Advanced Scientific Computing Research (ASCR) FY 2023 RENEW Awards

Mobilizing the Emerging Diverse AI Talent (MEDAL) through Design and Automated Control of Autonomous Scientific Laboratories

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The Mobilizing the Emerging Diverse AI Talent (MEDAL) project is a collaboration between the University of Texas at San Antonio, the Argonne National Laboratory, Bowie State University, Oakland University, Cleveland State University, Florida International University, and the University of Central Florida. The University of Texas at San Antonio, Florida International University, and the University of Central Florida are Hispanic-Serving Institutions (HSIs). Bowie State University is one of our Historically Black Colleges and Universities. Cleveland State University and Oakland University are doctoral universities with high research activity (R2).

The MEDAL project aims to train faculty, doctoral, graduate, and undergraduate students at the HBCU, three HSIs, and two urban R2 universities on contemporary AI research relevant to the Department of Energy, including topics such as transformers, perceivers, large language models, pre-trained visual and scientific models, and control of autonomous scientific labs. The project comprises four distinct tasks that aim to enhance learning outcomes on these topics by catering to diverse learning preferences: (i) adaptive delivery of video lectures using AI, (ii) automated evaluation and feedback generation assisted by large language models, (iii) deep reinforcement learning and pre-trained models for autonomy in scientific labs, and (iv) outreach through summer workshops, asynchronous online AI classes, and a VR-based testbed for autonomy in scientific labs.

The project team seeks to pursue scientific and technical innovations to support its educational and outreach plans. The project team, including Ph.D. students and undergraduate researchers, will study topics of contemporary research, such as (i) deep reinforcement learning with symbolic information, (ii) verification of image responses from student programs and generation of explanations for incorrect images, (iii) designing a calibration metric for feedback on codes in Jupyter notebooks, (iv) enhancing privacy and fairness of the underlying AI models, (v) fine-tuning and pruning pre-trained visual models for robotic control in autonomous scientific lab CPS test-beds, and (vi) robustness metrics for pre-trained models. The research team will work together as a collaborative group of six academic institutions mentored by Argonne National Laboratory to actively investigate these fundamental research problems. The MEDAL project will provide AI education and training opportunities to diverse and hitherto underserved populations and promote DOE-relevant research by leveraging online learning and recent advances in large language models and other large pre-trained models for visual and scientific information.

This research was selected for funding by the Office of Advanced Scientific Computing Research

Reaching an Advanced Computing Technologies Workforce through Education Initiatives in Quantum Information Science and Engineering (ReACT-QISE)

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Quantum information technology is rapidly emerging and expected to disrupt modern critical communications, computing, and sensing infrastructure. Here, a new Consortium is formed to build, support, and connect a diverse population of students to create a new generation of quantum engineers trained in advanced computing and communications technologies. With significant national investment from the U.S. Department of Energy (DOE), in particular the Advanced Scientific Computing Research (ASCR) program, quantum computing and communications are among the most promising applications of emerging quantum technologies and recognized globally as challenging in both a scientific and technological sense. The community also recognizes that the realization of advanced quantum computing and communications technologies requires a skilled, diverse workforce to bring ideas central to quantum information to real-world application outside of the laboratory.

Therefore, seven institutions spanning from predominantly women institutions, Historically Black Colleges and Universities (HBCUs), and Hispanic-Serving Institutions (HSIs), to those in states designated by the DOE's Established Program to Stimulate Competitive Research (EPSCoR), have created the ReACT-QISE Consortium, with a mission to provide comprehensive education pathways for a diverse population of students aimed to meet the national need for a highly skilled quantum workforce in engineering. Shorthand for "Reaching an Advanced Computing Technologies Workforce through Education Initiatives in Quantum Information Science and Engineering," ReACT-QISE's mission is to broaden the quantum capabilities, curriculum, and degree offerings in quantum engineering at each institution, empower faculty at Minority-Serving Institutions (MSIs) to participate in quantum information education, and address the near-term (i.e., less than five years) needs of the national quantum workforce of interest to ASCR and the Reaching a New Energy Sciences Workforce (RENEW) Initiative.

This research was selected for funding by the Office of Advanced Scientific Computing Research

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Basic Energy Sciences (BES) FY 2023 RENEW Awards

HBCU Undergraduate Program toward a*b initio* Prediction of Single-Photon-Emitters and Spin Qubits in Defected 2D Semiconductors

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This research project is a collaboration between Tuskegee University (TU), a Historically Black Institution (HBCU), and the University of Central Florida (UCF), a high-level research (R1) minority serving institute (MSI), in support of quantum workforce development. The training, internship, and research opportunities will provide students and faculty the potential to further pursue a scientific career. A major goal of the collaboration is to recruit, sponsor, and mentor basic science and engineering undergraduate interns (UI) at TU to actively participate in research on how the composition and structure of rationally tailored defects in two-dimensional semiconductors determine their electronic and optical properties. Applying these fundamental results will reveal paths to more efficient single-photon emitters operating in the near-infrared region applicable in quantum telecommunications, as well as optically controllable spin-based quantum bits of information. We will test a rational design hypothesis to tailor defects in semiconductors for improved efficiency by (a) selecting suitable semiconductors and defects, (b) performing calculations for prediction and validation, and (c) collecting the calculated data to test, change, and refine the hypothesis. The research of each of the proposed materials for the above applications will be performed in two main parts: (i) Evaluation of the stability of the materials by calculating their energetics and vibrational properties applying the Density Functional Theory approximation, which is appropriate for ground-state properties. (ii) Evaluation of the electronic and optical properties of the stable proposed materials using state-of-the-art methods to deal with exited electronic states, such as the GW and the Bethe-Salpeter-equation methods. The UIs will be trained and engaged in the research via a one-year internship program covering (1) basic topics to understand and initiate the research project, including quantum mechanics and programming, (2) an introduction to specialized software and computational skills to carry out the calculations of total energy, electronic structure, ionic relaxation, vibrational spectra, electron-phonon coupling, and optical excitations, and (3) hands-on activities on performing and interpreting the first-principles electronic structure calculations to accomplish the scientific part of the project.

This research was selected for funding by the Office of Basic Energy Sciences

Building a Diverse Nuclear Energy Workforce: Hunter College/Brookhaven Partnership to Investigate Technetium-99 and Rhenium Speciation in Molten Salts

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This project investigates the chemistry of technetium-99 (Tc) in molten salts (MS), which is important to future U.S. clean energy. Molten salt reactors (MSRs) are an emerging nuclear reactor technology where the fissile nuclear fuel is dissolved in a molten salt that also acts as a coolant. As the reactor operates, the fuel salt composition will change due to the accumulation of fission products, which negatively affect reactor performance. Removing the fission products is challenging, therefore understanding what chemical forms the fission products take is key to designing effective separation systems. Studies on the very important fission product technetium-99 in MS are lacking, and that is the gap that this project intends to fill as it trains the next, diverse generation of radiochemists and molten salt chemists. *The overall hypothesis* of this research is that Tc in MS occupies a range of local environments, charge states and coordination states that depend on temperature and the composition of the salt. Rhenium (Re), the third-row congener of Tc, is used as a non-radioactive surrogate to develop the skills of trainees and validate experimental systems and methodologies before studying the Tc analogs. This project focuses on chloride-based systems because they pose significant scientific questions while being easier to handle and thus better suited for training purposes than fluorides.

The research hypothesis will be addressed by objectives 1-3: *Objective 1. Understand Tc-Cl complex speciation in low-melting chloride salts (ionic liquids, ILs).* Chloride ILs are good proxies for examining the speciation (coordination and electron transfer properties) of various Tc and Re valence states because they offer only chloride ions for coordination to the metal ions. Chloride ILs allow characterization of Tc speciation in ambient conditions convenient for training and skill development. *Objective 2. Elucidate the effects of molten salts' strong cation-anion interactions on Tc and Re speciation using pure molten $ZnCl_2$.* Here Tc and Re speciation in molten $ZnCl_2$ (m.p. 290 °C) is investigated with optical spectroscopy, synchrotron and radiolysis experiments at temperatures up to 400-450°C. The goal is to understand how the cation-anion interactions intrinsic to $ZnCl_2$ control the Tc–solvent (salt) interactions. *Objective 3. Interpret the speciation and redox chemistry of Tc and Re in $ZnCl_2$-KCl, a complex, tunable salt system*. Building on the characterization in molten $ZnCl_2$, $ZnCl_2$-KCl mixtures are used to explore how Tc and Re speciation can be controlled by tuning mixture composition over temperatures up to 700 °C. *Objective 4 is cross-cutting* and involves an examination of the advantages and limitations of X-ray absorption fine structure spectroscopy for Tc and Re speciation in ILs and MS. *Objective 5 is also cross-cutting* and includes targeted recruitment, mentoring, and retention of groups underrepresented in science. A hallmark of this BES-RENEW project will be internships at BNL (3-4 mo/yr). These will provide training in a rich science environment by world class scientists employing the unique facilities of a national laboratory.

This research was selected for funding by the Office of Basic Energy Sciences

Structure Property Relationships in Two-Dimensional MXenes

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The research project focuses on the comprehensive investigation of structural, optical, magnetic, electrochemical, and electrical properties of two-dimensional MXenes, a class of two-dimensional inorganic compounds with the chemical formula $M_{n+1}X_nT_x$, where M denotes an early transition metal, X indicates a carbon, nitrogen or both, and T is a surface termination group. The goal of the project is to improve the fundamental understanding of the correlation between synthesis and processing routes in search of the best material for energy storage technology and spintronic applications. This project capitalizes on the fundamental knowledge of deviations in parent MXene materials' magnetic, structural, and microstructure properties as a function of gamma radiation dosage and time. It will provide insights into the important steps of electrochemical processes in MXenes and examine the optical and electrical properties of MXenes and MXene quantum dots in connection with chemical structure, morphology, gamma radiation dose, and interfaces.

The project will significantly strengthen the quality of research in two minority serving institutions in collaboration with Savannah River National Laboratory (SRNL), provide opportunities for increased exposure of these institutions to the scientific community, and help establish their presence in the energy-technology area. The underrepresented student populations with minorities, women, and military students in multiple science, technology, engineering, and mathematics (STEM) disciplines at Fayetteville State University (FSU) and North Carolina Agricultural and Technical (NC A&T) State University will have essential opportunities to understand research techniques and methodologies. During the grant period, it is anticipated that ten undergraduate students and one graduate student will be mentored and trained in MXene synthesis and characterization techniques each year. Four undergraduate student interns will spend four weeks at SRNL each year, who will have opportunities to participate in the studying of the physical properties of pristine and gamma irradiated MXenes. A graduate student at NC A&T and postdoctoral researchers hired at FSU and NC A&T will also visit SRNL one week per year for research and training. Students will be better prepared for graduate schools in STEM fields and the workforce by training them in the fundamentals of materials synthesis, material processing, photophysics, electrochemistry, magnetism, simulations, and theoretical calculations. The project is directly relevant to the DOE's Basic Energy Sciences-Reaching a New Energy Sciences Workforce (BES-RENEW) program goal to increase the participation of underrepresented groups in BES's research portfolio and advance a diverse, equitable, and inclusive research community.

This research was selected for funding by the Office of Basic Energy Sciences

A New "Spin" on Designing First Row Transition Metal Photosensitizers

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This project expands the energy sciences frontier in two critical dimensions: (1) probing the use of spin-selectivity to extend the lifetime of photosensitizers based on manganese - a cheap, earth-abundant first-row transition metal (FRTM), and (2) increasing the representation of historically underrepresented and minoritized (URM) groups in STEM.

Photosensitizers are compounds that absorb energy from light and convert that into chemical potential, which can be used to overcome energetic barriers and/or photocatalyze difficult chemical transformations. The overarching scientific goal of this project is to investigate ways to control the properties of earth-abundant FRTM photosensitizer complexes such that they compete with or outperform the historical benchmarks based on rare, expensive metals, such as ruthenium. In the FRTM manganese complexes, a Lewis acid binding event provides a new electronic pathway in the photoexcited state that turns-on photoactivity through a change in the spin-state. The spin of the new excited state pathway partially dictates how long the absorbed light-energy can be stored for later use, i.e., the lifetime. Structural factors, such as appended ligand flexibility and electron donor strength, are also likely to impact this mechanism and the complexes dipolar characteristics in the ground and excited states.

Similarly, the overarching goal of this project for *REaching a New Energy sciences Workforce (RENEW)* is to intentionally address obvious and invisible barriers for academics, students, and researchers from URM groups such that equitable opportunities to compete and perform in STEM are created where historical benchmarks have limited participation. Toward both goals, resources at Metropolitan State University of Denver (MSU Denver), a primarily undergraduate Hispanic Serving Institution, and National Renewable Energy Laboratory (NREL) will be combined to synthesize manganese complexes with systematic structural and Lewis acid changes and subsequently analyze the photoexcited energy pathways, molecular dipolar characteristics, and electronic spin-states. Scaffolded research teams consisting of post-baccalaureate and undergraduate researchers will be co-led by a postdoc paired with project PIs specializing in synthesis, spectroscopy, microwave, and spin-related research techniques. URM specific programs such as the Wilton Flemon Postdoctoral Teaching Fellowship, Postdoc and Grad Student Employee Resource Group, and two newly developed post-baccalaureate bridge programs will be employed to recruit students and researchers. These programs include multi-tiered mentorship, competitive pay, benefits, community-building and networking activities, and long-term, immersive research experiences for students from URM groups. This structure intentionally enables students and researchers to engage in high-impact research, expand their skillset, and build their STEM identity in an inclusive, safe community. As such, this project will capitalize on the strengths of both MSU Denver and NREL to provide transformational opportunities in the energy sciences workforce.

This research was selected for funding by the Office of Basic Energy Sciences

Building a Diverse Workforce in Nanomaterial Characterization and Solid-State Chemistry

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Nanomaterials are an evolving area within the solid-state field. Fundamental research in nanomaterial characterization and solid-state chemistry is important for developing foundational knowledge of the unique properties of nanomaterials. This knowledge serves as a basis for new theories and models which describe or predict nanoparticle behavior and interactions. Nanoparticle characterization helps to meet regulatory requirements and facilitates the development of safe and effective nanoparticle-based products. Nanoparticles often exhibit different behaviors than bulk materials, as seen in toxicity profiles, which are influenced by factors such as size, shape, and surface chemistry. A diverse workforce in this area advances the opportunity for innovation and creativity in future solid-state product and process designs. The goal of this research project is the fundamental understanding of functional nanomaterials with unique electronic and magnetic properties. Research projects include the synthesis and characterization of non-centrosymmetric magnetic materials, chiral magnetic oxides, graphene and graphene-oxide metal ferrite nanocomposites, and metal oxide nanocomposites.

Like all Historically Black Colleges and Universities (HBCUs), Prairie View A&M University (PVAMU) focuses on increasing the development of unserved and underserved populations including students from low-income families. Nanomaterial characterization and solid-state chemistry training and development is a collaborative effort between PVAMU and Oak Ridge National Laboratory (ORNL). The collaboration provides an inclusive environment for training a diverse group of undergraduate, graduate, and post-doctoral researchers in the basics of nanomaterial characterization and solid-state chemistry to assist in developing the future STEM (Science, Technology, Engineering, and Mathematics) workforce. This Basic Energy Sciences RENEW program follows a Promoting Inclusive and Equitable Research (PIER) plan which includes creating and fostering an inclusive research environment, providing opportunities for professional development for all team members, and providing multi-tiered mentorship plans for all participants. The research projects and mentorship provide students with valuable experience and training including writing techniques and laboratory standards. At PVAMU and ORNL, students will gain exposure to the investigative tools in in the areas of materials synthesis, structural characterization, measurement of physical properties as a function of temperature and magnetic field, and data acquisition and analysis. The PVAMU researchers will receive training with state-of-the-art characterization and synthesis instruments at ORNL. Student researchers will engage with ORNL researchers during online workshops and seminars, campus visits by ORNL staff, summer workshops and internships at ORNL, conference attendance, and research meetings.

This research was selected for funding by the Office of Basic Energy Sciences

Broadening Accessibility & Training to Emerging Researchers for Innovative Energy Storage (BATTERIES)

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The BATTERIES project addresses two crucial goals in basic energy science research: (1) the development of novel materials for enhancing stability, catalytic activity, and conductivity of lithium-sulfur (Li-S) batteries to meet energy storage demands and (2) the preparation of future STEM (Science, Technology, Engineering, and Mathematics) scientists from underrepresented minority (URM), first-generation college student (FGCS), and women subpopulations. Although Li-S batteries theoretically have capacities up to four times higher than that of current Li-ion batteries, several challenges related to the dissolution and diffusion of polysulfides limit commercialization of Li-S batteries. To overcome these challenges, a computation-guided experimental approach to investigate three interwoven scientific lines of inquiry will be employed:

1. Control of layered topology Metal Organic Framework (MOF) pores to stop polysulfide shuttling caused by the dissolution of intermediate lithium polysulfide species in the electrolyte resulting in poor battery cell performance,
2. Determination of potential catalytic effects of conductive MOFs on Li-S electrochemistry, and
3. Quantification of the cycling capability of Li-S batteries containing porous and conductive MOFs.

The outcomes will enable the rational design and control of *electrically* conductive cathode additives and sulfur hosts, as well as *ionically* conductive interlayers in the Li-S battery. To achieve the scientific goals, over one third of students who self-identify as URM, FGCS, and/or female will be recruited at the two participating minority serving institutes. The project's plan for Promoting Inclusive and Equitable Research (PIER) includes:

1. Comprehensive recruitment workshops,
2. An inclusive environment management for research and training of all participants, and
3. Mentorship matching for 22 student participants and two postdoctoral scholars (PDS), providing the participants with unique career development opportunities.

The goal is retention and graduation of more than 90% of the participants, jumpstarting the careers of two early career scientists, and serving as a role model on techniques to retain and prepare a diverse STEM workforce.

This research was selected for funding by the Office of Basic Energy Sciences and the DOE Office of Electricity.

Biological and Environmental Research (BER) FY 2023 RENEW Awards

Strengthening Education and Research Capacity for Bioenergy Science at Alabama A&M University through a Combination of Education, Research and Partnerships

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2: Joint Genome Institute, Berkeley, CA 94720
3: Hudson Alpha Institute of Biotechnology, Huntsville, AL 35806
4: Center for Advanced Bioenergy and Bioproducts Innovation (CABBI)/University of Illinois Urbana Champaign, Urbana, IL 61801

Alabama A&M University (AAMU) investigators have been conducting genetics and breeding research for a suite of related, model C4 bioenergy crops including Miscanthus and sorghum. The proposed research will leverage this strong foundation to enhance and build an up-to-date bioenergy science research and education program at AAMU. With guidance from collaborating partners, and new investments in modern research tools for high-throughput phenotyping, genomics, bioinformatics, and gene editing, AAMU students will be exposed to the available latest cutting-edge technologies. Specifically, the research will leverage the diverse and well-established populations of Miscanthus genotypes and ongoing sorghum projects at the AAMU's Winfred Thomas Agricultural Research Station (WTARS). Miscanthus field trials will be used to study genotype by environment (G x E) by incorporating high-throughput phenotyping in partnership with CABBI/University of Illinois Urbana-Champaign, through which 2 undergraduates will be trained each year. These Miscanthus trials also will be used to conduct microbiome wet-lab and bioinformatics studies in partnership with JGI, through which the project expects to train 2 undergraduates each year. A Sorghum Association Panel (SAP) planted at the WTARS will be used to study the effect of nitrogen deficiency, through which 2 undergraduate students will be trained each year; phenotypic and molecular characterization of gene-edit sorghum lines will be used to train 1 graduate student. The sorghum research and student training will be in partnership with CABBI/HudsonAlpha Institute for Biotechnology.

This research project aims to enhance bioenergy science program at AAMU, with the areas of high throughput phenotyping, omics and bioinformatic analysis, and plant genomics and biotechnology strengthened by our partnership with and receiving support from JGI and CABBI. The recruitment and training of a total of 18 undergraduates and 1 masters student in this Bioenergy Science program will establish a recruitment pipeline for the Bioenergy workforce and/or graduate training programs.

This research was selected for funding by the Office of Biological and Environmental Research.

Catalyzing STEM Training and Partnerships through Comparative Analysis of Transferable Watershed Function in East River and Southern California Watersheds

Dr. Barry Hibbs[1], Professor
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3: Stanford Linear Accelerator Center (SLAC), Menlo Park, CA 94025

This project presents a vertically integrated set of mentor-focused research and experiential training to provide career pathways for diverse students in fields of study in watershed analysis, while contributing to intellectual growth of Science, Technology, Engineering, and Math (STEM) communities at a notable Hispanic Serving Institution, California State University, Los Angeles (Cal State LA). The project aims to examine overall patterns of watershed and riparian function, including solute/nutrient flux and isotope hydrology along the course of the Los Angeles River and tributaries. The project also aims to understand how fire ecohydrology and extremes in flooding and drought affect chemistry and flows of the river. For enhanced intellectual growth, the project will leverage new capabilities and research directions within the Watershed Function Scientific Focus Area (SFA) in the East River watershed of the Upper Colorado River Basin. In addition, research activities will engage LBNL, SLAC, and Cal-State LA faculty and students in a team environment, fostering a sense of belonging while cultivating scientific identity through independent projects. These collaborative efforts will also lead to joint publications, where students will be co-authors and as appropriate, first-authors.

This research was selected for funding by the Office of Biological and Environmental Research.

BER-RENEW iSAVe: New Energy Sciences Workforce to Advance Innovations in Sustainable Arid Vegetation

Dr. Marina Kalyuzhnaya[1], Professor
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The southwestern US is challenged by climate change, reduced water supply, and air pollution. As one of the strongest academic institutions in the region, San Diego State University (SDSU) has a collective mission to devise and implement solutions for local and global problems, supporting both the educational and economic development of historically excluded communities (HEC). This project will provide meaningful, equity-centered mentoring to HEC graduate students as they engage in cutting-edge research focused on developing novel climate-smart solutions for agriculture (with a focus on sorghum) in marginal soils with partnerships at Lawrence Berkeley National Laboratory (LBNL) and Pacific Northwest National Laboratory (PNNL).

The overarching goal of the research is to provide transformative solutions for current agricultural practices by delivering fundamental knowledge of plant-growth-promoting microbiome interactions, thus providing incentives for sustainable production while decreasing water usage and greenhouse gas emissions. HEC graduate students will play critical roles, with meaningful participation in all these culturally and socially relevant project areas. This integrative study represents a unique platform for interdisciplinary preparation in key areas of science, technology, engineering, and math (STEM) that will increasingly be called upon to solve many of humanity's environmental challenges. The research is designed to equip HEC graduate students with advanced experimental, computational, and mathematical skills and provide a modern-day biotechnology perspective that requires the integration of scientific discoveries with long-term social, economic, and sustainability considerations. These efforts will serve to create a robust pipeline for diversifying the biotech workforce of the future by developing interest in biotechnology and training SDSU students for rewarding careers in the rapidly emerging field of bio-based innovations. The research aims to fund the training of four graduate students.

This research was selected for funding by the Office of Biological and Environmental Research.

Applied Geospatial Data-science Initiative for Urban Climate Change Studies (AGDI-UCCS)

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Predictive understanding of the complex and interrelated urban processes in general, and more specifically their effects on heat build-up and local climate within rapidly growing cities at variable spatial scales and during specific heat events is of critical need towards achieving urban climate change resilience. This project aims to establish the Applied Geospatial Data-science Initiative for Urban Climate Change Studies (AGDI-UCCS). The overarching goal of AGDI-UCCS is to enhance collaborative research, education, experiential training, and professional development opportunities for students and emerging researchers from historically underrepresented minority communities. AGDI-UCCS research will focus on developing geospatial modeling applications by integrating remotely sensed data and products to achieve a predictive understanding of urban climate change impacts in general, and more specifically the dynamic processes of rapidly developing urban landscapes of mid-size cities and their suburban landscapes of the mid-south. Through proposed AGDI-UCCS activities, the project aims to expand and strengthen AAMU's collaborations with two national laboratories (NLs): Pacific Northwest National Laboratory (PNNL) and Oak Ridge National Laboratory (ORNL). The funded project addresses its science objectives in multiple ways: 1) research findings (i.e. development of the geospatial modelling framework, urban heat islands (UHI) simulations at variable scales, quantification and spatial modelling of UHI) will contribute to improve predictive capabilities of world research forecasting – urban canopy modeling (WRF-UCM) to advance scientific understanding of urban-climate interactions and their impacts on incidences of heat waves, heat stress, and energy demands in rapidly growing cities to help identifying potential adaptation and mitigation strategies towards achieving urban climate change resilience; 2) financial support will help alleviate existing barriers of AAMU for expanding the principal investigator's current research, teaching and student training capabilities; 3) the collaborations with the DOE's national laboratories will facilitate a two-way engagement between DOE funded research to facilitate the exchange of data, products, research and technical expertise; and 4) experiential learning opportunities will help students from traditionally underrepresented communities to develop research, technological skills (i.e., spatial modelling) and professional skills to enter DOE and STEM careers leading to enhanced diversity in future STEM workforce.

This research was selected for funding by the Office of Biological and Environmental Research.

Sub-seasonal to Interannual Variability and Predictability of Rainfall Over East Africa

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The overarching objective of this project is to build capacity of the Atmospheric Science and Meteorology Program at North Carolina A&T State University (NCAT), a historically black colleges and universities (HBCU), through experiential training and mentoring of graduate and undergraduate students. The project aims to train NCAT students with advanced computation techniques and equip them with cutting-edge research with a new collaboration with PNNL's Water Cycle and Climate Extremes Science Focus Area (WACCEM SFA). The partnership with WACCEM SFA will fill a critical gap that involves high-end computational regional climate modeling. In addition, the partnership will provide an opportunity for a sustainable undergraduate and graduate education and research program in climate and environmental sciences, consistent with DOE's strategic plan through the Office of Science Biological and Environmental Research. The project will focus on two distinct but integrated areas of research: (i) intraseasonal to interannual variability of precipitation and its interaction with different types of moist convective processes and (ii) frequency and variability of extended wet and dry events within the rainy period and how they relate to intraseasonal modes of variability. The project expects to advance knowledge and understanding of the sub-seasonal to interannual variability of precipitation processes including the impact of intraseasonal modes on different types of deep convection, and diurnal rainfall cycle over East Africa. The project will accomplish its objectives through experiential learning and training of students and conduct deep observational and theoretical analysis, integrated with regional modeling. The project will address one of the most important concerns of the Nation: increasing participation of underrepresented minorities that have very little involvement in atmospheric sciences research and, thereby, increase a well-trained diverse workforce. This research and educational program will be impactful because it will fill a critical gap in climate science education and research through a lasting partnership with PNNL WACCEM SFA in areas of shared interest. It will provide undergraduate and beginning graduate students' practical introduction to regional climate modeling at sub-seasonal to seasonal timescales, familiarizing them with high performance computing methods and tools.

This research was selected for funding by the Office of Biological and Environmental Research.

Bridging Disciplines, Empowering Students: A JGI-UC Merced Data Science and Genomics Training Program for the Energy Sciences Workforce

Dr. Suzanne Sindi[1], Professor
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2: Lawrence Berkeley National Laboratory (LBNL)/Joint Genome Institute (JGI), Berkeley, CA 94720

The proposed UC Merced-JGI RENEW Internship Program is built upon a successful and established partnership between investigators. Since 2014, UC Merced (through Dr. Sindi) and LBNL/JGI (through Wang) have co-managed a Summer Undergraduate and Graduate Internship program. The program matches students with projects and mentor scientists at JGI that provide hands-on experience in cutting-edge genome research and apply experimental and computation tools to solve problems in computational biology and genomics. Initially, the program began with two graduate students, but in recent years has grown to an annual cohort size of 10. Since 2014, the program has supported sixty students who have contributed to approximately forty JGI projects.

This UC Merced-JGI training program will be expanded through Department of Energy's (DOE) Reaching a New Energy Sciences Workforce (RENEW) program in 4 innovative directions: (1) expanding our Summer internship to a year-long research & training program; (2) engaging the training program's Alumni both for workforce building & mentoring of new trainees (3) strengthening the research and scientific exchange between UC Merced and JGI; (4) employing data-driven assessment to improve the training program and to serve as a model for other DOE/academic partnerships.

The proposed program extends the activities between UC Merced and JGI from the existing Summer to throughout the entire calendar year. Graduate students will be supported to carry out their research during the academic year, providing continuity to their own work and increasing the opportunity for engagement with research from students at UC Merced beyond the supported cohort. Joint workshops and seminars continuously provide engagement and scientific exchange between UC Merced and JGI. As in the past, the research questions approached by trainees will be aligned with UC Merced and JGI's research to address important challenges in bioenergy and biosystems by using omics data to study microbial communities and critical species of interest.

This research was selected for funding by the Office of Biological and Environmental Research.

Partnership for Fostering Graduate Training in Atmospheric Sciences at Texas Southern University

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Texas Southern University (TSU), a Carnegie R2 research institution and one of the largest Historically Black Colleges and Universities (HBCUs) in the nation builds a long-term and sustainable research partnership with the Brookhaven National Laboratory (BNL) to train graduate students in Atmospheric Sciences. Through the ongoing engagement with research activities in the DOE Science Focus Area (SFA) project "PASCCALS: Process-level Advancements of Climate through Cloud and Aerosol Lifecycle Studies" (https://asr.science.energy.gov/projects/15588), this project aims to expand existing research programs, develop new capacities at TSU, and provide additional exciting opportunities for research and hands-on training for underrepresented and underserved graduate and undergraduate students. The main goal of the proposed program is the creation of a positive and inclusive learning and research environment that will nurture the next generation of a scientifically and technologically savvy, globally competitive energy workforce. Towards this end, the project sets the following objectives: 1. Provide experiential training to graduate students from the Department of Physics, Department of Chemistry and Department of Environmental and Interdisciplinary Sciences (EIS) at TSU by leveraging existing collaborations with staff scientists in the Environmental and Climate Sciences Department at BNL, and through broadening mentoring, science and immersion opportunities coupled with curricular development. 2. Enhance research capabilities at TSU by fostering a sustainable partnership with the BNL research group with the goal of developing both theoretical physical models and computational chemistry models of particulate reaction formation and its interaction to the formation of cloud condensation nuclei (CCN). 3. Leverage the Department of Energy's (DOE) Atmospheric Radiation Measurement (ARM) Facility by actively partnering on analyzing data from the Tracking Aerosol Convection Interactions Experiment (TRACER) campaign, and other ARM deployments, towards creating predictive models of critical aerosol formation and convective interactions in cloud processes, in conjunction with empirical statistical analysis methods.

This research was selected for funding by the Office of Biological and Environmental Research.

Co-designing Foundational Capabilities to Diversify the Scientific Workforce

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As the United States (US) population diversifies, the environmental science workforce lags the inclusion of historically underrepresented minorities (URM). To address the scope and scale of the dual environmental crisis faced by people and nature, this project seeks to ambitiously transform the understanding of climate-relevant processes while increasing workforce-ready URMs inclusion in climate science. By creating a foundationally solid URM pipeline through effective mentorship, the project will increase diversity and chances of understanding the urban-rural impacts due to climate change in the US most populated cities, which is critical to preparing and protecting Earth from future hazardous scenarios. This proposed Office of Biological & Environmental Research Reaching a New Energy Sciences Workforce (BER RENEW) project is designed to create a Promote Inclusive and Equitable Research (PIER) plan that catalyzes partnerships with the Department of Energy (DOE) Earth and Environmental Systems Sciences Division (EESSD) Offices address identified solvable historically black colleges and universities (HBCU) barriers. The project will accelerate inclusion and diversity of the US science and technology ecosystem to increase the future pool of young scientists with critical skills and expertise. In the long term, the overall goal of this project's motivation is for DOE labs to accelerate the ability to hire students out of these workforce ready programs which would further diversity DOE staff. The Program will be centered around Student First development and Student chosen research. By selecting a cohort of at least 3 students to be mentored in the development of DOE emerging and Critical Science Questions e.g., a required predictive capability as it is hindered by the strong heterogeneity of urban terrain, and the wide range of scales and processes that dictate how urban systems interact with the surrounding Earth system -- DOE need for the Urban Integrated Field Laboratories. The project objectives are to: i) broaden existing institutional capabilities, (ii) develop competitive advantages for experiential training opportunities, (iii) increase workforce ready URMs through effective individualized mentorship plans and PIERs. HBCU Barriers to funding will be addressed to bridge these gaps over the three-year term with in-person (tri-quarterly) and virtual (monthly) meetings with strong mentoring to accelerate workforce development. The project aims to educate and integrate URMs into DOE science with intentional inclusion in an equitable manor, through RENEW team members visiting each other's facilities (host site tours) to share science communications (oral and posters) that result in co-developed competitive proposals. Beneficial outcomes of this project will be new fundamentally inclusive partnerships with DOE and HU tasked to understand the urban-rural impacts due to climate change in the US, related to energy issues driven by heat stress and the energy cycle that can be scaled. The overall impacts of the RENEW will be in paving the way to ensure the inclusion of diverse voices to increase climate resilience with a transdisciplinary partnership that will minimize impacts on the most vulnerable communities while constraining barriers to HBCUs and URMs.

This research was selected for funding by the Office of Biological and Environmental Research.

Liquid Metal-Materials Interactions in Extreme Environments

Osman Anderoglu [1], Associate Professor

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The main objective of this project is to establish a unique, inclusive, and sustainable experiential-based research and educational program for the next generation of researchers and engineers in key areas of liquid metal coolant technology for fusion energy. The project's focus is on the effects of external magnetic field on eutectic Lead-Lithium (Pb-16Li) flow including magnetohydrodynamics (MHD) and structural materials compatibility. The project will include both experimental and computational opportunities for diverse students by both establishing and utilizing the unique capabilities and expertise of the participating partners. The liquid metal (LM) blanket and coolant in a deuterium-tritium (D-T) fusion reactor is responsible for energy transfer at high temperatures and tritium breeding using the ^{6}Li isotope. Therefore, LMs are one of the most important components of the tokamak designs. Tokamak fusion designs use external magnetic fields to confine plasmas and therefore LMs are exposed to very high magnetic fields. The interaction of high external magnetic fields with flowing conducting LM results in a MHD force. This Lorentz force due to the external magnetic field exerted on the flowing LM causes a significant pressure drop. In addition, MHD changes the LM flow stability and velocity distribution, therefore, affecting heat transfer as well as the corrosion/erosion behavior of the structural materials. In the progress towards commercial fusion energy, this technological gap needs to be addressed. Experimentally, this issue offers many materials and technological challenges to researchers, and outstanding opportunities to recruit and train young and diverse underrepresented students into new areas of fusion science and engineering. The proposed integrated educational and research project can be grouped into two components. The research component includes: (1) Establishing a unique flowing PbLi forced convection loop with external magnetic field capability to perform systematic experimental studies, (2) Developing and validating multi-physics computational models of LM fusion reactor blankets and coolants using the newly developed PbLi loop, and (3) Characterization of test specimens including Al-rich corrosion resistant coatings using various techniques and establishing structure-property relations. Concurrently, the educational components include: (A) Development of new course modules at partner institutions directly derived from the research subjects, (B) A new 1-week summer school focusing on various aspects of liquid metal coolants, and (C) Safety-focused training required for handling of liquid metals and other related subjects.

Fundamental Studies of Nanoparticle Synthesis and Growth in Plasma-Liquid Systems

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The goal of this work is to understand the synthesis and growth of metal nanoparticles in ionic liquids when exposed to a plasma discharge. The unique properties of the plasma-liquid interface enable the formation of a wide range of materials and the opportunity to probe the underlying physics in ways that are inaccessible during conventional synthesis. This work will use atomic-scale diagnostics including scanning electron microscopy and X-ray photoelectron spectroscopy to investigate the evolution of nanoparticle nucleation and growth in plasma-liquid systems. The results of this study will aid in understanding the processes that occur at the plasma-liquid interface and can be used to develop methods for optimizing nanoparticle production and controlling for particle size and shape. This work also seeks to develop a new workforce of innovative scientists in plasma physics by engaging undergraduate students at The College of New Jersey (TCNJ) in authentic research experiences. This work will leverage existing programs at TCNJ to broaden participation in plasma research, enable students to develop valuable technical skills, and create an environment focused on professional and personal growth. Involving students in research early on in their careers improves their self-efficacy, confidence, and ultimately their retention in STEM. Undergraduates at TCNJ will be involved in all aspects of the proposed work including experimental design, data collection, and analysis. TCNJ is a public, primarily undergraduate institution that enrolls approximately 7,000 undergraduates and has earned a national reputation for its commitment to excellence. We are committed to the teacher-scholar model, and 75% of our science majors graduate with a semester or more of research experience. TCNJ grants 15-25 B.S. degrees in Physics per year, earning it distinction as one of the top producers of physics majors in the U.S. By maintaining a healthy plasma physics program at a primarily undergraduate institution within a relatively large department, the work proposed here can help develop the next generation of vibrant, creative scientists in plasma physics.

This research was selected for funding by the Office of Fusion Energy Sciences

Simulations and experiments of ion acceleration and qubit synthesis with high power lasers

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This program is a new collaboration between the University of Hawai'i (UH) at Mānoa and the Lawrence Berkeley National Laboratory (LBNL). The UH at Mānoa is designated as a Minority Serving Institution (MSI) as well as an Asian American and Native American Pacific Islander Serving Institution (AANAPISI) with more than half of its student body as Hawai'i (in-state) residents in 2022. UH has a strong high energy density (HED) physics modeling capability, but there are no high-power laser experimental facilities in the DOE LaserNetUS network on or nearby the islands of Hawaiʻi. This new partnership focuses on direct student and faculty participation in LaserNetUS experiments for "qubit synthesis." Quantum bits (or qubits) form the heart of quantum computers and qubits also enable quantum sensing and quantum communication as applications of quantum information science (QIS). QIS is bound to revolutionize information technology and could transform our understanding of concepts of information. There is an international race to identify the best qubit candidates and to integrate these qubits for applications. To form qubits one must select a spot in a material where it is possible to access and control the "weird" properties of quantum systems (such as superposition of states and entanglement). We will explore qubit formation by rapidly heating materials using intense laser and particle beams. The heating pulses are very short and the material cools very quickly, and during this rapid cooling new qubit structures that had formed during the intense heat pulse stabilize so that they can be studied. High Performance Computing (HPC) modeling of the experiments will use the UH PISALE (Pacific Island Structured-AMR with ALE) code. The exchange will train a more diverse DOE workforce and give new opportunities to Hawai'i's students. It will provide undergraduate students exposure to HED science and qubit experiments that will influence them to consider going to graduate school in key fields. Graduate students and their UH advisors will benefit from direct exposure to experiments as a real-world application. Committed to being the leading indigenous serving university in the country, UH Mānoa maintains a unique multicultural global experience with a history of adherence to principles of sustainability and the essence of aloha. In addition to technological aspects of the exchange, the program will bring a more diverse experience and perspective to the national laboratory environment. This collaboration will help to train a new DOE workforce while attaining important overarching science goals of the proposed work which include energy security, sustainability, and energy justice – related to fusion, HED science, advanced quantum information technology, and advanced manufacturing with a focus on novel materials phases and qubits for quantum applications. We are also champions of 'information justice' - equal access to quantum technologies. Participants will join the LBNL team in laser-driven qubit synthesis experiments, work with LBNL in the analysis of data from high-power laser runs, material response to ion heating, and atomic properties of silicon and diamond used for qubit synthesis far from equilibrium. Students will become part of the team that will go full circle from preparation of experiments with model predictions, running the experiments, analyzing qubit samples after laser pulses, comparing to model predictions, and dissemination of results in publications.

This research was selected for funding by the Office of Fusion Energy Sciences

Research Training Pathway for Underrepresented Minority Students in Advancing Materials and Manufacturing for Fusion Power

Dr. Vijay K Vasudevan,[1] Chair and Professor, Principal Investigator
Co-PIs: Srinivasan Srivilliputhur,[1] Narendra Dahotre,[1] Thomas Scharf,[1] Sundeep Mukherjee,[1] Michael Baskes,[1] Bibhudutta Rout,[1] Nicolas Argibay,[2] Prashant Singh,[2] Xiao-Ying Yu,[3] Yutai Kato,[3] Saumyadeep Jana,[4] and Jaydeep Deshpande[5]
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The **vision** of this RENEW project is to create a platform for research training and education of a diverse body of undergraduate and graduate students and postdoctoral scholars, especially women and under-represented minorities to advance computation, and materials and manufacturing science and engineering relevant to the FOA research needs in fusion power, *sub-program area of burning plasma long pulse - materials*. **Areas of training** include high performance computing, modeling, and simulations of irradiation effects; fusion/nuclear materials science; materials design; modern synthesis, processing, and manufacturing; high energy density-materials interactions; advanced characterization, property, and performance evaluation; data science; technical writing, communication skills and teamwork. The **three specific goals** are to: **(1)** Develop, promote, and catalyze interdisciplinary study in advanced materials and manufacturing relevant to fusion science and technology. **(2)** Prepare a significant set of four Ph.D. and nine BS/MS grad-track students for careers in materials and manufacturing science relevant to fusion power. **(3)** Create protocols for inclusion, equity, and outreach to recruit and train transformative and skilled scientists and engineers to advance the future fusion power industry. The research training will focus on the science, engineering, processing, and manufacturing of prototypical W-based alloys and refractory high-entropy alloys (RHEA), including oxide and carbide dispersion strengthened (ODS/CDS) counterparts. All activities at UNT and at our laboratory partners will be closely coordinated and integrated via extended student visits to conduct the important parts of the research under the respective national laboratory mentor(s). The students will learn to quantitatively link, assess, and extrapolate the composition-processing-microstructure-property-performance relations in their prototypical materials to requirements of commercial fusion power. The recruitment, inclusion, and outreach goals of this project are ambitious, and it leverages the rich educational and cultural diversity inherent at UNT and our Dallas Fort Worth metroplex home region. These goals will be boosted by excellent facilities at UNT and at our three partner DOE laboratories. The hands-on experiences on modeling-design-processing-structure-property-performance relations students gain in this project will advance fusion materials and manufacturing science, open a career pipeline, and create a diverse body of talented professionals to take on challenges in futuristic energy sector that enhance America's global competitiveness.

This research was selected for funding by the Office of Fusion Energy Sciences

Partnering to Improve Diversity in the Fusion Workforce

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5. Tennessee State University, Nashville, TN 37209

The stated goal of the Fusion Energy Science - Reaching a New Energy Sciences Workforce (FES-RENEW) funding solicitation is, "to increase participation of underrepresented groups in FES's fusion and plasma science and technology research portfolio." The primary objective of this program is to provide opportunities for students from Minority Serving Institutions (MSIs) to participate in summer-internship research in the Fusion Energy Division (FED) at Oak Ridge National Laboratory (ORNL). This program will initially focus on recruiting talented students from MSIs that are geographically regional to ORNL, (e.g. Fisk University in Nashville, TN; Lane College in Jackson, TN; and Tennessee State University in Nashville, TN) to maximize opportunities to interact between the students and ORNL staff outside of the summer internship period. Since the targeted MSIs do not historically have programs in fusion science, ORNL staff will provide introductory lectures on plasma science at the MSIs during the academic year. These lectures are intended to recruit students interested in fusion science and technology to apply for FES-RENEW sponsored summer internships (typically 10 weeks) at ORNL. The close collaborative relationship between ORNL FED and the University of Tennessee-Knoxville (UTK) will be leveraged, as part of this program. Many UTK graduate students participate in directed-PhD research at ORNL. A 1-week intensive course at UTK on plasma science and fusion technologies will initiate the summer internship, taught in partnership with UTK professors and ORNL researchers. This will enable FES-RENEW participating students (and faculty) to become familiar with graduate education opportunities relevant to fusion at UTK in Nuclear Engineering, Material Science, Mechanical Engineering, interdisciplinary research, etc. In this way, the ultimate objective of this program is to establish a sustained "pipeline" of undergraduate students from the participating MSIs (currently underrepresented in fusion science), to graduate opportunities (e.g. at UTK and collaboratively at ORNL), leading to career paths in fusion (e.g. at ORNL), thereby accomplishing the stated goal of FES-RENEW "to increase participation of underrepresented groups in FES's fusion and plasma science and technology research portfolio."

This research was selected for funding by the Office of Fusion Energy Sciences

High Energy Physics (HEP) FY 2023 RENEW Awards

A Transformative Master's Program in High Energy Physics (HEP at SJSU)

Dr. Kassahun Betre[1], Assistant Professor
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2: SLAC National Accelerator Laboratory

This project will, in collaboration with SLAC National Accelerator Laboratory (SLAC), (1) create a 1.5 year long traineeship program for San Jose State University (SJSU) graduate and undergraduate students with primary emphasis on master's students, (2) enhance the physics curriculum to prepare students to work with theoretical and experimental high energy physics (HEP) practitioners, and (3) develop research infrastructure in HEP at SJSU, an institution that has not traditionally been part of the DOE particle physics portfolio. The traineeship program will enhance the cooperation between SJSU and SLAC and establish a sustainable pathway for talented students from underrepresented minority groups (URM) at SJSU to enter the HEP workforce. More than just a traineeship, this project also facilitates building a long term High Energy Group at SJSU by supporting the research of SJSU HEP faculty and their collaboration with researchers at SLAC.

At the heart of HEP at SJSU is a 1.5-year traineeship, supporting up to three trainees per cohort across three cohorts, for a total of nine trainees. Traineeships will enhance students' academic coursework, provide hands-on research and professional development opportunities, offer mentorship, provide financial assistance, and create a supportive community, ultimately providing the structure and supports to prepare trainees to be competitive candidates for PhD programs in HEP or other STEM careers. Trainees will be paired with SJSU mentors and SLAC research mentors. Trainees will be financially supported to work on research and development activities during the academic year and, during the summer, trainees will conduct full-time paid research at SLAC, under the supervision of a SLAC research mentor. The mentorship model is an inclusive, asset-based framework and training will be given to all mentors on the mentorship approach.

The project will fund the two SJSU PIs to build their research portfolio and research and training infrastructures at SJSU through collaborations with researchers at SLAC and the broader San Francisco Bay Area. This project will establish a strong master's program in HEP at SJSU and a pathway for students to begin careers in HEP. After the three year project period, the program will be well positioned to continue thriving through the new courses established, the strong ties forged with SLAC, and by the faculty research programs that will be competitive for external funding.

The HEP at SJSU project and partnership with SLAC will also be beneficial to SLAC and DOE efforts to increase the diversity of the HEP field since SLAC researchers will gain experience and training in effective mentorship practices with students from URM communities. The success of the program will be assessed using a combination of specific and holistic metrics that are both quantitative and qualitative.

This research was selected for funding by the Office of High Energy Physics

Long Island High Energy and Astrophysics Undergraduate Pathway (LEAP-UP)

Dr. John Estes[1] (Assistant Professor)
Co-Principal Investigators: Dr. Michael Kavic [1], Dr. Matthew Lippert [1] Dr. Ketevi Assamagan [2], Dr. Mary Bishai [2], Dr. Mateus Carneiro [2], Dr. Anze Slosar [2]
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The Long Island High Energy and Astrophysics Undergraduate Pathway (LEAP-UP) program teams up the new physics program at the State University of New York at Old Westbury (OW), the most diverse SUNY campus, with the world-class research programs at Brookhaven National Laboratory (BNL). Through this partnership, OW and BNL will create a new pathway which supports students, starting with recruitment efforts at local high schools and community colleges, mentorship and support throughout the students' academic journey, an interactive research experience, and ending with support as students apply to graduate programs and beyond. This will be done along three main thrusts: Build: The project will construct an active bridge between OW and BNL by pairing the HEP theory expertise of OW faculty with the experimental expertise of BNL researchers. Once built, this bridge will continue to provide HEP experimental research opportunities to OW's diverse student population.

Accelerate: OW is launching a new physics program. This grant provides essential resources to establish a robust physics program at OW, generating diverse physics student enrollment, with higher participation in HEP research and more graduates entering the HEP workforce. Mentor: Finally, this grant will support the development of teaching and mentoring training for both OW faculty and BNL staff emphasizing diversity, equity, inclusion, and justice, with the goal of increasing success of underrepresented minority students in HEP.

Two-year traineeships will provide students with stipends and support for tuition and housing. The key element is a fully mentored research experience, involving a 10-week summer program at BNL, with continued support as trainees continue their research during the following academic year. Students will have the opportunity to work on high-energy experiments like ATLAS, DUNE, LuSEE, and BMX, as well as theoretical projects in string theory and applications of holography to quantum field theory. Collaborative experiments: ATLAS, Deep Underground Neutrino Experiment (DUNE), Lunar Surface Electromagnetic Experiment (LuSEE) – Night, Baryon Mapping eXperiment (BMX), All Sky Transient Radio Array (ASTRA).

This research was selected for funding by the Office of High Energy Physics

Creating a Pipeline of Underrepresented Minorities in Applied Superconductivity for High Energy Physics

Dr. Fumitake Kametani[1], Professor
Co-investigators: Dr. Simone Hruda[1] and Dr. Eric Hellstrom[1]
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The goal of our RENEW program is to develop a strong pipeline that recruits, trains, and retains larger numbers of underrepresented minority (URM) undergraduate and graduate engineering students in the field of applied superconductivity relevant for the Department of Energy - High Energy Physics Accelerator R&D program. Our RENEW program leverages the strengths of an HBCU (Florida A&M University - FAMU) and a Research-1 University (Florida State University – FSU) through the joint FAMU-FSU College of Engineering. This is the nation's only engineering college that is joint between two such universities. The students will do hands-on laboratory work in the Applied Superconductivity Center (ASC), which has done state-of-art research on superconducting materials and magnets for nearly 40 years. Combining the academic and social strengths of FAMU and the FAMU-FSU COE with the hands-on research opportunities at ASC creates a unique opportunity to develop a strong pipeline of URM students. We have a structured paradigm that focusses on recruiting, advising, and mentoring mainly undergraduate URM students. It synergistically combines active advising and teaching at the FAMU-FSU College of Engineering, with strong, hands-on research mentoring at ASC, and an overarching nurturing structure that will help students identify and resolve challenges they face early on. Key aspects of the RENEW program are: Reaching out to FAMU pre-engineering freshmen to inform them of research opportunities in ASC to recruit them into the program. This will include touring ASC lab facilities and job shadowing undergraduate students already working at ASC so the students can see the breadth of research areas available to them within ASC and visualize themselves working in ASC. Creating a nurturing environment for the RENEW students through faculty/mentor meetings where we discuss the students' welfare and how we can help them address the challenges they face in college. We believe that focusing on the students' holistic wellbeing will be a key component for the success of this RENEW program. Helping the RENEW students take advantage of existing academic assistance, which students often ignore or are unaware of. During the first two weeks of each semester, they will be required to go to office hours to meet their course instructors and TAs, and to the academic Help Center to meet upperclassmen who are there to assist underclassmen with core courses. We believe that nudging the RENEW students to meet their instructors and to learn about mentoring available in the Help Center early in the semester will increase their success in classes. Informing the RENEW students about academic and professional programs that are available in the College of Engineering and FAMU including help with time management, study skills, test taking, resume writing, and career counseling. We will have activities to introduce the RENEW students to these service providers so that students learn what help is available. Building a strong scientific and technical mentoring program for the RENEW students that will include the PIs and the technical staff within ASC meeting regularly with the RENEW students. The students will work on existing research projects in applied superconductivity within ASC. Assimilating URM graduate students into existing research projects in ASC.

The URM students will benefit from having a higher success rate in college courses, increasing their self confidence that they can succeed in a technical environment, and getting the hands-on experience in the field of applied superconductivity. The field will potentially benefit from these RENEW students doing graduate studies in applied superconductivity.

This research was selected for funding by the Office of High Energy Physics

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***Particle Accelerator Capabilities Enhancement and Modernization Apprenticeship Program* (PACEMAP)**

Danielle Kuglin Seago[1]
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To keep up with modern technology and globalization, regional industries are implementing sophisticated equipment in their production systems and need employees with high levels of STEM education and technical training in order to administer the advanced computing systems. However, statistics show that a significant percentage of available jobs remain unfilled. As accelerator laboratories modernize critical systems, a skilled Electrical Technician workforce equipped with the knowledge for projects within particle accelerator fields is necessary. Meeting this need will rely on the ability to recruit and retain a diverse and capable technical workforce skilled in implementing new technologies. As a designated Minority-Serving Institution, Community College District 502 (College of DuPage/COD), and COD Project Hire-Ed Registered Apprenticeship Program, in partnership with Fermi National Accelerator Laboratory, seeks to create a multi-year apprenticeship program for Electrical Technicians. The *Particle Accelerator Capabilities Enhancement and Modernization Apprenticeship Program* (PACEMAP) project will focus on workforce needs for FRA\Fermilab Accelerator Directorate (AD). Apprenticeships are a reliable pathway for training workers from underrepresented populations for good jobs and allow them to earn while they learn. This project is in alignment with the goals of the RENEW program to broaden and diversify the high energy physics community as well as the federal mandate to meet next generation accelerator technologies with a highly skilled and diverse workforce.

PACEMAP will pilot and implement a coordinated school-to-career ecosystem with an apprenticeship model of services and training instruction for six apprentices by end of the grant term. The proposed apprenticeship program will have 3 components: 1) Customized curriculum of a specific set of courses offered by COD, from which participants can follow 3 separate tracks to meet the minimum education and skill requirements for Electrical Technician postings at FRA\FERMILAB. 2) Onsite paid apprenticeships focused on specific PIP-II activities or standardization and modernization activities of the accelerator complex. Apprentices will achieve 2,000-hours total in on-the-job learning and a minimum of 435 hours of classroom instruction over the two-year program (minimum 27 credits; 9 courses). 3) In addition to establishing a Department of Labor Registered Apprenticeship certification for the program, individual apprentices will also earn both the Electronics Technology Certificate and the Advanced Electronics Technology Certificate from the COD.

All students will complete academic coursework, which will result in an industry credential necessary for their position. Some industry tracks may support students completing their Associates' degree or certificate. By blending mentorship, on-the-job training, and classroom instruction, the apprenticeship program provides an efficient pathway to a career in the energy industry. Apprenticeships also build a diverse workforce by intentionally recruiting and training workers who are usually underrepresented in the energy sector. The program will also reduce barriers to success and engage these learners in transdisciplinary activities to increase knowledge and skills.

This research was selected for funding by the Office of High Energy Physics

Advancing sCientific exCELlence by Empowering Research in Accelerators Through Education (ACCELERATE)

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2: Morgan State University, Baltimore Maryland
3: Michigan State University, Lansing Michigan

The Advancing sCientific exCELlence by Empowering Research in Accelerators Through Education (ACCELERATE) program is increasing the participation of scientists from minoritized groups – those that are underrepresented and marginalized in society – in accelerator research through a partnership between scientists at minority serving institutions and the Center for Bright Beams (CBB), an NSF Science and Technology Center. This program has two main goals: establishing a novel collaboration with MSIs in accelerator science and improving the research infrastructure at the MSIs. This effort will establish an inclusive and welcoming training environment for undergraduate students from underrepresented groups.

The Center for Bright Beams (CBB, http://cbb.cornell.edu) is creating the knowledge and technology needed for 100x brighter electron beams. Applications for these beams range from electron microscopes to free electron X-ray sources to industrial applications such as EUV lithography and waste treatment. Two MSI faculty members will join the CBB team together with two to three undergraduate trainees from each institution whom we will refer to as ACCELERATE Fellows. One of these scientists will be Professor Willie Rockward of Morgan State University (Morgan); the second will be from either Morgan or North Carolina State University (NCCU). Among Historically Black Colleges and Universities (HBCUs), these two institutions have the physics programs that are well-suited to initiating a collaboration in accelerator physics.

Each MSI faculty member will partner with a CBB faculty member for 2-3 weeks to gain familiarity with CBB research goals and to develop a specific research project that fits their expertise and is suitable in scope. The MSI faculty members will then mentor student Fellows from their institution. To establish a cohort, there will be at least two students at each MSI and the program will host a meeting that brings together students from multiple RENEW programs annually. The faculty and student Fellows will join biweekly videoconferenced meetings of their CBB research theme, and from time to time, the faculty member or a Fellow will present their research. Because CBB involves multiple institutions that are widely dispersed, video-conferencing is the norm. The MSI participants will attend CBB's annual in-person collaboration meeting and will contribute to activities of the new Accelerator Physics section at the annual National Society for Black Physicists (NSBP) conference. In addition, the faculty will participate in research planning meetings within CBB and with CBB's External Advisory Board and will attend a major conference in their area of specialization annually.

To maximize the impact and outcomes of the ACCELERATE Fellows, the program incorporates the keys to success identified by the American Institute of Physics TEAM-UP report on the causes of and remedies for underrepresentation of Black students. These keys include fostering a sense of belonging and student perception of themselves as physicists.

This research was selected for funding by the Office of High Energy Physics

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Renew Midwest From the Underground to the Cosmos

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3: Benedictine University

This joint project between the University of Michigan, Black Hills State University, and Benedictine University is establishing a long-term partnership to increase student diversity in STEM and to enable Black Hills State and Benedictine University to be successful in the Department of Energy's grant funding process. We will recruit a cohort of about six undergraduate students per year with a focus on underrepresented minorities. Black Hills State and Benedictine University can recruit from a wide range of backgrounds, from rural and American Indian students to students from disadvantaged urban backgrounds. The students will attend a ten-week summer program at the University of Michigan to learn professional, writing, and research skills. Following the summer program, the students will continue in a year-long project at Black Hills State or Benedictine University for further research and professional development. The outcome will be assessed by a professional evaluator, and improvements incorporated into successive years.

Each of these institutions has a unique strength to bring to this program: the University of Michigan is a world leader in research and participates in many prominent science experiments. PI Penning and Co-PI Soares-Santos lead major programs in dark matter and cosmology and are leaders in the wider physics community. Black Hills State University is located close to the Sanford Underground Research Laboratory and Benedictine University is very close to Fermilab. Co-PI Mount at Black Hills State University has extensive experience working with the REU program at BHSU and is heavily involved in underground research at SURF. Co-PI Wiesner has been involved in cosmology research for some time, much of that time in collaborations at Fermilab; he is also a highly trained educator, with a Master's degree in Education and experience teaching science in urban high schools.

By combining the strengths of these three institutions and these four investigators, we can help students pursue careers in science, can improve the diversity of students in the pipeline to graduate education, and can strengthen the research profile of smaller primarily undergraduate institutions.

This research was selected for funding by the Office of High Energy Physics

RENEW: Accelerating Underrepresented Engineering Careers through Accelerator Innovations

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The goal of this grant has two mutually beneficial foci: 1. Increasing opportunities for Northern Illinois University (NIU) students from under-represented populations to pursue careers in engineering while simultaneously, 2. Advancing the technology in magnet fabrication and operations in accelerator science. While starting within the narrow path of existing questions or specific magnet design features described in the US Magnet Development Program, the outcomes of the grant activity will have network tendrils that extend in a number of directions through the engagement with a diverse NIU student population from underrepresented demographics. Students will discover and advance the technology readiness levels of DOE roadmaps while also learning and practicing the soft-skill training in oral presentations, written communication, and conducting literature reviews. Rather than selecting the narrow path for particular accelerator features or specific magnet design, methodology proposed will:

1. Introduce underrepresented engineering students to faculty with broad areas of expertise in order to build collaboration with Fermilab to research magnet design
2. Foster innovation through entrepreneurial structures where ideas germinate from something other than specific design requirement or existing research objectives
3. Integrate training of engineering skills to the real-world technologies of accelerator development through simulation, structural analysis, thermal management, system monitors, and potential experiments
4. Manage a Technical Advisory Board that considers proposed ideas intended to advance technology development with appropriate timeline and personnel effort along with review of training program effectiveness
5. Conduct a bi-annual rapid review process by which students self-report on progress and setbacks while proposing new ideas and previously unanticipated avenues of inquiry based on mixed learning experiences. The results of the review will allow resources to be periodically reallocated in order to pursue the ideas which have the greatest potential impact (distinct from those ideas with the highest likelihood of success)

The combined perspectives of scientists, engineers, entrepreneurs, and diverse students will lead to enhanced communication across technical boundaries, innovation processes that are simultaneously more effective and more efficient, and the creation of valuable new ideas that none of those groups would have done independently. The bi-annual plenary workshops occurring at on-campus Cultural Resource Centers will offer a robust evaluation of intermediate accomplishments in research and a sense of community among the diverse engineering population who can sometimes feel isolated. By purposely mixing the expertise of multiple engineering disciplines and physics simultaneously, the dissonance and “creative friction” could extend HEP achievements to other unexpected realms.

This research was selected for funding by the Office of High Energy Physics

Developing novel high-performance SPAD detectors for HEP - creating a training and research path for minority students

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For the new era of exploring physics laws, high energy physics (HEP) demands highly sensitive, fast, noise-free and radiation hard detectors. Silicon photomultipliers (SiPMs), an array of single photon avalanche diodes (SPADs), have gained popularity in recent years as single photon sensitive, solid-state alternatives to conventional photon detectors due to their compactness, low operating voltage, robustness, invulnerability to magnetic fields, and lower cost. Furthermore, SiPMs and SPAD arrays implemented in a standard complimentary metal-oxide-semiconductor (CMOS) process, as opposed to a dedicated optical process, allow the optical sensor to be integrated on the same chip with the readout electronics, resulting in scalable and high-speed detectors. These detectors with picosecond scale resolution and high throughput are much needed for registration of simultaneous single photons as in the spectrometers for optical interferometers and a variety of other applications. Also, due to the trend toward higher luminosities and, therefore, higher levels of irradiation, SiPMs/SPADs may degrade for high radiation dose environment at future particle colliders, which makes them unsuitable for some experiments due to the noise deterioration. As a solution, we propose developing low-cost, compact, and high performance SPAD arrays, specialized for HEP applications, in particular, for quantum-assisted two-photon interferometry with great impact on the cosmic frontier topics and radiation hard SPAD arrays for the energy frontier topics. Moreover, it will provide excellent educational and training opportunities for developing a diverse workforce with advanced skills in detectors, microelectronics, and data acquisition, much needed not only in HEP but in other areas of science and industry. The overall goal of this project is to broaden and diversify the HEP community by lowering academic and social barriers through cutting-edge HEP-oriented research activities with associated education, training, mentoring and support programs at the Florida International University (FIU), one of the largest minority-serving institutions in the U.S. in collaboration with Brookhaven National Laboratory (BNL). The research part of the project aims to develop novel high-performance single photon avalanche (SPAD) detector arrays for HEP applications, which will provide training and research opportunities for underrepresented communities in HEP related fields at FIU. The project will provide associated mentoring, training, and outreach activities to build a strong and diverse future workforce in HEP. The project also plans to expand FIU's capacity to conduct research on HEP projects by developing sensor design and testing facilities at FIU in collaboration with BNL. The proposed infrastructure will fill a crucial need in HEP research and education in the area of transformative photon detection systems for HEP applications.

As a result of this research, we expect to create new classes of single photon detectors with improved noise performance and specialized architectures that will be suitable for multiple applications within and outside of HEP. As FIU is one of the largest minority-serving universities in the nation, this project will broaden the participation of minority students and women in science and engineering, particularly in HEP. Students at all levels studying different majors will be involved, which will foster interdisciplinary interactions and will build a solid foundation for their education and future productive work. Students at FIU will have skill development opportunities through the lab visiting and training at advanced experimental facilities at BNL.

This research was selected for funding by the Office of High Energy Physics

Training through research in quantum information science and engineering at the SQMS Center

Dr. Silvia Zorzetti[1]
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We aim to create new and sustainable career paths in Science, Technology, Engineering, and Mathematics (STEM) fields, including High Energy Physics (HEP) and Quantum Information Science and Engineering (QISE), for historically underserved communities. To achieve this, we will leverage the collaboration between the Fermi National Accelerator Laboratory (FNAL, or "Fermilab") and minority-serving institutions (MSIs). Our initiative will support investigators and students at institutions not traditionally involved in particle physics research. We will invest in their educational and research infrastructure to provide them with opportunities in QISE, a multidisciplinary field that offers promising prospects for high-value and in-demand careers.

The Superconducting Quantum Materials and Systems Center (SQMS) at Fermilab plays a significant role in offering traineeships and access to exciting research projects and emerging technology industries. This project leverages previous investments made by DOE-HEP in radiofrequency and superconducting radiofrequency (SRF) technologies for particle accelerators and quantum computing, areas where engineering physics programs offered by MSI partner institutions have developed relevant skills.

By providing unique opportunities, such as internships, externships, and hands-on research, we will contribute to the strategic plan outlined in the QIST National Workforce Plan. Through the MSI HEP-QISE network, students and faculty participating in our program will be exposed to impactful and diverse careers in the expanding and innovative field of QISE, which is currently facing a shortage of skilled professionals. Our objective is to build strong and sustainable career paths by providing hands-on research experiences for undergraduate students at MSIs, ultimately filling critical workforce needs in HEP and QISE.

This research was selected for funding by the Office of High Energy Physics

Minority Serving Institutions for Manufacturing Sustainable Isotopes and Mainstreaming Scientific Inclusion (MSI^3)

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Three Minority Serving Institutions (MSI) in the Richmond, Virginia, area will form a consortium with the relatively close-distanced Oak Ridge National Laboratory (ORNL) to train undergraduate and graduate students in all aspects related to isotope production, including computational and experimental techniques. The universities in the ***M**inority **S**erving **I**nstitutions for **M**anufacturing **S**ustainable **I**sotopes and **M**ainstreaming **S**cientific **I**nclusion (**MSI^3**)* consist of the Department of Mechanical and Nuclear Engineering at Virginia Commonwealth University (VCU), the Department of Chemistry at Virginia State University (VSU), and the Department of Natural Sciences (physics) at Virginia Union University (VUU). Not only are all three of these universities MSIs, but the makeup of the PI/Co-PIs have ethnicities from South America, North America, Africa, and Asia. There is also gender equality with four female and three male investigators. The investigators feel strongly that the goal of MSI^3 is not just to teach students and conduct research, but to create a lifelong mentorship program where every student is looked after and guided through all aspects of academia, including employment after graduation. The expected outcome of MSI^3 is to support/create 63 B.S., 6 M.S., and 1 Ph.D. degreed students from VCU, VSU, and VUU with the knowledge and hands-on experience in isotope production. The new coursework developed, equipment acquired, and connections generated between the universities and ORNL will strengthen the group's ability to sustain the MSI^3 program and perform future isotope production research. All research conducted by MSI^3 will be connected to a central theme of improving the efficiency of isotope production with each student having their own research topic. These research projects will start by quantifying the inefficiencies of producing critical actinides (^{232}U for tracers, ^{238}Pu for space applications, ^{252}Cf for neutron sources, etc.) when using traditional target irradiation methods. Since feedstock actinides (^{230}Th, ^{231}Pa, ^{237}Np, curium) are in short supply and expensive to procure increasing the efficiency of neutron capture-based actinide production methods by limiting the loss of target materials and intermediate products is vital. This will be done by placing neutron-filtering materials around the irradiation target to preferentially remove neutrons with energies that are likely to cause fission or other undesirable capture reactions in the target material. A second approach is to limit losses of the target materials with a dynamic irradiation system that moves the target material in and out of a neutron flux. This approach is well suited for products that require multiple neutron captures to create the desired nuclide, where intermediate "short-lived" nuclides have large undesirable neutron capture reactions.

This research was selected for funding by the Office of Isotope R&D and Production

Multidisciplinary Training Experience in Nuclear Science (Mt. ENS)

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The **Multidisciplinary Training Experience in Nuclear Science (Mt. ENS)** program will establish a sustaining partnership between Lawrence Livermore National Laboratory (LLNL) and our neighboring Minority Serving Institution (MSI) partner San José State University (SJSU). Under Mt. ENS, a course-based nuclear data measurement traineeship will be created for the first time. The goal of this traineeship is to introduce students to nuclear science through a credited course at the early stages of their undergraduate degrees, while enabling them to actively engage in research activities at LLNL. Mt. ENS will open new career avenues for under-represented minority (URM) students, broaden the nuclear science workforce, and foster success of the Nuclear Physics (NP) mission. At SJSU, undergraduate students will earn credit towards their degree while being trained in nuclear science. Providing a class with credit has several educational benefits, and it is attractive to students for their graduation requirements, as well as for their transcripts, if they decide to pursue a master's or a Ph.D. degree in nuclear science. The course format will consist of lectures with introductory concepts in nuclear physics and nuclear chemistry, geared to contextualize current nuclear science research efforts at LLNL. One unique aspect to this planned course, which leverages the proximity of SJSU to LLNL, is the hands-on fieldtrips that will be integrated directly into the course material. During these fieldtrips to dedicated facilities at LLNL, each topic introduced in class will be further explored, giving students the opportunity to experience the different components of nuclear data measurements, from target fabrication to irradiation to final analysis. As a result, they will gain an understanding of what goes into a full measurement, which is sometimes missed when different groups perform each of these different steps. This comprehensive experience is needed to support our nuclear science pipelines, which often pulls from knowledge in different areas. Students will experience being part of a team working together through the complete lifecycle of an experiment. Each student will be paired with an LLNL mentor who will oversee their technical work. In addition, being onsite at the LLNL campus offers interactions with other students, postdoctoral researchers, and research staff scientists engaged in nuclear-science research. An important component of this traineeship is for students to fulfill their course requirements and pursue their research projects full-time, free from the stress of financial burdens. The Mt. ENS program is a joint effort between LLNL and SJSU, focusing on strengthening the pipeline needed to establish an equitable and inclusive workforce that reflects the greater US population. Mt. ENS offers an immersive, collaborative research experience in which students gain hands-on knowledge and meaningfully contribute to nuclear science; these approaches have proven to be a high-impact practice for engagement and retention of URM students in STEM. Recruiting young talent and improving retention of underrepresented groups in nuclear physics will broaden the nuclear science pipeline and bring expertise needed for the full breadth of the Office of Science research activities.

This research was selected for funding by the Office of Nuclear Physics

BNL-MSI Fellowship Program for Research Excellence and Preparation in Nuclear Physics (PREP-NP)

Dr. Mickey Chiu[1], Senior Scientist
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The BNL-MSI Fellowship Program for Research Excellence and Preparation in Nuclear Physics is a partnership program between Brookhaven National Laboratory and five core Minority Serving Institution's: Florida A&M, Howard, Morgan St, Texas Southern, and the Univ. of Puerto Rico. The program was created to help place undergraduate students from under-represented populations on a path to graduate school in Nuclear Physics, thus increasing the pool of scientific talent in the US. The BNL-MSI Fellowship program achieves this goal by pairing upper-class students interested in a career in physics with Faculty Advisors and BNL Scientists to pursue a cutting-edge Nuclear Physics research project over a two-year term. The program is designed to efficiently leverage the resources at BNL, making them available for use by the students and professors at MSI's. The mentoring provided by world class scientists, and educational expertise from BNL's Office of Educational Programs work in concert to provide a supportive research experience to the student fellows. This fellowship gives them the opportunity to acquire the scientific skillsets that they need to succeed, and builds their own confidence in their future as possible scientists. The program completed a two-year pilot in mid-2023. Out of the 9 PREP-NP Fellows in the program ready for the next stage in their career, 8 are in or will be attending graduate school in physics or closely related STEM fields. In addition, strong research relationships are being developed between BNL and the professors at the MSI's, helping to improve the quality of science being done in the US. This RENEW award allows the BNL-MSI PREP-NP program to continue providing research opportunities to under-served populations, keeping this successful pipeline into graduate school going. It also furthers the nuclear physics research being done by the MSI's at BNL.

This research was selected for funding by the Office of Nuclear Physics

<u>NU</u>clear **<u>R</u>**ecruitment **<u>T</u>**hrough **<u>U</u>**ndergraduate **<u>RE</u>**search (***NURTURE***)

Dr. Partha Chowdhury (Professor)
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The objective is to provide a ten-week summer research experience, continued by an academic year traineeship, to a cohort of six students a year from minority-serving community colleges in Massachusetts, leveraging the established research infrastructure of nuclear science and applications at the University of Massachusetts Lowell Radiation Laboratory. This is a key university research center, with a strong nuclear physics program at national laboratories, coupled with a unique combination of a 5.5 MV Van de Graaff accelerator and a 1 MW research reactor on campus. Trainees from minority-serving community colleges neighboring UMass Lowell will gain an appreciation of advanced nuclear detection techniques as well as the excitement of state-of-the-art experimental nuclear science, through hands-on experiential learning on campus, immersed in a welcoming research group of undergraduates, graduate students, post-doctoral researchers, and faculty. This would be supplemented with a visit to a national lab for a research experiment and a capstone experience of attending a national nuclear physics conference specifically tuned for undergraduate participation. The goal is to leverage ongoing funded research to recruit, nurture and spark interest in the cohort for the field of experimental nuclear physics and increase chances for under-represented minorities to continue onto a four-year undergraduate and eventually a graduate degree in the field. This program would also establish strong communication channels with minority-serving institutions in the region, creating a bridge for students to access other available opportunities at UMass Lowell and beyond.

This research was selected for funding by the Office of Nuclear Physics

Undergraduate Internships in Nuclear Physics at FIU

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Florida International University (FIU) is one of the 10 largest universities in the US and serves a diverse student population with nearly 65% identifying as Hispanic and 12% as Black or African American. This award funds four undergraduate internships per year to work within the nuclear physics group at FIU along with partial support for a new tenure-track faculty member in the group. The FIU nuclear physics group currently consists of five experimentalist and three theorist. The group's research focuses on intermediate energy nuclear physics, specifically the programs at Jefferson Lab and the future electron-ion collider. The internships are natural extensions of these current research programs and cover a range of physics topics in both experiment and theory, with resulting training in skills ranging from hardware assembly to coding for data analysis and theoretical physics studies. These internships include possible research stays at Jefferson Lab. These internships give the selected students a paid research opportunity (which makes a significant impact on the financial well-being of students) while also providing the necessary training for a career in nuclear physics. Next to the training of core skills useful in nuclear physics research, these internships focus on the wider picture. Participants will have opportunities to present their results in local and national meetings, will interact and engage with a large nuclear physics network and be exposed to the broad range of nuclear physics career options, both inside and outside of academia. Special attention will be paid to the sense of belonging of minorities at the FIU physics department through collaboration with our local evaluator Dr. Dionne Stephens from FIU's department of Psychology. Participants will engage with the wider community through outreach components at their former high schools, FIU events and the Frost Science Museum, increasing the exposure of nuclear physics as a field and career path to underrepresented minorities in our community. The new faculty member is needed within the group as several members near retirement or have duties in university administration. The continued success of the group in training both undergraduate and graduate student in the field depends on having the faculty in place to do so. The new faculty member will also play a role in the mentoring of the intern students.

This research was selected for funding by the Office of Nuclear Physics

Improving Recruitment and Retention in nEXO and the Double Beta Decay Community

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The nEXO next-generation neutrinoless double-beta decay experiment is a collaboration of about 200 members and strives to be a leader and role model in community building within the international nuclear and astroparticle physics field. This project extends and strengthens many of the initiatives the collaboration has undertaken. The American Institute of Physics will be engaged to survey the collaboration climate and the results will be used to create new initiatives aimed at broadening participation within nEXO. A follow-up survey two years later will measure the effects of those initiatives. Student and dependent care travel grants will help develop the physics identity of junior researchers by removing a barrier to their participation in nEXO collaboration meetings. Volunteer ombudspersons, elected from within the collaboration, will receive formal training through the International Ombuds Association. Increased diversity will be encouraged through access to job boards targeting groups historically underrepresented in physics. Quarterly presentations from external experts in broadening participation will be supported. A workshop will be held with members of other nuclear and particle physics collaborations sharing experiences and lessons learned in broadening participation.

This research was selected for funding by the Office of Nuclear Physics

Institute for Nuclear Science to Inspire the next Generation of a Highly Trained workforce (INSIGHT) at FRIB

Dr. P. Gueye[1], Associate Professor
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The INSIGHT Center at FRIB has two objectives: (1) provide a center to support and coordinate a nationwide traineeship effort; and (2) offer traineeships at FRIB by leveraging its scientific opportunities. This will provide an environment to: (i) recruit and retain undergraduate students in (nuclear) physics and sustain and/or increase their interest, confidence, and enthusiasm in this field; (ii) provide participants with a toolset to become effective independent researchers who pursue further research opportunities as undergraduates; and (iii) encourage participants to pursue graduate studies and potential careers in nuclear science, or related STEM fields. INSIGHT leverages the existing collaboration between FRIB and eleven Minority Serving Institutions (MSIs): eight Historically Black Colleges and Universities, two Hispanic Serving Institutions and one Tribal College to assist and coordinate a nationwide effort encompassing at least 11 MSIs to address the issues of representation within the nuclear physics community. Recruitment: The excellence of the FRIB research program coupled to the various resources available at MSU, makes this site uniquely suited to serve as a cradle for the proposed INSIGHT Center. MSU is ranked the number one nuclear physics graduate program in the nation and FRIB has developed and implemented many successful programs specifically targeted at increasing the participation of under-represented groups in (nuclear) science. Education: An 8-week summer school for undergraduate students will offer research training, academic preparation and professional mentoring, all designed to empower students and encourage them to pursue graduate education in nuclear science. An undergraduate nuclear physics specialization at MSIs will enable continuous education in nuclear science and a series of 4 workshops for technical training in various areas that leverage the RENEW-NP nationwide traineeship programs. Mentoring: A year-long mentoring program will maintain the undergraduate student (nuclear science cohort) cohort involved in INSIGHT, providing a sustained sense of community, belonging and ensuring academic and research excellence. This extensive mentoring program includes mentors from the minority community that have been appropriately trained for this purpose. Research: FRIB brings the capability to study more than 3,000 new isotopes, spanning the limits of stability for many isotopic chains and opening the door to new discoveries. INSIGHT will include specific research projects on current FRIB research problems with state-of-the-art instrumentation, increasing the students' nuclear physics identity. Evaluation: The success of INSIGHT will be measured against its primary goals. The evaluative efforts will generate rich, contextual knowledge and insights useful for improving the development, adaptation, implementation, and replication of evidence-based practices and support strategies to ultimately increase under-represented groups participation in STEM career pipelines.

This research was selected for funding by the Office of Nuclear Physics

Continuation of the Nuclear Research Experiences for Minority Students in Texas Program

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The University of Texas at Arlington Nuclear Physics (UTA-NP) research group will continue to operate the Nuclear Research Experiences for Minority Students in Physics program. This traineeship program hosts year-round, paid research internships for minority students, prioritizing those at Minority Serving Institutions (MSIs). Trainees will work on topics within UTA's nuclear physics research program, which is centered around the leadership of the US part of the NEXT (Neutrino Experiment with a Xenon TPC) neutrinoless double beta decay program. Students will receive extensive laboratory experience working on time projection chamber test stands and barium tagging experiments as well as training in basic and transferrable skills such as coding, electronics, and vacuum system development, working under the mentorship of UTA's skilled team of nuclear physics researchers lead by PI's Jones, Castillo and Asaadi and with additional support from Presidential Distinguished Professor David Nygren and the wider UTA Physics Department and High Energy and Nuclear Physics center. The program supports a cohort of 4-5 trainees each year at the senior undergraduate level, beginning with a summer research experience and offering the opportunity for a second summer of research the following year and for paid research experiences in the intervening semesters. The program covers a stipend, housing in UTA dorms, travel costs to and from UTA for the Summer from anywhere in Texas, and support for travel to present the results of research work at a conference. UTA is an R1 minority-serving institution, and the UTA-NP research group has a diverse composition of students at all levels. Program participants are thus immersed in an environment with peers who may share their backgrounds and provide relatable guidance about their future educational and career development. The NREMST tiered research mentoring plan takes advantage of this natural benefit, pairing students with both junior mentors from among our advanced undergraduate researchers and graduate students as well as with senior members from among the UTA-NP PIs to provide a supportive environment to grow their research skills. This plan was highly successful in previous years, resulting in at least three of the four members from the first-year cohort either applying to or actively planning to apply to graduate school for PhD study in scientific disciplines, at least two in the area of nuclear physics. Active recruitment from Texas MSIs is crucial for finding and selecting enthusiastic participants. The program supports recruitment trips each year during application season, focused within Texas due to the increased probability of students applying based on their geographical proximity, though minority candidates from any state are eligible to apply. The program partners with both UTA's Office of Undergraduate Research and the McNair program in order to integrate the trainees in a wider network of research trainees and build a local social and professional support network. The students also participate in our local neutrino and rare events searches journal club and group meetings, and in group outreach events. Finally, they will also contribute to the development of a novel educational program to build and operate a working particle detector from parts, the UTA Build-a-TPC Challenge, developed collaboratively within the wider NP-RENEW program.

This research was selected for funding by the Office of Nuclear Physics

Expanding NCCU Participation in Experimental, Low-Energy, Nuclear Physics Research at TUNL

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This collaborative project supports increased capacity at North Carolina Central University (NCCU), a designated Historically Black University (HBCU), to engage in low-energy nuclear structure and nuclear astrophysics research using the accelerator facilities at the Triangle Universities Nuclear Laboratory (TUNL). TUNL is a Department of Energy (DOE) Center of Excellence in experimental nuclear physics that is run by a consortium of universities: Duke University (Duke), University of North Carolina at Chapel Hill (UNC), North Carolina State University (NCSU) and NCCU. This program addresses all three of the goals outlined in the funding opportunity: increasing entry points with undergraduate internships, supporting retention through post-baccalaureate fellowships, and expanding research at an HBCU with the creation of a faculty position dedicated to experimental nuclear physics research. NCCU faculty with their students have a long history of engaging in low-energy experimental nuclear physics research at the nearby TUNL facility located on the Duke University (Duke) campus about 20 minutes away by car. This program expands that collaboration to extend the research projects and areas of experimental nuclear physics that NCCU students are involved in and concentrates on hands-on experiences using the accelerator facilities. Through a previous DOE award, NCCU and TUNL partnered to create a successful undergraduate traineeship program for underrepresented minority undergraduate students. This project continues that program by supporting three undergraduates from regional minority schools, or underrepresented minority students from 4-year colleges to be involved in mentored TUNL research during the summer months. In addition, this proposal supports a nearby Durham Technical Community College instructor and students to take part in summer TUNL research. These efforts greatly expand the reach of experimental nuclear physics research to communities usually not represented or do not traditionally participate. A new postbaccalaureate (postbac) program will be created for students not ready to enter a graduate degree program. This postbac program includes the opportunity for the person to gain research experience and increase their foundation in physics through undergraduate or Master's degree coursework at NCCU. The project creates a new faculty position at NCCU to participate in accelerator based nuclear physics research at TUNL. Priority will be given to persons of color with a proposed research program that integrates with the existing activities at one of the three onsite accelerators: the Tandem laboratory, the High Intensity gamma-ray Source (HIgS) at the Duke Free Electron Laser (DFEL) facility, and the Laboratory for Experimental Nuclear Astrophysics (LENA) facility. All researchers on this program will work with faculty, research staff and students from the TUNL consortium institutions and will be encouraged to focus on one experiment while contributing to other experimental efforts to broaden their experience and skills. With the programmatic mentoring and professional development activities, this project will nurture the growth of a diverse research community and increase their retention in the field while expending the active participation of NCCU faculty and students in TUNL accelerator physics.

This research was selected for funding by the Office of Nuclear Physics

NuSTEAM: Nuclear Science in Texas to Enhance and Advance Minorities

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This project is the continuation of a successful Texas-based program under the guidelines of the NP-RENEW FOA (Nuclear Physics – Reaching a New Energy Sciences Workforce). The program is based on recruiting a diverse set of undergraduate students to be trained and do research on state-of-the-art Nuclear Physics topics, retaining some of them as graduate students, and preparing others for the nuclear workforce. Four of the largest minority-serving institutions in the United States have participated in the first phase of this collaborative program, the **Nuclear Science in Texas to Enhance and Advance Minorities (NuSTEAM)**, funded from 2021 to 2023. The initial team consisted of the University of Houston (UH), University of Texas - Rio Grande Valley (UTRGV), University of Texas - El Paso (UTEP) and Prairie View A&M University (PVAMU), with the University of Houston serving at the lead institution. For this renewal, Lamar University, joins the project starting with the summer traineeship in 2024. The University of Houston has an extensive Experimental and Theoretical Nuclear and High Energy Physics Research Program for graduate and undergraduate students and will serve as a host for the summer program of the year-long traineeship. UTRGV and UTEP have a graduate program, but not in Experimental Nuclear/High Energy Physics. Prairie View A&M and Lamar University only have undergraduate programs. All five institutions will provide minority undergraduate students to the program. After completing a six-week summer course at UH, Brookhaven National Laboratory will host the students for a two-week hands-on experience in the laboratory environment. Upon returning to their home institutions, the students will continue to be supported for the Fall and Spring semesters for 15 hours/week, while working on a research topic chosen through the traineeship program. The curriculum of the summer course focuses on developing a Nuclear Physics based skill set, which will be applicable to future professions in academia and industry within the Nuclear Physics field. Areas that will be covered in the course are low- and high-energy Nuclear Physics research, Nuclear radiation applications in Space Science and Medical Physics, Instrumentation and Detectors, Electronics, Software Development, Analysis tools, Machine Learning, and finally Networking, Presentation Skills and Career Planning. Upon completion of the UH and BNL experiences, the student, in coordination with the local supervisor and the program coordinator at UH, will receive a research project to be addressed and completed over the next two semesters at their home institutions. Possible topics will include heavy ion data analysis, phenomenological modeling of data from RHIC and LHC, radiation physics studies, machine learning applications in nuclear physics, detector and electronics development, simulation, and testing for new instruments. Retained graduate students will work on more complex problems within the same topics.

This research was selected for funding by the Office of Nuclear Physics

Nuclear science research training at Virginia State University, a member of the MoNA Collaboration

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A 2019 consensus study report of the National Academies of Sciences, Engineering, and Medicine entitled Minority Serving Institutions: America's Underutilized Resource for Strengthening the Science Technology Engineering and Mathematics (STEM) Workforce underscores the clear connection between "the STEM readiness of students of color" and "the nation's economic growth, national security, and global prosperity." As the United States population grows more diverse, investments in educational opportunities at all levels are essential to ensuring that the nation's STEM workforce also reflects this growing diversity in order to maintain global competitiveness. As a subset of the STEM workforce, the nuclear physics community realizes the need for a diverse community of researchers and students to drive advances in fundamental and applied nuclear science. One challenge to cultivating a diverse workforce is recruiting students of color into career and academic pipelines that, historically, have not involved a large fraction of participants that reflect the students' racial and/or ethnic identities. One approach to overcoming this challenge is to involve students in hands-on research to help them develop a sense of belonging and envision themselves on a career path in the field. A key finding from the aforementioned report is that "exposure to undergraduate research experiences remains a predictor of successful outcomes for students of color in STEM." This project will provide an entry point for undergraduate students from Virginia State University to get involved in cutting-edge nuclear physics research by continuing a research traineeship program that mentors students as they work on projects related to science at the new Facility for Rare Isotope Beams (FRIB). Virginia State University (VSU) is a Historically Black University founded in 1882 and located 25 miles south of Richmond, Virginia. The VSU Nuclear Science Laboratory works on detector development and data analysis as a member of the Modular Neutron Array (MoNA) Collaboration which maintains and operates an array of 288 plastic scintillator detectors for experiments at FRIB and the Los Alamos Neutron Science Center. Over the past two years, three VSU students have worked in the Nuclear Science Lab on two projects to (1) develop a new target system for MoNA experiments at FRIB and (2) investigate the application of machine learning techniques to analyzing data from MoNA experiments. Currently, three students are continuing this work. The current project will recruit two student trainees and introduce them to basic principles of nuclear science research including radiation detection and measurement and data analysis techniques. To accomplish this, trainees will be guided through advanced lab exercises dealing with radiation detection, and they will present their results at the VSU Undergraduate Research Symposium. After completing these introductory exercises, trainees will shadow student researchers working on detector development and data analysis projects with the goal of taking over these projects as the senior students graduate. Through establishing and supporting a cohort of student researchers, meaningful research experiences will be provided to help students develop a sense of belonging and envision how they can contribute to nuclear science and broader STEM communities.

This research was selected for funding by the Office of Nuclear Physics

HBCU Collider Consortium

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Abstract:

The Relativistic Heavy Ion Collider (RHIC) at BNL has made many notable discoveries over the past two decades of operation, yet there are still new discoveries being made. In particular, with the upgrade of PHENIX to sPHENIX, for the first time at RHIC there will be a detector capable of high-rate data acquisition to exploit the full luminosity of a mature RHIC, and full jet reconstruction capability using hadronic calorimeters. The three HBCU's on this team proposal, Howard University, Florida A&M University (FAMU), and Texas Southern University (TSU), formed the HBCU Collider Consortium in 2019 to initiate the formation of a collaborative research group across our institutions that would join the PHENIX and sPHENIX collaborations, in order to exploit the possibility of discoveries with the two experiments. Two of the institutions in this proposal comprise 50% of all HBCU's that offer a PhD with a specialization in nuclear physics. Our group was initially funded by a small NSF EiR grant that started in 2019 and ends this fiscal year. The funding has supported the effort of 4 graduate students. Two of these students analyzed UPC J/Psi production in PHENIX for their theses, which provides valuable information about how the nuclear materials are distributed. This new proposal seeks to continue support for several graduate students as they pursue their dissertations. As well, this proposal will support crucial detector development for the sPHENIX Minimum Bias Detector during the 3 years of sPHENIX data-taking. The HBCU Collider Consortium also seeks to provide new opportunities for future graduate students and post-docs to contribute to developing detectors that can exploit the opportunities for measuring very rare isotopes in the very forward rapidities at the EIC, as well as further analyze UPC data from sPHENIX.

This research was selected for funding by the Office of Nuclear Physics

Pathways to Improved Representation in Advanced NucleAr science

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This project is aligned with the three core objectives of the Department of Energy's Nuclear Physics – Reaching a New Energy Sciences Workforce (NP-RENEW) program: increasing entry points, supporting retention, and investing in research capacity at minority-serving institutions (MSIs). More specifically, the project will help diversify the field of nuclear physics by fostering undergraduate MSI student involvement in the ongoing research and development (R&D) efforts towards an increased sensitivity follow-up to the now-complete Enriched Xenon Observatory (EXO). The new, scaled-up experiment, called nEXO, consists of a ~5 tonne liquid xenon-filled detector designed to discover neutrinoless double-beta decay, a rare and subtle form of radioactivity with a half-life longer than ~10^{26} years. Through this project, Skyline College, a 2-year MSI, will help students gain confidence in their ability to participate in original research in advanced nuclear physics. The project will support a total of twelve students, six per academic year, beginning in fall 2023. During each program year, three students will be responsible for supporting nEXO R&D at the SLAC National Accelerator Laboratory (SLAC), and the other three will be distributed among various nEXO collaborating institutions. Student participants will contribute to the following nEXO activity areas: (a) supporting the screening of electronegative outgassing in liquid xenon at SLAC; (b) supporting xenon gas purifier development; (c) supporting radon distillation column development at SLAC; (d) supporting silicon photomultiplier (SiPM) R&D; and (e) supporting diversity, equity, and inclusion (DEI) efforts of the nEXO DEI committee. For all areas (a)-(e), participants will be expected to use some or all of the skills they acquire through special workshops led by the Co-PIs and one lab coordinator. The expected project outcome is an increased likelihood that students from underrepresented populations will choose to pursue graduate studies in nuclear physics, thereby helping to diversify the field. Success will be assessed by observing whether participants have achieved the learning outcomes and skills at the end of their programs. Project learning outcomes are as follows: (1) student participants are acquainted with the field of experimental nuclear physics; (2) student participants have confidence in their ability to independently pursue graduate studies in experimental nuclear physics; (3) student participants have a clear sense of the career possibilities in nuclear physics; (4) student participants have seen firsthand and understand how a modern experimental nuclear physics project is run; and (5) student participants understand how some nuclear physics collaborations handle DEI. In the course of attaining the project learning outcomes student participants will also acquire the following skills: (1) computer programming; (2) electronics test and assembly; (3) rapid prototyping; and (4) design of experiments.

This research was selected for funding by the Office of Nuclear Physics

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Texas Research Expanding Nuclear Diversity (TREND)

Dr. Sherry J. Yennello[1], Distinguished Professor
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The State of Texas is uniquely situated to contribute to broadening participation in nuclear physics. This program will couple the research capabilities at the Texas A&M Cyclotron Institute with dedicated mentoring of students from schools that have a significant number of students from underserved populations over an extended period of time so we can open the field of nuclear physics as a career possibility for this cohort of promising students. One of the challenges is the financial burden of a college education. The program will meet this challenge by enabling the students to *earn income while they are engaged in physics research*. This will alleviate some of the financial strain of obtaining a college degree without working in a job that does not further their career objectives. It will also demonstrate to the students that they can earn a reasonable income with a career in nuclear physics. Science identity is important to persistence in science. This program will give the students the opportunity to enhance their **competence** in fundamental knowledge**,** afford them the opportunity for **performance** through research and lead to **recognition** of them as physicists, the three key attributes of developing science identity. Additionally, the activities in this program will have a much larger sphere of influence, as new nuclear physics instrumentation will be incorporated into the undergraduate experience at each of our partner institutions. This network of schools will also facilitate experienced faculty with strong, vibrant nuclear physics research to connect with some younger faculty in less well-developed physics programs. This is a unique opportunity for faculty development and building research infrastructure at schools that have a significant number of students from underserved populations. Additionally, this program will enhance the visibility of nuclear physics in Texas. Students beyond the TREND cohort who would normally not have been exposed to nuclear physics or considered a career in physics at all will get to learn more about nuclear physics, whether through a TREND talk at a Texas APS conference or by using the nuclear instrumentation as part of their undergraduate experience. Texas A&M’s pre-existing relationships with professors in physics departments at University of Texas at El Paso (UTEP), Texas Lutheran University (TLU), Prairie View A&M University (PVAM) and San Jacinto College (SJC) gives us an advantage when it comes to recruiting students who are likely to consider a career in nuclear physics, if given appropriate opportunities. With a variety of talented students, outstanding mentoring faculty, and quality research opportunities, TAMU, UTEP, TLU, PVAM and SJC are uniquely situated to partner in the project to increase the workforce pipeline of students from underserved populations to careers in nuclear physics.

This research was selected for funding by the Office of Nuclear Physics

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