Table of Contents

MT - 17-EPSCoRProp-0001

Exploring Extreme Gravity: Neutron Stars, Black Holes and Gravitational Waves

SMD

Director: Angela Des Jardins

Sc-I: Nicolas Yunes

This proposal is focused on (i) nuclear physics in extreme gravity, (ii) experimental relativity in extreme gravity, and (iii) multi-messenger astrophysics in extreme gravity. Regarding (i), we propose to improve and develop new tools to extract the most astrophysics from X-ray data obtained with NASA's Neutron star Interior Composition ExploreR (NICER). These tools will allow for precise constraints on the neutron star equation of state through measurements of their mass and radius. Regarding (ii), we propose to create a framework through which to test General Relativity with both gravitational wave data from the Laser Interferometer Space Antenna (LISA) and X-ray data from NICER in a robust and model-independent fashion. This framework will allow for consistency checks of Einstein's theory and the search for modified gravity anomalies with neutron stars and black holes. Regarding (iii), we propose to learn about nuclear physics and General Relativity by combining X-ray information from NICER, gamma-ray information from NASA's Fermi and Swift telescopes and gravitational wave information from advanced LIGO.

The proposed work is of direct relevance to NASA's strategic mission to better understand the universe through observation and NASA's mission of discovery and knowledge. The region of the universe where gravity is unbearably strong and dynamically changing (the extreme gravity universe) is one of the last unturned stones. This is in part because extreme gravity objects, like neutron stars and black holes, are difficult to resolve due to their size and distance from Earth. NASA's investments in neutron star astrophysics and in space-borne gravitational wave astrophysics are aimed at resolving such objects and, for the first time, exploring the extreme gravity universe in detail. The focus of this proposal is to aid in this endeavor by developing the tools and the understanding needed to extract the most information from the data.

NM - 17-EPSCoRProp-0002

Autonomous Structural Composites for Next Generation Unmanned Aircraft Systems

STMD

Director: Patricia Hynes

Sc-I: Don Ryu

In this proposed study, PIs will devise autonomous structural composites capable of self-powered delamination detection in FRP composites and harvesting energy. The autonomous composites will be fabricated by embedding multifunctional thin films into structural FRP composites. The multifunctional thin films will be designed to perform self-powered strain sensing as well as energy conversion of ambient vibration to electrical energy. Research objective is three-fold. First, the copper-doped zinc sulfide (ZnS:Cu)/poly(3-hexylthionphene) (P3HT)-based multilayered thin films will be designed and optimized through theoretical and experimental studies. ML light emission of the ZnS:Cu-based layer and the photoactive P3HT-based layer will judiciously designed to exhibit multifunctional capability. The material and geometric design of the multilayered thin films will be optimized through in-depth studies for enhancing sensing capability, energy conversion efficiency, and micro-/nano-mechanical performance. Second, autonomous structural composites will be fabricated by embedding the designed ZnS:Cu/P3HT-based thin films into FRP composites. Multifunctional capabilities (i.e., self-powered delamination detection and energy harvesting) of the autonomous structural composites will be validated under space environmental effects (e.g., thermal gradients, space radiations, and blast, among some others). Last, Aerostructures Test Wing (ATW) will be fabricated using the developed autonomous structural composites to be tested at Flight Loads Lab (FLL) at NASA Armstrong Flight Research Center (AFRC) using Ground Vibration Test (GVT) setup. The autonomous delamination detection capability of the autonomous ATW will be validated through vibration-based SHM framework (e.g., natural frequency shift and mode shape changes) in mid-range vibrational loadings. Furthermore, energy harvesting capability of the autonomous ATW will be validated under ambient vibrations. Space environmental effects will be studied on the performance of the autonomous ATW in the state-of-the-art facilities at FLL at NASA AFRC.In this proposed study, PIs will devise autonomous structural composites capable of self-powered delamination detection in FRP composites and harvesting energy. The autonomous composites will be fabricated by embedding multifunctional thin films into structural FRP composites. The multifunctional thin films will be designed to perform self-powered strain sensing as well as energy conversion of ambient vibration to electrical energy. Research objective is three-fold. First, the copper-doped zinc sulfide (ZnS:Cu)/poly(3-hexylthionphene) (P3HT)-based multilayered thin films will be designed and optimized through theoretical and experimental studies. ML light emission of the ZnS:Cu-based layer and the photoactive P3HT-based layer will judiciously designed to exhibit multifunctional capability. The material and geometric design of the multilayered thin films will be optimized through in-depth studies for enhancing sensing capability, energy conversion efficiency, and micro-/nano-mechanical performance. Second, autonomous structural composites will be fabricated by embedding the designed ZnS:Cu/P3HT-based thin films into FRP composites. Multifunctional capabilities (i.e., self-

powered delamination detection and energy harvesting) of the autonomous structural composites will be validated under space environmental effects (e.g., thermal gradients, space radiations, and blast, among some others). Last, Aerostructures Test Wing (ATW) will be fabricated using the developed autonomous structural composites to be tested at Flight Loads Lab (FLL) at NASA Armstrong Flight Research Center (AFRC) using Ground Vibration Test (GVT) setup. The autonomous delamination detection capability of the autonomous ATW will be validated through vibration-based SHM framework (e.g., natural frequency shift and mode shape changes) in mid-range vibrational loadings. Furthermore, energy harvesting capability of the autonomous ATW will be validated under ambient vibrations. Space environmental effects will be studied on the performance of the autonomous ATW in the state-of-the-art facilities at FLL at NASA AFRC.

WV - 17-EPSCoRProp-0005

Fast Traversing Autonomous Rover for Mars Sample Collection

STMD, SMD

Director: Majid Jaridi

Sc-I: Yu Gu

The success of future NASA Mars Sample Return (MSR) mission can significantly benefit from increased onboard autonomy of planetary rovers. Therefore, the technical objective of this proposed project is to develop and experimentally validate key technologies needed for autonomous rover traversing on Mars-analog terrains. The goal is to reduce the number of sols needed to complete the MSR mission-required total traverse distance (i.e., "fast traverse "). This will be achieved through increased rover operation "duty cycle" and "mean time between human interventions," while utilizing limited onboard power and computational resources. More specifically, the fast traverse problem will be broken down and solved with five main research tasks: 1. prepare a test-bed rover and realistic test environments; 2. achieve a high-level onboard situational awareness with limited computing resources; 3. enable robust, flexible, and efficient decision making; 4. develop new modes of human-robot collaboration with delayed and infrequent communications; and 5. test and demonstrate the developed rover capabilities in relevant environments.

The project will be conducted through a tight collaboration between West Virginia University (WVU) and NASA Jet Propulsion Laboratory (JPL) with project members from both sides. The project will leverage WVU's autonomous rover, Cataglyphis, the only robot to successfully complete NASA's Sample Return Robot Centennial Challenge, and JPL's Athena rover and simulators in completing the proposed research tasks. In particular, the WVU team will work closely with JPL's Mobility and Robotic Systems Section in performing rover research and conducting joint experiments at WVU, JPL's Mars yard, and in the red rock deserts of southern Utah. The lessons learned through these efforts will be used to support MSR trade studies currently being conducted by JPL Mars Program Formulation Office.

Systems-level innovation will be emphasized throughout the project: that is, leveraging unique opportunities provided by the MSR mission to support novel rover autonomy capabilities. In addition, the project will emphasize end-to-end development and demonstration in realistic physical environments. In general, the project will advance the-state-of-the-art in autonomous robot operation in cluttered environments with severely limited onboard resources, which is well aligned with NASA's technology roadmap in robotics and autonomous systems. Through this research effort, technologies, infrastructure, and expertise closely related to NASA planetary rover missions will be developed at WVU, which in turn will improve West Virginia's competiveness in pursuing future NASA funded research projects.

KY - 17-EPSCoRProp-0014

Coordinated Position and Attitude Control for Formations of Small Satellites

STMD

Director: Suzanne Smith

Sc-I: Thomas Seigler

Small-satellite swarms are an integral part of future space missions, including exploration, atmospheric measurements, comet detection, cosmological and biological studies, and space-weather monitoring. Small-satellite formations are candidates for next-generation interferometers, large-aperture space telescopes, antennas, radiometers, and gravity-wave detectors.

The primary actuation-and-sensing challenge for small satellites is their strict size-and-weight limitations. Conventional large-satellite actuation systems (e.g., propellant thrusters and reaction wheels) are not well suited for small satellite swarms. This project will develop and integrate innovative actuation, sensor, and control technologies that are both small, efficient, and have renewable power sources. The objective of this project is to develop and integrate three key enabling technologies: 1) a noncommutative-attitude-control (NAC) system for orientation control, 2) an electromagnetic actuation-plus-sensing (EAS) system for relative-position control and sensing, and 3) discrete-time formation (DTF) control algorithms that address the unique features of the NAC and EAS systems. The research team is currently applying noncommutative-attitude-control for medical microrobots and discrete-time formation control algorithms for multi-vehicle aerial distributed sensing systems. The unique combination of technologies developed in this project will advance the state-of-the-art in small satellite swarms for NASA. These technologies will also have broader application for NASA challenges such as formations of large satellites and small terrestrial robots.

Our research plan includes collaborations with NASA Ames (ARC), NASA Kennedy Space Center (KSC), NASA Marshall Space Flight Center (MSFC), and industry partner Space Tango Inc. This plan leverages the research team's recent developments on small-satellite attitude control, discrete-time formation control, and electromagnetic formation-flying technology (KSC), as well as expertise on video guidance sensors and small-satellite design and testing (MSFC). Major milestones of this project include a 5-satellite cooperative-control experiment using MSFC's flat-floor facility, and a 2-satellite formation-flying experiment using Space Tango's TangoLab-1 facility on the International Space Station (ISS). After successful completion of this project, our research roadmap envisions follow-on projects including satellite formation-flying experiments in orbit.

This proposal leverages results of prior NASA EPSCoR seed investments to build a unique experimental infrastructure that expands Kentucky's research capability in a new dimension, develops specialized knowledge and expertise for faculty and students, increases collaborations between Kentucky's researchers, start-up companies and NASA, and supports future research funding success. The work aligns with the Kentucky Science and Innovation Strategy priority for High-Value Research and Development. The proposed research directly supports NASA Space Technology Mission Directorate

(STMD), specifically, the Small Spacecraft Technology Program (SSTP), which is tasked with identifying and developing new technologies to enhance or expand the capabilities of small spacecraft and support flight demonstrations of new technologies. This project has a high potential to impact future NASA missions and produce technologies for the growing U.S. small-satellite sector.

WY - 17-EPSCoRProp-0015

Advanced Optical Measurements of Ice Adhesion on Icephobic Aircraft Surfaces

ARMD, HEOMD

Director: Shawna McBride

Sc-I: William Rice

Ice accretion on aircraft, helicopter, spacecraft, rovers, and airflow control surfaces is a significant problem for commercial, military, and NASA aerospace operations. It is estimated that these ice-related problems cost the aerospace industry over a billion dollars a year and cause nearly 10% of all weather-related aircraft fatalities. Despite the pressing need for ice mitigation on mission critical surfaces, icephobic materials are difficult to design and evaluate, since (1) ice adhesion is poorly understood and (2) current testing methods are destructive and not adaptable to real-world conditions. Here, we propose to design and build an optical system to examine ice adhesion on several aerospace-relevant surfaces. The proposed optical system will measure the vibration frequencies of the surface with and without ice. Since the adhered ice strains the underlying substrate lattice, we expect that the vibrational frequencies of the material will energetically shift proportional to the ice adhesion strength, a phenomenon that is well known in semiconductor science. In order to establish the accuracy of this optical technique for iced surfaces, we will evaluate the same iced surfaces using shear strength measurements and x-ray diffraction. Once the validity of the optical method has been established, we will test multiple NASA-provided coatings to examine icephobicity material trends and enhance NASA's numerical ice model (LEWICE). Finally, based off the results obtained at Wyoming, we will miniaturize the optical setup for testing at NASA facilities.

DE - 17-EPSCoRProp-0017

Laser based Remote Magnetometry with Mesospheric Sodium Atoms for Geomagnetic Field Measurements

SMD

Director: William Matthaeus

Sc-I: Renu Tripathi

Although technology for in situ measurement of geomagnetic field or planetary magnetic field has been well developed and widely used in NASA missions, technology for remote field measurement has not been realized so far. The scientific research described in this proposal focuses on the development of a new laser based remote magnetometer (LRM) which will enable remote measurement of earth's magnetic field at mesospheric altitude (> 90 km above the earth's surface) with high sensitivity. The proposed technology can be scaled to develop an optimal, low-cost global magnetic sensor array for large-area mapping of the magnetic field. We propose to design the LRM prototype by integrating various components such as laser source, modulator, photon detector, optics and electronics onto a single platform. To realize a compact design of the LRM prototype, we plan to explore a new Raman fiber laser (RFL) technology. We will also develop a relatively inexpensive, compact amplified-DFB laser source to overcome any unanticipated polarization or linewidth related problem with RFL technology. Our ultimate goal in this effort will be to engineer the LRM prototype to demonstrate high sensitivity (~10-20 nT/âˆšHz) in remote magnetic field measurement by leveraging advantages of its components.

We will conduct lab experiments with LRM to measure magnetic resonance in the return signal from a sodium vapor cell. These experiments will be designed to analyze the performance of LRM under simulated mesospheric conditions. We will conduct experiments with buffer gas filled sodium cell to measure various characteristics of magnetic resonance as functions of sodium density (or cell temperature), laser polarization, laser power, and magnetic field intensity and orientation. This will help us in determining optimal conditions for achieving highest sensitivity for LRM, and establishing scaling rules for sensitivity enhancement. We will develop a theoretical model for LRM using a comprehensive atomic density-matrix based calculation. Results obtained from this model will be compared to validate with our experimental results. We will carry out field-test and technology demonstrations of LRM by launching the laser beam into mesosphere from the NASA GSFC optical site. Effects of velocity-diffusion and spin relaxation of mesospheric sodium atoms on magnetic resonance will be thoroughly investigated. We will collect science data using LRM to infer strength and variation of the geomagnetic field in the mesosphere. Our primary goal in this study will be to demonstrate remote magnetic field measurement with LRM, and assess its technology-readiness level (TRL) for potential future mission development.

The proposed research will create a unique technological advancement capability for remote magnetic field measurement which is of significant relevance to NASA Science Mission Directorate (SMD) and Science Technology Mission Directorate (STMD). DSU Science team of this project will collaborate with three prominent NASA GSFC scientists who are experts involved in many technology missions at NASA.

The Sc-I will be able to expand her technology development research in remote sensing, thereby enhancing the State's research capacity in NASA related technology areas. The Sc-I will create a host of education and research opportunities for prevalently underrepresented minority and women students at DSU. Students involved in the project will acquire special skills in magnetometer design, development, and testing experiments. The students will have opportunities to gain hands-on knowledge on all aspects of the proposed research, and interact with NASA scientists via meetings, discussions, and internship opportunities at NASA GSFC. The Sc-I will also conduct outreach activities in local high schools and middle schools in Delaware encouraging them for active participation in NASA related research and STEM education.

AR - 17-EPSCoRProp-0025

EPSCoR Research: Bio-Inspired PTFE-Based Solid Lubricant Coatings on Nickel-Titanium for Space Mechanisms and Aerospace Applications

ARMD, STMD

Director: Mitchell Hudson

Sc-I: Min Zou

The goal of this project is to develop bio-inspired polytetrafluoroethylene (PTFE)-based solid lubricant coatings for 60NiTi (NITINOL 60) material. NITINOL 60 is currently under extensive evaluation at NASA due to its unique combinations of physical properties that make it very desirable for NASA's space mechanisms and aerospace applications. However, it has poor friction and wear performances in dry contact conditions. The proposed novel coatings consist of a bio-inspired polydopamine (PDA) adhesive under-layer and a PTFE or a mixed PTFE and graphite solid lubricant top-layer. The coatings are expected to reduce the friction of the NITINOL 60 material by over 85% and its wear rate by 50% during dry contact conditions to meet a range of NASA's critical application needs. Specifically, the novel coatings will enable NITINOL 60 ball bearings and timing gears to be developed for use in the water recovery system of the International Space Station (ISS) to combat current issues with these tribological components.

The proposed research will be performed collaboratively by three investigators from three different disciplines in two Arkansas universities. The project will integrate coating process development, computational and analytical modeling, and performance evaluation to address NASA's critical needs in solid lubrication of NITINOL 60. The research will be closely guided by NASA senior scientists Drs. Christopher DellaCorte and Samuel A. Howard from the NASA Glenn Research Center (GRC) and integrate with their research and development efforts to ensure its direct benefit to NASA. The project goal will be attained by accomplishing the following specific research objectives: 1) develop processes to fabricate bio-inspired PTFE-based solid lubricant coatings on NITINOL 60 substrates (Zou), 2) experimentally evaluate the mechanical and tribological properties of the coated NITINOL 60 (Zou), 3) gain a fundamental understanding of the adhesion mechanisms of PDA/PTFE coating on NITINOL 60 through multi-scale modeling, which will provide feedback for experimental refinement of the solid lubricant coatings (Wang), and 4) develop analytical models to predict static and dynamic performances of the coated NITNINOL 60 bearings (Miller).

The proposed coating technologies address the needs of the Human Exploration & Operations Mission Directorate (HEOMD) for improving the waste water processing bearings and gears in the ISS, the needs of the Space Technology Mission Directorate (STMD) for resilient mechanical systems in life support systems for long term exploration, and the needs of the Aeronautics Research Mission Directorate (ARMD) for lightweight aircraft components. The successfully developed coatings can be applied to shockproof and corrosion proof bearings for spacesuits; life support machinery; guidance, navigation, and control mechanisms; and other mechanisms that require solid lubrication. The project provides opportunities to build partnerships among Arkansas universities, NASA GRC, and Arkansas industries. It will strengthen Arkansas's research infrastructure and science and technology capabilities in advanced materials, which is one of the six economic clusters in Arkansas. Due to the versatility of the proposed coating system, the fundamental understanding gained from this research and the coating technologies developed can be applied to improve the durability of surfaces of various mechanical components used in Arkansas manufacturing, aerospace, defense, agriculture, and gas and oil industries. We also plan to commercialize the technologies developed by partnering with NASA and Arkansas-based Companies. The successful completion of this project will enable the creation of new products and new high-paying jobs, which will contribute to and bolster the knowledge-based economy in Arkansas.

PR - 17-EPSCoRProp-0032

NASA EPSCoR: Development of Nanoporous Adsorbents for Aqueous Phase Separations in Life Support Systems

HEOMD, STMD

Director: Gerardo Morell

Sc-I: Arturo Hernandez-Maldonado

Water reclamation and proper inventory and supply of medications are all crucial for NASA space missions, particularly for the longâ€“term ones. Reclaiming water in portable and closed-volume applications is certainly not an easy task, particularly in space missions where weight and volume limitations are stringent. Reclaiming in a closed-loop environment also brings challenges associated to achieving high purity water, particularly when taking into account siloxane based problematic compounds (PCs).

The implementation of this research project will lead to innovative adsorbents for aqueous phase treatments that will be developed through a comprehensive, synergistic computational-experimental-engineering design strategy and will enable new technology for NASA Life Support systems. The new adsorbents will efficiently (i) remove PCs in the form of siloxanes that arise from crew hygiene products, adhesives, caulks, lubricants, various nonmetallic materials and reactions at Urine Processor Assembly (UPA) of the International Space Station (ISS), and (ii) recover medications (MCs), such as those based on N-acetyl-D-glucosamine, produced by NASA's Synthetic Drug Synthesis Systems (SDSS) prototypes. The overall goal is to produce novel adsorbent materials with superior selectivity toward PCs and MCs at ambient temperature with minimal physical volume requirements. Hence, the results of this research and development effort will enhance NASA's capabilities for long-term exploration missions, specifically those related to human life support and in situ resource utilization. The specific objectives include: (i) screening adsorption material surfaces based on anchored transition metals (Co, Ni, Cu or Zn) for weak complexation and enhanced, electrostatic interactions, and predictions of PC and MC adsorption loadings and energy via periodic boundary conditions calculations, and using quantum mechanics/molecular mechanics methods; (ii) synthesis and characterization of nanoporous adsorbents and composite adsorbents based on the theoretical/computational work output; (iii) performing single component batch and dynamic adsorption experimental tests to provide feedback to the computational component; (iv) developing testbeds in collaboration with NASA Marshall Space Flight Center (MSFC) and Ames Research Center (ARC) for adsorbent particle mechanical tests and small scale multicomponent adsorption tests, including processing of ISS Water Processor Assembly (WPA) and SDSS representative effluents containing PCs or MCs and other unavoidable background contaminants or competitive adsorbates (TRL 1-3).

The siloxane-based contaminants targeted in this proposal are inherent to the ISS infrastructure and are not effectively removed by the ISS WPA and UPA. Moreover, the administration of medicines to space crew during space missions is essential for success. Although systems like the SDSS are still prototypes, the underlying principles are critical to elucidate the best possible way to provide space crew with the

tools necessary to achieve feasible onboard production of medications, particularly those that would be deemed with short life spans. The deliverables anticipated from this project will also find important terrestrial applications. Efficient water treatment and reclamation methods are of utmost necessity to deal with potable water scarcity while the ever increasing number of epidemic diseases, particularly in remote areas with little or no resources, mandates the development portable synthesis systems for onsite medication production.

MS - 17-EPSCoRProp-0036

High-Fidelity Loci-CHEM Simulations for Acoustic Wave Propagation and Vibration

HEOMD, STMD

Director: Nathan Murray

Sc-I: Shanti Bhushan

The objective of the proposed research is two-folds: (1) establish a multi-institutional aero-acoustics research program in Mississippi by bringing together computational expertise at Mississippi State University (MSU) and experimental expertise at University of Mississippi (UM), which have thus far been developed independently; and (2) develop and validate a high-fidelity fluid-structure acoustic interaction (FSAI) solver capability for the predictions of far-field acoustics and associated structural vibrations, including procurement of state-of-art experimental data for coupled fluid-structure response induced acoustics. The proposed research will build upon existing computational fluid dynamics (CFD)â€“ Loci-CHEM, computational aero-acoustics (CAA) â€“ Loci-THRUST (an extension of CHEM), and computational structural dynamics (CSD) solvers developed at MSU, and the experimental facilities at UM. The CFD and CAA solvers has been developed under NASA funding, and the former is used extensively at NASA Marshall for launch vehicle, propulsion, and missile systems analysis. The CSD solver has been developed under AFRL funding, and has been extensively validated for transonic flutter analysis and used for design of thermally stressed structures. The proposed research will focus on:

(a) enhancement of the hybrid Reynolds Averaged Navier Stokes (RANS)/Large Eddy Simulation (LES) turbulence modeling capability in Loci-CHEM by developing and implementing an adaptive LES turbulence model based on numerical dissipation; (b) enhancements to the capability and performance of the high-order accurate discontinuous Galerkin (DG) scheme to improve the accuracy and efficiency of Loci-THRUST; (c) development of coupling interface for CFD, CAA, and CSD solvers for time-accurate predictions of acoustics generation, propagation, and associated fluid-structure vibration response; (d) measurement of near- and far-field acoustics and surface loading for a novel test case involving jet interaction with flexible surfaces, which will serve as a state-of-art validation dataset for FSAI solvers; and (e) dissemination of the results to the scientific community via peer-reviewed conference and journal papers.

The research will contribute to the advancement of computational modeling via development of a new LES model; and advance fluid-structure interaction flow physics knowledge by improving the understanding of interaction between acoustics and structural-vibration. The advancements of Loci-CHEM will directly influence NASA Marshall Aerothermodynamics team research. The FSAI computational tool will likely have broad applicability, but it should be immediately useful to NASA’s launch vehicle development program need of assessment of vehicle vibrations and resonance due to far-field acoustic loads. This computational tool also has the potential to influence the research needs of NASA’s Aeronautics Research Mission Directorate (ARMD), who are currently focusing on high-fidelity simulations for the design and analysis of main landing gear noise reduction technologies. In addition, the availability of the new vibro-acoustics experimental data set will impact the broader CFD community by providing additional validation data for emerging FSAI solvers.

The proposed research will further strengthen the ties between researchers at MSU and UM as well as their external partners at NASA. Beyond that, the proposed research activities will bring together existing computational and experimental expertise in Mississippi to build the foundations of a strong aero-acoustics research program. These activities will enhance the competitiveness and sustainability of aerospace research in the state, and improve the Mississippi Space Grant portfolio through the publication of peer-reviewed conference and journal papers. In addition, the project will enhance educational infrastructure through funding of four (4) graduate students, and enhance diversity in STEM disciplines.

GU - 17-EPSCoRProp-0044

GEOCORE: Geospatial Studies of Coral Reef Ecology and Health using Satellite and Airborne Data

SMD

Director: John Peterson

Sc-I: Terry John Donaldson

The University of Guam is at the cusp of a rapid expansion of capacity for scientific research, especially in the areas of marine and geospatial studies. The recent award of a $6 million National Science Foundation EPSCoR program and a NASA EPSCoR Space Grant Research Infrastructure Development grant provide the focus and the resources to build cyberinfrastructure, STEM education capabilities, workforce development, and coral reef genomic research.

For the proposed project, UOG will collaborate with JPL scientists and associates with expertise on NASA science technologies and missions. Dr. Bruce Chapman, of the Radar Science and Engineering Section, and Dr. Ben Holt, of the Ocean Circulation and Air Sea Interaction group, will guide the application and analysis of SAR data for understanding landscape change, erosion, and oceanic dynamics. Leo Cheng, a Physicist and JPL Systems Engineer raised on Guam, will perform technical management and educational outreach. Dr. Eric Hochberg and Dr. Michelle Gierach, of the NASA CORAL mission, and Dr. Arjun Chennu and Dr. Joost den Haan, of the Max Planck Institute, will provide expertise on imaging spectroscopy and its use in studying coral reefs and coastal ecosystems. Dr. Douglas Comer, University of Guam Adjunct Professor and Director of CSRM Foundation, will coordinate the engagement of UOG scientists with NASA JPL scientists and oversee the development of a reef fish spawning aggregation site predictive model. Dr. Tom Schils and Dr. Atsushi Fujimora, of UOG, will contribute to the Ocean Science proposed here, and Dr. Terry Donaldson, a UOG Marine Biologist, will serve as Sc-I.

In pursuing this CAN, NASA Guam EPSCoR has two primary goals for the three-year project period:

1. To significantly further NASA research and technology development by contributing to the NASA Science Mission Directorate (SMD) Earth Science Division’s science goals and the Jet Propulsion Laboratory’s (JPL) research areas, and by informing the science and engineering requirements of coming NASA missions; and

2. To continue UOG’s momentum in expanding and deepening higher education, science and technology capacity, research infrastructure, and the economy on Guam.

To achieve these goals, NASA Guam EPSCoR has designed its project mission around two specific objectives:

1. We will develop a geodatabase of Micronesian reef habitats by incorporating remotely sensed data on ocean and land conditions, such as SST, turbidity, productivity (chlorophyll concentration), salinity, sedimentation, bathymetry, and geomorphology. This geodatabase will constitute the

foundation of a cutting-edge UOG research regime for the study of coral reef health, its relation to sedimentation dynamics and ocean environmental forcing, and the dynamics of reef fish spawning aggregation. Remotely sensed data will be validated with field data collected in situ by the GEOCORE team and integrated into the GIS structure.

2. Based on this geodatabase, we will build a predictive model that will forecast reef fish spawning aggregation sites and their spatial changes over time.

VI - 17-EPSCoRProp-0051

UVI BurstCube: Developing a flight-ready prototype Gamma-Ray-Burst detection nanosatellite at the University of the Virgin Islands

SMD

Director: David Morris

Sc-I: Antonino Cucchiara

The University of the Virgin Islands physics department will partner with scientists from NASA's Goddard Space Flight Center to develop a low-cost gamma-ray-burst detecting nano-satellite (BurstCube). This project will leverage previous work at UVI in GRB studies and x-ray detector development and will support student research opportunities in UVI's new physics undergraduate degree program. UVI BurstCube will be only one in a constellation of BurstCube units under development by a consortium of groups at various institutions. The combined constellation will be able to add significantly to the detection rate of GRBs. Moreover, expertise in astrophysics hardware development and data analysis developed through this project will continue to grow technical capability in this arena at UVI.

ID - 17-EPSCoRProp-0053

Space-Grade Flexible Hybrid Electronics

STMD, HEOMD

Director: Joseph Law

Sc-I: David Estrada

The intersection of additive manufacturing and nanotechnology stands to transform the way NASA approaches its mission of advancing science, technology, aeronautics, and space exploration. The ability to manipulate matter at the nanoscale enables the bottom-up design of innovative nanomaterial based sensors, which benefit from unique properties such as high surface area to volume ratio and tunable transport processes. The ability to print nanomaterials using additive manufacturing techniques highlights a path towards the digital design and in-space manufacturing of mission specific sensors. Our vision is to leverage the unique physical properties of nanomaterials to create a new design paradigm for space-grade flexible hybrid electronics (FHE) sensor systems, and build a light, flexible, and self-sustaining multifunctional sensor in accordance with performance goals outlined in NASA's Space Technology Roadmap. Printed carbon nanotubes, polymer brushes, chalcogenide glasses, and thermoelectric nanomaterials will be combined with flexible silicon integrated circuits and wireless communications hardware to create a flexible multifunctional sensor node capable of transmitting real-time sensing data for trace gas vapors and exposure to radiation. To ensure project success the PI and SI have composed a team of experts in nanomaterial design, synthesis, and characterization; as well as industry partner American Semiconductor, Inc. â€“ a global leader in the manufacture of flexible silicon integrated circuits. Additional partnerships with Ames Research Center, Johnson Space Center, Marshall Flight Space Center, Air Force Research Laboratories, and PakSense/Emerson will help guide project progress towards NASA's performance goals and translation of sensor technology into the defense and consumer electronics industries. Integrating our nanomaterials with advanced manufacturing techniques and flexible silicon integrated circuits extends impact, potentially serving the public by providing a low-cost path towards large-scale manufacturing of nanomaterial-based sensors for agricultural technologies, human health monitoring systems, and aerospace sensors, all connected through the internet of things. Positioned in the Pacific Northwest near global and regional industry leaders, the proposed work will establish the foundation required to build a nationally and internationally recognized center for flexible hybrid electronics technologies, thus significantly enhancing research capacity and competitiveness in the Idaho EPSCoR jurisdiction.

HI - 17-EPSCoRProp-0054

Autonomous Control Technology for Unmanned Aerial Systems with Agricultural and Environmental Applications in Central Pacific Islands

ARMD, SMD

Director: Luke Flynn

Sc-I: Dilmurat Azimov

The goal of this project is to create a real-time and autonomous control technology for unmanned aerial systems with agricultural and environmental applications in Central Pacific Islands. To achieve the proposed goal, the objectives are (1) to create and validate integrated targeting, guidance, navigation and control (TGNC) framework and software algorithms for an onboard implementation, and (2) to develop and disseminate educational courses and outreach activities in the design and development of unmanned aerial systems (UASs) with applications to Earth sciences in the Central Pacific Islands. These objectives are accomplished by the following research and educational tasks:

1) Demonstrate and simulate new analytical and/or numerical trajectory and attitude solutions, and an autonomous and target-relative guidance scheme utilizing the instantaneous screw motion (ISM) invariants to perform various maneuvers and tasks of interest; 2) Establish a new, high- fidelity computational framework of a hierarchical mixture of experts (HME) utilizing a new sensor data fusion technology to obtain real-time navigation solutions; 3) Integrate TGNC framework and software algorithms for agricultural and environmental applications in the Central Pacific Islands, namely the Hawai'ian Islands Oahu, Maui, Lanai and Kauai, and in Marshall Islands and Guam; and 4) Develop and disseminate educational curriculums for courses in flight dynamics and control, and in UAS design and development for the Earth sciences applications, including the proposed agricultural and environmental applications.

The proposal titled "Autonomous Control Technology for Unmanned Aerial Systems with Agricultural and Environmental Applications in Central Pacific Islands" is to be submitted in response to 2017 NASA EPSCoR CAN Announcement.

The proposed work will be performed in collaboration with partners in Maui, Lanai and Kauai Islands of the State of Hawai'i and with the College of Marshall Islands and the University of Guam.

The proposed work addresses the topics of the Engineering Research priority areas of the Science Mission Directorate (SMD) and Aeronautics Research Mission Directorate (ARMD). The areas of expertise required for the research are flight mechanics, theory of estimation, guidance, navigation and control for unmanned aerial systems, and their integration into the national airspace and utility in a wide range of applications.