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MISSOURI SPACE GRANT

CONSORTIUM

Preface

This volume contains the abstracts of 37 technical research reports that were written and presented by graduate, undergraduate, and high school students supported by the NASA-Missouri Space Grant Consortium. The primary purpose of the Consortium is 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 sponsoring, mentoring, and training students to perform independent research, as well as supporting student lead research group and design team activities. This year's Annual Spring Meeting was held at the Missouri University of Science and Technology on April 19-20, 2013.

The Missouri Consortium of the National Space Grant College and Fellowship Program is sponsored by the National Aeronautics and Astronautics Administration and is under the direction of Ms. Diane DeTroye, National Program Manager. It is my pleasure to thank the Affiliate Directors of the Consortium: Dr. Mike Reed, Missouri State University; Drs. Frank Feng and Sudarshan Loyalka, 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, and Mr. John Lakey, St. Louis Science Center; for their outstanding merit in directing and coordinating Space Grant activities at their respective institutions. I would also like to thank our 2011-2012 Associate Directors Dr. Majed Dweik, Lincoln University of Missouri; Dr. Michael Swartwout, St. Louis University; Dr. Eric Patterson, Truman State University, and Ms. Tasmyn Front, St. Louis Challenger Learning Center 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 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,

Fathi Finaish, Director
NASA-Missouri Space Grant Consortium

Table of Contents

Generating Electricity using Thermoelectric Generators

Cedric Rashad Bailey
University of Missouri - Columbia
Advisor: Dr. Zaichun Frank Feng

Abstract

The goal of this experiment is to maneuver thermoelectric generator around so that it can produce a large amount of electricity to charge a small electrical device (such as a cell phone.) A thermoelectric generator is a device which converts heat directly into electrical energy. Thermoelectric generators likewise can be used as thermocouples. Thermocouples use rare-earth metals (chromium, aluminum, nickel, etc), usually in pairs. As these metals heat up, they react with one another and one metal sheds off an electron, which is then seen as electricity. The ignition source for this experiment would be using a flame or starting a flame. Once this application is completed a voltage and current can be created.

Cedric Rashad Bailey is from Dallas, Texas, and a senior at the University of Missouri – Columbia; majoring in Mechanical & Aerospace Engineering. He is also pursuing a minor degree in East Asian Studies (Emphasis in China). He is a Bill & Melinda Gates Millennium Scholar and graduated in the top 5% of his High School graduating class. He has also taught an engineering summer camp at a high school in Cape Town, South Africa. His future career goals are to graduate and work for an engineering firm such as Boeing or Lockheed Martin. He would also like to play the double bass and cello for a professional symphony orchestra.

University of Missouri- St. Louis Planetarium Outreach Program

Anamaria Baluyut
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 fifth grade students and aims to stimulate critical thinking and encourage student interest in space, science, and engineering. It consists of a planetarium presentation and a classroom presentation with demonstrations and science related activities. Attendance numbers were very low for this year's program, and efforts will be made to contact schools earlier in the academic year along with considering other options of advertising the program.

Anamaria Baluyut is a graduate student in the Department of Physics and Astronomy at the University of Missouri- St. Louis. She comes from O'Fallon, Missouri and hopes to obtain her PhD in astrophysics.

Connecting Trace Metal Partitioning and Isotope Fractionation during Fe(II)-Catalyzed Recrystallization of Fe(III) Oxide Minerals

Katherine G. Becker
Washington University in Saint Louis
Advisor: Dr. Jeffrey G. Catalano

Abstract

Fe(III) oxide minerals are abundant in natural systems. Biogeochemical iron redox cycling often creates conditions where aqueous Fe(II) and solid Fe(III) oxide minerals coexist and can undergo a series of secondary, abiotic reactions involving oxidative Fe(II) adsorption, electron transfer through the mineral, and reductive dissolution of Fe(III) at a spatially separate surface site. These reactions cancause complete self-recrystallization of crystalline, thermodynamically stable iron oxide minerals. During this recrystallization trace metals may be incorporated into or released from the iron oxide mineralstructure. Trace metals such as Zn and Ni are critical plant micronutrients, yet are also water and soil contaminants, and their isotopes are used as proxies for both modern and ancient systems. Therefore, understanding the processes that modify the availability and fate of trace metals and providing a foundation for using stable isotope ratios to identify the occurrence of metal incorporation in modern and ancient aquatic systems is essential.This study aims to identify trace metal isotope fractionations associated with iron redox cycling and to probe how various conditions effect the partitioning of trace metals and their isotopes during Fe(II)-catalyzed recrystallization of Fe(III) oxide minerals. XAFS spectroscopy will allow for the quantification of trace metal incorporation into Fe(III) oxide minerals which will then be coupled with mass spectrometer analyses to identify and explain isotopic fractionations observed during trace metal incorporation into Fe(III) oxide minerals. This paper presents proposed research and preliminary results demonstrating the importance of accounting for isotopic fractionations during iron redox cycling.

Katherine G. Becker is from Flower Mound, Texas. For her undergraduate education, she attended Southern Methodist University in Dallas, Texas, where she majored in Earth Sciences and Environmental Chemistry. After her graduation in 2008, Katherine became a staff research associate at the Scripps Institute of Oceanography in La Jolla, California where she applied stable isotope analyses of ice cores to paleo-climate reconstruction. In 2010, Katherine began graduate school at the University of Texas at Dallas and earned her MAT in science education in 2011. She taught high school Chemistry in Dallas, Texas until she began a doctorate program in the fall of 2012. She is currently a first year Ph.D. student studying with Professor Jeffrey Catalano in the Earth and Planetary Sciences Department at Washington University in St. Louis. Her focus is on trace-metal interactions with iron oxide minerals in the natural environment. Katherine's goal is become a professor in an Earth Sciences department

Quantitative Analysis of Infrared Spectra of Glasses

William Kevin Black (Lindbergh High School, St. Louis Mo)
Department of Earth and Planetary Sciences
Washington University
Advisor: Research Professor Anne M. Hofmeister

Abstract

To better constrain the presence of glass in the interstellar medium and other astrophysical environments, reflection and thin film absorption spectra of oxide glasses with various proportions of Mg, Si, Al, and Ca were collected, merged, and processed. Several procedures were developed and crosschecks were used to ensure that the values of reflectivity were absolute and that the thickness of the films were constrained. The efforts of this research reveal that reflectivity values are low and provide the optical functions (n and k) that are needed in radiative transfer models used in astronomy.

William Kevin Black graduated from Lindbergh High School in St. Louis Missouri.

Variations of Lithium Content and its Effect on Surface Area and Electrochemical Properties

Hope Bretscher
Department of Energy, Environmental, and Chemical Engineering
Washington University in St. Louis, 1 Brookings Drive, St. Louis, MO 63130
Advisor: Professor Richard Axelbaum

Abstract

Electric Vehicles (EV) and Plug-in Hybrid Electric Vehicles (PHEV) are becoming attractive alternatives to petroleum-powered vehicles because they can decrease the dependence of the transportation sector on petroleum. However, to electrify the transportation sector, we must improve the range of EVs and PHEVs. To make EVs and PHEVs a practical alternative to gasoline powered vehicles, lithium ion batteries must have a high energy density, should be inexpensive and safe. Layered-layered composites of $xLi_2MnO_3 \cdot (1\text{-}x) LiMO_2$ (where $0 \leq x \leq 1$ and M = Ni, Mn, Co) were developed as promising alternative cathode materials. This class of material shows improved safety, lower cost, less toxicity and higher practical capacities (close to300 $mAhg^{-1}$). However to make EVs and PHEVs a competitive option, cost must be reduced and capacity should be increased. A new spray pyrolysis synthesis was developed at Washington University in St. Louis as an alternative, aerosol-based synthesis method for production of lithium-transitional metal-oxides. Spray pyrolysis allows precise control of the stoichiometry and the purity of the powder. The effect of lithium content and annealing time on capacity retention of powders was studied. Using the Brunnauer-Emmett-Teller (BET) machine, we measured the surface area changes due to varying production conditions to correlate annealing time and lithium content with electrochemical performance. As annealing time increased, surface area decreased. According to the preliminary results, the capacity retention of the materials can only be affected slightly by extending the annealing heat treatment; however, annealing compromises the electrochemical performance.

Hope Bretscher is a second year physics major and human rights minor studying at the University of Chicago. She is originally from Ballwin, Missouri.

A Comparison of the Simulated Dynamics of Various Models Used To Predict Undeformed Chip Thickness in High-Speed Low-Radial-Immersion Milling Processes

Josiah A. Bryan
University of Missouri-Columbia
Advisor: Dr. Roger C. Fales

Abstract

Various models have been proposed to estimate the undeformed thickness of chips produced by a CNC milling tool, in order to calculate the forces acting on the tool. The choice of model significantly affects the simulated dynamics of the tool, thereby affecting the dynamic stability of the simulated process and whether or not chatter occurs in a given cutting scenario. Simulations of the dynamics of the milling process can be used to determine the conditions at which chatter occurs, which can lead to poor surface finish and tool damage. The dynamics of a traditional model and a more detailed numerical model are simulated here with particular emphasis on the differences in their chatter bifurcation points. High-speed, low-radial-immersion milling processes are simulated because of their application in industrial high-precision machining and because their bifurcation points can be easily verified by experiment.

Josiah Bryan graduated in December 2011 with an MS in Mechanical & Aerospace Engineering from the University of Missouri in his hometown of Columbia, MO. He is now pursuing a Ph.D. there in the same discipline. His Ph.D. research involves dynamics and controls for chatter prevention in milling processes under the guidance of Dr. Roger Fales. He hopes to finish coursework in May 2013 and complete the degree in May 2014.

Positive Displacement Fluid Flutter using Plate Strain Energy Deflection

Robert D. Chapman
University of Missouri – Columbia
Advisor: Dr. Frank Feng

Abstract

In nature, there exist highly evolved mechanical systems which exploit passive mechanical compliance and material property transients to impart hydraulic actuation and fluid motion. The human heart generates blood flow through periodic geometric chamber contraction and expansion. Delicate red blood cell corpuscles transport oxygen and nutrient requirements throughout the body. Applying a cyclical impulse pressure transient, the heart squeezes this incompressible fluid through the vascular network. No such current state fluid flow device exists that is capable of replicating nonlinear fluid particle motion without severely damaging the fragile oxygen-carrying red blood cells. A new type of pump mechanism is provided to demonstrate flow pressure and mass transport that can be utilized as to replicate the cardiac cycle fluid motion. The concept of fluid flutter using shell mechanical pre-compression strain energy is provided as a viable method for actuation of fluid particles in a nonlinear periodic cycle. Using commercially available software and implicit numerical solver schemes, a fluid-structural interaction problem is formulated. Simple flask container geometry is developed to illustrate symmetric chamber halves undergoing simultaneous fluid contraction and expansion. Passive valve actuation is employed as a means to regulate the induced fluid chamber ejection pressure.

Robert D. Chapman is a Master of Science Degree candidate at University of Missouri-Columbia.

Photometric Analysis of Nine 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 December 2012 a group of yellow supergiant and bright giant stars was observed with the 14-in. telescope and Apogee Alta u77 CCD camera at the Missouri State University Baker Observatory. The CCD images were calibrated to obtain the brightness of the program stars using differential photometry. To be certain of the variability, stars presumed to be constant stars of like spectral class were observed concurrently.

Philip Crouse is from Columbia, Illinois. He is a junior student of physics, astronomy, and mathematics at Missouri State University.

Close Spacecraft Proximity Operations Using Stereoscopic Imaging

Jacob Darling
Missouri University of Science and Technology
Advisor: Dr. Henry Pernicka

Abstract

The relative guidance, navigation, and control of a pair of spacecraft using real-time data from a stereoscopic imaging sensor are investigated. Because line-of-sight measurements from a single imager are typically insufficient for system observability, a second imager with a known baseline vector to the first imager is included to achieve system observability with the addition of relative range measurements. The stereoscopic imaging system as modeled provides measurements capable of achieving a complete navigation solution. An SDRE controller is used to provide closed-loop control to maintain a desired relative orbit. An Unscented Kalman Filter is used to estimate the chief spacecraft's inertial states using GPS measurements and the deputy spacecraft's inertial states with stereoscopic imaging relative position measurements. Close proximity operations using a stereoscopic imager are shown to be feasible using low-power, low-cost, commercial-off-the-shelf hardware aboard small spacecraft.

Jacob Darling is currently a doctoral graduate student in Aerospace Engineering at the Missouri University of Science and Technology. His research is focused in the areas of astrodynamics and estimation theory. He is the former Chief Engineer for the Missouri S&T Satellite research team, which is developing two flight-worthy microsatellites to perform visual-based proximity operations. He received his B.S. degree in Aerospace Engineering summa cum laude from Missouri S&T in 2011.

Comet C/2002 T7 (LINEAR): a Study of Methane

Matthew A Dennis
University of Missouri-St. Louis
Adviser: Dr. Erika Gibb

Abstract

Comets are thought to be a source for volatile compounds (such as methane and water) on Earth, providing components for oceans, atmospheres, and possibly life. We examine spectra taken from Comet C/2002 T7 (LINEAR) to determine production rates and abundances of methane present within the comet's ices. These observations will contribute to a growing catalog of chemical abundances within comets, which will in turn lead to a better understanding of the conditions in the early solar system and the origins of the complex chemistry found on Earth.

Matt Dennis grew up in and around the Greater St. Louis Area in Missouri. After a brief but very eventful time as a music major, and a brief but very uneventful time as a drafter, he decided that the time was right to fulfill a life-long desire: to earn a PhD in science. Matt is now making the most of his time at the University of Missouri - St. Louis, working closely with Dr. Erika Gibb on her comet research, and learning all he can about the origins of the universe. He still enjoys music, but only as a hobby.

Star Formation in the Serpens Main Cluster

Kristen Erickson
University of Missouri St. Louis
Advisor: Dr. Bruce Wilking

Abstract

We are working on a spectroscopic survey of an unbiased, extinction-limited sample of candidate young stars in the Serpens molecular cloud. While infrared and X-ray surveys of the cloud have identified many young stellar objects (YSOs), these surveys yield no information on the YSOs' ages and masses and the infrared studies have a bias against YSOs with little circumstellar dust. The goal of our study is to identify YSOs and to estimate their ages and masses, so that the star forming history of the region can be determined and to investigate disk evolution. We have obtained 346 optical spectra for candidate young stellar objects, used to confirm youth, determine effective temperatures and bolometric luminosities. Using these spectra, we have constructed a Hertzsprung-Russell (H-R) diagram to get a estimate of the stellar ages and mass. Results suggest that YSOs in this region have a median age of 2 Myrs and show an intrinsic age spread. This age spread may be the result of contamination due to foreground clouds.

Kristen Erickson is a graduate student at the University of Missouri St. Louis, in the Astronomy and Physics Department. She grew up on Ramstein Airforce Base in Germany. She received her undergraduate degree in Physics and Astronomy from the University of Arizona, Tucson. She is currently working on research in star formation. Her dissertation will focus on two star forming regions, Rho Ophiuchi and Serpens molecular clouds. She hopes to complete her Ph.D. and to continue with her research in Astronomy.

CFD Analysis of Open Rotor Engines Using an Actuator Disk Model

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

Abstract

In the world of transportation today, efficiency is essential and energy efficient systems are in high demand. Due to its high propulsive efficiency, an Open Rotor gas turbine engine has the potential to significantly minimize the specific fuel consumption and reduce CO2 emissions in a new generation of transport aircraft. In mid-1980's GE invested significant effort in advanced turbo-prop technology (ATP). The un-ducted fan (UDF) on a GE36 ultra high bypass (UHB) engine on MD-81 at Farnborough air show in 1988 created enormous buzz in the air transportation industry because of its fuel efficiency. However, in spite of its potential for 30% savings in fuel consumption over existing turbofan engines with comparable performance at speeds up to Mach 0.8 and altitudes up to 30,000 ft, for a variety of technical and business reasons, the advanced turboprop concept never quite got-off the ground. However, with current emphasis on "Green Aviation" NASA and aircraft engine industry (GE, Pratt-Whiney and Rolls-Royce) are investing significant resources in Open Rotor research and development for their deployment in next generation of single isle aircraft. The goal of this study is to develop a numerical model to study the performance of counter rotating open rotors (CROR). Advanced CFD studies using the unsteady Reynolds – Averaged Navier-Sokes (URANS) equations are quite complex and computationally intensive. Therefore as a first step, we have developed a simplified model based on Froude's actuator disk method to replace the two spinning rotors by two actuator disks. This method collapses the rotor blades into an infinitely thin plane with a discontinuous pressure jump across it to simulate the effects of the rotor. Applying this method to an axisymmetric configuration further simplifies the problem, allowing it to be solved quickly. The URANS computations for this model were performed using the CFD solver ANSYS- FLUENT. The results of computations have been compared using the wind tunnel data on F31/A31 CROR from NASA Glenn's Research Facility. A good agreement is found between the computed pressure distribution and the test data. Due to its simplicity the actuator disk method could be used in early design phases to understand the efficiency of a CROR engine.

Bryan Farrar graduated with a Master of Science degree in Aerospace Engineering from Washington University in St. Louis in December 2012. He is currently continuing research in CFD modeling of open rotor engines. He is originally from Philadelphia, Pennsylvania.

Simulation of Secondary and Separated Flow in a Serpentine Diffuser (S-Duct) for Air Breathing Propulsion

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

Abstract

The focus of this paper is on numerical simulation of compressible flow in a diffusing S-duct inlet. S-ducts are very common component of both commercial and military aircraft, for example the Boeing 727 and McDonnell Douglas F-18. The F-18, being a relatively small aircraft, requires a short, highly curved S-duct with non-uniform cross-sectional area. The S-duct decelerates the flow, increasing the static pressure, in order to provide a uniform velocity and pressure distribution at the engine face. The curved nature and increasing cross sectional area creates secondary flows and boundary layer separation which causes non-uniform flow and total pressure loss at the engine face. Total pressure loss and flow non-uniformity at the engine face reduce engine performance and cause increased wear on parts such as turbine blades. Engine stall is also a concern when the flow inside the S-Duct becomes highly distorted. An ideal S-duct would efficiently decelerate flow uniformly while minimizing total pressure loss and magnitude of transverse velocity components. Due to the necessity to minimize size and maximize stealth of aircraft, including Unmanned Aerial Vehicles (UAVs) and cruise missiles, designers are challenged to use shorter and more highly curved S-Ducts. The accurate modeling of flow in S-duct is therefore a problem of great interest and significance in propulsion. In this paper, we study the flow field in an S-duct by numerical simulations using the Reynolds-Averaged Navier-Stokes (RANS) equations in conjunction with a variety of two equations turbulence models such as k-ϵ and SST k-ω models. The geometry employed in this investigation is the one used in an experimental study conducted at NASA Glenn Research Center in the early 1990's. The CFD flow solver ANSYS-FLUENT is employed for computing the compressible flow inside the S-duct. A structured mesh is generated using GAMBIT. A second-order accurate steady density-based solver is employed in a finite-volume framework. The computed results compare well with the experimental data and with the computations of other investigators. The flow field and pressure recovery are captured with good accuracy.

Colin Fiola is a Master of Science student in Aerospace Engineering at Washington University in St. Louis. He earned his Bachelor of Science degree in Mechanical Engineering from the University of Missouri, Columbia in 2008. Colin is originally from Kansas City, Missouri.

Investigating the Pulsations of Subdwarf B Star KIC 3527751 (Samwise)

Heather Foster
Missouri State University
Advisor: Dr. M.D. Reed

Abstract

We present our findings on the pulsating Subdwarf B star Samwise (officially Kepler Input Catalog 3527751). We fit lightcurves and their corresponding Fourier transforms to identify significant frequencies and use those frequencies to determine the average periods for both l=1 and l=2 modes. Multiplet splittings and period spacings help us to assign mode identifications to 51% of pulsation periods. We determine average period spacings of 259 seconds for l=1 modes and 153 seconds for l=2 modes.

Heather Foster is from Springfield, Missouri, and is a sophomore in the College of Arts and Letters at Missouri State University. Her major field of study is Professional Writing and she is seeking a minor degree in Astronomy. Heather aspires to a career editing technical astronomy journals.

Monopropellant Exhaust Gas Manifold Study

Matthew S. Glascock
Missouri University of Science and Technology
Advisor: Dr. Joshua Rovey

Abstract

In the study of a dual-mode plasma space propulsion concept combining the benefits of chemical and electrical propulsion in a single monopropellant system, the observation of plasma formation in monopropellant exhaust gas mixtures is necessary. This demands a manifold system capable of delivering varying mixtures of N_2, CO_2, and H_2O into a vacuum chamber, and interfacing with the current laboratory experiment equipment. The approach to this requirement was to design a system that regulates the three gases separately and, using mass flow controllers, mix the three gases before injecting them into the chamber. This task proved trivial for the N_2 and CO_2 gases, yet more challenging for the mixing of gaseous H_2O. A number of hardware solutions were investigated in the interest of designing the least expensive system possible. A proof of concept for the water vapor delivery portion was constructed and tested. The result is a manifold system design meeting the requirements for testing and allowing for continued study.

Matthew Glascock is a Junior level student at the Missouri University of Science and Technology currently in pursuit of an Aerospace Engineering Bachelor's degree, with a minor in Physics. Matthew is from the town of West Plains, Missouri. He has enjoyed a very successful academic career thus far. Outside of the curriculum, Matthew is involved in the Missouri Satellite Project (M-SAT) student research team on campus at Missouri S&T, developing a small satellite. Matthew is also conducting undergraduate research under the advisement of Dr. Joshua Rovey in the space propulsion field in the Aerospace Plasma Laboratory on campus. He has plans to attend graduate school for a Masters degree in the Aerospace Engineering field following graduation in May 2014. His research interests lie mainly in the field of electric space propulsion, and its application to small satellites.

Machine Tool Chatter Internship

Joseph Gu
University of Missouri-Columbia
Advisor: Dr. Roger Fales

Abstract

Over the summer of 2012, I interned at a lab studying machine tool chatter, advised by Dr. Roger Fales. During my internship, I helped perform experiments and run an analysis program in order to process data into a usable format. The experiments gathered data on cutting forces. This data is used to form a model of the cutting forces and when tool chatter occurs. The purpose of the lab work is to initially create a better model of tool chatter and the forces involved, and eventually create ways to eliminate or prevent chatter.

Joseph Gu is a senior at Rock Bridge High School in Columbia, Missouri. After solidifying an interest in engineering during the 2012 FIRST Robotics Competition, he is pursuing a degree and career in mechanical engineering.

Searching for Interacting Early-Type Galaxies at Late Cosmic Times

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

Abstract

Major gas-poor (dry) mergers between two comparably massive spheroidal galaxies are postulated to be the central mechanism responsible for the assembly of giant elliptical galaxies. Numerical simulations predict that these mergers may occur at late cosmic times and typically in dense environments. Previous work using the SDSS Galaxy Group Catalog provided a lower limit to the frequency of interacting early-type galaxies (ETGs) as a function of group mass. Yet, the tidal signatures of such interactions may be too faint to be clearly detected in shallow SDSS data. To improve constraints, we investigate a unique sample of major ETG-ETG pairs that are both close in projection and redshift, belong to common group hosts, and yet lack signs of interaction according to an SDSS analysis. We have obtained V-band imaging 1.5 times deeper than SDSS for 23 pairs with redshifts $z \leq 0.12$ and combined stellar masses $M_{star} \geq 10^{11}$ M_{sun}. Using a tidal interaction parameter derived from GALFIT image residuals we identify interaction signatures in 17% of our sample. Our preliminary results indicate a higher frequency of interacting ellipticals at the centers of groups and clusters at late cosmic times.

Xiachang Her is a second year Master of Science degree student at the University of Missouri–Kansas City, majoring in physics. He has been working with Dr. McIntosh in his Galaxy Evolution Group since spring of 2010. Upon graduating in the fall of 2013, Xiachang would like to continue his education by pursuing a doctorate in astrophysics.

Molecular Simulations of Viral Leukemia Protein-RNA Interactions

Megan T. Hoffman and Wesley T. Hodges
Truman State University
Advisor: Dr. Maria C. Nagan

Abstract

Human T-cell leukemia virus type-1 (HTLV-1) infects around 10 to 20 million people worldwide, causing a variety of health problems including adult T-cell leukemia. Rex is a viral protein critical for the transition from early to late stages of the viral life cycle. Rex uses an arginine rich-motif to bind to a specific sequence of viral RNA known as the Rex Response Element (RxRE). An in vitro selected RNA aptamer of RexRE has a higher binding affinity to the Rex peptide than the wild-type RNA. Previous studies indicate that R7 and R13 participate in RNA-peptide water networks. The purpose of this study is to better understand the water network interactions with R7K and R13K Rex mutants. Complexes have been simulated under 200 mM KCl with explicit water molecules. The water networks are analyzed in these systems to determine if water binding decreases when R7 and R13 are changed to lysine.

Megan Hoffman is a senior biology major from Kansas City, MO. This is Meggie's first year working in the interdisciplinary astrobiology program at Truman State University, under the direction of Dr. Maria Nagan. She then plans to attend Mayo Graduate School next year in the Ph.D. Program for Biochemistry and Molecular Biology.

Wesley Hodges is a senior biology major from Liberty, MO. This is Wesley's first year working in the interdisciplinary astrobiology program at Truman State University, under the direction of Dr. Maria Nagan. He plans on attending graduate school in biochemistry upon graduation from Truman.

Maria Nagan is a professor of chemistry at Truman State University. She graduated with a BA in Chemistry from Grinnell College ('97) and a PhD in physical and biological chemistry from the University of Minnesota-Twin Cities ('01). Dr. Nagan is a member of the RNA Society and the American Chemical Society. She studies RNA recognition specifically the role of modified bases in protein translation, peptide-RNA recognition and overall RNA stability through quantum mechanical studies.

Structural and Electrical Properties of CVD and PECVD Grown Graphene

Michelle Langhoff
Missouri State Univeristy
Advisor: Kartik Ghosh

Abstract

There is a robust research effort on graphene due to its unique properties. In particular, graphene is predicted to have extremely high carrier concentrations. While the ultimate goal of this research is to study the electrical properties of graphene, a multistep process of research is required to reach the point at which it is possible to make the necessary measurements. Graphene is typically grown using chemical vapor deposition on a copper substrate: this substrate is currently considered to offer the best results. Unfortunately, this requires the transfer to alternate, non-conducting, substrates in order to effect electrical measurements. This work seeks to determine the optimal transfer process of graphene using Raman spectroscopy and analyzing the prominence of the defect peak. Preliminary electrical properties conducted using AFM showed linear behavior with no presence of n-type or p-type doping. Further electrical analysis is needed, including 4-probe resistivity measurements and Hall Effect measurements to determine carrier concentration. Additionally, it is planned to anneal the samples in different atmospheres: oxygen, nitrogen, and argon. Structural and electrical properties can then be assessed to determine if this process can be used to control defects and consequentially n-type and p-type doping of the graphene.

Michelle Langhoff is an MS student in Materials Science at Missouri State University in Springfield, Missouri. She has received numerous honors including being selected for a spotlight story on exceptional students at Missouri State University. Additionally, she had the opportunity to conduct research at the Air Force Research Laboratory courtesy of a grant from the American Society for Engineering Education and at Pune University courtesy of a grant from the American Physical Society. She is currently conducting research at Missouri State University funded by a grant from NASA and the Missouri Space Grant Consortium

Investigation of TiO_2 and Other Electrode Materials in Lithium-ion Batteries: Improving Capacity and Cycling Performance

Alyssa M. McFarlane, Dongxue Zhao, E.H. Majzoub
Center for Nanoscience, and
Department of Physics and Astronomy
University of Missouri, Saint Louis

Abstract

Two promising areas of research with respect to lithium ion batteries (LIB's) include (a) transition metal oxides, and (b) other high capacity Li-containing compounds that can serve as conversion reactions. Recent studies show that utilizing conversion reactions leads to greater capacities, and nano-porous carbons (NPCs) impregnated by materials such as metal oxides have yielded high reversible lithium storage capacities. A capacity of 600 mAh/g has been achieved using TiO_2 particles formed inside NPCs and lithium foil as a counter electrode. The sample was cycled at a constant current of 0.5 mA between .1 V to 4 V. Ordered mesoporous carbon-TiO_2 (OMCT65) was prepared by a basic polymerization method utilizing self-assembly and pyrolysis. Light metal hydrides are also attractive as conversion materials and may improve these results when used instead of metal oxides, as they have exhibited high lithium mobility. Ordered mesoporous carbon containing $LiBH_4$ particles inside the pores has been synthesized using a similar method, and results are pending.

Alyssa McFarlane is a sophomore in the Department of Physics and Astronomy at the University of Missouri – St. Louis.

Exoplanet Detection Using Transit Method

William Melvin
Truman State University
Advisor: Dr. Vayujeet Gokhale

Abstract

We present light curve analysis based on observations made at the Truman State Observatory and at the Lowell Observatory on the exoplanetary systems: Wasp-12, GJ-436 & Hat-p3. We describe our selection criteria, such as brightness and position of the potential targets in the sky; and on transit times determined from publicly available databases. We elaborate on the data collection process, which involves taking a series of images on the target stars over several nights; and on image processing which improves the quality of our data by accounting for noise and other distortions on the CCD chip. We conclude by outlining strategies for improving the efficiency of exoplanet detection in order to meet our future goals in this field.

Will Melvin is a Sophomore Biology Major from Ewing, MO. Will has been doing research for one year in the interdisciplinary astrobiology program at Truman State University. He is working under the direction of Dr. Vayujeet Gokhale.

Vauyjeet Gokhale is an assistant professor of physics at Truman State University. He earned his BSc. in physics ('96) and MSc. in nuclear physics ('98) from the University of Bombay, followed by a PhD in astronomy from Louisiana State University. The Gokhale group is interested in identifying and observing exoplanets in transiting systems.

A Study of Numerical Simulation of Supersonic Conical Nozzle Exhaust

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

Abstract

While Computational Fluid Dynamics (CFD) has become a common tool in the design and analysis of a wide variety of fluid flow problems, the accuracy of CFD simulations remains dependent on many physical and numerical variables. In order to understand the effects of these variables on the solution, a number of benchmark problems have been proposed by the aerospace industry, under the auspices of AIAA, both in the areas of external aerodynamics and propulsion. The aim of this study is to conduct CFD simulations of a benchmark problem in aerospace propulsion - the simulation of steady supersonic exhaust from a conical convergent nozzle. The goal is to identify the best physical and numerical models for accurate simulations as determined by comparisons against the experimental data. This study was conducted using the Ansys Fluent CFD code within Ansys Workbench. In addition to Fluent, the Workbench suite includes a CAD modeler and an automatic mesh generation program Gambit which were employed for geometry modeling and mesh generation respectively. By modeling this problem in an axisymmetric domain with only moderate resolution and then employing a gradient based adaptive meshing strategy, highly resolved flow features were generated with relatively small computational expense. Running this mesh with a pressure based, finite-volume solver with a k-ω SST turbulence model and QUICK discretization scheme, yielded results in excellent agreement with the experimental data. The developed CFD model appears to be a good candidate for adoption as a benchmark case for its accuracy as well as its generality and computational efficiency.

John Mern is a senior majoring in mechanical engineering and finance and minoring in Robotics and Mechatronics at Washington University in St. Louis. He is originally from Long Island, New York and grew up in Coral Springs, Florida. Upon graduation in May, John plans to begin working as a propulsion design engineer in the Phantom Works division of The Boeing Company in St. Louis, Missouri.

Development of a Sliding Mode Integrated Guidance and Control Altitude Hold Autopilot

Trevan G. Michael
Missouri University of Science and Technology
Advisor: Dr. SN Balakrishnan

As the use of unmanned air vehicle (UAV) systems grows, the need for reliable, robust autopilots grows with it. This paper illustrates the effectiveness of a sliding mode based integrated guidance and control algorithm with disturbance estimator as an altitude hold autopilot. Though altitude hold is just part of an overall UAV autopilot system, it is important for execution of UAV missions. Sliding mode architecture is shown to be robust to sudden changes in the dynamics, while the slower disturbance estimator cancels any uncertainty and updates the dynamic model. This autopilot system takes into account the coupled dynamics of aircraft. Whereas controllers which separate the dynamics into longitudinal and lateral modes, like PID and LQR, may break down due to dynamic inaccuracies during banking maneuvers, this autopilot continues to be effective. Other methods, such as Fuzzy based or Neural Network algorithms, have been proposed to solve this problem, however, the proposed Sliding Mode Integrated Guidance and Control (SM-IGC) can achieve the robust and effective control more efficiently than these other, more complicated algorithms. Simulations are conducted to show the effectiveness of the novel autopilot over a PID control law.

Trevan Michael is a graduate student at Missouri University of Science and Technology, pursuing a Master of Science in Aerospace Engineering. With emphasis in control systems, Trevan has worked on the attitude determination and control system for the Missouri satellite team. As an associate engineer at IST-Rolla, Trevan has worked on small business contracts involving missile guidance and spacecraft orbit determination. After completing his M.S. this summer, Trevan will begin his career at Boeing in St. Louis as a Guidance, Navigation, and Control Engineer working on cruise missiles.

Mechanisms of Amino Acid Formation in the Interstellar Medium

Alexis Morris, Brittany Curtis and Matthew Kummer
Truman State University
Advisor: Dr. Eric V. Patterson,

Abstract

The syntheses of the chemical building blocks of life, such as amino acids, are of interest when looking at the origins of life. The detection of over 100 organic molecules in the interstellar medium (ISM) suggests that the complex organic molecules that make life possible may have formed extraterrestrially. The discovery of amino acids in the Murchison meteorite provides further evidence that other extraterrestrial bodies may contain precursors to other amino acids. Although the existence of precursors is a possibility, the mechanisms through which they form remain unknown. In the present study, computational methods have been used to propose possible reaction mechanisms from the formation of extraterrestrial compounds that could be potential precursors in forming the larger biomolecules, such as amino acids in the ISM. Data from a few of these reaction pathways will be presented.

Alexis Morris is a junior chemistry major from St. Louis, MO. This is Lexi’s third year working in the interdisciplinary astrobiology program at Truman State University, under the direction of Dr. Eric Patterson.

Brittany Curtis is a senior chemistry major from Kansas City, MO. This is Brittany's first year working in the interdisciplinary astrobiology program at Truman State University, under the direction of Dr. Eric Patterson. She plans to attend graduate school in chemistry upon graduating from Truman.

Matthew Kummer is a sophomore chemistry major from St. Louis, MO. He has been working in the astrobiology program at Truman State University for one semester with Dr. Eric Patterson as his faculty mentor.

Eric Patterson is a professor of chemistry at Truman State University. He received his BS in chemistry from Southwestern University (’91) and his PhD in organic chemistry from the University of Wisconsin – Madison (’96). The Patterson group uses quantum chemical calculations to understand properties and reactivity of interstellar molecules.

Utilizing Modern Electron Microscope Techniques to Characterize Silicon on Insulator Edge Defects

Meredith Ordway
University of Missouri St. Louis
Advisor: Dr. Phil Fraundorf

Abstract

In the world of Silicon on Insulator (SOI) technology it is often beneficial to look at the structures of the SOI on the nano-scale. The simplest way to observe SOI is a top down view, however many details regarding the structure are more easily viewed in cross section. This study aimed to examine different methods of obtaining and viewing SOI cross sections to observe nano-scale edge defects of SOI wafers. Methods include SEM cross-section, SEM cross sections utilizing a conductive coating, FIB/SEM cross-sections as well as TEM cross-sections.

Meredith Ordway is from Jefferson City, Missouri. She currently resides in St. Louis Missouri and is attending the University of Missouri – St. Louis; she is a graduate student and will be receiving her master's degree in May. Meredith plans to continue to work in the microscopy field and to eventually earn her Ph.D.

Deformation of Elastomeric Porous Structures

Katy Shi
University of Missouri - ColumbiA
Advisor: Dr. Frank Feng

Abstract

The purpose of this experiment is to demonstrate the effect that pressure has on deformities in soft porous structures and find the reason for the pattern switches of these structures. Through this, it will be possible to design soft, tunable, multi-functional materials whose characteristics stem from their pattern switches. This experiment is based on a study done by Katia Bertoldi at Harvard University. Pattern switch is being shown as a repeatable and reversible transformation. First, models of porous structures with circular holes on a square lattice are created on a sheet made of tunable metamaterials. The pattern switch is observed when pressure is applied to a certain point. The same should be observed with circular holes on an oblique lattice and elliptical holes on a rectangular lattice.

Katy Shi was born in Hefei, China, and is currently a junior at Rock Bridge High School in Columbia, Missouri. Katy plans to major in Mechanical Engineering and possibly double major or minor in Political Science or International Affairs.

Integrated Guidance and Control of a Hypersonic Flight Vehicle using the Finite State-Dependent Riccati Equation

Jason Stumfoll
Missouri University of Science and Technology
Advisor: Dr. S. N. Balakrishnan

Integrated guidance and control (IGC) design has been under study for many years for its improved performance over traditional individual control and guidance design processes. IGC design is of particular interest for next generation missile systems and hypersonic aircraft where more accurate performance is mission critical. A suboptimal IGC technique applying an approximate solution to the finite-state-dependent Riccati equation to the nonlinear longitudinal dynamics of a generic hypersonic flight vehicle is presented. The current status of the project is discussed, along with difficulties encountered, and the plan to complete the work.

Jason Stumfoll is a first year Master's student in the Department of Aerospace Engineering at Missouri S&T, currently focusing on the area of nonlinear controls and estimation. Jason received his Bachelor of Science in Aerospace Engineering from Missouri S&T in 2012. In 2012 Jason attended the MS&T Undergraduate Research conference as an Opportunities for Undergraduate Research Experiences (OURE) student. Jason aspires to work in the space industry, designing control systems for next generation space and launch vehicles.

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

The motivation for studying the dynamics of embedded clusters with infrared astrometry is presented. In particular, we have begun to analyze infrared images of the nearby Rho Ophiuchi star-forming region taken from 2001-2012 at the U.S. Naval Observatory. We plan to calculate the velocity dispersion of the cluster members in three different sub clusters based on observations of their proper motions. This will allow us to compare the actual velocity dispersion to that which is predicted by models of embedded clusters. We will compare this to the velocity dispersion predicted assuming virial conditions in the cluster. We will also investigate whether or not there is a correlation between higher velocity dispersions and lower mass cluster members which will test models for the formation of very low mass stars and brown dwarfs.

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

Thermal Consequences of Subterranean Nesting in a Prairie-Dwelling Turtle, *Terrapene ornate*

Charles R. Tucker, Day B. Ligon; Missouri State University
Jeramie T. Strickland; US Fish and Wildlife Service
David K. Delaney; US Army Construction and Engineering Research Laboratory
Advisor: Day Ligon

Abstract

Nesting behavior was monitored for two seasons in a northwestern Illinois population of ornate box turtles. Direct observations were used to confirm that among 31 nesting events, six females oviposited while beneath the substrate surface, and comparisons of body length with nest depth indicated that 5 additional females likely also constructed nests while buried. Nests laid while females were underground were deeper than other nests (16.7 cm versus 11.2 cm), and while average nest temperatures were similar between groups, temperature fluctuations and maximum temperatures were lower among nests that were laid while females were below the surface. Nest site selection and nest depth variation among large bodied species have been cited as methods by which females can influence incubation temperatures, but nest depth is generally limited by hind limb length for females that nest from the surface. Subterranean oviposition in this population appears to have moderated incubation conditions by allowing females to oviposit at greater depths than would be possible from the surface. This previously undocumented behavior may be a mechanism for this species to overcome limitations imposed by limb length to moderate incubation temperatures, a critical factor in determining sex in this species. Annual reproductive rates, incubation temperatures of nests, and rates of preliminary behavior associated with cavity construction in this species are reported.

Charles Tucker is a Master of Science degree candidate at Missouri State University in Springfield, Missouri.

Zinc Isotope Composition in Iron Meteorites

Charlotte Weinstein
Department of Earth and Planetary Sciences
Washington University in St. Louis
Advisor: Assistant Professor Frederic Moynier

Abstract

Iron meteorites can be grouped into two general categories – magmatic and non-magmatic. Non-magmatic meteorites are thought to have formed from pools of metal melted by the heat of impacts. Magmatic meteorites are thought to have formed within the cores of asteroids, assembled by fractional crystallization processes. Zinc isotopes can be used to help to understand the physical and chemical conditions present at the time the meteorite was formed. Since zinc is moderately volatile, high temperatures cause isotope fractionation and so lead to isotopic variability. Consequently, analysis of the zinc isotopic variability can constrain some of the physical conditions hypothesized by theories of the origin and early evolution of the meteorites' parent bodies. This study analyzed 32 samples from 10 meteorite groups, using a multi-collector inductively-coupled plasma-mass spectrometer. Measurements of both ^{66}Zn and ^{68}Zn were compared to ^{64}Zn measurements for all of the individual meteorite samples, and compared to the "Lyon" standard JMC 3-0749L. The results indicate: that all of the samples are consistent with the occurrence of mass-dependent fractionation, forming a linear trend on a three-isotope plot. Two samples from one parent body clearly show that volatile depletion could not be due to evaporation, which favors the non-condensation hypothesis.

Charlotte Weinstein was an undergraduate research intern in the Department of Earth and Planetary Sciences at Washington University in St. Louis

Pulsating M Dwarfs: Continuing the Search

Amanda Winans
Missouri State University
Advisor: Dr. Andrzej Baran

Abstract

This study continues the search for pulsating M dwarf stars. Current models suggest that M dwarf stars should pulsate with a frequency of about 36 cycles per day. *Kepler* data for stars with temperatures below 5000 K are processed and searched for an amplitude at that frequency. Of the 544 stars that were looked at, only eight showed potentially close peaks though none of them strong. These stars will be spectroscopically classified in the future. Since we assume that most of the stars that were looked at are M dwarfs due to *Kepler's* planet hunting nature, finding only a few weak possibilities suggests that current M dwarf models may need to be looked at again.

Amanda Winans is a junior pursuing a Bachelor of Science degree in physics with an emphasis in astrophysics at Missouri State University (MSU) in Springfield, Missouri. During the summer of 2012 she participated in a National Science Foundation Research Experience for Undergraduates program at Purdue University working with Dr. John Peterson. Her work with the Large Synoptic Survey Telescope Image Simulator included a program modeling multilayer thin film filters as well as researching information on the effects of atmospheric aerosols. She is currently employed as a NASA intern in the Physics, Astronomy, and Materials Science Department at MSU as supported by the Missouri Space Grant Consortium. Amanda also plays violin in the symphony at MSU as well as participates in a Christian college ministry. Her hometown is Kansas City, Missouri.

Development of a New 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 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 developments have extended the capabilities of many RANS turbulence models, improvements are still greatly 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 Rahman-Agarwal-Siikonen (RAS) turbulence model and its extensions for computing separated flows, rough wall flows, flows with rotational and curvature effects, and high temperature flows. To demonstrate the effectiveness of the new RAS model, it is compared against the industry standard Spalart-Allmaras (SA) and SST k-ω models for turbulent flow over a flat plate, separated flow behind a hump, separated flow over NACA 4412 airfoil at high angle of attack, flow over a backward facing step and flow inside a 90 degree bend. It is demonstrated that RAS model performs better than SA and SST k-ω models in most cases. It is anticipated that the RAS 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 mechanical engineering 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.

SAE Aero Design Competition Team

Missouri S&T Advanced Aero Vehicle Group
Department of Mechanical and Aerospace Engineering
Missouri University of Science and Technology
Advisor: Dr. Walter Eversman

Abstract

The Advanced Aero Vehicle Group (AAVG) is a student design team built around aerospace design projects, which incorporate many different academic fields to successfully complete the projects in a competitive fashion. AAVG participates in multiple projects including the Society of Automotive Engineers (SAE) Aero Design Series competition.

This year, AAVG participated in the Aero Design East Advanced Class in Fort Worth, Texas April 15-17. The goal of the Advanced Class is to design, build, and fly a remote-controlled, fixed wing aircraft. With an 8 pound target empty weight, the aircraft is to be loaded with a 15 pound static payload and a three pound deployable humanitarian aid package (sandbag). While being guided by a First-Person View camera system and live telemetry data, the sandbag must be dropped within 50 feet of a target from 100 feet above ground level. The Advanced Class competes against top-tier technological and engineering universities from around the world. For the 2013 competition, AAVG received 1st Place Overall, 1st Place in Presentation, and 3rd Place in Design.

Jason Brown: President, Rocket Team Co-Lead
John Schaefer: Chief Engineer (SAE Aero Design)
Jacob Sinclair: Rocket Team Co-Lead
Jonathon Boerema: Business Manager
Lennia Knupp: Treasurer
Steven Ryan: Secretary

University Student Launch Initiative Competition Team

Missouri S&T Advanced Aero Vehicle Group
Department of Mechanical and Aerospace Engineering
Missouri University of Science and Technology
Advisor: Dr. Walter Eversman

Abstract

The Advanced Aero Vehicle Group (AAVG) is a student design team built around aerospace design projects, which incorporate many different academic fields to successfully complete the projects in a competitive fashion. AAVG participates in multiple competitions including the National Aeronautics and Space Administration (NASA) University Student Launch Initiative (USLI) intercollegiate high-power rocket competition.

The team competes in the USLI competition with the objective of building a high-power rocket that can carry a scientific payload to one mile in altitude above ground level. The competition takes place at NASA's Marshall Space Flight Center in Huntsville, Alabama and draws teams from top technological and engineering teams all across the nation. Scoring is based off a series of design reviews and presentations presented to NASA staff and professional engineers, as well as the altitude differential from one mile and the scientific value of the selected payload. The USLI team is also actively engaged in outreach efforts to inspire and educate the next generation of engineers and STEM field students. This year the team is being lead by two past Chief Engineers with the intention of strengthening the technical depth of the team by providing classes and workshops that cover the basics of rocketry flight, propulsion, design, construction, and the competition project cycle. By giving new team members a strong foundation in rocketry and the opportunity to experience the complete project cycle, the AAVG USLI team strives to lay the groundwork for highly successful teams for years to come.

Jason Brown: President, Rocket Team Co-Lead
John Schaefer: Chief Engineer (SAE Aero Design)
Jacob Sinclair: Rocket Team Co-Lead
Jonathon Boerema: Business Manager
Lennia Knupp: Treasurer
Steven Ryan: Secretary

Miners in Space

Department of Mechanical & Aerospace Engineering
Missouri University of Science and Technology
Advisor: Dr. Hank Pernicka

Abstract

If an astronaut should suffer a medical emergency in which their heart rhythm is disrupted, the current NASA CPR procedure requires three to four minutes of preparation, two rescuers, and a large rigid surface to which the patient can be strapped. The Miners in Space are exploring a new method that only requires 90 seconds of preparation, one rescuer, and a small, free-floating strap system using our active compression decompression cardiopulmonary resuscitation (ACD-CPR) procedure. In addition to the compressions of traditional CPR performed terrestrially, our procedure actively decompresses the chest by using a suction device that pulls the chest upward increasing the blood flow through the heart improving the resuscitation success rate. Our procedure uses a small device, the "CardioPump," to aid in the CPR process. The procedure begins with the rescuer attaching themself behind the patient with a strap restraint, placing the device on the victim's sternum, and then performing ACD-CPR. During space flight, our method would be preferred to traditional methods because the CardioPump is smaller, is more versatile and decreases setup time. Our procedure was tested aboard NASA's 'Weightless Wonder" microgravity aircraft during June 2012; the test showed our procedure could achieve the rate and depth of compressions necessary for effective resuscitation. NASA accepted our proposal to continue testing this procedure this summer, improving on the previous design. This summer, a more complex fluids model will be implemented to further validate whether ACD-CPR is effective in a microgravity environment. As with last year, we are using a CPR mannequin to empirically test whether the proposed procedure is effective. A greater degree of precision will be achieved through the use of more accurate sensors in the mannequin. With the increasing prevalence of commercial space flight, an improved CPR procedure will be necessary to save lives in the future.

2013 Missouri S&T Satellite Project

Matthew Glascock & Samuel Haberberger
Department of Mechanical & Aerospace Engineering
Missouri University of Science and Technology
Advisor: Dr. Hank Pernicka

Abstract

The Missouri S&T Satellite Team (M-SAT) is a design team whose current project involves the complete design and construction of two microsatellites. The mission of the M-SAT team is to test the use of stereoscopic imaging in space with the intent to perform a circumnavigation of an uncooperative resident space object (RSO) to obtain imaging data that may be utilized by the team and any other customers to determine its possible capabilities. The project will develop this technology using two small spacecraft in a free flying formation. After insertion into orbit, the secondary satellite will be deployed and various data will be collected on the performance of the dual-spacecraft formation. The spacecraft pair are designed, built and tested by the students and faculty at Missouri S&T.

Matt Glascock is a Junior student currently in pursuit of an Aerospace Engineering Bachelor's degree, with a minor in Physics. He has enjoyed a very successful academic career thus far. Outside of the curriculum, he is involved in the Missouri Satellite Project student research team on campus at Missouri S&T, developing a small satellite. He is also conducting undergraduate research in the space propulsion field in the Aerospace Plasma Laboratory on campus. Matt has plans to attend graduate school for a Masters degree in the Aerospace Engineering field following graduation in May 2014. His research interests lie mainly in the field of electric space propulsion, and its application to small satellites.

Samuel Haberberger is a Junior student currently in pursuit of an Aerospace Engineering Bachelor's degree. Outside of his curriculum work, he is also very involved in the Missouri Satellite Project student research team on campus at Missouri S\&T, testing and developing a small satellite. He is also conducting undergraduate research in the guidance, navigation and control (GNC) field working under his research advisor Dr. DeMars. Samuel has plans to attend graduate school at Missouri S\&T in the Aerospace Engineering field following his graduation in May 2014. His research interests lie in the field of GNC and its application to autonomous aerospace vehicles.

Pathfinder Program in Environmental Sustainability
Case Study: Southwestern United States

Christina Kreisch, Undergraduate Teaching Assistant
Department of Earth and Planetary Sciences
Washington University in St. Louis
Advisor: Professor Raymond Arvidson

Abstract

The Pathfinder Program in Environmental Sustainability provides a four-year association between small groups of undergraduate students and a senior faculty mentor. The program uses a clustered approach to course work augmented with case studies that explore problems and solutions in environmental sustainability. Case studies include a comparison of National Park Service and Bureau of Land Management maintenance of the Mojave Desert and issues associated with volcanoes, tsunamis, landslides and earthquakes in Hawaii. The program culminates during students' senior year with capstone projects addressing issues and solutions based on students' area of interest. Students apply for the Pathfinder Program at the time of the application to Washington University. Because each entering class is limited to 15 to 20 students, the Program's selectivity is high. The students selected have demonstrated the potential for outstanding academic achievement.

This poster reports on the field trip to the Mojave Desert, conducted March 9 – 15, 2013. Seventeen Pathfinder students – seven men and ten women – participated, along with Professor Raymond Arvidson, Computer Systems Manager Thomas Stein, and Teaching Assistant Christina Kreisch. The group toured several sites within Death Valley National Park, Joshua Tree National Park, and the Mojave National Preserve. They observed the geomorphology and ecology at sites ranging in elevation from 300 feet below sea level to 11,000 feet above sea level. They observed the existing landforms, flora, and fauna, and the effects of human activities such as mining and groundwater removal on the various habitats.

Christina Kreisch is a sophomore undergraduate teaching assistant in the Department of Earth and Planetary Sciences at Washington University in St. Louis.

The Argus CubeSat Mission

Tyler Olson, Tom Moline, Wesley Gardner,
Joe Kirwen, Phillip Reyes, and Nate Richard
Saint Louis University
Advisors: M. Swartwout, S. Jayaram, and K. Mitchell

Abstract

This report covers the final design of the Argus CubeSat, a partnership between Saint Louis University and Vanderbilt University to build and fly a space mission. Argus will improve the modeling of the effects of radiation on modern electronics by providing in-orbit data on the upset rates of known electronics. This data will be used to calibrated Vanderbilt's models. Argus will launch in October 2013 on a new rocket, the Super Strypi, as part of NASA's ELaNa-VII mission.

NOTES