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NASA - MISSOURI SPACE GRANT CONSORTIUM
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MISSOURI SPACE GRANT

CONSORTIUM

Preface

This volume contains the abstracts of 44 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 20-21, 2012.

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; Ms. Tasmyn Front, St. Louis Challenger Learning Center; and Dr. Patrick Bunton, William Jewell College 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

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Boulder Densities at the Compton-Belkovich Volcanic Complex

Natalie J. Accardo
Dept. Earth & Planetary Sciences and The McDonnell Center for the Space Sciences, Washington University in St. Louis
Advisor: Bradley Jolliff

Abstract

Boulders on the Moon typically occur in close proximity to large or fresh impact craters and associated with weathering of outcrop on steep slopes. They are also associated with volcanic landforms including domes, lava flows, and mare wrinkle ridges. In this study we report boulder size distributions in the Compton-Belkovich volcanic complex (CBVC) located ~ 100°E, 61° N. We seek to relate the occurrence of the boulders to the rock type and style of volcanism, and to understand the physical properties and weathering of CBVC materials. Boulder occurrences in the CBVC are correlated with these small domes and bulges, reflecting the style of volcanism, consistent with slow extrusion of late-stage, viscous, silica-rich rhyolite in mounds that just barely broke the surface regolith. These features occur on rims of depressions and degraded craters, zones of weakness favorable for extrusion.

Natalie Accardo is a senior undergraduate at Washington University in St. Louis majoring in Earth and Planetary Sciences. She has recently been accepted into the Geophysics PhD program at Columbia University in New York City where she plans to begin in the fall.

Control of Laminar Separation Bubbles with a Periodically Pulsing Plasma Actuator: A Computational Model

Justin Aholt
Missouri University of Science and Technology
Deptartment of Mechanical and Aerospace Engineering
Advisor: Dr. Fathi Finaish

Abstract

A parametric computational study is conducted to evaluate the effectiveness of a plasma actuator operated in a low frequency 'burst' mode as an active control strategy of a Laminar Separation Bubble formed over the leading edge of an airfoil. The changes in LSB dimensions and the corresponding effects on airfoil aerodynamic performance due to actuator pulsing frequency and duty cycle are observed. The performance enhancements effected by the pulsed actuator are compared to those of a power-equivalent 'steady' actuator to determine whether actuator effectiveness can be enhanced via unsteady actuation. Pulsed actuation is found to be capable of improving lift augmentation effectiveness by as much as 4 percent, while improving drag reduction effectiveness by as much as 13 percent for the observed cases. In the best case observed, the strategy was found to improve the effectiveness of the actuator in terms of L/D enhancement by nearly 20 percent. These results are promising, indicating that pulsed actuation can result in significantly improved effectiveness with respect to 'steady' operation, and warranting future work regarding this topic.

Justin Aholt is a PhD candidate currently enrolled in the department of Mechanical and Aerospace Engineering at the Missouri University of Science and Technology. He graduated with a Bachelors degree in Aerospace Engineering in May 2010 and a Master's degree in July 2011.

Maximum-Range Trajectories for an Unpowered Reusable Launch Vehicle

Josiah A. Bryan
Department of Mechanical and Aerospace Engineering
University of Missouri - Columbia
Advisor: Dr. Craig A. Kluever

Abstract

A software package has been developed that numerically maximizes the range of an unpowered reusable launch vehicle (RLV) during the Terminal Area Energy Management (TAEM) phase of reentry into Earth's atmosphere by adjusting the angle-of-attack control profile at preselected energy heights along its trajectory. The software computes the optimal trajectory in terms of angle-of-attack deviations from a maximum lift-to-drag trajectory, which is the traditional trajectory used to maximize range of an unpowered aerial vehicle. In order to test the optimization software, an aerodynamic model of the X-34 launch vehicle was developed to calculate lift and drag coefficients for a given angle of attack and Mach number. Consideration of different numbers of control nodes is made, primarily with gradient-based optimization, though particle-swarm optimization is briefly tested. The merits of alternative control laws, such as constant-velocity or constant-dynamic-pressure quasi-equilibrium glide (QEG) algorithms, have also been investigated in an attempt to find a control law that does not require the inherent computational costs associated with numerical optimization. A two-point boundary-value problem is briefly considered using optimal control theory to describe the optimization problem with simplified aerodynamic and atmospheric models.

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 control for chatter prevention in milling processes under the guidance of Dr. Roger Fales.

Improved Methods of Cryopreservation of Biological Specimens using Geometrically Modified Vials

Darnell M. Cage
Department of Mechanical and Aerospace Engineering
University of Missouri-Columbia
Advisors: William G. Zhao and Gary L. Solbbrekken

Abstract

The goal of the current set of experiments is to evaluate the spatially-dependent cooling rate in geometrically modified vials. Numerical heat transfer simulations of an annular vial geometry show more uniform cooling rates than conventional cylindrical vials. The explanation for the improved uniformity is based on the surface-area-to-volume ratio increase for annular vials compared to the cylindrical vial. Experimental measurements and numerical analysis will be carried out in both cylindrical and annular prototypes to clearly compare the different designs. The problem is that cylindrical vials exhibit spatially non-uniform cooling rates. Changing the geometry of the vial by adding a middle channel increases the surface-area-to-volume ratio which should reduce spatial variation. Experiments on these redesigned vials need to be conducted on vial prototypes to validate this claim.

Darnell Cage hails from Saint Louis, MO and is currently a freshman undertaking Mechanical Engineering with an Aerospace emphasis at the University of Missouri – Columbia (Mizzou). He is working with Dr. Gary Solbrekken and the Mechanical Engineering department of the College of Engineering on his research entitled "Numerical Simulations and Experimental Evaluations of Heat Transfer Performance of Improved Cryogenic Vials for Cryopreservation". At Mizzou, Darnell is involved in the Mizzou Black Male's Initiative, National Society of Black Engineer, American Society of Mechanical Engineers, and Diversity in Engineering. He is also a George C. Brooks scholar, Diversity in Engineering scholar, Chamber's scholar in engineering, Gates Millennium scholar, William L. Clay scholar, and William Pablo Feraldo scholar. This summer, he plans to intern with Pratt and Whitney in Middleton Connecticut. After graduating with his Bachelor's degree in Mechanical Engineering, he plans to attend graduate school to further his education with hopes of opening his own engineering firm.

Positive Displacement Fluid Flutter using Coupled Plate Strain Energy Deflection

Robert Chapman
Department of Mechanical and Aerospace Engineering
University of Missouri – Columbia
Advisor: Professor Zaichun Feng

Abstract

In nature, there exist highly evolved mechanical systems which feature passive mechanical compliance using sophisticated geometrical and material structural changes to impart hydraulic actuation. The human heart generates vascular blood flow through periodic geometric ventricular contraction, servicing cellular nutrient transport requirements throughout the body. Applying a cyclical pressure transient, the heart squeezes fluid through the vascular network. To date, no such mechanism exists that is capable of achieving the desired motion of fluid particles without severe damaging the fragile oxygen-carrying red blood cells. It is thus required that a new pump class be contrived to govern the flow of blood in a similar motion to that of the human heart. The concept of fluid flutter using mechanical pre-compression strain energy is provided herein as a viable method for passive actuation of fluid particles in a nonlinear periodic cycle. As a prelude to the ongoing technical challenges, this paper is to provide the reader with a brief overview of the conceptual idea and foregoing analytical strategies employed to design, analyze and test such a mechanism.

Robert Chapman in the first year of his graduate education at the University of Missouri – Columbia is working towards his MScME. A local to Blue Springs, Missouri, in his adolescence; Robert graduated from the Missouri University of Science and Technology in 2009 with a BScME. He then went on to work full-time at the Bettis Atomic Power Laboratory as an associate engineer specializing in core mechanical design. Robert then accepted a position as a manufacturing engineer at the Lake City Ammunition plant. With the aim to achieve the extraordinary in his professional career, Robert then elected to return to academia for further technical refinement of specialized engineering skill-sets. Robert has a passion for knowledge and a love for learning that is matched only by the love for his wonderful family and friends. To date, the fondest of his achievements is that of his three-year old child Zoey and his amazing wife Ashley, to which he is forever indebted.

Optimization of Hydrofoils Using a Genetic Algorithm

Travis Cocke
Department of Mechanical Engineering & Materials Science
Washington University in St. Louis, St. Louis
Advisor: Dr. Ramesh K. Agarwal

Abstract

In this paper, we employ a genetic algorithm (GA) for shape optimization of hydrofoils for application in a sailing craft. The hydrofoil for a sailing craft should have high lift at lower speeds and low drag at higher speeds. Computations are performed for a hydrofoil in deep water as well as one close to the free surface. The commercially available software FLUENT is used for calculation of the flow field. It is shown that the GA optimization technique is capable of accurately and efficiently finding globally optimal hydrofoils.

Travis Cocke is a B.S/M.S student in the department of Mechanical Engineering and Materials Science at Washington University in St. Louis. He is currently working as a Research Assistant in their CFD laboratory. He will graduate with a MS degree in May 2012.

Prediction of Dual-Mode Spacecraft Propellant Performance of Binary and Ternary Ionic Liquid Mixtures

Timothy A. Collard
Department of Mechanical and Aerospace Engineering
Missouri University of Science and Technology
Advisor: Dr. Joshua L. Rovey

Abstract

The theoretical chemical and electrospray performance of [Bmim][dca], [Bmim][NO_3], or [Emim][$EtSO_4$] mixed with HAN in aqueous solution for dual mode chemical monopropellant/bipropellant and electrical electrospray rocket propulsion have been investigated. A ternary mixture comprised of 80 percent HAN, 20 percent of each ionic liquid fuel, and no water yielded the maximum specific impulse and chamber temperature: 290 seconds and 2700 Kelvin, respectively. The specific impulse was computed for a 1000 V accelerating voltage. For a binary mixture of [Bmim][dca] and HAN the upper limit on the specific impulse performance was 4655 to 6683 seconds and the lower bound was 2567 to 3745 seconds. For [Bmim][NO_3] and Han the limits were 4743 to 6683 seconds and 2595 to 3745 seconds, respectively. For [Emim][$EtSO_4$] and HAN the bounds were 4128 to 6683 seconds and 2380 to 3745 seconds, respectively. At a HAN weight ratio of 0.4 the mass of the molecular combinations is maximized by coupling an ion from HAN with a neutral molecule of the ionic liquid fuel.

Tim Collard is currently pursuing a Bachelor's of Science at Missouri S&T in both Aerospace Engineering and Mechanical Engineering. Originally from Olathe, KS, he expects to graduate in December 2013.

Preparing Silicon on Insulator Specimens for Transmission Electron Microscopy Analysis

Ashlynn Conner
Department of Physics and Astronomy
University of Missouri – St. Louis
Advisors: Philip Fraundorf and Bruce Wilking

Abstract

In order for a silicon on insulator (SOI) specimen to be studied using Transmission Electron Microscopy (TEM) it must be a certain shape and thickness. The specimen must have a diameter of no more then 3mm in order to fit in the TEM specimen holder. The specimen must also be thin enough for electrons to pass through it. Several methods were studied for each step in the specimen prep process. Droplet and immersion etching of 3 mm discs dimpled to about 30 microns central thickness showed that if the surface is unpolished, etch rates dropped below that expected for <100> Si surfaces. Polishing the surface helps, but mask life time is still the limiting our ability to thin the handle to perforation.

Ashlynn Conner was born and raised in Florissant Missouri which is a suburb of St. Louis County. She attended St. Louis Community for several years before transferring to University of Missouri-St. Louis and is currently working on a Bachelors of Science in Physics with emphasis in Engineering Physics. After completing her bachelors degree, Ashlynn's plan is to earn a Master's degree in Physics

The Role of AGN in the Major Merging Process

Andrew Cooper
Department of Physics
University of Missouri-Kansas City
Advisor: Dr. Daniel McIntosh

Abstract

A merger-fueled AGN and its subsequent quenching of star formation is postulated to be a central mechanism in explaining the growth of the massive, red and dead spheroidal galaxy population over cosmic time. The AGN activity of massive galaxies involved in major interactions and highly-disturbed objects postulated to be ongoing mergers were investigated. A large, complete sample of 63,454 SDSS galaxies with z < 0.08 and $M \geq 10^{10} M_{sun}$ was data-mined. 684 interacting galaxies and 73 major merger byproducts were visually identified. To quantify the level of nuclear activity, nebular emission line data based on SDSS DR7 fiber spectra from the MPA-JHU Emission Line Analysis were used. By employing a variety of emission-line diagnostics, the sample used was separated into a variety of spectra types (star-forming, Seyfert, LINER and quiescent). The interactions and mergers to each other and to non-interacting control samples were compared using galaxy color and axial ratio to split the comparisons by coarse galaxy type: star-forming disk vs. dead spheroidal. Galaxies with strong nebular emission were determined to rarely have purely star-forming central spectra as found in lower-mass emission-line systems. The results show that a significant fraction of interacting galaxies and mergers have measurable AGN activity in their central spectra, which indicates that AGN activity is common among high-mass mergers, with higher activity strength relative to non-merging systems.

Andrew Cooper is a senior in Physics at the University of Missouri – Kansas City. He grew up in the small town of Blairsville, which is located under the dark skies of Northern Georgia. He moved to Harrisonville, Missouri, in 2004 and began his college career at the age of sixteen in 2006 at Longview Community College. Astronomy has always been a strong interest of his since he was very young, so when he started college he set out to work in astronomy and physics. In 2008, Andrew transferred to UMKC to begin his major-based course work. Since transferring, he has been an active member of UMKC's Honors Program, an officer in the Society of Physics Students chapter at UMKC, and a recipient of the James M. Phillips Scholarship in Physics. In 2009, Andrew joined UMKC's Galaxy Evolution Group (GEG) and has been working for Dr. Daniel McIntosh ever since. By having the chance to work in research as an undergraduate for the GEG and experience what life as an astronomer is like, Andrew has definitely decided that he wants to attend graduate school in astrophysics. Andrew's overall research interest is in high-energy astrophysics and he would ultimately like to research the dynamic behavior of stellar remnants or various types of active galactic nuclei.

Water and HDO in Comet 103P/Hartley 2

Matthew A. Dennis
Department of Physics and Astronomy
University of Missouri-St. Louis
Adviser: Dr. Erika Gibb

Abstract

For the purpose of comparing H_2O / HDO ratios found in comets with the ratio found in Earth's oceans, an attempt to identify and quantify water and HDO from spectra taken of comet 103P/Hartley 2 is presented.

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 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.

Reaching for the Stars:
UMKC Astronomy Outreach Program

Emily Ellsworth
Department of Physics
University of Missouri – Kansas City
Supervisor: Dr. Daniel McIntosh

Abstract

A three month long Astronomy Outreach program was set up and implemented by a MOSGC undergraduate educational intern at University of Missouri – Kansas City under the direction and supervision of Dr. Daniel McIntosh, Physics Professor at UMKC. The purpose of the program was to educate underrepresented minority groups within the Kansas City area about basic Astronomy/Physics concepts. The program mainly targeted elementary school children in the third, fourth, and fifth grade, however opportunities to learn were extended to grades Kindergarten to second as well. The program lasted roughly three months, starting in June 2011 and ending in August 2011. Throughout those three months, visits to classrooms and community programs were made. Each visit lasted roughly forty minutes in which during such time three main topics were discussed and demonstrated. The three main topics were Gravity, the Earth-Sun-Moon system, and the Eight Planets of our solar system. Data regarding previous knowledge was also collected from the children prior to the start of each presentation. Feedback from children, teachers, and administrators expressed the importance of such a program and its benefits for both children and teachers.

Candidate Young Stellar Objects in the Serpens Main Cluster

Kristen Erickson
Department of Physics and Astronomy
University of Missouri St. Louis
Advisor: Bruce Wilking

Abstract

High-resolution spectra over a large range in wavelength for 18 stars in the direction of the Serpens Main Cluster using the double Magellan Inamori Kyocera Echelle (MIKE) spectrograph on the Clay 6.5m telescope have been obtained. These objects have been previously observed as part of a comprehensive, mid-resolution optical spectroscopic survey of candidate young stellar objects (YSOs) in Serpens Main. Eleven of the echelle targets are known YSOs, including 2 objects with disks that are transitioning from optically thick to optically thin, known as transition disk objects which may be in the process of forming planets. The remaining objects are unclassified sources. Signatures of youth and surface gravity will verify the nature of these objects. Accretion rates will be estimated from the hydrogen, He I, O I, and Ca II IR triplet emission lines. These spectra will also be used to determine radial velocities (RVs) and infer the average velocity and velocity dispersion of the cluster. These data are part of a larger project to investigate the star forming history, initial mass function and disk evolution for YSOs in the Serpens molecular cloud

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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. Kristen's 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.

Program Management of a Microsatellite Project

Stephanie Evans
Department of Mechanical and Aerospace Engineering
Missouri University of Science and Technology
Advisor: Dr. Henry Pernicka

Abstract

In the engineering industry, organization and management play a crucial role in the successes or, in some cases, failures of projects. The Missouri University of Science and Technology's Satellite team (M-SAT) is no exception. The Air Force Research Laboratory has tasked M-SAT with designing, testing, and integrating a fully functional satellite in two years with a budget that would be considered minimal at best by larger industry entities. If this enormous task is to be accomplished, it is pertinent that the project is managed effectively and in such a fashion that keeps the team on task while still fulfilling the mission designed. Much is at stake due to the fact that the winner of this Air Force competition, named the Nanosat-7 Competition, is allotted a free launch as a secondary payload. The Program Manager of the team must fulfill his or her duties as effectively as possible while working with the team's Chief Engineer and Principal Investigator if this goal is to be realized as the competition draws to a close in January of 2013.

Stephanie Evans is from Mascoutah, Illinois. She graduated from Mascoutah Community High School in May of 2008 and is currently attending Missouri University of Science and Technology for her undergraduate degree. She is pursuing an aerospace engineering degree, and is planning on graduating in May of 2012. Stephanie is currently the Program Manager of the Missouri S&T Satellite team and hopes to pursue a career in the aerospace field that would involve testing and integration.

Optimization of Power Generation from Shrouded Wind Turbines

Tudor Foote
Department of Mechanical Engineering and Material Science
Washington University in St. Louis
Advisor: Dr. Ramesh K. Agarwal

Abstract

In past several years, several studies have shown that the shrouded wind turbines can generate greater power compared to bare turbines. The objective of this study is to determine the potential of shrouded wind turbines for increased power generation by conducting numerical simulations. An analytical/computational study is performed by employing the well known commercial Computational Fluid Dynamics (CFD) software FLUENT. An actuator disc model is used to model the turbine. The incompressible Navier-Stokes equations and a two equation realizable $k - \varepsilon$ model are employed in the calculations. The power coefficient Cp and generated power are calculated for a large number of cases for horizontal axis wind turbines (HAWT) of various diameters and wind speeds for both bare and shrouded turbines. The design of the shroud is optimized by employing a single objective genetic algorithm; the objective being the maximization of the power coefficient Cp. It was found that the shroud indeed increases the Cp beyond the Betz's limit significantly and as a result the generated power; this effect is consistent with that found in the recent literature that the shrouded wind-turbines can generate greater power than the bare turbines. The optimized shape of the shroud or diffuser further increases the generated power and Cp.

Tudor Foote completed his M.S is in the department of Mechanical Engineering and Materials Science at Washington University in St. Louis in December 2011. He is currently working as a Research Assistant in CFD laboratory

A Case Study of the Age and Location of Stars in Plausible Post-Merger Galaxies

Tim Haines
Department of Physics
University of Missouri – Kansas City
Advisor: Dr. Daniel McIntosh

Abstract

In simulations, it is found that merging two gas-rich spiral galaxies usually leads to starbursts and then on to a massive, quiescent spheroidal galaxy. The merger hypothesis for the formation of new elliptical galaxies provides a physical explanation to the observed buildup of this population. A key prediction is a brief phase of morphological transformation from highly-disturbed remnant to blue elliptical. Presented here is a study of 14 merger remnant candidates with varying degrees of morphological peculiarities visually selected from a larger parent sample of nearby ($0.01 \leq z \leq 0.04$), massive ($M \geq 10^{10}$ Msun), concentrated (Petrosian R90/R50 $\geq$ 2.6), and optically blue galaxies from the SDSS DR4 catalog. Using integral field spectroscopy, two-dimensional spectra are constructed and azimuthally binned into concentric annuli to determine the age of the stellar populations as a function of radius. Using this data and conclusions from simulations, a distinction between post-mergers and galaxies undergoing other modes of mass assembly is sought.

Tim Haines is currently a second-year graduate student in the department of physics at the University of Missouri-Kansas City. After completion of his master's degree, Tim plans to pursue a PhD in astronomy.

Antibiotic Control of Spaceflight Isolated *Staphylococcus aureus* Cultured in a Spaceflight Analog

Jeremy Harris
Department of Biochemistry
University of Missouri - Columbia
NASA Mentors: Dr. Duane Pierson and Dr. Mark Ott
Johnson Space Center

Abstract

The presence of humans in space is accompanied by the presence of microorganisms. The microgravity environment experienced during spaceflight is descriptive of quiescent, low fluid shear conditions. The NASA designed rotating wall vessel (RWV) cell culture systems acts as a spaceflight analog that mimics aspects of microgravity, in which only a very low level of fluid shear is experienced a cell as it is maintained in suspension. The low-shear modeled microgravity (LSMMG) environment created by the RWV has been shown to have drastic effects on the physiology of microbial pathogens and their behavior concerning potential hosts. As antibiotics are the treatment method for in-flight infections, it is of major interest to study how a microorganism, cultured in the RWV, will respond to antibiotic treatment. *Staphylococcus aureus* is an opportunistic human pathogen that is carried by approximately 40% of the population. Additionally, it is prevalent in the environment and has been isolated from the International Space Station. The culture of a spaceflight isolated *S. aureus* strain, under LSMMG conditions, revealed that it grew at a slower rate and to an overall lower concentration as compared to a control culture. Furthermore, using ciprofloxacin as the antibiotic of choice, demonstrated that *S.aureus* cultured in LSMMG was more susceptible to the antibiotic when in both the presence of an antibiotic inside the RWV, and when in the presence of an antibiotic outside of the RWV. Knowledge gained from this research will prove valuable in determining the proper course of treatment to microbial pathogenic infections experienced in-flight by astronaut crews.

Jeremy Harris is a senior in the Department of Biochemistry at the University of Missouri in Columbia.

Experimental Investigation of the High Gravity Startup and Operation Of 18-turn and 20-turn Oscillating Heat Pipe

Aaron Hathaway
Department of Mechanical and Aerospace Engineering
University Of Missouri - Columbia
Advisor: Dr. Hongbin Ma

Abstract

An experimental investigation of the thermal performance of three-dimensional flat-plate uneven turn oscillating heat pipes under unfavorable high acceleration loading. The bulk dimensions for the heat pipes were 30 x 30 x 2.54 mm^3. Two devices of each design were manufactured, and then charged with either acetone or water and tested on a spin-table centrifuge. It was found that the heat pipes operated and performed independently of the applied acceleration loading up to 10g's. It was also found that the OHPs were capable of starting and maintaining oscillating motion while already under ten time's gravitational acceleration (10g) with an increased maximum input power which is very different from a conventional oscillating heat pipe.

Aaron A. Hathaway is from Chicago, IL. And received both his Masters of Science and Bachelors of Science in Mechanical Engineering from the University of Missouri Columbia. He is currently a Doctoral Candidate in Mechanical Engineering at the University of Missouri Columbia. Aaron's career goal is to go into the defense industry and perform research and development.

Searching for Interacting Elliptical Galaxies at Late Cosmic Times

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

Abstract

Major gas-poor (dry) mergers between two high-mass spheroidal galaxies are postulated to be the central mechanism responsible for the assembly of giant elliptical galaxies. Numerical simulations predict that such galaxies may form at late cosmic times and typically in dense environments. The SDSS Galaxy Groups Catalog is an ideal resource to search for massive dry mergers. Yet, the signatures of such interactions are short-lived and often too faint to be clearly detected visually in the shallow SDSS. To better constrain the frequency of these mergers, a unique sample of elliptical pairs with combined stellar masses Mstar > 10^11 Msun and residing in common host groups at low redshift (z<0.12) were investigated. 1.5 mag deeper V-band images for 38 pairs with no visible interaction signs according to a previous SDSS-based analysis were obtained. Being able to identify and quantify interacting pairs of galaxies will put a better constraint on of the growth rate of giant ellipticals.

Xiachang Her is a second year master 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 summer of 2012, Xiachang would like to continue his education by pursuing a doctorate in astrophysics.

Utilization of Satellite Remote Sensing for Assessment of the Impact of Cattle Ranching on Desert Ecosystems

Lisa Herbert
Department of Earth and Planetary Sciences
Washington University in St. Louis
Advisor: Professor Raymond E. Arvidson

Abstract

Grazing cattle adversely affect the delicate ecosystems of desert environments. They destroy the fragile biological crusts that supply nutrients to otherwise infertile soil. Grazing raises the albedo of the soil, so the higher albedo could be detectable from satellite imagery. Albedo analysis could thus indicate the range of the grazing cattle and the extent to which the disturbed soil is damaged.

Lisa Herbert, a native of Laramie, Wyoming, is a freshman in the College of Arts and Sciences at Washington University. She is considering majoring in Earth and Planetary Sciences to pursue her interests in the environment and in planetary sciences. She is a participant in the Pathfinder Program in Environmental Sustainability.

BORAT (The Baker Observatory Robotic Autonomous Telescope)

Lee Hicks and Matthew Thompson
Department of Physics, Astronomy, and Material Science
Missouri State University
Advisors: Mike Reed and Lloyd Smith

Abstract

The Baker Observatory Robotic Autonomous Telescope project is described. The hardware includes a 16 inch Meade LX-200 telescope, an AstroHaven 7 foot dome, an Apogee U47 CCD camera and filter wheel, a Boltwood Cloud Sensor II, and various other minor hardware. RTS2 for the Telescope Control System is being implemented and custom drivers for ancillary systems are incorporated.

Lee Hicks is from Conway, MO. He is currently studying Computer Science at Missouri State University. After completing his undergraduate program he plans to complete his Master of Natural and Applied Science degree.

Matthew Thompson is from Hardin, MT. He completed his bachelor's degree at Missouri State University in Computer Science in 2010. Currently, he is employed by Intuitive Web Solutions in Springfield, MO and is working towards a Masters in Natural and Applied Science at Missouri State.

Star Formation in the Serpens Molecular Cloud

Krystal Kasal
Department of Physics and Astronomy
University of Missouri St. Louis
Advisor: Dr. Bruce Wilking

Abstract

The goal of this study is to gain a better understanding of star formation, particularly star formation occurring in the Serpens molecular cloud. In order to accomplish this, we find ages and masses of the stars in the star forming region. Spectra were taken from the Bok 2.3 meter telescope at Kitt Peak, AZ., the WIYN 3.5 meter telescope at Kitt Peak Az., and the MMT 6 meter telescope at Mount Hopkins AZ. Spectral types and temperatures were determined for each source and the luminosity calculated in order to make Hertzsprung-Russell (H-R) diagrams. The sources were determined to be either association members of Serpens, extinction members, or "other". H-R diagrams were made for each of the groups to determine ages and masses. According to the H-R diagram, the sources that are likely to be YSOs in Serpens range in mass from 0.12 solar masses to about 3 solar masses and have a median age of 3 million years.

Krystal Kasal is a senior at UMSL, majoring in physics with an emphasis in astrophysics. She plans on going to graduate school next year. Krystal hopes to get her PhD in physics and continue doing research in the future.

CFD Modeling of Mixed Convection Flows in Building Enclosures

Alexander Kayne
Department of Mechanical Engineering & Materials Science
Washington University in St. Louis, St. Louis
Advisor: Dr. Ramesh K. Agarwal

Abstract

In recent years Computational Fluid Dynamics (CFD) simulations are increasingly used to model the air circulation and temperature environment inside the rooms of residential and office buildings to gain insight into the relative energy consumptions of various HVAC systems for cooling/heating for climate control and thermal comfort. This requires accurate simulation of turbulent flow and heat transfer for various types of ventilation systems using the Reynolds-Averaged Navier-Stokes (RANS) equations of fluid dynamics. Large Eddy Simulation (LES) or Direct Numerical Simulation (DNS) of Navier-Stokes equations is computationally intensive and expensive for simulations of this kind. As a result, vast majority of CFD simulations employ RANS equations in conjunction with a turbulence model. In order to assess the modeling requirements (mesh, numerical algorithm, turbulence model etc.) for accurate simulations, it is critical to validate the calculations against the experimental data. For this purpose, we use three well known benchmark validation cases, one for natural convection in 2D closed vertical cavity [1], second for forced convection in a 2D rectangular cavity and the third for mixed convection in a 2D square cavity [3]. The simulations are performed on a number of meshes of different density using a number of turbulence models. It is found that k-ε two-equation turbulence model with a second-order algorithm on a reasonable mesh gives the best results. This information is then used to determine the modeling requirements (mesh, numerical algorithm, turbulence model etc.) for flows in 3D enclosures with different ventilation systems. In particular two cases are considered for which the experimental data is available. These cases are (1) Air flow and heat transfer in a naturally ventilated room [4] and (2) Airflow and temperature distribution in an atrium [5]. Good agreement with the experimental data and computations of other investigators is obtained.

Alexander Kayne is a B.S/M.S student in the department of Mechanical Engineering and Materials Science at Washington University in St. Louis. He is currently working as a Research Assistant in the CFD laboratory and plans to graduate with M.S degree in May 2012.

Compact Reconnaissance Imaging Spectrometerfor Mars (CRISM) Along Track Oversampled (ATO) Observations

Christina D. Kreisch
Department of Earth and Planetary Sciences
Washington University in St. Louis
Advisor: Raymond E. Arvidson

Abstract

The Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) on the Mars Reconnaissance Orbiter (MRO) has been imaging the surface of Mars since 2006 in order to obtain more information about Mars's mineralogy. By studying the mineralogy of Mars, CRISM can help reveal more information about the presence of water on the red planet. The images taken are normally Full Resolution Targeted (FRT) images, where the distance between each pixel corresponds to about 15-19m on Mars. However, CRISM has recently begun to take Along Track Oversampled (ATO) images, where the distance between each pixel is less than 18m, in order to obtain even more information about the planet's mineralogy from the images. This study aims to characterize and determine the amount of oversampling in the ATO images. The distances between pixels in an ATO image and a regular FRT image of Botany Bay and Cape York are analyzed and compared with plots and map projections. There is significant overlap in the ATO compared to the FRT, and most of the overlap is in the along track direction, although there is a small amount in the cross track direction, as well. The clarity of the virtual mosaics confirms that the overlap in the ATOs allows for more information to be obtained from the ATO images.

Christina Danielle Kreisch is a Lake St. Louis, MO native and is currently a freshman attending Washington University in St. Louis where she is a Steve Fossett Fellow and Eliot Scholar. She is majoring in Physics, and will potentially double major in Mathematics and minor in Philosophy.

Optical Imaging of Reaction-Driven Fluid Instabilities

Samantha Lampe
Department of Physics and Mathematics
William Jewell College
Advisor: Patrick H. Bunton

Abstract

Fluid instabilities are of importance to wide ranging technologies from aeronautics to petroleum recover. Recent experiments have shown that the presence of chemical reactions at the fluid interface can significantly alter the instabilities that occur and their symmetries. Schlieren, shadowgraph, and interferometric techniques are being tested to optimize visualization of chemical-reaction-driven flow instabilities. Systems are being designed wherein the degree of reactivity can be tuned to yield new insight into these instabilities.

Samantha Lampe is a sophomore physics major at William Jewell College. She is originally from Falls City, Nebraska. Samantha plans to pursue a Ph.D. in physics or related field.

Visual-based Navigation through Stereoscopic Imaging

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

Abstract

Proximity operations and small satellite fleets are of growing interest to the satellite industry. Small satellites provide a modular approach to satellite systems and design, where several small satellites in close proximity can perform the same functions as a larger satellite for a fraction of the price. These operations, however, demand close maintenance of the satellites' formation and orbital states. These requirements can be met with a relatively simple stereoscopic imaging system for small satellites, which is being designed and implemented on the Missouri University of Science and Technology Satellite team's Missouri-Rolla Satellite (MR SAT).

Keith LeGrand is a sophomore in the Department of Mechanical and Aerospace Engineering at the Missouri University of Science & Technology in Rolla,MO.

Toward a Complete Spectroscopic Sample of Low-Redshift Galaxy Interactions

Justin Mann
Department of Physics
University of Missouri - Kansas City
Advisor: Dr. Daniel McIntosh

Abstract

The Sloan Digital Sky Survey (SDSS) spectroscopic sample has been a tremendous success for understanding galaxy properties, populations, and environments at late cosmic times. But even with one million galaxies with high (92%) average completeness, the spectroscopic fiber geometry causes a systematic incompleteness for close galaxy pairs, which critically impacts the UMKC Galaxy Evolution Group's work on understanding interacting galaxies. A subset of SDSS DR4 (63,455 galaxies with stellar mass > 10^{10} solar masses and z < 0.08) was visually inspected and over 1900 pairs of galaxies with signs of gravitational interaction (e.g., tidal tails, significant asymmetry) and small projected separations (<50 kpc) were found. Among these pairs, 45% had spectra for both galaxies, 51% had only one spectrum, and 4% had no spectroscopic information from SDSS. For the subset with dual spectroscopy, 78% were found have velocity differences of less than 500 km/s, confirming their close physical proximity. An improved understanding of galaxy interactions and merger progenitors requires better statistics on confirmed close pairs. A pilot campaign to increase the spectroscopic completeness of the sample using the KPNO 2.1m telescope is discussed.

Justin Mann has been doing research with Dr. Daniel McIntosh and the Galaxy Evolution Group at the University of Missouri - Kansas City since the spring of 2010. This is now his final semester as an undergraduate. Justin will be graduating with a BS in Mathematics and Physics intends to pursue a PhD in Physics or Astronomy.

Molybdenum Oxide Electrochromics and Anode Properties

Aron McCart
Department of Physics, Astronomy, and Material Science
Missouri State University

In this paper we describe the deposition and characterization of thin films of molybdenum oxide (MoO_x). MoOx films were deposited by pulsed laser deposition (PLD) and electrodeposition. MoO_x has attracted wide spread interest because they make excellent anodes for lithium ion batteries. MoO_x also exhibits electrochromic properties and hence can be used in smart windows. MoO_x samples were deposited using PLD at various oxygen levels. A 238nm Krypton laser with energy 300mJ/pulse was used to ablate a MoO_x target. The ablated material then traveled by line of sight on to a glass substrate. Visually, the color of the films varied with oxygen content. The color of the films changed from dark to transparent with increasing oxygen content. Once deposited the samples were also characterized by x-ray diffraction. Also, MoOx thin films were deposited using electrodeposition for possible applications in lithium ion batteries. The electrolytic cell contained molybdic acid for the electrolyte, stainless steel for the substrate, and a graphite plate acted as the counter electrode. The characterization and results will be discussed in greater detail.

Aron McCart is a Senior student in the Deparment of Physics, Astronomy, and Material Science at Missouri State University.

Non-Symmetric Responses in Symmetric Structures

Joe Neal
Department of Mechanical and Aerospace Engineering
University of Missouri - Columbia
Advisor: Dr. Frank Feng

Abstract

In physical systems, a symmetric structure is often subjected to a symmetric and consistent force. Examples of such systems include factory machinery or even a train that symmetrically bounces up and down while traveling on the tracks. If these systems continue to respond symmetrically and consistently at a singles steady state, there are few issues; however, serious problems could arise if they begin to oscillate asymmetrically (symmetry breaking), inconsistently, or at extreme amplitudes. To investigate the potential for symmetry breaking and multiple steady state oscillations in symmetric structures, a simple pendulum model was developed. The response of a pendulum is well-understood, and modeling the system is much simpler than complex systems such as a train on rails. Using MATLAB and the built-in ode45 function, simulations were run to study the response of a single pendulum and coupled and uncoupled multiple pendulum systems subjected to symmetric forcing. Using the angular displacement outputs, steady state amplitudes corresponding to specific forcing frequencies and forcing amplitudes were calculated. Plots of steady state amplitude versus forcing frequency were created to analyze the existence of multiple steady state responses at a single forcing frequency. This phenomenon was shown to occur with the single pendulum and coupled and uncoupled multiple pendulum systems. These results suggest that symmetry breaking and the existence of multiple steady state responses for symmetric structures can occur in reality. Still, there is room for improvement in the pendulum model and more simulations should be conducted to verify results.

Joe Neal is a senior at the University of Missouri and will be graduating in May 2012 with a bachelor's degree in Mechanical Engineering with an aerospace emphasis. Joe was born in Columbia, MO and has lived there his entire life. He was valedictorian of his high school class of 550 students and has maintained a 3.94 GPA throughout his college career. He has conducted undergraduate research each semester in college and has completed two summer internships. The first was at NASA's Marshall Space Flight Center in Huntsville, Alabama working in the propulsion systems department, and the second was at DRS Technologies Inc. in St. Louis, Missouri as part of the Cornwell Student Initiative Internship. After he graduates, Joe will be attending Purdue University with RA support to obtain his Masters of Science degree in Aerospace Engineering. Joe hopes to then get a job in the aeronautical/defense industry.

A Cratering History of Callisto

Luke Nowicki
Department of Earth and Planetary Sciences
Washington University in St. Louis
Advisors: William B. McKinnon and Kelsi N. Singer

Abstract

By mapping craters on Callisto, data to better understand the cratering records of all Jupiter's moons is being gathered. To accomplish this task, a region of Callisto with suitable imagery was selected and its craters were identified and recorded. These craters can then be analyzed to develop a better understanding of the cratering history of Callisto, and by extrapolation the cratering history of the outer solar system in general.

Luke Nowicki is a senior in the Department of Earth and Planetary Sciences at Washington University in St. Louis.

Investigating Condensation Rates with Q-DLTS

J.P. O'Keeffe
Nuclear Science and Engineering Institute
University of Missouri
Advisors: M.A. Prelas and S.K. Loyalka

Abstract

Presented is the current progress on an investigation into the rate of adsorption of various vapors onto AlN and silicon sensors. As vapors adsorb onto the sensor surface, new traps are created. Charge-based deep level transient spectroscopy (Q-DLTS) is used to measure the change in the trap density over time. A curve is fit to this data and differentiated to obtain a function for the rate of change in the trap density, which is proposed to be proportional to the growth rate of the adsorbate layer. Theory is developed to predict the growth rate of the film, and comparisons are made with experimental data. A curve obtained from the adsorption of water vapor onto AlN exhibits the same nature as predicted by the theory, but further work is needed to produce a more quantitative comparison. A fabrication method for silicon sensors is still being pursued.

John "Patrick" O'Keeffe was born in Ft. Hood, Texas on January 26, 1988. He attended public schools in Kitzingen, Germany, Ft. Lewis, Washington, Ft. Carson, Colorado, and Rolla, Missouri. He continued his education at the University of Missouri in Columbia, Missouri and received a Bachelor of Science degree in both Physics and Mathematics in December 2010. In January 2011 he began the pursuit of his Master of Science degree in Nuclear Engineering at the University of Missouri, which he expects to complete in July 2012.

The Thickness of the Venusian Crust and Lithosphere

C. P. Orth and V. S. Solomatov
Department of Earth and Planetary Sciences
Washington University in Saint Louis
Advisor: V. S. Solomatov

Abstract

Thermal isostasy is a reasonably accurate model for the topography and gravity anomalies associated with a convecting system (at least under certain conditions). The globally variable crustal thicknesses is added to the thermal isostasy model to achieve a near perfect match between the observed and modeled geoid anomalies. It is assumed that the stagnant lid (including both the lithosphere and the curst embedded in the upper part of the lithosphere) overlying a convective mantle is in isostatic equilibrium and ignore any contribution of dynamic, elastic, and transient effects on the topography and geoid (the isostatic stagnant lid approximation[1]).

Christopher Orth is a doctoral candidate in the Department of Earth and Planetary Sciences at Washington University in St. Louis.

Subdwarf B Stars

Marcus Shadwick
Department of Physics, Astronomy, and Material Science
Missouri State University
Advisor: Mike Reed

Abstract

The study of Subdwarf B (sdB) stars is desirable to fit evolutionary models. The optical and UV wavelengths to collect data from Feige 48, a pulsating sdB star, were used. The findings indicate three pulsation periods ranging from 344 to 352 seconds with amplitudes less than 1%. These periods allow the match of evolutionary models to observed data, thus allowing for the evaluation of stellar evolutionary models.

Marcus Shadwick resides in Springfield MO and attends MSU as a Math Major and Astronomy Minor undergraduate. Marcus' goal is to earn his doctorate in Mathematics and use the knowledge gained to enter into the field of Asteroseismology

Sulfate and Phyllosilicate Mapping of the Rio Tinto Area of Spain: Implications for Identifying Areas of Potential Biopreservation on Mars

Christine Simurda
Department of Earth and Planetary Sciences
Washington University in St Louis
Advisor: Raymond Arvidson

Abstract

The identification of hematite and jarosite in the Meridiani Planum region on Mars indicates the presence of a past acidic aqueous environment. In order to better understand the formation of these minerals, terrestrial analogs provide an exceptional comparison that allows for human interaction and further laboratory investigation. The Rio Tinto area in southern Spain is an ideal terrestrial analog for the Meridiani Planum on Mars since the river is an extremely acidic aqueous system with an extensive microbial community. During the summer of 2007, 18 sites were visited south of Berrocal where the Rio Tinto River merges with a neutral stream. Both reflectance and emission spectra were taken in the field to analyze the endmember phases present at each site and to determine the general mineralogy of the region. Collaboration with Dr. Victor Parro from the Centro de Astrobiologia in Madrid, Spain, aimed to verify whether any of the sites analyzed along the Rio Tinto River preserved biological markers. Analysis of the reflectance and emission data from the field indicated that samples closer to the current river flow exhibit higher concentrations of sulfates and iron-oxides, while higher levels of phyllosilicates are found with increasing distance from the river. The antibody microarray testing demonstrated that biosignatures are best preserved in areas dominated by phyllosilicates and in lower layers protected from surface weathering. The goal of the continued collaborative study of these sites is to determine possible locations on Mars with biopreservation and to verify the proposed past aqueous system on Mars.

Christine Simurda completed her bachelor's degree at Washington University in St. Louis in December 2011. During her undergraduate years, she conducted research in the Remote Sensing Laboratory and studied Geophysics as an Earth and Planetary Science major. Christine's professional goals include pursuing a graduate program in Planetary Geoscience and eventually teaching at a distinguished university

Photoelectric Properties of Carbon Nanotubes in Solar Cells

Glenn Starke
Department of Natural Sciences
Lincoln University of Missouri
Advisor: Majed Dweik Ph.D

Abstract

Observations indicate that certain quantum effects occur when carbon is exposed to photonic radiation. This experiment was designed to demonstrate that such phenomena can be taken advantage of in the construction of a low cost, not toxic, recyclable solar cell. Copper wire conductors and carbon nanotubes were fixed on a clear, non-conducting, glass slide by means of a clear drying polymer adhesive. Another slide with a conductive surface was coated manually with a Titanium Oxide paste and allowed to air dry for 24 hours. The slides were clipped together with a 1/16 inch spacer on what was used as the top portion of cell. The cell was placed in a stand at a 45 degree angle with a variable light source. An electrolytic solution containing lemon juice and red wine vinegar (5% acidity) mixed 1 to 1 was introduced by means of dropper. Readings were taken without exposure to the light source and with the light source set at 150, 200 and 250 watts. Then a reflector, a mirror with minimal concavity, was introduced behind the cell. Readings were taken again at 150, 200 and 250 watts. This construction resulted in a cell that provides sustained low output readings that only vary with light intensity. The introduction of a reflector substantially increased electron flow. Further research is indicated to explore if controlled thickness of layers and alignment of nanotubes would increase efficiency. Additionally, an exploration and investigation is indicated as to why the introduction of a reflector so significantly increases electron flow.

Glenn Starke is a senior in the Department of Natural Sciences at the Lincoln University of Missouri in Jefferson City.

Yellow Supergiants: A Heterogeneous Group of Variable and Non-variable Stars

Henry G. Stratmann
Department of Physics, Astronomy, and Material Science
Missouri State University
Advisor: Dr. Robert S. Patterson

Abstract

Yellow supergiant (YSG) stars traverse the Cepheid instability strip during their evolution. However, not all YSG stars have been found to be variable. Observations of seven program YSG stars were made at the Missouri State University Baker Observatory between August and October 2011 to assess their variability. The observatory's 0.36 m telescope and Apogee u77 CCD camera were used to acquire images. One or both of two spectral class A or F visual binaries were imaged during each observing session for purposes of quality control. Five of the program YSG stars showed no variability at a precision level of 1%. One other YSG star showed probable low-level variability and the remaining YSG star, UU Her, a known variable star, showed clear variability. Our results support the idea that not all YSG stars are variable. Although they have some similarities, YSG stars appear to represent a heterogeneous group of post-main sequence stars. Differences contributing to the presence or absence of significant variability might include their particular stage of evolution, mass, or chemical composition.

Henry G. Stratmann is a senior in the Department of Physics, Astronomy, and Material Science at Missouri State University in Springfield, MO.

Thermal Implications for a Prairie Dwelling Turtle (*Terrapeneornata*)

Charles Tucker
Missouri State University
Advisor: Day Ligon

Abstract

Maintaining body temperatures within an appropriate range is essential for the metabolic function of all animals. Ectothermic animals employ many thermoregulatory strategies, but behavioral thermoregulatory mechanisms are not available during long sessile subterranean periods such as hibernation or incubation. During these periods an ectothermic animal's body temperature will approximate that of the surrounding substrate, which often varies by depth. Nest depth selection is critical in species that display temperature dependent sex determination (TSD), such as Ornate Box Turtles. In these species, hatchling sex is determined by the temperature of the eggs during development, meaning that clutch depth can determine the sex ratio of a population and thus its propensity for growth and ability to remain viable. Subterranean oviposition may modulate nest cavity temperatures by allowing deeper deposition of eggs. This study aims to document this rare behavior and verify that deeper deposition leads to cooler incubation temperatures. Using miniature data loggers, the temperatures of natural Ornate Box Turtle nests on a sand prairie in northwestern Illinois were recorded. Preliminary data show that temperatures are within the range of temperatures that would produce a relatively even sex ratio. Because clutch temperature varies with depth subterranean oviposition may represent a behavioral mechanism allowing deeper deposition of eggs, thus ensuring cooler incubation temperatures. This behavior may be important for the maintenance of even sex ratios in the face of changing thermal regimes and may provide an adaptive mechanism for this species to cope with climate change.

Charlie Tucker is from Saint Paul, Minnesota and has a BS in wildlife ecology and an MS in restoration ecology from UW-Madison. He is currently seeking an MS in Biology from Missouri State University studying the activity patterns, reproductive habits and conservation of Ornate Box Turtles. In the future, Charlie hopes to contribute to research with natural resource management implications that will be relevant on a landscape scale.

Identifying Massive First-Generation Elliptical Galaxies in the SDSS

Cory R. Wagner[1], Daniel H. McIntosh[1], Allison M. Christian[1,2], Andrew Cooper[1], Tim Haines[1], Justin Mann[1], H. J. Mo[3], Frank C. van den Bosch[4], Xiaohu Yang[5]
[1]Department of Physics, University of Missouri - Kansas City
[2]Massachusetts Institute of Technology
[3]University of Massachusetts
[4]Yale University
[5]Shanghai Astronomical Observatory
Advisor: Dr. Daniel H. McIntosh

Abstract

The growth of massive red elliptical galaxies has dominated galaxy evolution over the last eight billion years. Although the net growth has been well established observationally, there are a number of physical processes that are thought to be responsible and their relative roles have yet to be constrained in detail. Foremost, major spiral-spiral mergers are predicted to form new ellipticals, which should experience rapid morphological transformation from post-merger remnants, to disturbed and then relaxed ellipticals with blue colors, and finally quenched red systems. To better constrain the portion of "first-generation" ellipticals added at late cosmic times; 1300 normal ellipticals, 100 peculiar ellipticals, and 100 post-mergers were visually identified from a complete sample of 8000 massive, blue, early-type galaxies (ETGs) at low redshift ($z<0.08$) in the SDSS. These galaxies were found to be structurally matched to red ellipticals of the same mass. Yet, other processes that simply add mass to existing ellipticals (e.g., minor merging, gas accretion) may also result in blue ellipticals with varying levels of morphological disturbances, complicating the ability to clearly identify true first-generation ellipticals. To better constrain the contributions of different elliptical growth modes, the core colors and nuclear spectra of galaxies in the visually-identified subsets were investigated.

Cory Wagner is a senior at the University of Missouri in Kansas City, majoring in Physics and Computer Science. He has been working with Dr. McIntosh in his Galaxy Evolution Group since May 2010. Upon graduating in the spring of 2012, Cory would like to continue his education by attending graduate school and pursuing a master's degree in astrophysics.

Numerical Investigation of Plasma Actuator Configurations for Flow Separation Control

Thomas K. West IV
Department of Mechanical and Aerospace Engineering
Missouri University of Science and Technology
Advisor: Dr. Serhat Hosder

Abstract

The primary objective of the study presented in this paper was to analyze the effectiveness of aerodynamic plasma actuators as a means of active flow control over a low speed airfoil. Detailed parametric studies based on steady and unsteady Navier-Stokes simulations were performed for a NACA 0012 airfoil at a chord Reynolds number of 10^5. In particular, parametric studies were performed to investigate the influence of the number, the location, the imposed body force magnitude, and steady vs. unsteady operation of actuators on the flow control effectiveness and power requirements. The effectiveness of plasma actuators was studied when applied to the airfoil at a relatively low angle attack, which involved the development of a laminar separation bubble (LSB). The results show that plasma actuators can provide significant improvement in aerodynamic performance for the flow conditions considered in this study. For LSB control, as much as a 45% improvement in the lift to drag ratio was observed. Results also show that the same improvement can be achieved using an unsteady or multiple actuators, which can require as much as 75% less total body force magnitude compared to a single steady actuator.

Thomas Kelsey West IV was born on July 29, 1987 in Lake St. Louis, MO. After graduating from Troy Buchanan High School in Troy, MO in 2006, he began his undergraduate education at the Missouri University of Science and Technology in Rolla. Over the course of his undergraduate education he was selected for the NASA Undergraduate Student Research Program where he spent a semester at NASA's Jet Propulsion Laboratory in 2008. In 2010, Thomas graduated Summa Cum Laude, earning his Bachelor of Science degrees in both Aerospace Engineering and Mechanical Engineering, as well as an undergraduate minor in Applied Mathematics. He then continued his education, earning a Master of Science degree in Aerospace Engineering in 2012. Currently, Thomas is in pursuit of a Doctoral Degree in Aerospace Engineering at Missouri S&T.

Development of Intrinsic Thermocouple Arrays

Cody Williams
Department of Mechanical and Aerospace Engineering
University of Missouri-Columbia
Advisor: Dr. Frank Feng

Abstract

The Department of Defense is currently working on new technology for defense against ballistic missiles. To aid in improving the technology, the ability to measure temperature distributions needs to be improved. Current techniques to obtain temperature distribution measurements consist of attaching several traditional thermocouples to the test material. Research is being conducted to find a more convenient way to determine temperature distributions. Such a way is through the use of intrinsic thermocouples. Rather than using two dissimilar wires as in a traditional thermocouple, an intrinsic thermocouple consists of single wires and a plate of a dissimilar metal to create the thermocouple. The plate then can be used to measure the temperature distribution. An intrinsic thermocouple made of a stainless steel 304 plate and constantan wire was tested. The constantan wires were spot-welded to the stainless steel plate and the intrinsic thermocouple was connected to a Multifunction Input/Output box. The I/O box was connected to a LabView program through a USB cable and the intrinsic thermocouple was tested over the temperature range of 60-300 °C in a controlled oven. Two calibration curves were obtained and compared to observe similar trends and to understand sources of error and uncertainty. The results show promise that intrinsic thermocouples have the potential and ability to measure temperature distributions. With further refinement intrinsic thermocouples could be a primary method of exploring material reaction to directed energy heating.

Cody Williams is a senior at the University of Missouri-Columbia, majoring in Mechanical and Aerospace Engineering; and will graduate in May 2012. He was born in Sedalia, MO, but attended Smithton High School. Cody currently holds a 4.0 GPA in his college career and hopes to maintain that for this last semester. Last summer he interned in the design department at Hayes Lemmerz, a steel wheel manufacturing company, and just recently has accepted an offer of employment at Burns and McDonnell where he will be starting in the middle of June and working in the Nuclear Division.

Characterization of Deep Centers in Semi-Insulating 4H-SiC: An Application of Charge Based Deep Level Transient Spectroscopy

Denis Wisniewski
Nuclear Science and Engineering Institute
University of Missouri-Columbia
Advisor: Dr. Mark Prelas

Abstract

In this paper, an attempt to characterize the deep level traps in high-purity semi-insulating (undoped) 4H-SiC is presented. These traps were measured by a method known as Charge Based Deep Level Transient Spectroscopy (Q-DLTS). Unlike other DTLS methods, Q-DTLS allows measurements of high resistivity samples to be made. By varying the sample rate and temperature, this method provides the ability to determine the capture cross-sections, activation energies, and emission rates of traps present in the semiconductor material.

Denis Wisniewski is originally from Kansas City, MO, and is a first year masters student at the Nuclear Science and Engineering Institute at the University of Missouri – Columbia. His current work is in the study of radiation damage to silicon carbide. Applications of this research include sensor technology, radiation detection, and nuclear batteries. Denis intends to finish his master's degree by the end of this year and move on to the Ph.D. program.

Turbulence Modeling of Flows with Roughness and Rotation

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

Abstract

Accurate simulation of turbulent flow on surfaces with roughness remains a difficult and challenging problem in turbulence modeling. Although there have been many attempts to develop turbulence models for rough wall flows, the predictions have been unsatisfactory when compared to the experimental data. In this project, one of the goals is to improve the prediction capability of existing one-equation models. Two well known one-equation models are considered, the Spalart-Allmaras model [1] and the modified Baldwin-Barth model [2]. Flow over a NACA 0012 airfoil is considered. For this airfoil, experimental data is available [3] for both the smooth and rough airfoil. Computations are performed using the well known commercial CFD solver FLUENT and the open source CFD code OpenFOAM. A comparison of results using the Spalart-Allmaras model and a low Reynolds number extension of the Baldwin-Barth model is performed. The Spalart-Allmaras model is derived using empiricism and arguments of dimensional analysis (having no link to the k-ε model), whereas the modified Baldwin-Barth model is derived using the theory behind the k-ε closure. Both models are used to compute the flow over smooth and rough NACA 0012 airfoil at angles of attack of 6, 8 and 10 degrees for a Reynolds number of 6 million. The results are compared with the experimental data. Roughness corrections are then added to each model to create the capability for accurate prediction of flows over rough surfaces. A roughness correction for the modified Baldwin-Barth model is developed. The roughness correction of the Spalart-Allmaras model is taken from the literature [4]. The models are used to compute the flow over rough airfoils and results are compared with the experimental data. To account for rotation and curvature effects that occur in flow in turbomachinery, these models are again modified. The rotation correction for the modified Baldwin-Barth model is developed while the Spalart-Allmaras correction is taken from literature [5]. A progress report towards the development of these models and their application is presented in this paper.

Tim Wray is a PhD student in the department of Mechanical Engineering and Materials Science at Washington University in St. Louis. He is currently working as a Graduate Research Assistant in the CFD laboratory.

Missouri S&T Advanced Aero Vehicle Group

Nick Eplin
Department of Mechanical and Aerospace Engineering
Missouri University of Science and Technology
Advisor: Dr. Walter Eversman

Abstract

The Advanced Aero Vehicles Group (AAVG) aims to design and construct a heavy-lift, fixed wing, remote-controlled aircraft for entry into the Society of Automotive Engineers (SAE) Aero-Design East competition in Marriata, GA from April 27-29 2012. The objective of the competition is to offer undergraduate and graduate engineering students an opportunity to design and construct a radio controlled aircraft capable of lifting a large, weighted payload. At competition, these aircraft compete against other top technological and engineering universities where the triumphant aircraft lifts the largest fractional payload versus structural (empty) weight and measures liftoff and landing distances.

Moreover, besides the Aero Design West competition, AAVG is once again immersed in preparation to gain admittance to the University Student Launch Initiative (USLI), a NASA sponsored high-powered rocketry competition scheduled for April 21, 2012 in Huntsville, Alabama. The premise of the competition is to challenge university-level engineering students to design and assemble a reusable rocket with scientific payload that must ascend to one mile in above ground altitude. After recovering the vehicle, students must analyze the gathered payload data and report their findings and how these findings correlate to scientific merit. Several awards are available for fulfilling specific goal criteria: vehicle and payload design, project review, outreach, web design, closest to altitude, visual appearance, team spirit, rookie award, and best overall composite score. USLI affords AAVG further opportunity to compete amongst internationally prestigious technological and engineering institutions. In 2011 Missouri University of Science and Technology achieved the award for best looking peer award and hopes to build on that success and look for more innovative payload designs to capture more awards this upcoming year.

Nick Eplin, President
Zach Lucker, Chief Engineer (SAE)
Jacob Sinclair, Chief Engineer (USLI)
Heather Steele, Secretary
Jonathon Boerema, Treasurer
Ha-Oun Son, Business Manager

Enhancing the Multidisciplinary Astrobiology Research Community at Truman State University

Amare Assefa, Michael "Mikey" Hermann, Rachel Kreher, Katie Loock, Alexis Morris, Jessica Olson, Erin Sanders, Dorian Shimotani, Caleb Smith, and Marie Young
Truman State University
Advisors: Dr. Marc Benson, Dr. Laura Fielden, Dr. Vauyjeet Gokhale, Dr. Maria Nagan, and Dr. Eric Patterson

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. Five teams composed of one faculty and two undergraduate students pursued astrobiology research projects and participated in weekly community-building events. This project supported the activities of the astrobiology research program at Truman, strengthened the new Center for Astrobiology, and inspired students from a range of science disciplines to consider careers in astrobiology. A total of ten students and five faculty members from Biology, Chemistry, and Physics participated in activities sponsored by this project.

Amare Assefa is a senior chemistry and biology double major from St. Peters, MO. This is Amare's second year working in the interdisciplinary astrobiology program at Truman State University, under the direction of Dr. Eric Patterson. Upon graduation, Amare plans to attend medical school.

Michael "Mikey" Hermann is a sophomore physics major from St. Genevieve, MO. This is Mikey's first year working in the interdisciplinary astrobiology program at Truman State University, under the direction of Dr. Vayujeet Gokhale.

Rachel Kreher is a sophomore at Truman State University. She grew up in Smithton, IL, approximately 45min SE of St. Louis. She recently became an Anthropology major, with Physics, Math, and French minors. She is considering a double major with Anthropology and Physics. This is her first year working in the astrobiology program under the direction of Dr. Vayujeet Gokhale. She learned about the opportunity through her work as secretary of the Stargazers (astronomy) club.

Katie Loock is a junior biology major from St. Louis, MO. This is Katie's first year working in the interdisciplinary astrobiology program at Truman State University, under the direction of Dr. Laura Fielden.

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UMSL Fifth Grade Astronomy Outreach Program

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Abstract

The University of Missouri–St. Louis has directed a Fifth Grade Elementary School Outreach Program since 1992 with funding from the NASA/Missouri Space Grant Consortium. The program is designed to enhance the curriculum requirements of the Missouri Department of Elementary and Secondary Education. Students attend a variety of presentations including: a slide show on stellar evolution and the planets, a planetarium show, and comet and liquid nitrogen demonstrations. One hundred percent of the teachers reported in the Program Evaluation that the planetarium program is worth the time and effort necessary to arrange the field trip, and that they are inclined to request a similar visit in the future. In addition, all teachers stated that the program increases students' interests in math, aerospace sciences, and engineering.

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