# CURRENT EPSCoR RESEARCH PROJECTS

**TITLE OF PROJECT:** A suborbital flight experiment for validating a satellite inertia identification method

**CONTACT:** Ou Ma

**ABSTRACT:** This research project supports a group of NMSU undergraduate students to develop an autonomous suborbital flight experiment, which is designed to validate a recently developed robotics-based method of identifying the inertia property of a flying satellite. The method was originally developed at NMSU, studied using computer simulation, and published in the AIAA Journal of Guidance, Navigation and Control. However, the method has not been experimentally validated because it is difficult to physically simulate 6-degree-of-freedom (6-DOF) microgravity condition on the ground. This flight experiment is intended to accomplish such a 6-DOF microgravity test with a suborbital flight vehicle.

The concept of the proposed experiment has won the first place in a student project contest sponsored by the 2010 Next-Generation Suborbital Researchers Conference, Feb.18-20, 2010, Boulder, Colorado. As a part of the award package the conference sponsors have elected to fly this experiment on their suborbital vehicle to be launched in about one year from now. The project is intended to redesign and test the IPAV flight experiment system (designed for and flown with NASA's microgravity flight) to meet the new requirements and challenges specific for the intended suborbital flight.

This project will impact not only on research but also on education and outreach. It provides students with a unique hands-on learning opportunity to gain experience in developing a real flight system using industrial standards. The know-how and experimental system developed by the project will remain at NMSU to benefit many other students interested in developing space flights. For outreach, this exciting flight endeavor will stimulate many young people's interest and enthusiasm in space science and aerospace engineering.

**TITLE OF PROJECT:** Mars Astrobiology: Pushing the Limits of Organic Detection using Data Fusion of Multiple Spectroscopy Techniques

**CONTACT:** Horton Newsom

**ABSTRACT:** The goal of the proposed work is to determine the ability for data fusion to enhance the organic, mineralogical, and chemical analyses of environments likely to be encountered in future Mars rover missions. Data fusion is the deconvolution and recombination of complementary datasets to enhance discrimination and detection capabilities; here, I propose to apply Laser-Induced Breakdown Spectroscopy (LIBS), Raman spectroscopy, and reflectance infrared (IR) spectroscopy to Mars analog materials and extend the scope of previous studies in which only simple comparisons of results between instruments were made. These three techniques are among the most productive instruments for rover missions due to their relatively low energy requirements and ability to analyze surfaces remotely; LIBS and Raman instruments are already selected for the instrument suites of the 2011 MSL and 2018 ExoMars rover missions, respectively. The primary objectives of the project are 1) to determine experimentally the capability of LIBS, specifically the ChemCam LIBS instrument onboard the Mars Science Laboratory mission, to detect trace organics in mineral matrices, and 2) to assess the degree to which data fusion of LIBS, Raman and IR spectroscopies enhances discrimination of organic and mineral species in Mars analog samples.

**TITLE OF PROJECT:** Enhanced Dust Production Forecasts using Soil Moisture Models

**CONTACT:** Mark Stone

**ABSTRACT:** Windblown dust can result in wide range of negative consequences including dust related human illnesses, local environmental degradation, and even a loss of water resources through reduced snowpack albedo. Severe dust storms commonly occur in arid regions including western China, Saharan Africa, and the Southwest United States. In some regions, such events are increasing in magnitude, duration, and frequency due to desertification and severe droughts. It is thus important that we improve predictive models of dust production and transport. Scientists at UNM's Earth Data Analysis Center have been engaged in NASA supported windblown dust research for several years. In collaboration with researchers at the University of Arizona and George Mason University, the research team has improved descriptions of storm generated dust clouds by incorporating remote sensing data into simulations using a dust model. The objective of the proposed research Is to demonstrate the use of spatially explicit hydrologic models to Improve descriptions of dust emiSSions. HydrologiC models are capable of simulating the boundary conditions necessary for describing dust emissions - namely soil moisture content and land cover.

We hypothesize that these tools can be used to improve our ability to forecast dust emissions from a landscape. Such tools can also digest remote sensing data to parameterize or calibrate vegetation characteristics, snow cover, and precipitation patterns. Thus, this approach will combine the best available information from simulations and remote sensing to better describe spatial distributions of the conditions that control dust emissions.

**TITLE OF PROJECT:** Superconductor Gravity Experiment

**CONTACT:** Stephen Pate

**ABSTRACT:** Podkletnov has reported modification of gravitational acceleration above levitated, rotating superconductors, (the Podkletnov effect). Other researchers have reproduced portions of this experiment with varied results. These researchers including Tajmar and NASA have never faithfully reproduced the experimental setup originally described by Podkletnov. The present research proposes to reproduce Podkletnov's experiment in its entirety including portions of the experiment missing from other attempts: alternating current magnetic levitation of the superconductor and the stator/rotor rotation mechanism. These aspects of the original experiment create crossed, pinned magnetic fields in the superconductor that may be responsible for the results observed by Podkletnov, but subsequently either not observed or not observed in the same quantities by other researchers.

The objectives of the research are:

- review existing theoretical explanations of the Podkletnov effect
- review historical theories that may explain the effect such as the BCS theory of superconductivity and the Higgs mechanism
- review historical experiments which may have unknowingly observed the same effect such as the Fairbank group's verification of the Schiff Barnhill theory of gravitationally induced electric fields and the Tate group's Cooper pair mass anomaly
- incorporate this knowledge into a completed experimental design for the attempted duplication of the Podkletnov effect.

**TITLE OF PROJECT:** Robust Estimation and Control for Small Spacecraft with Reconfigurable Sensors and Actuators

**CONTACT:** Amit Sanyal

**ABSTRACT:** The main objective of this research is to formulate algorithms for robust plug-and-play attitude determination and control subsystem (ADCS) software for small spacecraft that are reconfigurable in their actuator and sensor hardware. Small spacecraft can be maneuvered easily, but are also susceptible to external inputs. The approach to attitude determination and control would be to use algorithms that can work for tumbling spacecraft and are not limited to small motions. The research is applicable to motion estimation and control of small spacecraft in both Earth (planetary) orbit and interplanetary space, and can be implemented using existing actuators and sensors. This research can potentially impact missions that use single or multiple small spacecraft, ranging from nanosatellites (like CubeSats) to spacecraft that weigh upto 100 kg. The expected outcomes of this research would be to obtain feedback control and estimation algorithms that ensure convergence to a desired state trajectory for large motion ranges, while being robust to sensor noise characteristics and disturbances due to actuator and sensor misalignments and other external effects. This research will proceed through the following three stages in chronological order: (1) design of robust feedback control algorithms that can reject external disturbances, (2) design of motion estimation algorithms that are robust to sensor noise characteristics, and (3) estimation of uncertain external inputs in the dynamics model. These algorithms will be tested through software simulations throughout the period of this research.