2025 Palmetto Academy Research Sites:

1. Dr. Qiushi Chen, Clemson University: **Learning from images - unveiling lunar regolith properties from rover tracks**
   NASA's Artemis program necessitates the continuous innovation and development of efficient tools for in situ characterization and utilization of lunar regolith. In this Palmetto project, team will explore the use of track images from a Lunar Terrain Vehicle to infer important properties of lunar regolith. Students will learn and develop machine learning-based image processing methods and will also have hands-on experience setting up a rover-regolith system.

2. Dr. Kaelyn Leake, The Citadel: **Fabrication and characterization of sub-millimeter metal nanoparticle and polymer thin film structures**
   Advances in nano-scale fabrication techniques can lead to an increase in device design choices and functionalities for scientists and engineers to address challenges associated with space travel. Such advances in nanotechnology may lead to new approaches for sensors and instruments, for example, which are critical to the mission of NASA. We will partner with the student researcher to design, fabricate, and characterize sub-millimeter patterned structures. The laser modified layer by layer process will be used with both metal nanoparticles and polymers.

3. Dr. Ana Oprisan, College of Charleston: **Universality laws in pure fluids and critical point experiments under density gradient**
   The race for space exploration and, more recently, the Artemis Space mission requires reliable and efficient propellant management systems rooted in a more detailed understanding of the thermophysical properties of liquid oxygen (LO). The main objective of this project is to investigate the universal power laws that govern the dynamics of LO under magnetic levitation and sulfur hexafluoride in microgravity near critical points using a novel Haralick feature method. Our established collaboration with Drs Beysens's research team will allow us access to experimental data related to turbidity near the critical point from the HYdrogen DEvice Levitation (HYLDE) facility at the Commissariat à l'Energie Atomique (CEA)-Grenoble (France), which compensates gravity to within a few percents of Earth gravitational acceleration.

4. Dr. Sorinel Oprisan, College of Charleston: **Altered time perception under stress. The role of (micro)gravity stressor in time perception**
   The ability to perceive durations is vital for survival and adaptation, playing a critical role in core cognitive functions such as decision-making, rate calculation, and action planning. Environmental stressors, including (micro)gravity, disrupt sensorimotor feedback loops

and alter the brain's spatial and temporal perception. Our objective is to integrate recent advancements in understanding the cellular-level effects of microgravity into a realistic, neurobiologically informed neural network model of the cortico-thalamic-striatal loops.

5. Dr. Monirosadat Sadati, University of South Carolina: **Engineering Sustainable Structural Batteries for Greener Aviation**
   Polymer solid electrolytes for lithium-ion (Li-ion) batteries are at the forefront of battery technology innovation, offering a safer and more stable alternative to conventional liquid electrolytes. Comprising a polymer matrix that facilitates ion conductivity, these solid electrolytes are key to improving the overall safety and performance of Li-ion batteries. They eliminate risks associated with liquid electrolytes, such as leakage, volatility, and flammability, significantly enhancing battery safety. Our research focuses on the design of polymer membranes with high ionic-conductivity and enhanced mechanical properties. The polymer design, synthesis, and characterizations will be performed in the Department of Chemical Engineering at the University of South Carolina under the supervision of Prof. Sadati.

6. Dr. Nader Taheri-Qazvini, University of South Carolina: **3D-Printable High Solid Formulations for Integrated Radiation Protection in Space Habitats**
   This research project aims to address a fundamental challenge in space exploration by developing innovative composite materials that integrate structural and radiation shielding functions into space habitat construction, eliminating the need for separate protective layers. Using advanced manufacturing techniques and AI-enhanced research methods, student researchers will investigate the relationships between material composition, processing conditions, and performance metrics of these multifunctional composites. The project combines hands-on experimentation using direct ink writing 3D printing systems with sophisticated materials characterization, while leveraging modern AI tools to accelerate scientific discovery and literature analysis. Through this research experience, students will gain expertise in advanced materials development and space technology, contributing to NASA's mission of enabling sustainable human presence beyond Earth.

7. Dr. Ralph White, University of South Carolina, **Investigation of electrochemical performance for Structural Batteries with Ultrasonic Coating**
   Structural batteries are innovative batteries that can be embedded directly into the structure of electric cars and airplanes, replacing traditional stand-alone battery packs to save weight and space. This project, under the guidance of Prof. Ralph E. White, focuses on optimizing the electrochemical performance of lithium-ion structural batteries using

ultrasonic coating on carbon fiber electrodes. Students will conduct hands-on research in the Department of Chemical Engineering, gaining experience with advanced cathode, anode, and solid electrolyte materials for applications in electric vehicles and aerospace.

8. Dr. Ming Yang, Clemson University, **Pulsed Operations of Dual-Atom Alloy for Catalysts for Electrochemical Carbon Dioxide Capture and Utilization**
The Yang Group in the Department of Chemical and Biomolecular Engineering at Clemson University plans to recruit three students to engage in a 10-week research training, where the research is centered around the critical mission of NASA within the scope of in situ resource utilization and, specifically, carbon dioxide capture, storage and utilization to enable sustainable and long-duration space exploration. Our Palmetto Academy research project comprises 1) configuring pulsed voltage operations of bipolar-membrane-based electrochemical cells to enable the facile recovery and conversion of the captured CO2, 2) tuning dual-atom alloy catalyst compositions to enable active and selective product formations, and 3) project discussion with NASA Jet Propulsion Laboratory and research showcase at Clemson and SC NASA EPSCoR summer research symposia. The Yang Group at Clemson greatly values diversity and inclusion in STEM, and we welcome undergraduate students attending SC Space Grant member institutions to apply for the program!