouri. He is an Eagle Scout, a member of the Tau Beta Pi Engineering Honors Society, and has been consistently recognized for his academic achievements on the Missouri S&T Academic Scholar's List. He hopes to use his degree to help advance space transportation technologies of the future.

Performance of a Hydraulic Steering System in Failure Modes under Over-Steering Conditions

Emily Hall
University of Missouri-Columbia
Advisor: Dr. Roger Fales

Abstract

Working to enhance its operation, a steering system is being tested to see its performance under failure modes. These failures are simulated through induced leaks at various points in the hydraulic fluid line. These leaks will cause less fluid to be moved in the same steering adjustment. As a result, the output of a given steering input for a normal system would be much more drastic than the output for the same input where leaks are present. An operator may be more inclined to make large steering inputs in an effort to pump more hydraulic oil to obtain the desired steering output. The objective of this research is to see how the system responds when these “over-steering” inputs are used and to see if “over-steering” can make it more difficult to detect leaks in the system. Another goal is to see if “over-steering” can damage any component of the system further. This system can be applied to aircraft as well as off-highway trucks.

Emily Hall is a senior in Mechanical Engineering at the University of Missouri-Columbia. In addition to her Bachelor of Science in Mechanical Engineering, she is also pursuing a minor in Aerospace Engineering. With these academics, Emily will pursue a career in the aerospace industry. After gaining industry experience, she plans to obtain her Professional Engineer (PE) license as well as a Master of Business Administration degree to advance her professional career.

A Study of the Precipitation of Metal Ions (Zn^{2+}, Fe^{3+}) on Mesoporous FDU-12 Silica under Hydrothermal Conditions

Steven Harrellson
Missouri State University
Advisor: Dr. Robert Mayanovic

Abstract

FDU-12 mesoporous silica was hydrothermally treated in the presence of metal ions (Zn^{2+}, Fe^{3+}) for applications in chemical and energy industries. The effect of pH of the reacting solution was examined to better understand how the metal ions best precipitate on FDU-12 mesoporous silica. The vibrational and morphological changes of the mesoporous silica after hydrothermal treatment were examined using Raman spectroscopy and scanning electron microscopy (SEM).

Steven Harrellson is a Senior at Missouri State University.

Isolation of Native Algae and Comparison of Growth between Biodegradable Plastic and non-Degradable Plastic Bags for Floating Outdoor System

Ali Hasan
Department of Nanotechnology
Lincoln University of Missouri
Advisors: Balakrishnan Baskar, PhD and Majed El-Dweik, PhD

Abstract

Microalgae are the fastest growing plants on Earth, contributing to the environmental friendly production of biodiesel. Many outdoor floating cultivation technologies of microalgae rely on plastic materials. Using the plastics remains a biggest environmental concern as they do not break down and they are dangerous to the aquatic life. An alternative way is the use of biodegradable bags which are more environmental friendly in terms of their degradation. However, the common concern for replacing it with biodegradable plastic is that the stability of the bags and the effect of those bags on the growth rate of algae. Our study investigated the growth rate of algae that are cultured in biodegradable plastics and non-biodegradable bags and the effect of those bags on the biomass and their effects on the environment. Isolated dominant and fast growing native microalgae from Callaway and Cole Counties in the state of Missouri have been collected and subjected for morphological and cultural identification. The isolated algae cultivated in different polybags (Biodegradable and non-degradable), floating on a laboratory stimulated water body. The growth was estimated in terms of Biomass, and the biodiesel production was estimated in terms of lipid. Based on the results it is proved that there is no significant difference between the use of biodegradable poly bags with non-degradable bags. The stability also remains same between two bags after 45 days of the experiment. Based on the results, we conclude that the use of biodegradable plastics bags can substitute the use non-biodegradable bags because they have less impact on the environment.

Ali Hasan is a Junior at Lincoln University of Missouri.

A Characterization of Lithium-Ion Conducting Amorphous Solid Electrolytes

Gavin Hester
Department of Physics, Astronomy, and Materials Science
Missouri State University
Advisor: Saibal Mitra

Abstract

Lithium-ion batteries are currently one of the most prevalent energy storage devices available. However, these batteries often utilize liquid electrolytes that are corrosive, poisonous, and prone to developing dendritic shorts. A solid state electrolyte that conducts lithium well can mitigate these issues and provide additional benefits. The compound Li_2SO_4-Li_2O-P_2O_5 is a promising candidate for a solid state electrolyte due to its high ionic conductivity and low electronic conductivity. The characteristics of this compound were studied using two forms of neutron spectroscopy: neutron diffraction and quasielastic scattering, studying the structure of the solid electrolyte and the diffusion of lithium ions in the electrolyte, respectively. It is found that this compound conducts lithium using a jump diffusion mechanism that is promoted by vacancies in the compound.

Gavin Hester was raised in Jefferson City, MO and currently attends Missouri State University. Gavin is a junior physics major with an emphasis in graduate preparation. He plans on attending graduate school upon graduation to obtain a PhD. in condensed matter physics. He would then like to obtain a job as a professor of physics and join the ranks of academia.

Electromechanical Properties of Carbon Nanotube Fuzzy Fibers

Rachel Hough
University of Missouri – Columbia
Advisor: Dr. Matt Maschmann

Abstract

Carbon Nanotubes (CNTs) are a developing technology that have applications in multi-functional composites because of their conductivity and strength. This study hopes to elucidate the electrical and mechanical properties of CNTs grown on both planar substrates of silicon and glass fibers. The CNTs are grown using chemical vapor deposition. Using a puck that is wired to a digital multi-meter (DMM), the electro-mechanical properties of the CNTs on the glass fibers are compared to the response of the similar arrays grown on planar silicon substrates. The nano-indenter indents the substrates using a given force, typically around 15 mN which is used to analyze its mechanical properties. Each indentation point has the force and displacement into the surface recorded. This can be used to calculate the stress on the nanotubes. The force versus displacement curve also indicates the elastic or plastic response of the nanotubes. To further this research, many more nanotube forests need to be grown simultaneously on planar and silicon substrates which can then be tested. Once more data has been compiled, the planar and glass substrates can be compared and conclusions about the structural and electrical properties of nanotubes can be made.

Rachel Hough is a senior pursuing a Bachelor's of Science in Mechanical Engineering with an Aerospace minor at the University of Missouri – Columbia. During her time at Mizzou she has been involved in organizations such as the Mizzou Chapter of AIAA (American Institute of Aeronautics and Astronautics) and its build team, Rocket Team, Alpha Omega Epsilon, a social and professional sorority for women in engineering and technical sciences, and Pi Tau Sigma, the mechanical engineering honors fraternity. Rachel has also had the opportunity to study abroad and enjoys traveling. She has hopes of pursuing a graduate degree in aerospace engineering and ultimately to work in research and development in the aerospace industry.

Response of Growth and Water-use Efficiency of Radish Seedlings to Nutrient Solution Nitrogen Concentration in Hydroponic Culture

Lyric S. Howard
Lincoln University of Missouri
Advisors: Jonathan Egilla, Majed El-Dweik

Abstract

The National Aeronautic Space Administration (NASA) has demonstrated successfully for many decades the feasibility of using plants as a component a bioregenerative life support system (BLSS) to regenerate the atmosphere, purify water, and produce food for crews during long-duration space missions. Hydroponic plant production in Controlled Ecological Life-Support System (CELSS) can be a simple potential method to fulfill these needs. Limited nitrogen supply to plant root may induce phytohormone, particularly abscisic acid (ABA) regulation of shoot growth and the water relations of the plant. Conversely, excess nitrogen can reduce the quality of crop plants. Information about the optimum nitrogen for normalized plant growth in CELSS is limited. The objective is to determine the growth and yield response of radish (Raphanus sativus L.) to two levels of nitrogen concentration will be evaluated in a Flood-and-Drain (Ebb&F) hydroponic system. Radish seedlings raised in 2.5-cm rockwool cubes were transferred into Ebb&F culture at the second true-leaf stage and will be grown until maturity in a plant growth chamber (PGC). The PGC was set at 16/8, 25/22 oC and 90/75% day/night photoperiod, temperature and relative humidity, respectively. The treatments comprised of Hoagland nutrient solution at full– or half–strength nitrogen maintained at pH 6.5–7.0. At harvest, plants will be harvested for fresh and dry weight, leaf area measurements. It is anticipated that this research will enhance further understanding of how plant nutrient elements influence plant growth and water relations CELSS, when this experiment is repeated under hyperbaric conditions.

Lyric S. Howard is a Junior at Lincoln University of Missouri.

Lifetime Analysis of Beryllium Reflector

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

Abstract

In the Advance Test Reactor (ATR), High Flux Isotope Reactor (HFIR), and University of Missouri Research Reactor (MURR), the beryllium reflector(s) are a structural component of great interest due to its cost and importance to reactor operation. The transmutation of the beryllium reflectors by the fast neutron flux combined with thermal stress due to gamma heating in the beryllium limits the reflector's lifetime in these reactors. The conversion from an HEU-based fuel to an LEU-based fuel in these reactors will be accompanied by a shift in neutron energy spectrum leading to a reduction in gamma heating of the beryllium reflector per megawatt of core power. Therefore, time at which components may fail should consequently shift.

Detailed analyses, including neutronic, thermal, mechanical and hydraulic, are to be carried out at the University of Missouri in order to assess the relative change in expected life span of Be reflectors. Historic life prediction for the beryllium reflector at MURR is based on the empirical observation of a single material failure coupled with a simple gamma-heating induced stress estimate. Numeric simulations based on operational assumptions and boundary conditions for both HEU and LEU cores will be used to estimate the relative life expectancy for the new LEU core.

It is also not clear that the modeling strategy used by MURR is transferrable to other the other reactor sites that utilize beryllium as a reflector material. The objective of this study is to analyze the detailed thermal/structural behavior of the beryllium reflectors at MURR, HFIR, and ATR. This will be examined for both the current HEU and the proposed LEU cores.

Annemarie Hoyer is from Columbia, MO and is currently pursuing her doctorate degree in Mechanical Engineering at the University of Missouri – Columbia, under Dr. Solbrekken as her advisor. Her field of study is thermo-mechanical analysis and specifically her research deals with material lifetime prediction in radioactive surroundings such as those in a nuclear reactor. After graduation, she would like to pursue a career in research with a national lab, much like her fellowship at Oak Ridge National Laboratory in Oak Ridge, Tennessee.

Optimization of Growth Parameters
for the Pulsed Laser Deposition of Molybdenum Disulfide

Dan Jones
Missouri State University
Dr. Kartik Ghosh

Abstract

Fabricating large are 2-dimensional thin films has become an area of great interest to researchers over the past several decades. Many materials have been found to exhibit unique, highly desirable electrical and optical properties at the atomic layer level. Here, I report on the growth of crystalline MoS2 thin films using Pulsed Laser Deposition (PLD) on substrates such as SiO2(300 nm)/Si, sapphire, and quartz. 2-Dimensional Molybdenum disulfide (MoS2) displays novel optical and electrical properties such as high charge carrier mobility and an optical band gap transition with wide ranging applications in transistor (such as FET's) and detector devices. The Raman active vibrational modes, morphology, and crystallinity were characterized employing Raman spectroscopy, scanning electron microscopy (SEM), and X-ray diffraction (XRD) respectively. The Raman spectra of the thin films show E12g and A1g vibrational modes pertaining to bulk MoS2. The XRD pattern correspond to the 2H phase of crystalline MoS2 (space group of P63/mmc), and the diffraction peak at 32.90 indicates preferential growth of the films along (100) plane. SEM pictures reveal presence of a lacy structure at the nanometer range, correlating to the average crystalline size, and are produced only under certain growth parameters. From the obtained Raman and XRD spectra, the optimum growth parameters for MoS2 thin films is shown to be at 7000C and 10-2mbar pressure in the presence of forming gas. Further analysis of the lacey structure revealed by SEM and obtaining Raman spectra of monolayer MoS2 provide the foundation for future work.

Dan Jones is a junior at Missouri State University. He was born in Fargo, North Dakota but was raised in Springfield, MO. Dan entered college majoring in chemistry, but shortly after his freshman year he saw the light and switched to the physics department. Recently, Dan has applied for and received a position at the Notre Dame REU program for the summer of 2015. Dan expects to graduate after the Spring semester of 2016, after which he hopes to attend a graduate school in pursuit of a Ph.D. degree in physics.

Laser Production of Nanostructures for Bio Inspired Surfaces

John Keenoy
University of Missouri - Columbia
Advisor: Jian Lin

Abstract

Many surfaces in nature experience interesting phenomena, examples of this include lotus leaves, rose petals, and butterfly wings. All of these experience superhydrophobicity and other properties, and it has been shown that this is caused by surface structures at the micro- and nanoscale range. These types of structures can be created on surfaces using a high powered laser, and can replicate the surface properties of these organisms on other materials that have other possible applications.

John Keenoy is from O'Fallon, MO, and is currently a junior in the engineering school at the University of Missouri, Columbia; studying to earn a bachelor's degree in mechanical engineering. This summer he will be interning at Westar Display Technologies in St. Charles, MO. After graduation, John hopes to find a meaningful career in industry where he will be able to make a worthwhile contribution to the company he will be working for and the community as a whole.

Verification and Validation of Coupled Numeric Fluid-Structure Interaction Simulations

John C. Kennedy
University of Missouri
Advisor: Dr. Gary L. Solbrekken

Abstract

Numeric fluid-structure interaction (FSI) modeling is a growing area of interest in a number of fields. The ongoing work presented here seeks to verify and validate numeric FSI simulations. This effort begins through analysis of independent fluid (CFD) models and structural (FEA) models. The results presented here cover the current state of independent model validation as well as the plans for fully coupled CFD-FEA models. These coupled FSI models will be compared against experiment results. Finally, new techniques are being developed for modification of the CFD model mesh to more closely match the experiment geometry.

John C. Kennedy is currently a Ph.D. candidate in Mechanical and Aerospace Engineering at the University of Missouri. Mr. Kennedy is a specialist in numeric Fluid-Structure Interaction modeling and looks forward to a career applying these methods to a wide range of problems.

Analysis of Three Years of *Kepler* Data for the Pulsating Subdwarf B Star KIC 2697388

Joshua W. Kern
Missouri State University
Advisor: Dr. Mike Reed

Abstract

The Kepler spacecraft stared at ~150,000 stars over the course of its four year mission. Of those, 18 were discovered to be pulsating subdwarf B stars, including KIC 2697388. From three years of short-cadence observations, we detect 198 periodicities for KIC 2697388. Most of these variations have periods of ~1 to ~2.5 hours, which we associate with gravity-mode pulsations. Most of the variations show amplitude and/or frequency variations over the course of the observations. Mode identification techniques, including asymptotic overtone period spacings and rotationally-induced frequency multiplets, allowed us to identify 52% of the periodicities. Most of the identified modes were low degree (ℓ<2), but 14 were identified as ℓ=3 or 4. Frequency multiplets provide a rotation period for the star of ~45 days. A previously unobserved feature is seen in KIC 2697388's data; the frequency spacings in some of the multiplets changes over the course of the observations. Possibly this is associated with changing rotation velocities in different portions of the star, perhaps even exchanging angular momentum between rotation and pulsations.

Joshua William Kern grew up in Seymour, MO, where he graduated high school in 2008. He is now finishing his sixth year in the Department of Physics, Astronomy, and Materials Science at Missouri State University. Joshua's field of study is physics, with an emphasis in astronomy and astrophysics, and he is on pace to graduate in May 2016. Joshua aspires to go to graduate school for physics and/or astronomy in order to eventually become a professor. He would love to be able to teach science and math as well as continue to do observational astronomy research throughout his life.

Studies of the Mechanical and Extreme Hydrothermal Properties of Mesoporous Silica and Aluminosilica Materials

Dayton G. Kizzire
Department of Physics, Astronomy, Materials Science
Missouri State University
Advisor: Robert Mayanovi

Abstract

Periodic mesoporous SBA-15 silica and Al-SBA-15 aluminosilica have potential for applications in the energy and chemical industries. The structural properties of periodic mesoporous silica SBA-15 and periodic mesoporous aluminosilica Al-SBA-15 are being investigated using small angle x-ray scattering (SAXS). The SAXS measurements were made at the Cornell High Energy Synchrotron Source (CHESS). The pressure-dependent SAXS measurements were made on mesoporous SBA-15 silica and Al-SBA-15 aluminosilica samples using a diamond anvil cell (DAC) to ~ 12 GPa in pressure. SAXS measurements were also made of the mesoporous SBA-15 silica and Al-SBA-15 aluminosilica under extreme hydrothermal conditions (to 250 °C and ~ 110 MPa) using the DAC. Both SBA-15 and Al-SBA-15 possess amorphous pore walls and have similar pore size distribution. Analyses of the pressure-dependent SAXS data show that the mesoporous Al-SBA-15 aluminosilica has greater mechanical stability than the mesoporous SBA-15 silica.

Dayton Kizzire is from Ozark, Missouri. He obtained a Bachelor's of Science in Physics at Missouri State University and he is currently pursuing his master's degree in Materials Science at Missouri State University. He hopes to one day work in a national research lab or enter the private sector to advance research on nanomaterials.

Simulation of Forward Osmosis Flow in a Two-Dimensional Asymmetric Membrane Channel with Draw Channel Circular Baffle Implementation

James Koch
Department of Mechanical Engineering & Materials Science
Washington University in St. Louis
Advisor: Ramesh Agarwal

Abstract

Forward Osmosis (FO) driven asymmetric membrane filtration is a developing technology which shows promise for seawater desalination and wastewater treatment. Due to the fact that asymmetric membranes are widely used in conjunction with this technology, internal concentration polarization (ICP) - a flow-entrainment effect occurring within such membranes is a significant if not dominant source of overall osmotic pressure loss across the membrane. Accurate modeling of ICP effects is therefore very critical for accurate Computational Fluid Dynamic (CFD) modeling of asymmetric membranes. A related dilutive effect known as external concentration polarization (ECP) also develops on both the rejection and draw sides of the membrane further contributing to osmotic pressure loss. In order to increase the overall water flux, circular spacers can be implemented within the draw channel of FO cross-flow membrane exchange units to decrease the effects of ICP and draw ECP. The drawback of spacer inclusions is an increased pressure loss across the length of the feed channel. The system efficiency gained by the decrease in ECP must therefore be weighed against the energy cost of hydraulically making up the lost channel pressure. To model the geometry of a FO cross-flow channel, the open source CFD package OpenFOAM is used. A compressible flow solver with explicit boundary conditions is developed to simulate the flux transfer and ICP effects present within an asymmetric membrane when exposed to a NaCl solution. Results are validated by comparison with the numerical data generated by earlier models of asymmetric membranes implemented by other investigators using similar simulation conditions.

James Koch is a Master's student in the department of Mechanical Engineering and Materials Science at Washington University in St. Louis. His research interests are in Computational Fluid Dynamics and its industrial applications.

Observations of Hot Exoplanets

Kent Mastroianni
Missouri State University
Dr. Mike Reed

Abstract

The objective of this project is to obtain multiple band pass observations of known, transiting exoplanets using ground based telescopes in order to constrain atmospheric compositions. All the observed stellar systems have confirmed exoplanets orbiting their host stars with periods of less than a week; typical orbital periods observed were on the order of a few days. These short orbits imply a very close proximity to their host stars. Thus, it is theorized that the temperatures on these planets could be high enough to vaporize refractory materials; such as common silicates. The observational goal is to produce high-precision, phase-folded light curves of the star-planet systems so that the planets' reflected light can be measured. Constraints on these exoplanets' atmospheric compositions and Bond albedos can be made by using relative measurements between different filters as a proxy to using true spectroscopy.

Kent Mastroianni was raised in Jefferson City, Missouri and is currently a junior at Missouri State University pursuing a Bachelor of Science in Astrophysics with a minor in Mathematics. He has been a part of an EPSCoR funded project studying the atmospheres of hot exoplanets for a year. Kent plans on attending graduate school after completion of his degree.

Investigation of Electrode Materials in Lithium-ion Batteries: Improving Capacity and Cycling Performance

Alyssa McFarlane, Eric Majzoub, Dongxue Zhao, Waruni Jayawardana
University of Missouri Saint Louis
Advisor: Eric Majzoub, PhD

Abstract

Lithium-ion batteries are promising for energy storage applications, but further study of the active materials involved is required to overcome limitations on properties like energy density and reversible capacity. In this ongoing project our goal is to minimize limitations by investigating various cathode materials that utilize conversion reactions, which recent studies show lead to higher capacities. [1-2] Metal compounds implanted into the pores of Nanoporous Carbons (NPCs) were tested. [1-2] Lithium-ion half-cells were assembled out of various cathode materials and tested for capacity using a constant current tester. First, TiO2 particles formed inside NPC's were synthesized and tested. [3] Results show a capacity of 600 mAh/g. For reproducibility, NPCs were assembled in a similar coin cell and an irreversible capacity of 225 mAh/g was achieved which reflects the findings of Meng, et al. [4]. Light metal hydrides may improve these results when used inside NPC's instead of metal oxides or NPC's alone. [5] They are an attractive option for conversion reactions as they have been shown to obtain high reversible capacity and lithium mobilities [1-2]. Ordered mesoporous carbon containing LiBH4 particles inside the pores has been synthesized. [3] For future research, several different high-capacity light-metal hydrides will be tested.

Alyssa McFarlane is a Senior at the University of Missouri – St. Louis.

Injection Manufacturing of SiC/SiC Composites

Robert Meinders
Missouri University of Science and Technology
Advisor: K. Chandrashekhara

Abstract

Continuous fiber-reinforced silicon carbide (SiC/SiC) ceramic composites have been sought for their high temperature strength and graceful failure mechanisms. A disadvantage is the high cost and lengthy production processes that are required to develop these materials. Polymer Infiltration and Pyrolysis (PIP) is one of the most attractive fabrication processes for composites due to shape flexibility, mass production and relatively low cost; however, the quality of material obtained by this method has been considered insufficient due to the microstructure of the material obtained. This study investigates a hybrid of multiple polymer manufacturing processes to maximize quality of the SiC/SiC composites while minimizing manufacturing time. The composites are laid up using a prepreg process then pressed and injected with a preceramic polymer at high pressures. The composite is cured, pyrolyzed, and then reinjected to increase the density of the samples. The study encompasses several different injection pressures to examine the effects on the composite mechanical properties and microstructure. The mechanical properties are analyzed by means of four point bend tests at room and elevated temperatures. The microstructure is evaluated by void density measurements and scanning electron microscopy. The results show that the pressurized resin injection produces lower void contents than vacuum assisted reinjection; however, excessive pressure produces a decrease in the material strength due to matrix material damage.

Robert Meinders was born and raised in Bellevue, Nebraska, and graduated as valedictorian from Bellevue East High School in 2009. He was awarded a Bachelor of Science Summa Cum Laude in both Aerospace and Mechanical Engineering from Missouri S&T in 2013. He is currently pursuing a Master of Science in Aerospace Engineering at Missouri S&T under the guidance of his advisor Dr. K. Chandrashekhara. He plans to continue his education to earn a Ph.D. in Aerospace Engineering.

Computation of Turbulent Flow in a 2-D Lid-Driven Cavity Using a Number of Turbulence Models

Hakop Nagapetyan
Department of Mechanical Engineering & Materials Science
Washington University in St. Louis
Advisor: Ramesh Agarwal

Abstract

This study analyzes the accuracy of various turbulence models for simulating internal vortical turbulent flows with large recirculation by considering the flow in a 2-D cavity generated by the motion of its top wall. In particular, the accuracy of the newly developed Wray-Agarwal (WA) model is compared against the two well- known models - the Spalart-Allmaras (SA) and Shear-Stress-Transport (SST) k-ω models. The simulated results are compared to the published experimental results and computations with the Large Eddy Simulation (LES) model to determine which turbulence model (WA, SA and SST k-ω) gives the best results for a wide range of Reynolds numbers. In particular, the results are compared at Reynolds numbers of 10,000, 20,000, 50,000, and 100,000. The open-source CFD code OpenFOAM is used to calculate the flow field. The results clearly demonstrate that WA model outperforms the SA model and is at least competitive with SST k-ω model if not better for all cases considered.

Hakop Nagapetyan is a Master of Science degree candidate in the department of Mechanical Engineering and Materials Science at Washington University in St. Louis. He received his Bachelor’s Degree in Mechanical Engineering from Case Western Reserve University.

Dust-Obscured Star Formation in Galaxy Clusters at High Redshift via a Herschel Stacking Analysis

Dave Nair
University of Missouri - Kansas City
Advisor: Dr. Mark Brodwin

Abstract

As the most massive collapsed structures, galaxy clusters provide an excellent laboratory in which to study galaxy evolution and cluster formation in rich environments. A large number of rare, distant candidate galaxy clusters have recently been discovered via their infrared galaxy overdensities in a new, wide-area (100 square-deg) survey called the Spitzer-South Pole Telescope Deep Field (SSDF). This extremely distant sample of 257 cluster candidates allows one to observe star formation and mass assembly in the first generation of galaxy clusters. Using a stacking analysis, imaging of these candidates with Herschel SPIRE bands can be fit to infrared luminosity (LIR) curves associated with dust-obscured star formation. After fitting to a given LIR model, star formation rates (SFR) for these cluster candidates can be calculated and are observed to be as high as many hundreds of solar masses per year.

Dave Nair is a graduate research intern working with Dr. Mark Brodwin at UMKC. He is currently completing his Physics Masters and thesis in star formation in distant galaxy clusters. Hailing from Kansas City, KS, Dave has always been a fond supporter of the performing arts and the pursuit to further understand the natural sciences.

Signatures of Interaction Among Stripe 82 Spheroids

Patrick Newman and Xiachang Her
Department of Physics
University of Missouri-Kansas City
Advisor: McIntosh, Daniel

Abstract

A software pipeline was developed that selected galaxies, fit them with a variety of profiles, and found a figure of merit from the residual images called "tidal parameter." Lots of galaxies among 3 different groups were selected (something about sample history). Galaxies were selected by both intrinsic properties (quiescent vs recent post-merger) and image depth. Tidal features appeared to increase greatly with depth, though not other galaxy properties.

Xiachang Her is a master's student at UMKC's Physics and Astronomy department, and works in the Galaxy Evolution Group under Dr. McIntosh. He laid the groundwork for a pipeline for acquiring SDSS images of single and pair galaxies, and processing them with SExtractor, and GALFIT to acquire data and analyze them following the methodology outline in McIntosh et al. (2008) and Her et al. (in prep).

Patrick Newman is an undergraduate at UMKC's Physics and Astronomy department, and works in the Galaxy Evolution Group under Dr. McIntosh. He assisted in bringing the pipeline to operational status, expanded its scope, added documentation, and removed (almost) all need for manual fiddling.

Investigation of Femtosecond-Pulsed Laser Deposition for Synthesis of Mesoporous WO_3 Thin Films

Hayley Osman
Missouri State University
Advisor: Dr. Robert Mayanovic

Abstract

Mesoporous materials, such as WO_3 and TiO_2, are of growing importance in potential applications in the energy industry due to high surface to volume ratio and high electrical conductivities. We investigate WO_3 as a candidate for femtosecond pulsed laser deposition to study the ordering of nanoparticles (NPs) in the deposition process. Fine WO_3 powder is utilized to enhance fusing within the sample and provide a favorable target under sintering conditions. Characterization techniques including Scanning Electron Microscopy (SEM), X-Ray Diffraction (XRD), Photo-Luminescence (PL), and Raman Spectroscopy will be used to determine the viability of the sample prepared.

Hayley Osman is completing her senior year as a physics major in the Department of Physics, Astronomy, and Materials Science at Missouri State University. She is originally from Festus, Missouri. Hayley has held summer research internships at Massachusetts Institute of Technology and CERN. This is her second year as an intern with the Missouri Space Grant Consortium. She plans to start graduate school this fall to pursue a Ph.D. in Materials Science and Engineering.

Stratigraphy and Morphology of Iazu Crater, Mars

Kathryn E. Powell
Department of Earth & Planetary Sciences
Washington University in St. Louis
Advisor: Raymond E. Arvidson

Abstract

Iazu Crater is a late-Noachian- or Hesperian-aged 6.8 km-diameter impact crater located ~25 km south of the Opportunity rover's current location at Endeavour Crater. Iazu was likely formed by a low-angle impact (20-30°). This interpretation is supported by the existence of collapsed wall sections in the otherwise simple bowl-shaped impact crater and the "forbidden zone" present in the ejecta pattern. The crater walls contain a record of pre-impact aqueous alteration in the region, in that a thick section of Burns formation sulfates unconformably overlie Noachian-aged basalts slightly altered to smectite. The sulfates exposed in this section are polyhydrated, with gypsum signatures dispersed throughout the section. We estimate that the Burns formation section exposed at Iazu is 250 m. We identify three spectral endmembers in CRISM data that correspond to basaltic ejecta materials excavated by the impact, sulfates on the crater wall, and Meridiani sands that are likely a mixture of Fe-bearing minerals including hematite.

Kathryn Powell is a second year graduate student in the Department of Earth and Planetary Sciences at Washington University in St. Louis. She studies ancient Martian environments using remote sensing.

Asteroseismology of Otho (KIC10001893)

Breanna Quick
Missouri State University
Advisor: Dr. Michael Reed

Abstract

NASA's Kepler spacecraft observed the same portion of the sky from March 2010 until April 2013. It only stopped for one day per month to transmit data back to Earth, providing a nearly uninterrupted stream of data for over 150,000 stars for nearly three years. Many of the stars in the field are pulsating stars and their brightness changes in a periodic manner in accord with their properties, mainly density. This paper reports the analysis of a compact pulsating star, Otho (KIC10001893), which shows variability with periods between 2 minutes and 5.3 hours. 128 periods were detected with maximum amplitudes of 5.6 parts-per-thousand. These periodicities were inspected for rotational multiplets, from which a spin period of 104+/-15 days is determined for the star. A second mode identification method is applied which searched for, and found, asymptotic overtone spacings. Using the properties we discovered, models can be constructed to infer the internal structure of this star.

Breanna Quick is a Senior at Missouri State University.

Modeling Forming Pressure for Annular Targets used to Produce Molybdenum-99 from Low-Enriched Uranium

Jerome Rivers
University of Missouri - Columbia
Advisor: Dr. Gary L. Solbrekken

Abstract

The purpose of this experiment is to test the accuracy of a model designed to predict peak forming pressure of annular targets based on draw plug size. The model used in this experiment was developed by using the results of previous experiments, which used draw plug sizes of 1.046, 1.047 and 1.048 inches. A draw plug size of 1.049 inches was used in this experiment. The model predicted a peak forming pressure of 556 psi. Meanwhile, the peak pressure observed during the physical experiment was 354 psi, resulting in an error of approximately 36%. These results suggest that the model developed with a single independent variable is not sufficient enough to characterize the outputs and that the model must be adjusted to account for other variables that are impacting the results.

Jerome Rivers and is a Master of Science candidate in the Mechanical and Aerospace Engineering Department at the University of Missouri - Columbia. Jerome is from St. Louis, MO and is currently involved in research in the area of heat transfer and thermal design. Although he is focused on finishing his Master's degree in the spring of 2016, Jerome is considering pursuing a PhD shortly after.

The Role of Spheroids in the Evolution of Massive Galaxies During 0.6 < z < 2.5 in the CANDELS UDS and GOODS-S Fields

Zachary Rizer[1], Daniel H. McIntosh[1], Joshua Cook[1], Jeyhan S. Kartaltepe[2], Anton M. Koekemoer[3], Arjen van der Wel[4], Stijn Wuyts[5], Eric F. Bell[6], Christopher J. Conselice[7], Dale Kocevski[8], Guillermo Barro[9], David Koo[9], + CANDELS Collaboration[10]

[1]University of Missouri - Kansas City, [2]National Optical Astronomy Observatory, [3]Space Telescope Science Institute, [4]Max Planck Institute for Astronomy, [5]Max Planck Institute for Extraterrestrial Physics, [6]University of Michigan, [7]University of Nottingham, [8]Colby College, [9]University of California - Santa Cruz, [10]Varied

Advisor: Dr. Daniel McIntosh

Abstract

Spheroidal galaxies are linked to the observed buildup of massive non-star-forming (quiescent) galaxies over cosmic time. Yet, it remains unclear whether the primary growth channel involves the formation of new bulge-dominated galaxies followed by the quenching of star formation (SF), or the cessation of star production preceded by the transformation from disk-dominated to spheroidal galaxies. Using a new comprehensive catalog of visual classifications based on the HST/WFC3 imaging from the Cosmic Assembly Near-infrared Deep Extragalactic Legacy Survey (CANDELS), this work studies the nature and evolution of high-mass (M_{star} > 1e10 M_{sun}), ‘spheroids’ (elliptical and bulge-dominated galaxies) over a wide redshift range (0.6<z<2.5) in the Ultra Deep Survey (UDS) and the Great Observatories Origins Deep Survey South (GOODS-S) fields. These spheroids are rounder, smaller and more centrally-concentrated than visually disk-dominated galaxies. Using either rest-frame UVJ colors or total SF rates (IR + UV) when available, a clear increase in the fraction of high-mass galaxies that are quiescent spheroids with decreasing redshift is found, accompanied by a relatively constant low fraction (10-25%) of star-forming spheroids at z>1, and a possible drop to lower fractions at z<1. Quantitatively similar results using spheroid samples defined solely or jointly by automatic (Sérsic n>2) selection are found as well. It is discovered in this work that as the high-mass galaxy population becomes more quenched, it also becomes more dominated by spheroids with very few quiescent disks (<10%) at any redshift. Taken together, these results are consistent with a scenario in which new spheroids were continuously added and subsequently quenched, and inconsistent with an evolutionary process that primarily added newly quenched disks. The actual picture likely includes contributions from multiple channels and requires detailed modeling to better constrain the relative amounts from each.

Zachary Rizer is a graduate student at the University of Missouri – Kansas City.

Volatile Composition of Comet C/2012 K1 (PanSTARRS)

Nathan X. Roth
University of Missouri – St. Louis
Advisor: Dr. Erika Gibb

Abstract

Comets are among the most primitive remnants from the formation of the Solar System. The chemical compositions of cometary nuclei relate to the makeup of the midplane of the protoplanetary disk where they formed. Understanding the chemical composition of cometary nuclei is integral to understanding the chemical processes of the early Solar System and how it has evolved in its ~4.5 billion year lifetime. Additionally, comets may have served as an exogenous reservoir for water on Earth, a crucial ingredient for the formation of life. Presented are near-infrared, high resolution ($\lambda/\Delta\lambda \sim 25{,}000$), spectroscopic data of the comet C/2012 K1 (PanSTARRS) gathered in 2014 using NIRSPEC at the Keck II telescope on Mauna Kea, HI. C/2012 K1 was a dynamically new Oort cloud comet on its first voyage into the inner Solar System. Presented are fluorescent emission spectra of water and volatiles in the cometary coma and fits of spectroscopic models to the data, from which rotational temperatures and mixing ratios are determined.

Nathan X. Roth is a graduate student in the doctoral program in the Department of Physics & Astronomy at the University of Missouri – St. Louis. After completion of his Ph.D., he intends to become a Professor of Physics and continue research in astrophysics and cosmology alongside teaching.

Shape Optimization of an Axisymmetric Blunt Body in Hypersonic Flow for Reducing Drag and Heat Transfer

Christopher Seager
Department of Mechanical Engineering & Materials Science
Washington University in St. Louis
Advisor: Ramesh Agarwal

Abstract

A large design concern for high-speed vehicles such as next generation launch vehicles or reusable spacecraft is the drag and heat transfer experienced at hypersonic velocities. In this paper, the optimized shapes for minimum drag and heat transfer for an axisymmetric blunt body are developed using computational fluid dynamics (CFD) software in conjunction with a genetic algorithm (GA). For flow field calculations, the commercial flow solver ANSYS FLUENT is employed to solve the unsteady compressible Reynolds Averaged Navier-Stokes (RANS) equations in conjunction with the SST k-ω turbulence model. The hypersonic body shape is optimized using a multi-objective genetic algorithm (MOGA) to minimize both the drag and heat transfer. The MOGA creates a Pareto-optimal front containing the optimized shapes for various relative objectives of minimized drag and heat transfer. The results show a significant decrease in both the drag and heat transfer and exhibit the expected changes in the body profile. It should be noted that such results on shape optimization of a blunt body in hypersonic flow for reducing both drag and heat flux are reported in this paper for the first time in the literature. The proposed methodology will allow the simulation and optimization of more complex shapes for hypersonic vehicles.

Chris Seager is a senior B.S. student in the department of Mechanical Engineering and Materials Science at Washington University in St. Louis. He will graduate in May 2015 and then work for Boeing – St. Louis

Growth and Characterization of Two-Dimensional Materials: $NbSe_2$ and WSe_2

Austin Shearin
Missouri State University
Advisor: Kartik Ghosh

Abstract

Thin films of two-dimensional transition metal dichalcogenides, $NbSe_2$ and WSe_2, were synthesized using a pulsed laser deposition system. The films were characterized using Raman spectroscopy and X-ray diffraction (XRD). XRD results demonstrate uniformed films were obtained on the substrates. Peaks corresponding to the superconducting structure for $NbSe_2$ were seen in the XRD spectra and Raman results show characteristic peaks (A_{1g} and E_{2g}) corresponding to the superconducting structure 2H-$NbSe_2$.

Austin Major Shearin was born and raised in Springfield, MO. He attends Missouri State University and is working on his masters in materials science in the physics, astronomy, and materials science department. He got his bachelors of science in physics at Missouri State University. He graduated Magna Cum Laude in his class from the honors college. Ever since Austin was a kid, he dreamed of going into scientific research as a career and has pursued that dream ever since.

Feasibility of a Kalman Filter to Estimate Pump States

Tyler Shinn
University of Missouri – Columbia
Advisor: Dr. Roger Fales

Abstract

This paper outlines a method estimating states of a pump, given pressure measurements. The method to predict the nonmeasured states is a linear Kalman filter. The pump's 8^{th} order, nonlinear model has been linearized about the steady state operating conditions and then given a small disturbance to all the states to compare to the linear model with the same perturbations. After reducing the model to 6^{th} order, reducing the extremely fast states, relative to the other, it is demonstrated that a Kalman filter is capable of estimating all the states accurately in less than 3 seconds.

Tyler Shinn was born in Quincy, Illinois. He is currently at the University of Missouri – Columbia in the Mechanical and Aerospace Department. By the conclusion of the summer of 2015, he will have completed an MS in Mechanical Engineering. In the fall of 2015, he will begin pursuing a Doctorate in Mechanical Engineering, also at the University of Missouri – Columbia. His Master's thesis is on a robust controller design for a solar steam gasification reactor. The Doctoral work is the focus of this article – predicting states of a pump, initially using a Kalman Filter. Once done with his Doctorate, Tyler is going to pursue work in industry, in opportunities specifically related to mathematically modeling and simulating systems. Working with academia is another one of his interests.

Hollows on Mercury: New High Resolution Images Allow for More Detailed Analysis

Amanda Stadermann
Washington University in St. Louis
Johns Hopkins Applied Physics Laboratory
Advisors: Nancy Chabot, Dave Blewett

Abstract

MESSENGER is NASA's Discovery mission to Mercury and produces a large library of images, spectra, and laser altimeter measurements of Mercury. MESSENGER's recent Low-Altitude campaign has allowed for higher resolution images of the surface of Mercury. Hollows are relatively young, irregularly shaped depressions with bright halos and interiors, often found in or around craters; hollows are found only on Mercury The goal of this study is to vastly increase the catalog of hollows images and locations. With higher resolution images available, an increased number of hollows can be seen with increasing detail. We examined more than 21,000 images from the MESSENGER spacecraft and identified more than 500 images of hollows. With these images, we were able use the lengths of the shadows to calculate the hollows' depths. These hollows were categorized based upon their geographic location and global distribution. The locations of the hollows have been compared with pre-existing compositional maps and preliminary temperature maps. These comparisons have proved ineffective due to the size difference between the hollows (several km across) and the pixel size of these maps (hundreds of km across).

Amanda Stadermann is originally from St. Louis, MO. She is currently a junior studying geophysics at Washington University in St. Louis in the Department of Earth and Planetary Science. During the school year she doeslunar research with Brad Jolliff. Additionally, she is on the Washington University varsity swimming and diving team, and was an All-American in 2014.

Summer 2014 Scarecrow Testing: Dumont Dunes and Force Torque Sensors

Nathan Stein
Department of Earth and Planetary Sciences
Washington University in St. Louis
Jet Propulsion Laboratory

Advisor: Matthew Heverly, Mobility Systems Engineer, Curiosity Mars Rover
Jet Propulsion Laboratory, California Institute of Technology

Abstract

The Scarecrow test rover was taken to the Dumont Dunes, CA to better characterize rover performance in sand. Tests on artificial sand ripples yielded ~80-95% rover slip for forward and backward drives, which varied primarily as a function of rover position and ripple geometry. Force torque sensors were installed on three of Scarecrow's wheels and the rover was driven over a variety of obstacles to test new driving algorithms for minimizing wheel wear. The force torque sensors were integrated with Scarecrow's PC104 stack to allow data to be read directly to Scarecrow's log files in the future.

Nathan Stein is a senior at Washington University in St. Louis double majoring in physics and geophysics. Since his freshman year at Washington University he has worked in the laboratory of Raymond Arvidson on problems relating to Curiosity terramechanics and CRISM image processing. He hopes to attend graduate school in planetary science. He has no hobbies, as that would imply that he has free time, but nevertheless enjoys biking and watching bad movies.

Proper Motions in a Young Stellar Cluster

Timothy Sullivan
University of Missouri-St. Louis
Advisors: Bruce A. Wilking, University of Missouri-St. Louis
and Frederick J. Vrba, U. S. Naval Observatory, Flagstaff Station

Abstract

We investigate the potential differences between velocity dispersions in protostellar cores and the velocity dispersions of the embedded cluster members that form from them. Using proper motion data obtained at the USNO in Flagstaff, AZ we have calculated a velocity dispersion for the Rho Ophiuchi embedded cluster to be about 1.0 km s^{-1}. This is shown to be significantly higher than the velocity dispersion of the dense cores of the cluster as measured by André et al. in 2007.[1] Similar results have been found recently for NGC 1333 by Foster et al.[2] When we break our sample up by evolutionary state we see that there may be evidence of higher velocity dispersions in more evolved YSOs, although this is still inconclusive given our sample size. We discuss various physical phenomena that could be responsible for the differences observed in the velocity dispersions of embedded clusters and their dense cores.

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

New Compositional Data for Apollo 12 Samples 12013 and 12033: Insights into Proto-Lithologies

Sarah N. Valencia
Department of Earth and Planetary Sciences
Washington University in St. Louis
Advisors: Bradley. L. Jolliff, Randy. L. Korotev

Abstract

Apollo 12 sample 12013 is a dimict impact breccia composed that has traditionally been described as a two-component system, a black breccia and a gray breccia. New compositional data by INAA (instrumental neutron activation analysis) show that 12013 is better characterized as a three component system: a granitic component, an REE-rich (rare earth element) component and a mafic component. This three-component system is not obvious in thin section. The purpose of this work is to examine the chemical components of 12013 and provide insights into its protolithologies, thereby examining the relationship between granite and KREEP (potassium-, rare earth element and phosphorus-rich component in lunar samples). In addition, this work aims to examine the composition of 12033 and its relationship to regolith (soil) sample 12013.

Sarah Valencia grew up in South Lyon, Michigan. She attended the University of Michigan, Ann Arbor and received a bachelor's degree in geologic sciences. Currently, she attends Washington University in St. Louis where she is a third year graduate student in the Earth and Planetary Sciences department. Her focus is on evolved volcanic lunar rocks, particularly the NWA 773 clan and Apollo 12 granitic samples.

An LMI-Based Hedging Approach to Model Reference Adaptive Control with Actuator Dynamics

Benjamin C. Gruenwald, Daniel Wagner
Advanced Systems Research Lab – Missouri S&T
Advisor: Dr. Tansel Yucelen

Abstract

Although model reference adaptive control has been used in numerous applications to achieve system performance without excessive reliance on dynamical system models, the presence of actuator dynamics can seriously limit the stability and the achievable performance of adaptive controllers. In this paper, a linear matrix inequalities-based hedging approach is developed and evaluated for model reference adaptive control of uncertain dynamical systems in the presence of actuator dynamics. The hedging method modifies the ideal reference model dynamics in order to allow correct adaptation that does not get affected due to the presence of actuator dynamics. Specifically, we first generalize the hedging approach to cover cases in which actuator output and is known and unknown. We next show the stability of the closed-loop dynamical system using tools from Lyapunov stability and linear matrix inequalities. Finally, an illustrative numerical example is provided to demonstrate the efficacy of the proposed linear matrix-inequalities-based hedging approach to model reference adaptive control.

Daniel Wagner is a researcher at the Advanced Systems Research Lab. After receiving his BS at the University of Colorado at Boulder, he joined as a MS/PhD candidate here at Missouri University of Science and Technology. His topics of interest are adaptive controllers, optimization, and multi-agent systems. Daniel is a Chancellor's Fellow and a recipient of the NASA MOSGC award, and is attending the Air Force Research Lab this summer as a graduate researcher. He intends to continue his research within the field of aerospace after graduating in May of 2017.

The Lipid Profiles of Sulfate Reducing Bacteria During Growth on Different Electron Donors

Claire Wallace
Washington University in St. Louis
Advisors: Alex Bradley & Wil Leavitt

Abstract

In this study we examine the effect of different carbon sources on the metabolism of model sulfate reducing bacteria, strains of *Desulfovibrio alaskensis* G20. The growth rate, lipid profiles and hydrogen isotopic compositions (D/H) of the lipids are characterized from cultures grown on four different C sources, produced by three different strains of *D. alaskensis* G20. These strains are the parent Wild Type (WT) and two mutants in the electron bifurcating transhydrogenase, Dde1250 and Dde1251. These observations help develop our understanding of the carbon and energy metabolism during microbial sulfate reduction, and the roles that different electron donors play in determining the H-isotopic composition of bacterial fatty acids—compounds that are stable in the geological record.

Claire Wallace grew up in Moscow, Russia, and in Houston, Texas, prior to her move to St. Louis for her career at Washington University in St. Louis. She is working her way towards a Biology major with a concentration in Biochemistry as well as a minor in Entrepreneurial Studies. She enjoys rock climbing, running, and cooking and hopes to continue with a career in research and development. Once complete, the work herein will be submitted to a peer reviewed journal such as Organic Geochemistry or Geochimica et Cosmochimica Acta with C. Wallace as author.

Structure-Activity Study of Hydrazide Derivatives of Quinonoidal Compounds

Kayle Weghorst
Lincoln University of Missouri
Advisor: Zahra Afrasiabi

Abstract

Planar, polycyclic and aromatic hydrocarbon ligands such as ortho-quinone semicarbazones/thiosemicarbazones and their transition metal complexes have been synthesized and structurally characterized. The in vitro antiproliferative activity of these compounds against five human cancer cell lines revealed that they were effective against androgen receptor-positive/negative prostate cancer cells as well as COX-positive pancreatic BxPC-3 cancer cell line. The driving force behind such antiproliferative activity seems to be the up-regulated COX expression in these cells, which was amenable for targeting through metal complexation.

Kayle Weghorst is a Sophomore from Holts Summits, MO, and is studying Chemistry at Lincoln University of Missouri.

Using WISE to Find Obscured AGN Activity in SDSS Mergers & Interactions

Madalyn E. Weston, Daniel H. McIntosh, Xiachang Her
University of Missouri – Kansas City
Advisor: Daniel H. McIntosh

Abstract

In simulations, major encounters between gas-rich galaxies are predicted to drive gas to the centers of interacting and merging systems triggering new star formation (SF) and fueling an active galactic nucleus (AGN). Depending on the rate of SF, large amounts of obscuring dust can make detection of merger-induced activity difficult and may be at the heart of the ongoing merger-AGN connection debate. To provide better constraints on the importance of obscured AGNs, this study uses data from the Wide-field Infrared Survey Explorer (WISE) for a comprehensive sample of over 1000 major galaxy interactions and ongoing mergers visually selected from the SDSS with 10^{10} $M_{\odot}$ and $0.01 < z < 0.08$. Using the [3.4]-[4.6] versus [4.6]-[12] micron color-color plane, we find that 2 – 9% of mergers (and 1.0 - 2.5% of interactions) have unusually red [3.4]-[4.6] micron colors, which are associated with dust-obscured (Type-2) AGNs. We note that mergers are 5 - 18 times more likely to host a buried AGN than normal galaxies. This increased likelihood of dusty AGN activity in mergers and interactions supports an AGN-merger connection. We investigate the nature of merging and interacting galaxies with dusty AGN. Using SDSS urz colors to distinguish quiescent from star-forming galaxies, we find that more than three-quarters of this subpopulation are forming stars. Our findings indicate a strong association between ongoing star formation and dust-enshrouded black hole growth in merging galaxies as predicted in the modern merger hypothesis.

Madalyn Weston was born in 1989 in Independence, Missouri. Upon graduation from high school, she completed her Bachelor of Science degree in Physics at the Missouri University of Science & Technology. She continued her education in the Department of Physics and Astronomy at the University of Missouri – Kansas City. While attending UMKC, she presented her work at many conferences, including the 223rd and 225th American Astronomical Society meetings and the WISE@5 Conference at Caltech in Pasadena, CA. She will graduate with her Master of Science degree in Physics in May 2015. After graduation, she plans to pursue a career in science education.

Capturing the Stopping Energy of an Automobile

Julie Wisch
University of Missouri-Columbia
Advisor: Noah Manring

Abstract

The purpose of this paper is to explore the feasibility of designing a hydraulic system to capture the kinetic energy that is dissipated by stopping vehicles. A cabled system utilizing flywheels, hydraulic pumps, and hydraulic accumulators has been designed, the details of which are outlined in this paper. This cabled system has the capacity to store 1.33 W per compact car stopped, which becomes significant when considering the sheer volume of vehicular traffic on any given day in the United States. In the city of Los Angeles, applying this technology to all intersections that experience traffic volumes of greater than 20,000 cars per day could generate the equivalent of 5.94 MW.

Julie Wisch is a PhD candidate at the University of Missouri-Columbia in the department of Mechanical and Aerospace Engineering.

Data Extraction and Processing of NFAC Rotor Test Stand

Shannah Withrow
Missouri University of Science and Technology
Advisor: Dr. William Warmbrodt, Dr. Natasha Barbely, Mr. Eduardo Solis

Abstract

In August of 2014, Dr. Berend van der Wall from DLR Institute of Flight Systems in Braunschweig, Germany arrived at NASA Ames to participate in a three month sabbatical. The purpose of Dr. van der Wall's sabbatical was to study the effectiveness of the Rotor Test Apparatus (RTA) and Large Rotor Test Apparatus (LRTA). To prepare for his arrival, a model of the LRTA was imported from Rhino 5 into RotCFD in order to run computational fluid dynamic simulations on the test stands. The simulations were used to determine the fuselage induced velocities for different angles of attack in X,Y, and Z components and how the induced velocity from the test stand affects measurements collected at the tip of the rotor blades. Tecplot was used to assist in this analysis.

Shannah Withrow is a junior in Aerospace Engineering at the Missouri University of Science and Technology from Odessa, Missouri. She has had the privilege of working with NASA's Reduced Gravity Education Flight Program for two flights, as well as completing an internship in the Rotorcraft Aeromechanics division at Ames Research Center. She has received an invitation to return this summer to Ames as an intern. Shannah is the president of Miners in Space, a microgravity student research team, that is currently working with CASIS. She has contributed to many presentations and papers as a co-author or presenter. Some of these include the AIAA Region V Student Paper Conference 2013, SciTech 2014 (AIAA International Conference), the American Society of Gravitational and Space Research, and Gateway to Space 2014. She is actively involved in STEM outreach with grade school students. She is also actively involved in Sigma Gamma Tau aerospace honor society and Kappa Mu Epsilon mathematics honor society.

Development of a One-Equation Eddy Viscosity Turbulence Model for Application to Complex Turbulent Flows

Timothy Wray
Department of Mechanical Engineering & Materials Science
Washington University in St. Louis
Advisor: Ramesh Agarwal

Abstract

Computational Fluid Dynamics (CFD) is routinely used in the design and performance prediction of aircraft, turbomachinery, automobiles, and in many other applications where fluid flow is present. Over the last four decades, a great deal of progress has been made in prediction of a wide variety of turbulent flows using physical models based on the Reynolds-Averaged Navier-Stokes (RANS) equations, Large Eddy Simulation (LES) and Direct Numerical Simulation (DNS). Solving the RANS equations by modeling the turbulent stresses remains by far the most widely used approach for prediction of turbulent flows encountered in aerospace and other industrial applications. LES and DNS approaches are computationally very intensive and are at present impractical for routine 3D industrial applications. Although recent developments have extended the capabilities of many turbulence models for RANS equations, improvements are still needed in applications to complex turbulent flows. There is need to develop improved turbulence models for the RANS equations that can significantly increase the accuracy of flow simulations for separated flows, rough wall flows, flows with rotational and curvature effects, and high temperature flows. In this paper, we describe a newly developed one-equation eddy viscosity turbulence model, the Wray-Agarwal (WA) turbulence model and its extensions for computing separated flows, rough wall flows, and flows with rotational and curvature effects. To demonstrate the effectiveness of the new WA model, it is compared against the industry standard Spalart-Allmaras (SA) and SST k-ω models for turbulent flow for several canonical subsonic, transonic, and supersonic flow cases. Flow over a smooth and rough S809 airfoil is also examined. It is demonstrated that the WA model performs better than SA and SST k-ω models in most cases. It is anticipated that the WA model will provide the industry and turbulence modeling researchers a much needed alternative for accurate and reliable computation of a large class of complex turbulent flows.

Tim Wray is a doctoral student in the department of Mechanical Engineering and Materials Science at Washington University in St. Louis. He is originally from Champaign, Illinois. Before moving to St. Louis, he received his Bachelor's Degree in Mechanical Engineering from the University of Illinois at Urban-Champaign.

Hierarchical Cupric Oxide Structure Effect on the Thermal Performance of the Oscillating Heat Pipe

Feng Zhang
University of Missouri - Columbia
Advisor: Hongbin Ma

Abstract

With a surface treatment of hydrophilic CuO nanostructures on the channels inside a flat plate oscillating heat pipe (FP-OHP), the wetting effect on the thermal performance of a FP-OHP was experimentally investigated. Three FP-OHP configurations were tested: 1) evaporator treated, 2) condenser treated, and 3) untreated. Both evaporator- and condenser-treated FP-OHPs show significantly enhanced performance. The greatest improvement was seen in the condenser treated FP-OHP, a 60% increase in thermal performance. Neutron imaging provided insight into the fluid dynamics inside the FP-OHPs. These findings show that hydrophilic nanostructures and their placement play a key role in an OHP's performance.

Feng Zhang is a doctoral candidate at the University of Missouri – Columbia.

Miners in Space:
Testing of Active Compression-Decompression Cardiopulmonary Resuscitation (ACD-CPR) in Microgravity

Jill Davis, Jaykob Maser
Missouri University of Science and Technology
Advisor: Dr. Henry Pernicka

Abstract

In collaboration with NASA's Reduced Gravity Education Flight Program, the effectiveness of ACD-CPR was compared to traditional CPR in a microgravity environment. Elements compared included fluid flow output in a simulated chest cavity, depth and rate of compressions achieved, time required for implementation, and feasibility to perform compressions. ACD-CPR varies from traditional CPR in that it uses a small, mechanical device, similar to a suction cup, to raise the chest wall after compression, allowing decompression of the chest. Testing showed that rate and compression standards established by the American Heart Association could be reached doing ACD-CPR in microgravity. Flow data showed that the fluid flows similarly in a 0g environment as in a 1g environment. Average time required for implementation was reduced from two minutes, at which point brain damage is likely, to twenty-five seconds. Greater efficiency in medical emergency procedures will be crucial for long-term missions.

Jill Davis is a sophomore in Aerospace Engineering. She is currently a member of the research team Miner's in Space and a Project Lead for Missouri S&T's Advanced Aero Vehicle Group. She is enrolled in the Honors Academy and is an alumni of the Chancellor's Leadership Academy.

Jaykob Maser graduated with a Bachelor of Science with Honors in Physics in December 2014. He is now pursuing a PhD in Aerospace Engineering at the Missouri University of Science and Technology. Jaykob pushed the boundaries of his education through the Honors Program by pursuing difficult projects both within and outside the scope of his courses. One such project was the successful construction and test of a nuclear reactor for his Advanced Physics Lab. He has also published an article about atom-fullerene-hybrid photoionization in the Journal “Physical Review A.”

Missouri S&T Satellite Research and Design Team

Yezad Anklesaria and Pavel Galchenko
Missouri University of Science and Technology
Advisor: Dr. Henry Pernicka

Abstract

The Missouri University of Science and Technology Satellite Research team (M-SAT), in conjunction with a number of AFRL/NASA/industry mentors, is working toward the design, construction, and launch of its first mission that place first January 2015 at the University Nanosatellite Program (UNP) competition. M-SAT consists of two microsatellites, named MR SAT (Missouri-Rolla Satellite) and MRS SAT (Missouri-Rolla Second Satellite). MR SAT will act as an inspector satellite while MRS SAT will simulate an uncooperative resident space object (RSO), and the two will perform proximity operations during flight. The goals of M-SAT are to test new technologies in support of missions involving proximity operations, including the study of an R-134a-based cold gas propulsion system for use in formation flying applications and the development of a stereoscopic imager sensor used to determine the real-time relative position/velocity vectors between the satellite pair. Data obtained during the close formation flight phase will be evaluated for the benefit of future missions.

The associated Balloon Satellite program is designed to help students develop test bed platforms that are then flown to altitudes beyond 80,000 ft. via hydrogen-filled balloons. Students learn how to develop a mission goal and plan, integrate components and solder electronics to an existing microcontroller platform, program the system to run instrumentation and log data acquisition, and finally execute the mission through a high altitude balloon launch. The skills learned through this program helps mitigate the learning curve in joining the M-SAT team as well as providing skills needed in the industry. A summer camp for high school students was offered summer 2014, and will be offered again this summer. Both camps quickly sold out, with enrollment of 30 students.

Yezad H. Anklesaria received the Diploma in Mechanical Engineering Shri Bhagubhai Maftlal Polytechnic, Mumbai, India. He then joined the undergraduate program in Aerospace Engineering at the University of Missouri-Rolla (now the Missouri University of Science and Technology) and received his bachelors of Science degree and Masters of Science degree in July of 2009 and May of 2012. He is currently pursuing a Doctorate of Philosophy in Aerospace Engineering at Missouri S&T. At Missouri S&T he has been active member of number of academic and community programs. He plans to pursue an active research career in the aerospace industry.

Pavel Galchenko is currently a second semester senior in the undergraduate program in Aerospace Engineering at Missouri University of Science and Technology and will be graduating in May 2015. He is currently enrolled to start the Masters of Science Program in Aerospace Engineering with a focus on Astrodynamics during Fall 2015. At Missouri S&T he has been an active member of a number of academic and community programs including M-SAT, Miners in Space, Engineers without Borders, and Advanced Aero Vehicle Group.

Mars Rover Design Team

Missouri University of Science and Technology
Advisor: Dr. Melanie Mormile

Abstract

The Mars Rover Design Team (MRDT) has shown incredible growth since its founding just three years ago. The first year the team ending up having many technical issues and only being able to compete in half the challenges. The second year, the team placed 2nd internationally in the University Rover Challenge, and was 1st place within the United States. This year the team has worked extremely hard in order to make the third competition the most successful yet.

The mechanical sub-team has been iterating on the successful design from last year in order to make the rover as strong and light as possible. The group has been working with carbon fiber composites in order to achieve these goals as efficiently as possible. An unmanned air vehicle (UAV) has also been designed in order to assist the rover in longer range challenges.

Power sub-team has branched out into using different batteries than in past designs. By using lithium polymer cells rather than lithium ion, the team has again saved weight, while also gaining more experience into battery management. The lithium polymer cells have a custom designed battery management software that is needed in order to keep them working at optimal, and safe, levels.

The science sub-team, the newest addition to the team, has been very successful at preparing for this year's competition. Their purpose is to design and execute an experiment on the rover in order to prove the existence of life on the competition grounds. The team has been working hard on implementing spectroscopy onboard to be able to analyze anything they may come across.

Enhancing the Multidisciplinary Astrobiology Research Community at Truman State University

Tyler Gardner, Trevor Leighton, Charlyn Ortmann, Nathan Scott, and Neal Thompson
Truman State University
Advisors: Dr. Laura Fielden and Dr. Vayujeet Gokhale.

Abstract

Faculty and undergraduate students at Truman State University continued the activities of the Multidisciplinary Astrobiology Research Community and introduced new interdisciplinary educational opportunities for Truman students. We established a collaboration with Dr Neil Sargentini at ATSU, Kirksville in an attempt to include other local institutions in our astrobiology related activities. Four teams composed of one faculty and one or two undergraduate students pursued astrobiology research projects and participated in weekly community-building events. These projects supported the activities of the astrobiology research program at Truman, strengthened the Center for Astrobiology, and inspired students from a range of science disciplines to consider careers in astrobiology. A total of five students and three faculty members from Biology, Chemistry, and Physics participated in activities sponsored by this project.

Tyler Gardner is a Senior at Truman State University. He is pursuing a Physics degree with minors in Mathematics and Astronomy. This is his second year doing research with Dr. Vayujeeet Gokhale in the Astrobiology program, and he is eager to continue doing more work in this field.

Trevor Leighton is a Junior Chemistry major at Truman State University. He is considering a double major with Biology. He was born in Elkhart, IN and grew up in St. Louis, MO. This is his second year working in the Astrobiology program under the direction of Dr. Laura Fielden. He learned of this opportunity through his attendance of a biology seminar at which students presented their research.

Charlyn Ortmann is a Junior Physics major at Truman State University. She is a McNair scholar interested in pursuing astronomy and astrophysics in graduate school. This is her first year working in the Astrobiology program under the direction of Dr. Vayujeet Gokhale.

Nathan Scott is a Sophomore at Truman State University. He grew up in Chapel Hill North Carolina. He is a Biology Major with a minor in Chemistry. This is his second year working in the astrobiology program under the direction of Dr. Vayujeet Gokhale and Dr. Laura Fielden. He learned about the opportunity through his freshman level biology class.

Neal Thompson is a Sophomore at Truman State University. He is a physics and chemistry double major. He plans to continue with astrobiology/astronomy research in the future.

The Golden Age of Exoplanet Discovery

Dr. Peter Plavchan
Missouri State University

Abstract

Over 1800 exoplanets have been confirmed to orbit other stars over the past 25 years. This revolution in our understanding of our Universe is driven by a multitude of advances in data analysis techniques and engineering to achieve unprecedented precision and accuracy. Primarily, I utilize the Doppler method to detect the wobble of stars from the gravitational acceleration of unseen exoplanets. I will provide an overview of the technique, its promise and pitfalls. I will conclude with describing two new projects to build autonomous arrays of smaller telescopes to make cost-optimized use of the Doppler method.

Dr. Plavchan is an assistant professor at Missouri State University. He is a 2006 graduate of the University of California, Los Angeles, with both an MS degree and PhD in Physics. Prior to coming to Missouri State, he was a research scientist at the NASA Exoplanet Science Institute at Caltech. His research interests include extrasolar planets, M dwarfs, debris disks, and primordial disks. Peter is an executive committee member of the NASA Exoplanet Program Analysis Group.

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