Alaska
University of Alaska, Fairbanks

Application of a new generation of ground- and satellite based whistler-mode wave experiments as diagnostic tools for probing the structure of magnetospheric plasmas

Using whistler mode (WM) wave data from a new generation of space- and ground-based experiments, a three-year research program is proposed to investigate magnetospheric plasma density structures. OBJECTIVES. (1) Measure cold-plasma density (Ne), density irregularities (10 m to 100 km scale size), relative ion composition (H+, O+, He+) as a function of geophysical conditions (location, local time, and geomagnetic activity). (2) Propose empirical models of plasma density structures at altitudes below 5000 km for gaining new understanding of mechanisms important to magnetosphere-ionosphere coupling, and for use in space weather predictions. (3) Use the proposed work as a springboard to launch a new nationally competitive research in plasma wave experiment and theory at the University of Alaska Fairbanks. METHOD. Use radio sounding data from the IMAGE satellite, ELF/VLF data from Stanford Alaska Array, and broadband wave data from the CASSIOPE satellite to identify and characterize whistler mode events. By matching the measured dispersion with that calculated from ray tracing, determine Ne, characteristics of density irregularities, and ion composition. STUDENTS. Two graduate students and one undergraduate student will work on the proposed research. OUTCOMES. (1) A new generation of empirical models of the distribution of irregularities. The models should provide insights into physical processes that are unique to higher altitude regions as well as those that are common to both the ionosphere and the overlying regions. Companion outcomes would be plasma density distributions and ion composition distributions along field lines below ~5000 km, available for merging or integration with empirical models based upon measurements at higher altitude or in the ionosphere. (2) Development of a nationally competitive research program in plasma wave observations, theory and simulations. (3) Training of graduate and undergraduate students in space physics and related areas. Our proposed research relates to NASA¿s strategic sub-goal 3B.

Alabama
University of Alabama in Huntsville

Device Realization for Sensor and Health Monitoring of Space Transportation System

Nanotechnology offers many potential benefits for the research and development of integrated sensor and health monitoring in space transportation systems for future manned and unmanned NASA missions. Realizing the full promise of nano-technology is hindered by technical barriers to harnessing “nanoproperties” in a macroscopic world. Researchers from the University of Alabama in Huntsville and Alabama A&M University seek funding from the NASA EPSCoR program to form an interdisciplinary team to bridge the gaps from nanotechnology innovation to device realization.

The Nano and Micro Devices Center at The University of Alabama in Huntsville (UAH) and the Center for Irradiation of Materials at Alabama A&M University have built core research groups and facilities focused on the design, modeling, fabrication, and testing of sensors using nano & micro fabrication technologies. Researchers from the Computer Engineering Department of UAH have developed hardware and software tools to integrate sensors into networked embedded systems. This effort will merge the three capabilities to bring innovative advances in nanotechnology and MEMS to device realization in embedded sensors that address the critical needs for the sensor and health monitoring of the launch vehicle and manned environment.

To achieve the goal of enabling Alabama to develop an academic research enterprise directed toward long term, self sustaining, nationally-competitive capabilities in NASA-related research, the team will align with the strategic needs for Integrated Sensor and Health Monitoring branch at NASA MSFC. Four application driven research areas have been identified in advanced sensor technologies to bridge nano-innovation to device realization. The research thrusts include; Nano and Micro Electromechanical Sensors for Hydrazine, Hydrogen Detection, Biological Detection for Water Purification System, and Energy-Efficient Wireless Sensor Platforms for Deeply Embedded Systems. The effort will also focus on providing a pool of highly educated and trained engineers and scientists for NASA's current and future employment needs.

Arkansas
University of Arkansas at Little Rock

Noninvasive Prospecting for Lunar Ores and Minerals

NASA is committed to the journey of exploration of the solar system, with its first target, the Moon. For these long time missions to be economically and scientifically feasible, it is crucial for the resources needed for life support (oxygen, water, and energy), habitats and shielding, as well as propellants, to be produced in-situ. In order to accomplish this, innovative, robust technology and procedures must be developed for resource prospecting, extraction and beneficiation. This work focuses on the utilization of Ground Penetrating Radar (GPR) technologies to identify the presence of under the surface ilmenite ($FeTiO3$), which is considered one of the most promising minerals for the generation of oxygen and metals such as Fe and Ti. Scientists from the University of Arkansas at Little Rock (UALR), Hendrix College, NASA Kennedy Space Center, and ASRC Aerospace will work collaboratively to develop a comprehensive method for fast and accurate detection of minerals that are of interest to NASA present beneath the Moon surface. Since the distribution of minerals on Moon may not be uniform, the ability to quickly identify those areas with high concentration of the desired minerals is essential. This project is expected to generate a novel method for fast and accurate detection of various minerals, which can be used to support the life and the success of the long time manned NASA missions. The team will implement three independent schemes to study the electromagnetic signatures of a number of minerals that are of high value to NASA¿s missions and goals. These schemes are: (1) synthetic modeling of GPR data for specific minerals with different concentration in the simulated lunar soils and rocks. Detection capability will be measured as a function of percentage of mineral concentration in host soil and rock; (2) laboratory measurement of GPR data for natural minerals and ores. The detection capability will be investigated for both percentage of mineral concentration and depth; (3) geophysical fieldwork to collect data for natural deposits of the Tokio formation in southwest Arkansas. Heavy minerals, such as ilmenite, were discovered there and mapped by the Arkansas Geological Commission (AGC) (Hanson, 1997). Raman Spectroscopy and X-Ray Diffraction will be used to determine percentages of ilmenite and other minerals in Tokio sands and their corresponding mineralogy. The measurement of the dielectric constant and other electric properties will be performed by the NASA collaborators at the Kennedy Space Center (KSC). Measurement of electric properties and mineral concentration for lunar samples will be conducted at UALR and KSC. Lunar samples of the Apollo's missions are available to the research team. The results and analysis of the above three schemes will be integrated to develop ideal procedures for lunar prospecting and the ability to locate in a short time the areas rich in the minerals of interest.

Idaho
University of Idaho

Reliability Investigations of Radiation Resistant Multi-State Phase-Change Memory

We propose to investigate the reliability, including radiation resistance and failure mechanisms, of a novel, potentially multi-state, phase-change memory technology using test arrays and sensing circuitry. This potentially multi-state memory, based on a layered chalcogenide structure, would significantly increase the memory density by allowing more than one data state per bit, resulting in the much needed larger, denser memories for future space applications.

Phase-change memory technology is aligned to become the next generation of non-volatile memory, with the potential to replace Flash memory and hard-drive storage, and is ideal for space applications due to its radiation resistance, large number of cycles, and lower power operation. While much research is currently underway both in industry and in academia to build phase-change memory devices, there are little data available that can describe or guarantee how these types of memory arrays will perform under the conditions they will experience in a space application. In addition, these currently studied phase-change memories do not have the potential multi-state memory capabilities like our proposed materials do.

Our proposal comprises three main research areas: (1) design and fabricate a test chip for chalcogenide-based memory devices which use the multi-state memory material stack structures that we have previously explored under NASA EPSCoR grant NCC5-577, and are further researching under a DEPSCoR grant with the Air Force Office of Scientific Research; (2) design and perform reliability (including radiation tests) experiments on our test chip and, if it becomes available, on a commercial chip for a comparison study; and (3) determine failure mechanisms for these electronic devices and explore methods of yield enhancement. Reliability and radiation testing methods for phase-change materials, especially our potentially multi-state memories, need to be developed since they offer challenges that are unique to chalcogenide amorphous and crystalline materials.

Kentucky
Western Kentucky University

Efficacy of Countermeasures to Cardiovascular Deconditioning in Men and Women during Simulated Moon Explorations

The central objective of the proposal is to develop an easily administered countermeasure that would mitigate human cardiovascular risks (primarily fainting upon re-exposure to gravity) associated with physiological adaptations to microgravity during extended duration missions to the moon and eventually Mars. This objective will be accomplished, in collaboration with JSC and Ames investigators, by testing, a human (both men and women) model of space flight-induced cardiovascular deconditioning (hypovolemia protocol), in conjunction with 1) a countermeasure to cardiovascular deconditioning (compression stockings with spatially distributed, or cyclically applied, pressure), 2) a model of the first day of lunar activity (Alter-G lunar simulator) and 3) a model of g profiles experienced in a lunar mission (using NASA Ames' 20G Centrifuge). Methods: This study will determine deconditioned men and women's: 1) orthostatic tolerance limits (ability to maintain consciousness in a gravity environment), and 2) any reasons related to change in the limits, including: a) the relative distribution of fluid volume changes in four body segments (thoracic, splanchnic, thigh and calf), and intra/extravascular plasma volume shifts b) changes in responsiveness of heart rate, heart rate control sensitivity, cardiac output, continuous arterial pressure, total peripheral resistance, c) contributions from neurohormones. 3) Effectiveness of compression garments (either to prevent development of orthostatic intolerance Significance: This research is important to NASA because diminished orthostatic tolerance of astronauts continues to be a problem that may only become worse with long duration lunar explorations. The current countermeasures are insufficient to prevent orthostatic intolerance in ~30% of astronauts returning from short duration Shuttle missions and in 83% returning from missions that are longer than six months. Also, the decreased size of the proposed Crew Exploration Vehicle for moon missions compared to the current Shuttle dictates that the countermeasure be small and efficient. Therefore, testing of countermeasures in simulations of lunar explorations is a necessary component of upcoming NASA related research. The goal of developing optimally designed compression stocking has the potential to meet these requirements. It is also important to note that the cost of cardiovascular deconditioning studies using conventional bed rest is extremely expensive and time consuming for NASA. The use of the proposed hypovolumia model to simulate space flight and extraterrestrial cardiovascular deconditioning could decrease time and cost significantly. Likewise, blood pooling results from the proposed lunar mission G profile on the Ames centrifuge could serve as a good estimate for matching with existing tilt and LBNP data in order to use these devices as substitutes for expensive centrifuge experiments for testing countermeasures for lunar and other space missions. In addition, some musculoskeletal activity in extraterrestrial G environments and associated fluid volume shifts, could be approximated using the Alter -G device described in this proposal. Any one of these possibilities could significantly increase NASA's research productivity and decrease cost. Lastly, the educational component of the proposed research involves support for two graduate students per year and a continuation of our outreach program for undergraduate and high school students with special emphasis on the recruitment of women and minorities.

Louisiana
Louisiana Board of Regents

Smart Adhesively Bonded High-Performance Joint for Composite Structures

This joint LSU-Southern NASA EPSCoR project addresses adhesively bonded joints which have been widely used in aircraft, space shuttles, and other structures due to their ease of fabricating both large and integrated structures. It is well known that, for almost all the structures in-use, joints cannot be avoided and they are the weakest structural component and control the overall load carrying capacity of the structure. Unfortunately, joint-failure induced structural disintegration has been a challenging, on-going problem; as evidenced by many fatal incidents related to inadequate bonding in recent flight history. In this project, we plan to develop a 'smart' joint by integrating piezoelectric particle/fiber reinforced layers into the adherents and utilizing a functionally graded carbon nanotube reinforced shape memory polymer adhesive. The research objectives are to (i) dramatically and self-adaptively reduce the peel stress and shear stress concentration at the adhesive bondline, (ii) self-monitor, self-control, and self-heal the composite joint system in-situ, and (iii) extend the service life of aged/aging aircraft. The educational/workforce objective is to develop a 'research-oriented approach' designed to attract and retain a greater number of high quality students, including minority students, in STEM disciplines. Four tasks have been identified as essential: (1) analytical modeling and optimization; (2) raw materials selection and characterization; (3) fabrication technology; and (4) testing and validation. Our multi-institutional team will address each of these in consultation with NASA engineers. Several NASA field-centers (KSC, MSFC, GRC, Dryden) have expressed interest in this research since its applications span from aircraft to space systems to Lunar/Mars outposts. Moreover, applications in industry are potentially huge, thereby supporting Louisiana economic development. We are optimistic that this project will enhance NASA related composite materials and structures research in Louisiana as well as nationally.

Louisiana
Louisiana Board of Regents

Multiwavelength and Multimessenger Observations in Conjunction with the GLAST Satellite Mission

The GLAST (Gamma-ray Large Area Space Telescope) satellite mission is scheduled for launch in January 2008. GLAST will perform a sensitive survey of the sky at energies from approximately 10 keV to 200 GeV. Its target sources will include galactic black holes, active galactic nuclei, gamma ray bursts, and other sources of high energy photons. Energetic gamma rays are typically produced in non-thermal processes associated with the acceleration of energetic particles. In order to understand the mechanisms producing the high energy radiation and the processes driving the sources of the particles and gamma rays, it would be extremely useful to be able to do correlated measurements of the additional components of radiation produced in the sources: the X-rays produced in conjunction with the gamma rays by the synchrotron-Compton process, optical and radio fluxes from the sources, the very high energy cosmic rays produced by shock wave acceleration in sources such as active galactic nuclei observed by GLAST in gamma rays, and the neutrinos possibly produced by energetic particle interactions or in coincidence with gamma ray bursts. This proposed EPSCOR program will make such multiwavelength and multimessenger observations through a collaboration between Louisiana State University and Southern University-Baton Rouge which will allow Louisiana scientists to participate in the multiwavelength observing campaign and analysis program of the GLAST mission. The GLAST astrophysics will enhance faculty and postdoctoral training and will motivate and train students for STEM careers. The project involves collaborations with MSFC, GSFC and JPL, the IceCube neutrino detector, the Auger cosmic ray experiment, and ground-based optical and radio telescopes.

Maine
Maine Space Grant Consortium

Toxicology of Metal and Lunar Particles In Biological Systems

By 2020, NASA expects to complete a manned space station on the Moon as an essential component of future plans for manned space missions. Space dusts are unavoidable aspects of this exploration and pose significant and growing health hazards to NASA personnel. This proposal seeks to develop a research team of faculty and students to develop a system to characterize the hazards of space dusts so that exposure limits and engineering controls can be determined to assist in the design of the lunar station and ensure the safety of NASA personnel. This team will focus on the potential carcinogenicity of space dusts and their effects on DNA, starting with lunar dust. Human lung, skin, immune and brain cells will be used to assess the ability of lunar dust to induce cell death, DNA damage and neoplastic transformation. This study will be the first to investigate the carcinogenic potential of lunar dust, which is a key component of understanding the risk it presents to NASA personnel. When completed this research will have: 1) Developed a system for characterizing the genotoxic and carcinogenic hazards of space dusts; 2) Significantly advanced research capacity at the University of Southern Maine and the University of Maine; 3) Increased collaborations with NASA and competitiveness for Federal funding for investigators at these institutions; and 4) Provided exceptional research and education opportunities for a diverse group of students and faculty who will contribute to the current and future NASA toxicology workforce.

Montana
Montana State University

Biomolecular Substrates for Extraterrestrial Life: Revealing the Secrets of Extremophilic Archaea and their Viruses

Arguably, the greatest contribution that NASA will make to humanity will be the discovery of life beyond Earth. Of what this discovery will consist is a matter of ongoing debate. Many agree that the discovery of life within our solar system may be in the form of microorganisms that are able to survive and thrive in extreme environments. This project aims to study biomolecular systems in hyperthermoacidophiles and their viruses using techniques in microbiology, metagenomics, molecular biology, protein biochemistry and biophysics with the goal of understanding the molecular substrates that allow life to survive and evolve in harsh conditions. Although the principal focus will be on the stability and function of Sulfolobus heat-shock proteins (HSPs), the approach will consider protein interactions, the role of viruses in extremophile survival and evolution, and biotechnology applications of extremophile molecular systems. The four specific aims of this project include: (1) Identification and isolation of Sulfolobus and Fuselloviridae from presently understudied geothermal regions in order to complement previous work performed in Japan, Italy, Iceland, and the United States using techniques in metagenomics, genetics, microbiology, and electron microscopy; (2) Cross-infection and archaeal growth and virus production studies in identified and novel Sulfolobus host-virus systems with a secondary focus on the molecular substrates of viral genome integration using techniques in microbiology and biochemistry; (3) Characterization of heat-shock protein complex formation, stability, and cellular localization in various Sulfolobus host-virus systems under different environmental conditions using techniques in biophysics and fluorescence microscopy; and, (4) Structure-Function studies of biomolecular complexes in Sulfolobus using techniques in biochemistry, biophysics, and X-ray crystallography.

This work falls under the Science Mission Directorate of NASA and is in-line with the Goal 5, Objective 5.3 of the NASA Astrobiology roadmap. This project is organized as a collaborative effort between investigators at tribal colleges (Salish Kootenai College and Blackfeet Community College), public universities (Montana State University, The University of Montana, and Portland State University), government agencies (NASA Ames Research Center and the NASA Astrobiology Institute), and industry (Lucigen Technologies). A strong emphasis in mentoring junior-level faculty and training students from underrepresented groups has been developed as an integral part of this project with the goal of increasing the number of Native Americans pursuing careers in space sciences. It is anticipated that data resulting from this work will offer new insights into the basis of microbial evolution, advance understanding of modern biotechnological applications of ancient biomolecular systems, and significantly forward scientific understanding of the extents at which life may exist here on Earth and beyond.

Nebraska
University of Nebraska Omaha

Satellite Contaminant Materials Research Program

One of the main reasons for satellite/long duration flight vehicle degradation/failure is the deposition of opaque organic films that deposit on solar cells (the power source), radiator panels (thermal control system) and any other surfaces designed to interact with sunlight, other radiation sources and atomic oxygen present in low earth orbit (LEO). The organic film prevents radiation from reaching the solar cells resulting in power loss, and can dramatically change the temperature of the radiator panels influencing the temperature control system. The organic material originates from the RTVs used in satellite construction, such as RTV 2568 and RTV 2566. These materials continually out-gas over the life of the satellite/vehicle, and the out-gassed vapor deposits onto the satellite where it interacts with solar radiation, photofixing the material onto the satellite and causing it to become absorbing. An additional complicating factor is electron bombardment of the contaminant layer, causing further chemical/physical changes in the layer. These contaminant effects can lead directly to premature overall system failure.

The proposed research program is based on work we have been doing the past 5 years with Boeing Satellite Development Center (formerly Boeing Satellite Systems) in El Segundo, CA. Although this work has been proprietary, we have developed an experimental system that accurately simulates a wide variety of flight conditions. The system can incorporate atomic oxygen effects, AM0 solar radiation and electron bombardment simultaneously onto a temperature controlled substrate that can be either transparent or reflecting. The heart of the system is an in-situ spectroscopic ellipsometer that allows the calculation of the optical constants and deposition rate of photofixed material through direct observation of the depositing material in real time. Material deposition on transparent as well as reflective substrates can be observed, and films as thin as a few nm can be analyzed.

We are proposing a research program aimed at providing quantitative information on the physical, chemical, and optical properties of photofixed volatile contaminant materials. This program will have 3 major goals: 1. Quantify the optical properties and deposition rates of the contaminants produced by materials currently employed in flight vehicles. 2. Establish testing protocols in the form of an ASTM certified test, to properly evaluate materials for flights. 3. Provide guidelines for the development of new materials for flights.

Nevada
Desert Research Institute

Exploring Planetary Surfaces: Earth, Moon and Mars

NASA is in the midst of an ambitious exploration program to return humans to the surface of the moon and provide a continuous robotic presence at Mars. We propose to enhance the scientific return of these endeavors by developing a comprehensive database and immersion visualization program for two planetary analog sites in Nevada and California. These techniques will also be used to provide a virtual experience of the Mars Exploration Rover (MER) landing sites. This program combines existing strengths of NSHE researchers in the fields of geomorphology, geology, biology, remote sensing and computer visualization. Remote sensing data from the Mojave Desert and Lunar Crater Volcanic Field analog sites will be coupled with new, cutting edge experiments on surface processes at these sites. The resulting 'virtual field labs' will be used to train a new generation of investigators in terrestrial geosciences, the interpretation of image and other data from NASA planetary missions, and mission planning and operations for future manned and robotic surface exploration of the Moon and Mars. We will integrate existing airborne and spaceborne imagery with new high-resolution digital elevation data. The visualization approach will include the development of software which will immerse the viewer into the terrain and allow creation of landform and compositional maps. Experiments conducted at the analog sites will emphasize understanding the links between microbiology, mineralogy and oxidation in a dry, desert environment. In addition, studies of controls on sediment transport and implications for rover trafficability will be undertaken. Our proposal directly supports integration and synthesis of data on multiple scales, and from differing perspectives, in order to maximize future return from present and future robotic probes and train students and future mission teams in the interpretation of data on various scales to make informed decisions on navigation or understand landscape evolution. The proposed activities support NASA Strategic Goals and specific objectives outlined for both the Mars Exploration Program and Lunar Exploration Program as documented by MEPAG and LEAG.

New Hampshire
University of New Hampshire

Enhancing Research and Education Capacity for Integration of Earth Observations, Infectious Diseases Ecology and Public Health in New Hampshire

Integrating environment and human health is a great challenge in the 21st century, because changes in climate, land use, and socio-economic conditions are likely to alter the patterns and dynamics of coupled human-environmental systems, which would substantially affect the pathogen-vector-host relationships of infectious diseases. In the United States, a number of vector-borne infectious diseases (e.g., Lyme disease and West Nile virus) have experienced rapid geographic expansion; the number of human Lyme disease cases doubled from <10,000/yr in 1991 to >20,000/yr (when averaged over 2003-2005). Geospatial technology has played an important role in studies of infectious disease ecology and public health. This NASA EPSCoR team in New Hampshire is composed of partners among NH state governmental agencies, private industry and university. Its long term goal is to establish a center of excellence in application of geospatial technology for disease ecology and public health at the University of New Hampshire. This NASA EPSCoR project, puts together an interdisciplinary research team (geospatial technology, disease ecology, public health, mathematics), and combines Earth observations, in-situ disease surveillance and Bayesian hierarchical modeling in an effort to study ecology and risk factors of Lyme disease in New Hampshire and northeastern USA. The project uses both optical images (Landsat, MODIS) and synthetic aperture radar images (ALOS/PALSAR, L-band, HH and HV polarizations, 7.5-m spatial resolution) to generate improved geospatial datasets that would help improve our understanding of ecology and risk factors of infectious diseases. This project also has an interdisciplinary education and training component, including graduate student fellowships. This EPSCoR project will make substantial contributions to the public health, one of 12 national priorities identified by NASA. This project will substantially raise the competitiveness of research programs in NH and promote economic development and job opportunity in the fields of geospatial technology, science, mathematics and health in NH.

New Mexico
New Mexico State University

Structural Health Monitoring and Self-Healing of Aerospace Structures

Aerospace structural systems experience a broad spectrum of environmental and operational loads. Severe and/or prolonged load exposures may trigger the damage accumulation process even in recently deployed structures. The process of implementing a strategy of damage detection for engineering structures is referred to as structural health monitoring (SHM). Three important “new” issues/approaches impacting SHM methodology are addressed in this proposal. The first is to treat SHM as a comprehensive, multi-scale phenomenon in which damage detection may be needed over a spectrum of length scales from the microscopic to the macroscopic. The second issue is attributing to damage in joints and connections an importance commensurate with fracture and fatigue damage that develops in the structural material. Our third “new” approach is to develop material self-healing systems (SHS) capable of repairing material damage while maintaining structural integrity. The strategies proposed will be intended for many aerospace structures, including aircraft, launch vehicles, space vehicles, permanent structures placed on the moon or Mars, and robotic devices that patrol these structures for SHM. The lines of attack that will be followed in pursuit of the new SHM and SHS methodologies include new methods for use of nonlinear vibration data, novel use of electrical conductivity measurements for SHM, and embedded nonlinear ultrasonic methods for local damage detection. In addition, development of the theory and technology for self-healing systems (SHS) in metals, alloys and composites could lead to significantly improved safety of aerospace vehicles and structures. These approaches will be integrated to develop a comprehensive SHM/SHS strategy that will be of significant value to NASA during coming decades.

The proposed research enables development of research infrastructure in New Mexico in areas of strategic importance to NASA¿s mission and will enhance the capability of New Mexico to obtain space, aerospace, and related research support from sources outside the NASA EPSCoR program by 1) developing new approaches for SHM/SHS of aerospace structures and systems of importance to NASA, 2)developing research collaborations between NASA and New Mexico research groups, and 3) developing research credibility and national competitiveness in SHM/SHS through research publication and graduate student education. These objectives address NASA EPSCoR Goals 1, 2, 3 and 4 respectively. The research team has a long term relationship with New Mexico Space Grant Consortium (NMSGC) and their statewide partners and the team will work to increase interest in aerospace and other STEM disciplines among New Mexico’s students, especially women and minorities in fulfillment of Goal #5. A key element of this proposal is development of a collaboration among NASA Marshall and Glenn Centers, the other New Mexico research institutions, and Los Alamos and Sandia National Labs. This collaboration and the future funding generated by it will significantly enhance New Mexico¿s overall research infrastructure, including development of the graduate aerospace engineering programs in the state and attraction of aerospace entities to New Mexico.

Oklahoma
University of Oklahoma

Center for Lightning Advanced Studies and Safety (CLASS)

The objectives of the proposed lightning work address the following questions about lightning and lightning safety: 1.what determines whether a lightning flash makes a connection to ground or not, 2.what determines whether any particular lightning discharge will be observed from space by instruments such as the NASA Lightning Imaging Sensor (LIS, on board the TRMM satellite) and the planned geostationary lightning mapper, i.e., what are the characteristics of lightning discharges that are observed from space and the storms that produce them, and 3.how can we use ground-based electric-field data in combination with other lightning and storm observables to improve the timeliness and reliability of lightning hazard warning decisions?

We will use data from the Oklahoma Lightning Mapping Array, radar, electric-field data from the proposed new field-meter network, and electromagnetic and optical lightning data being obtained with NSF support during the proposed grant period. We will collaborate with scientists at NASA/MSFC on the analysis of ground-based lightning and LIS data.

We will continue collaboration with scientists at NASA/KSC on problems of lightning hazard-warning decision support using electric-field data, in-cloud lightning mapping (LMA/LDAR) data, and cloud-to-ground lightning strike data.

The proposed work will contribute to research infrastructure in areas of strategic importance to NASA Science and Space Operations missions and improve our capability to compete for support. The proposed work will benefit from and further develop ongoing partnerships among OU NWC, NASA, and Campbell Scientific, Inc., including continued development of new technology under three patents held jointly by the P.I.

The proposed work addresses NASA education goals to strengthen the future workforce and to attract and retain students in STEM disciplines and will help accomplish NASA education objectives to provide competency-building education and research opportunities.

Oklahoma
University of Oklahoma

Tissue Equivalent Detectors for Space Crew Dosimetry and Characterization of the Space Radiation Environment

The risk to astronaut health and safety incurred by prolonged exposure to chronic, low dose rate galactic cosmic radiation (GCR) and to rare but intense solar particle events (SPE) has been recognized as one of the major obstacles to long duration human space flight including the establishment of a permanent human settlement on the Moon and exploration missions to Mars. In support of the NASA Exploration System Mission Directorate in the area of Radiation, we propose to develop, fabricate, and test a progressively sophisticated and capable series of compact, self-contained tissue-equivalent ionization chambers and proportional counters for use in characterizing ionizing radiation environments in space and the upper atmosphere, and for monitoring astronaut exposure to radiation during long duration space flight. The instruments will operate either inside the habitable volume of piloted spacecraft or as a stand alone payloads on autonomous satellite, space probe, or high altitude balloon missions. By taking an evolutionary approach to the development of these instruments, both undergraduate and graduate students can be involved in each step of the process as part of a comprehensive STEM education program. Each instrument will be tested by means of high-altitude balloon flights over central Oklahoma conducted by students in the OSU Aerospace Engineering program, as well as at ground-based particle accelerator facilities, particularly the NASA Space Radiation Laboratory at Brookhaven National Laboratory. The objectives of the proposed EPSCoR proposal are: 1) to develop a tissue equivalent detector system suitable for use as a crew dosimeter or as an autonomous dose and dose equivalent spectrometer, 2) to promote STEM education and student interest in NASA's mission through the Radiation Physics and Aerospace Engineering programs at OSU, and 3) to develop and enhance the space radiation and aerospace engineering infrastructure at OSU.

Puerto Rico
University of Puerto Rico

Space Exploration Enabling Power Systems: Partnership to Develop the Fundamental Nanoscience at UPR and Perform the Corresponding Proof-of-Concept at NASA GRC

The new NASA Vision for Space Exploration calls for the development of reliable, efficient, compact power sources, which are of critical importance in support of crewed missions to the Moon for extended periods of time, and to eventually send crewed missions to Mars with a real chance of survival and return. Rechargeable lithium-ion batteries and fuel cells address the NASA priority of developing new, efficient, compact, portable, and environmentally friendly energy sources. Achieving a high degree of efficiency and durability that meets the needs and specifications of the Space Exploration Program, is however, a task yet to be accomplished. Ourapproach to making significant progress in this area consists in developing novel nanostructured electrochemical materials, understanding their electrochemical behavior under actual device operating conditions, and utilizing this knowledge to enhance their electrochemical properties.

The University of Puerto Rico will undertake an integrated experimental/theoretical research program to address functional issues relevant to the design, modeling, fabrication, and characterization of nanoscale materials suitable for enhanced rechargeable lithium ion batteries and fuel cells. Medullar to this program is the development of proof-of-concept and up scaled lithium battery and fuel cell prototypes in collaboration with the Electrochemistry Brach at NASA Glenn Research Center. The research will focus on applied issues of nanostructured cathode, anode, and polymer electrolyte materials relevant for their usage in lithium-ion rechargeable batteries and hydrogen-oxygen fuel cells. The research efforts are aimed at finding the best-performing, robust, most economical, and environmentally friendly nanostructured anode-electrolyte-cathode systems, which would also yield a significant gain in charge capability, along with higher cycleability with stability under harsh conditions. The proposed research is currently a forefront scientific field and our main objective is advancing its technological realization in the context of Space Exploration. The strong feasibility of this project arises from its multidisciplinary approach and synergistic collaboration with the pertinent device developers at Glenn Research Center from the early stages of nano material selection and synthesis, through prototype testing, until accomplishing a Technology Readiness Level appropriate for technology transferring to NASA scientists and engineers for further refinement.

South Carolina
The College of Charleston

Development of Advanced Unitized Regenerative Fuel Cells

The overall objective of the project is to establish a scientific and engineering basis for development of an advanced unitized regenerative fuel cell (URFC) system. The URFC with exploratory efforts being given to nanotechnology is priority NASA research area which is carried out currently in the Glen Research Center with objective to increase the life, performance and energy density of URFCs. The proposed work will employ some of the recent advances in design of catalyst, supports and membrane electrode assemblies accomplished at USC with a support form NSF and DOE. High surface area Ti1-xNbxO2 support will be synthesized using surfactant template approach developed at USC. The nanostructure bifunctional catalysts based on Pt-Ir, Pt-Ir-Ru and Pt-IrO2 will be synthesized by pulse electrodeposition, colloid deposition, organometallic route, and magnetron sputtering techniques. In collaboration with Kenneth Burke from NASA Glenn Research Center, an attempt will be made to increase the conductivity of polyethersulfone (PES) membrane. The performance of the URFC fabricated using PES membranes will be compared with the URFC prepared with conventional NafionTM membranes. First-principles models will be developed that will help to optimize the system integration and design of URFC stacks. John Staser, one of our graduate students, has been awarded with the NASA GRSP fellowship from July 2007 to June 2008. We plan John and other three graduate students to be supported from this project. The students will be involved in our electrochemical engineering graduate studies and will reach the level of national competitiveness at the end of funding period. Twelve undergraduate students will participate in this research through our NSF REU program. The project deliverables are development of advanced URFC system with: (i) highly reversible BOE based on corrosion resistant non-carbon support, (ii) nanostructured bifunctional catalysts, and (iii) highly conductive PES membrane for an improved water management.

South Carolina
The College of Charleston

Development of a Lunar Capable Rover Tweel for a Modular Manned Rover System: Analytical and Experimental Research

The primary long-term objective of this project is to deliver to NASA a critical subsystem, the wheels for manned and unmanned rover missions, that is adaptable to suit a wide range of mission scenarios. This objective will be realized initially through design, fabrication, and testing of Tweels for the Jet Propulsion Laboratory (JPL) Robotics Group's ATHLETE (All Terrain Hex-Legged Extra Terrestrial Explorer) rover system for use in lunar mobility applications. Thus, the ATHLETE will serve as a unique testbed for the wheel development as it moves forward in the selection process for the rover and habitation platform for the future manned and unmanned moon missions. Specifically, the outcome from this SC NASA EPSCoR project will be space worthy functional, proof-of-product prototypes delivered to NASA as proven critical subsystems for the impending Lunar missions (~2019) and all future extraterrestrial planetary rover missions.

Currently, only two extra-terrestrial wheels are available: the Apollo toroids made of piano wire (limited endurance; lasted days) and the Mars' rovers that are made of nearly solid billets (low mass to function ratio; low compliance). An alternative solution is the Michelin Tweel(TM) as currently found on the JPL ATHLETE. The challenge is that Tweel technology is dependent on the use of polyurethane (PU) material properties.

The desired functionality of the Tweel(TM) must be realized with non-polymeric materials, such as metals and textiles operating in the 100-400K range. In an attempt to achieve this functionality, Clemson in collaboration with Michelin and JPL, organized a senior design class in Fall'06 to explore various Tweel (TM) concepts. Analytical models are being developed to explore the many different geometric and material configurations based on the selected concepts. In this EPSCoR project, further development and testing, both physical and virtual, will be done through the temperature range to determine the sensitivity of the Tweel (TM) performance. This testing requires the development of appropriate experimental systems by tire/wheel experts at Clemson/JPL/Michelin and soil experts at NASA Glenn.

The specific scope of this three year project is to develop (Y1) virtual models built to explore each concept in order to test different materials under predicted use loading cases, physical 1/6th scale prototypes that can provide physical testing and validation of the virtual models developed, and optimization of Tweel (TM) configurations based on experimental results; (Y2) extensive testing of physical prototypes on the ATHLETE, continued fabrication for scaled prototypes using flight certified materials and acceptable fabrication techniques, and temperature based endurance and wear testing under load; (Y3) fabrication of full scale lunar Tweels(TM) for ATHLETE and develop scalable virtual models for different mission scenarios (size, load, mass).

South Dakota
South Dakota School of Mines and Technology

Continuous Nano-Scaled Carbon Fibers with Superior Mechanical Strength and Their Innovative Composites for Aeronautics and Space Applications

The objectives of this NASA-EPSCoR proposal include (1) developing continuous nano-scaled carbon fibers with superior mechanical strength and their innovative composites for aeronautics and space applications, (2) improving research infrastructure and science/technology capabilities in the State of South Dakota, particularly at the South Dakota School of Mines and Technology (SDSM&T), (3) providing broad-based, multi-level education on polymeric and carbonaceous nano-materials for pre-college, undergraduate, and graduate students, including Native American students, and (4) pursuing potential technology transfer and commercialization activities to promote economic development, particularly in the State of South Dakota. Three graduate students, two summer undergraduate students and two post-doctoral associates will be supported by this NASA-EPSCoR grant and/or the non-federal matching funds to conduct the proposed research. The continuous, nano-scaled and extremely high performance carbon fibers will be prepared by stabilization and carbonization of highly aligned and stretched (up to 10-times their original length) electrospun polyacrylonitrile copolymer (precursor) nanofibers under optimal tension. The proposed carbon fibers will also be utilized to develop innovative composites, particularly with the recently developed nano-epoxy resins. This research will not only significantly improve the scientific understanding of electrospinning and nanofibers but also create a new synthetic route for the development of extremely high performance carbon fibers and their composites. This is expected to yield the next-generation structural materials of particular relevance to aeronautics and space applications. Through successful execution of the proposed research, the research infrastructure and science/technology capabilities at SDSM&T will be greatly improved, and the collaborations/relationships with the NASA Ames Research Center, the North Dakota State University (NDSU), and the South Dakota Space Grant Consortium (SDSGC) and will be strengthened. This research has considerable potential to receive continuous funding support from NASA sources outside of the EPSCoR program as well as from non-NASA sources.

South Dakota
South Dakota School of Mines and Technology

Land Cover Dynamics, Regional Hydrometeorology, and the Vulnerability of Rain-Fed Agriculture to Climate Change under Scenarios of Extensive Cultivation of Biofuel Feedstocks

Land cover dynamics remains one of the continuing critical issues for weather and climate modeling. It is difficult to find the appropriate coupling of the slower land surface processes that can be highly heterogeneous at finer spatial scales with the much faster tempo of boundary layer processes that exhibit heterogeneity only at much coarser spatial scales. VegET, a novel model for estimation of evapotranspiration in non-irrigated croplands and grasslands has recently been developed for operational use in the Famine Early Warning System Network. This approach blends concepts from irrigation engineering with a remote sensing datastream to estimate actual ET quickly at low computational and data cost with a surprising degree of accuracy. A key piece of information for VegET is the land surface phenology (LSP), which describes the seasonal progression of vegetation growth and development at locations of interest. The LSP can be observed by spaceborne sensors, modeled by an empirical climatology, or modeled using simple functional forms linking vegetation growth to temperature and/or precipitation. We propose to refine, validate, and apply VegET to explore the consequences of land cover change and variability on seasonal water use in rain-fed croplands. We will evaluate alternative MODIS datastreams and vegetation indices for VegET (it currently uses AVHRR NDVI). We will explore synergies with daily passive microwave products from AMSR-E. We will compare VegET predictions against a complex mesoscale model WRF/CLM. We will validate VegET with data from in-situ and flux tower networks and in corn, soybean, wheat, and switchgrass fields in South Dakota and western Minnesota. The focal application of VegET will be to assess the vulnerability of rain-fed agriculture in the Northern Great Plains (ND, SD, NE, western MN and IA) under scenarios of extensive cultivation of biofuel feedstocks and the regional climate projections of the IPCC AR4. We will investigate how the LSPs associated with biofuel feedstocks may affect the regional hydrometeorology by changing the amount of ET and shifting peak seasonal latent heat fluxes. We will explore the impact of these changes on risk of drought and other forms of extreme weather and on wildfire risk.

Vermont
University of Vermont

Investigation of Critical Aerothermodynamic Phenomena for Hypersonic Vehicles

The objective of this proposal is to leverage a unique plasma torch facility at the University of Vermont (UVM) and the Vermont Advanced Computing Center (VACC) to provide NASA with a testing center and expertise to study critical aerothermodynamic phenomena of planetary entry. The research tasks address five fundamental problems: (1) investigation of gas/surface interactions for ablative thermal protection system (TPS) materials, (2) Numerical study of turbulence in the boundary layer developing over (TPS) in flight conditions, (3) thermo-mechanical atomistic modeling and characterization of TPS materials, (4) experimental study of micro-scale flow in a simulated char-like TPS materials, (5) in-situ monitoring of TPS material performance. The experimental test facility used in task (1) consists of a 30 kW Inductively Coupled Plasma (ICP) Torch with optical diagnostic that will be used both as a test capability for the study of chemical kinetics problems that include gas/surface interactions for different planetary atmospheres in contaminant-free plasma and as a prototypical design that could be duplicated at Ames Research Center (ARC) on a larger scale for on-site research studies. State-of-the-art measurement techniques will complement the ICP facility, including atomistic force microscopy and scanning electron microscopy (task 3) and micro-particle image velocimetry (task 4). The computing power of the VACC will support the development of numerical algorithms within NASA compressible flow code DPLR for the accurate simulation of turbulence (task 2), and the atomistic modeling of TPS materials (task 3). In addition to providing an important research capability for non-equilibrium chemistry, radiation, and gas/surface interactions, the proposed facility would become a training ground for graduate students in aerospace sciences. Undergraduate capstone senior projects will be developed around the challenges of hypersonic flight. Space exploration will be included in existing outreach K-12 programs to foster interest in aerospace careers. This proposal directly addresses several subtopics in the Hypersonics section of the NASA Research Opportunity Announcement 2007, in the following topics A.5.1 Materials and Structures, A.5.3 Aerodynamics, Aerothermodynamics and Plasma Dynamics.

West Virginia
West Virginia Space Grant Consortium

Molecular and Cellular Mechanisms Underlying Skeletal Muscle and Cardiovascular Adaptation to Simulated Microgravity

Microgravity-induced dysfunctions of the skeletal muscle and cardiovascular system are major impediments to prolonged space travel and countermeasures are essential if NASA is to fulfill their long-term objectives. Using rodent hindlimb unweighting (HLU) as a model of microgravity, we seek to: (1.) Explore two novel mechanisms that respond to microgravity, namely, changes in transcription factor signaling (causative) and modulation of circulating adult stem cells (restorative), and (2.) To identify countermeasures that attenuate these deleterious changes in order to improve the function of target tissues during and after spaceflight. The central hypothesis, based on strong preliminary data, is that signal transduction, chromatin structure, and restorative adult stem cells are affected by HLU (microgravity). The specific aims are: (1.) To evaluate how HLU-induced changes in Akt and nuclear factor-kappaB (NF- B) activity are related to alterations in muscle mass, ubiquitin ligase activity and muscle protein ubiquitination, (2) To evaluate the number and phenotype of adult stem cells in HLU animals and (3) To develop interventional protocols to reverse HLU-mediated skeletal muscle and cardiovascular dysfunction. Additional NASA priorities in the form of Administrative Aims will also be pursued and are: to support NASA¿s educational mission by providing a rich environment for training; to develop a partnership with West Virginia State University to cultivate educational diversity; and to enhance the applicant¿s competitiveness for extramural funding. This proposal outlines an integrated approach to investigate the mechanisms of these events and the use of novel interventions. Educational and outreach activities will provide “value added” effect and will result in the formation of an investigative group whose research will be centered on foci important to the mission of NASA. Information gleaned from these studies will have applicability to other disease conditions associated with muscle atrophy including cancer cachexia, aging, AIDS and diabetes.

West Virginia
West Virginia Space Grant Consortium

Design, Simulation, Validation, and Flight-Testing of Adaptive Fault-Tolerant Flight Control Systems

Subsystem failures pose significant threats to the safety of aircraft and spacecraft systems. The primary objective of this proposed research is the development of an integrated adaptive flight control system capable of detecting, identifying, and accommodating for both sensor and actuator failures in real time. A complete development cycle will be demonstrated, including conceptual and detailed design, PC-based and motion-based simulations, model-based software verification and validation (V&V), and incremental flight-testing validation. Emphasis will be placed on integrated fault-tolerant flight control system design and combined use of Small Unmanned Aerial Vehicle (SUAV) flight-testing and motion-based flight simulation for validating the adaptive flight control system under a variety of subsystem failures and flight conditions. It is envisioned that the success of this effort would advance both the state-of-the-art in fault-tolerant flight control theory and the state-of-the-practice in control system validation and testing methods. Five Graduate Research Assistants (GRAs), including 3 Ph.D. and 2 MS students, will be involved in this project. The proposing team is committed to championing diversity and to recruiting and mentoring among underrepresented groups. It is envisioned that students involved with this project would receive an invaluable research experience and an excellent preparation for the research challenges in their professional careers. The research activities will also enhance the competitiveness of the UAV industry in West Virginia.