2024 Palmetto Academy Research Projects

1. Dr. Frank Chen, USC, Producing Oxygen from Martian Atmosphere to Support NASA's Manned Mission to Mars
   Oxygen is critically needed for life-support in manned space travels in NASA's planetary exploration missions. The Palmetto Academy Fellow in this project will be involved with hands-on experience to build unique solid oxide electrolysis cells that can efficiently and reliably produce oxygen from carbon dioxide. The Palmetto Academy Fellow will learn the working principles as well as characterize the performance of such unique solid oxide electrolysis cells.

2. Dr. Qiushi Chen, Clemson, Wood wasp-inspired dual-reciprocating drilling into lunar regolith
   NASA's Artemis program necessitates the continuous innovation and development of efficient tools for automated drilling, sampling, and in situ characterization and utilization of lunar regolith. In this Palmetto project, the team will explore an innovative dual reciprocating mechanism inspired by wood wasps as an effective and energy-efficient solution for lunar drilling. Students will learn and develop computer designs and models for the wasp-inspired drills.

3. Dr. Kaelyn Leake, The Citadel, Approaches for index of refraction control and inclusion of metal nanoparticles in laser modified layer by layer thin films
   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 further develop our laser modified layer by layer process to fabricate submillimeter regions with specific refractive indices and to investigate control of metal nanoparticle inclusion in patterned thin films.

4. Dr. Ana Oprisan, CofC, 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 hydrogen and liquid oxygen (LHLO). The main objective of this project is to investigate the universal power laws that govern the dynamics of LHLO near critical points under magnetic levitation 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.

5. Dr. Sorinel Oprisan, CofC, Altered time perception under stress. The role of (micro)gravity stressor in time perception
   The perception of durations is essential for survival and adaptation and is critical for fundamental cognitive processes like decision-making, rate calculation, and planning of actions. Environmental stressors, such as (micro)gravity, modify the sensorimotor feedback loops and alter the brain's spatial and temporal perception. Our goal is to incorporate in a realistic neurobiologically neural network of the cortico-thalamic-striatal loops recent advances on the cellular-level effect of microgravity.

6. Dr. Sudeep Popat, Clemson, Undergraduate research experience in electrochemical technology to generate fuel and food from CO2 and urine to support life on Mars
   Life support systems (LSS) for long-term space missions require recycling nutrients from waste to grow food and removing CO_2 from cabin air, which can be reduced to fuel/chemicals of use. We have developed an electrochemical technology that allows both functions in a single device. Students selected to work on this project will conduct experiments and collect data showing the proof of concept for this technology. Successful demonstration of this technology will then allow the development of prototypes that could be sent to the International Space Station for further testing.

7. Dr. Ralph White, USC, Investigation of electrochemical performance for Na-ion Structural Batteries
   Structural batteries are batteries that can be embedded in the body of electric cars and airplanes, as a replacement for stand-alone battery packs, with the potential of saving weight and volume. The project aims to investigate the electrochemical performance of structural batteries in Na-ion battery cells. The cell will be built in the Department of Chemical Engineering under the supervision of Prof. Ralph E. White and Dr. Paul T. Coman.

8. Dr. Ming Yang, Clemson, Electrochemical Cell Integration for In-situ Utilization of Captured Carbon Dioxide
   This Palmetto Academy project aims to elevate students' education experience by igniting their research interests and career passion and aligning them with the missions of NASA. ISRU is at the heart of space exploration as NASA launches a new phase of missions to low Earth orbit, Mars, and beyond. Solely relying on fuel resources from Earth not only leads to high operational costs for sustainable space exploration but also adds an additional burden to our home planet's fragile energy and environmental system. Our research site at Clemson University proposes electrochemical-based research to empower self-sustained and long-duration space explorations. Our proposed technology will have the following advantages when measuring against the state-of the-art technology current used in space: 1) a single-stage reaction system is needed to release and convert the captured CO_2; 2) the entire process will take place at ambient temperature and pressure; 3) the production of highly flammable H_2 gas intermediate is not required.