NASA Space Life and Physical Sciences and Research Applications

SLSPRA has 11 topics listed below and on the following pages for your consideration and possible involvement.

(1) Program: Physical Sciences Program

(2) Research Title: Dusty Plasmas

(3) Research Overview:

Dusty plasma research uses dusty plasmas – mixtures of electrons, ions, and charged micron-size particles as a model system to understand astronomical phenomena involving dust-laden plasmas, and as a simplified system modelling the behavior of many-body systems in problems of statistical and condensed matter physics. Dusty plasma research also addresses practical questions of dust management in planetary exploration missions.

Proposals are sought for research on dusty plasmas, particularly on the transport of particles in dusty plasmas.

4) NASA Contact

a. Name: Bradley Carpenter, Ph.D.
b. Organization: NASA Headquarters Space Life and Physical Sciences Research and Applications (SLPSRA)
c. Work Phone: (202) 358-0826
d. Email: bcarpenter@nasa.gov

5) Commercial Entity:

a. Company Name: na
b. Contact Name: na
c. Work Phone: na
d. Cell Phone: na
e Email: na

6) Partner contribution

No NASA Partner contributions

7) Intellectual property management:

No NASA Partner intellectual property concerns

8) Additional Information:

All publications that result from an awarded EPSCOR study shall acknowledge NASA Space Life and Physical Sciences Research and Applications (SLPSRA).

NASA Space Life and Physical Sciences and Research Applications (continued)

1) **Program:** Fluids Physics and Combustion Science

2) **Research Title:** Drop Tower Studies

3) **Research Overview**:

Fundamental discoveries made by NASA researchers over the last 50 years in fluids physics and combustion have helped enable advances in fluids management on spacecraft water recovery and thermal management systems, spacecraft fire safety, and fundamental combustion and fluids physics including low-temperature hydrocarbon oxidation, soot formation and flame stability.

The microgravity environment provides an ideal experimental backdrop for probing many of the questions raised in boiling, capillary effects and combustion research. Because the microgravity environment allows for extended length and/or time scales certain diagnostic techniques, that otherwise prove intractable in 1-g environments, show promise in obtaining new experimental insights. Using well designed experiments the aforementioned research topics can successfully be explored in microgravity and will serve to greatly enhance the developmental pace of a number of important technologies for both terrestrial and extraterrestrial application.

4) **Research Focus**

This Fluids Physics and Combustion Science emphasis requests proposals for hypothesis-driven experiments and/or analysis that that will help address fundamental issues in these fields or will address important issues in spacecraft life-support.

Proposers are encouraged to include the use of NASA GRC drop tower facilities in their proposals. For more information about these facilities, please contact Eric Neumann (eric.s.neumann@nasa.gov; 216-433-2608). These facilities provide either 2.2 or 5.2 seconds of low-gravity.

(5) NASA Contact

a. Name: Francis Chiaramonte, Ph.D.
b. Organization: NASA Headquarters Space Life and Physical Sciences, Physical Sciences Program
c. Work Phone: 202-358-0693
d. Email: francis.p.chiaramonte@nasa.gov

6) **Commercial entity:**

a. Company Name: na
b. Contact Name: na
c. Work Phone: na
d. Cell Phone: na
e. Email: na

7) **Partner contribution**

No NASA Partner contributions

8) **Intellectual property management:**
No NASA Partner intellectual property concerns

9) **Additional Information:**
All publications that result from an awarded EPSCOR study shall acknowledge NASA Space Life and Physical Sciences Program.

1) **Program:** Combustion Science

2) **Research Title:** Transcritical Combustion

3) **Research Overview:**

Fundamental discoveries made by NASA researchers over the last 50 years has helped enable advances in fundamental combustion including low-temperature hydrocarbon oxidation, soot formation and flame stability. One area of fundamental research that NASA wishes to focus on is combustion at supercritical conditions. This study has two major applications: super critical water oxidation (SCWO) and hydrocarbon combustion processes as seen in diesel and jet engines.

The microgravity environment provides an ideal experimental backdrop for probing many of the questions raised in high pressure combustion research. Because the microgravity environment allows for extended length and/or time scales certain diagnostic techniques, that otherwise prove intractable in 1-g environments, show promise in obtaining new experimental insights. Using well designed experiments the aforementioned research topics can successfully be explored in microgravity and will serve to greatly enhance the developmental pace of a number of important technologies for both terrestrial and extraterrestrial application.

4) **Research Focus**

This Combustion Science Emphasis requests proposals for hypothesis-driven experiments and/or analysis that that will help determine: 1) fundamental phase change and transport processes in the injection of a subcritical fluid into an environment in which it is supercritical; 2) ignition and combination of hydrocarbons under these conditions; and 3) how to optimize SCWO systems for waste management in extraterrestrial habitats.

Proposers are encouraged to include the use of drop tower facilities in their proposals. For more information about these facilities, they can contact Eric Neumann (eric.s.neumann@nasa.gov ; 216-433-2608). These facilities provide either 2.2 or 5.2 seconds of low-gravity. The possibility exists that investigators could take advantage of an existing test rig for the 5.2 second drop tower. To learn about its capabilities contact: Daniel Dietrich (Daniel.l.dietrich@nasa.gov; 216-433-8759)

5) **NASA Contact**
   a Name: Francis Chiaramonte, Ph.D.
   b Organization: NASA Headquarters Space Life and Physical Sciences, Physical Sciences Program
   c Work Phone: 202-358-0693 or 202-834-7348
   d Email: francis.p.chiaramonte@nasa.gov

6) **Commercial entity:**
   a. Company Name: na
   b. Contact Name: na
   c. Work Phone: na
   d. Cell Phone: na
   e. Email: na

7) **Partner contribution**
   No NASA Partner contributions

8) **Intellectual property management:**
   No NASA Partner intellectual property concerns

9) **Additional Information:**
   All publications that result from an awarded EPSCOR study shall acknowledge NASA Space Life and Physical Sciences Research and Applications Division.

NASA Space Life and Physical Sciences and Research Applications (continued)

1) **Program:** Physical Sciences Program

2) **Research Title:** Quantum Effects

3) **Research Overview:**

Space offers a unique environment for experimental physics in many areas. Current areas of focus for NASA's Fundamental Physics program are cold atom physics, the application of cold atom technologies to research in quantum science and general relativity, and the physics of dusty plasmas.

Quantum physics is a cornerstone of our understanding of the universe. The importance of quantum mechanics is extraordinarily wide ranging, from explaining emergent phenomena such as superconductivity, to underpinning next-generation technologies such as quantum computers, quantum communication networks, and sensor technologies. Laser-cooled cold atoms are a versatile platform for quantum physics on Earth, and one that can greatly benefit from space-based research. The virtual elimination of gravity in the reference frame of a free-flying space vehicle enables cold atom experiments to achieve longer observation times and colder temperatures than are possible on Earth. The NASA Fundamental Physics program plans to support research in quantum physics that will lead to transformational outcomes, such as the discovery of phenomena at the intersection of quantum mechanics and general relativity that inform a unified theory, the direct detection of dark matter via atom interferometry or atomic clocks, and the creation of exotic quantum matter than cannot exist on Earth.

4) **Research Focus:**

Proposals are sought for ground-based theory and experimental research that may help to develop concepts for future flight experiments. Research in distance effects in quantum superposition and entanglement are of particular interest.

5) **NASA Contact**
   a. Name: Bradley Carpenter, Ph.D.
   b. Organization: NASA Headquarters Space Life and Physical Sciences Research and Applications (SLPSRA)
   c. Work Phone: (202) 358-0826
   d. Email: bcarpenter@nasa.gov

6) **Commercial Entity:**
   a. Company Name: na
   b. Contact Name: na
   c. Work Phone: na
   d. Cell Phone: na

7) **Partner contribution**

   No NASA Partner contributions

8) **Intellectual property management:**

   No NASA Partner intellectual property concerns

9) **Additional Information:**

   All publications that result from an awarded EPSCOR study shall acknowledge NASA Space Life and Physical Sciences Research and Applications (SLPSRA).

NASA Space Life and Physical Sciences and Research Applications (continued)

1) **Program:** Fluid Physics

2) **Research Title:** Flow Boiling in Reduced Gravity

3) **Research Overview:**

Study of two-phase flow instabilities began in the late 1920s, and in the nearly 100 years since, progress has been made in both experimental and theoretical understanding of them. Despite these advances, many key deficiencies remain, solution of which will provide appreciable value for system designers looking to leverage phase change heat transfer technologies in a safe and repeatable manner. There are several types of instabilities that are prevalent in flow boiling applications, but few modeling tools are available to predict operating conditions leading to their occurrence, or methods for mitigating their negative effects on flow boiling. These issues are especially concerning for flow boiling systems employed in space, given the added complexity of reduced gravity environment.

4) **Research Focus:**

The most prevalent and important forms of two-phase instability are (1) ***Density Wave Oscillations*** (DWOs) and (2) ***Parallel Channel Instability*** (PCI), both are *dynamic instability* types. The former is manifest by a liquid surge along a flow boiling channel, and precipitates fluctuations in both flow rate and wall temperature. The latter is encountered in cold plates containing parallel flow channels, where differences in interfacial behavior and void fraction between channels also causes fluctuations in both flow rate and wall temperature. A third important instability topic is ***Two-phase Choking***, which is a *static instability* limit. This phenomenon is the outcome of appreciable changes in specific volumes and enthalpies of liquid and vapor, and is known to both greatly increase pressure drop and/or impose upper limits on flow rate through the boiling channel. This focused flow boiling research emphasis requests ground-based, laboratory proposals for hypothesis-driven experiments and/or analysis to investigate and help determine: 1) Density wave oscillations 2) Parallel Channel Instability and 3) Two phase chocking instability.

5) **NASA Contact**
   a. Name: Francis Chiaramonte, Ph.D.
   b. Organization: NASA Headquarters Space Life and Physical Sciences, Physical Sciences Program
   c. Work Phone: 202-358-0693 or 202-834-7348
   d. Email: francis.p.chiaramonte@nasa.gov

6) **Commercial entity:**
   a. Company Name: na
   b. Contact Name: na
   c. Work Phone: na
   d. Cell Phone: na
   e. Email: na

7) **Partner contribution**

No NASA Partner contributions

8) **Intellectual property management:**

No NASA Partner intellectual property concerns

9) **Additional Information:**

All publications that result from an awarded EPSCOR study shall acknowledge NASA Space Life and Physical Sciences Research and Applications Division.

1) **Program:** Physical Sciences

2) **Research Title:** Physical Sciences Informatics System

3) **Research Overview:**
This call for proposals is for ground-based research proposals to utilize NASA's Physical Sciences Informatics (PSI) system (https://psi.nasa.gov/) to develop new analyses and scientific insights. The PSI system is designed to be a resource for researchers to data mine information generated from completed reduced-gravity physical sciences experiments performed on the International Space Station (ISS), Space Shuttle flights, Free Flyers, commercial cargo flights to and from the ISS, or from related ground-based studies. Specifically, this call is for the utilization of data from investigations that are currently available in the PSI system.

4) **Research Focus**
The call solicits ground-based research proposals that present a compelling case of how the experimental data from the PSI system (https://psi.nasa.gov/) will be used to promote the advancement of further research. Proposers must show a clear path from the scientific data obtained from the PSI system to the proposed investigation. In addition, the project must address an important problem in the proposed area of research and advance scientific knowledge or technology. The scope of the proposed work is unrestricted except that the use of data in the PSI database must comprise a substantial portion of the research.

This call solicits proposals in the following five research areas: 1) Combustion Science, 2) Complex Fluids, 3) Fluid Physics, 4) Fundamental Physics, and 5) Materials Science. The call specifically solicits proposals that utilize data from investigations listed in the table below. Of the eligible 63 investigations, 47 are from the ISS, eight from the Space Shuttle (Space Transportation System; STS), one from a Free Flyer experiment, three from commercial cargo flights to and from the ISS (Commercial Resupply Services; CRS), and four selected through PSI NRA (denoted with "PSI NRA science" in the table). Proposals that do not utilize data from investigations listed in the table below may be declared without further review.

#	Research Area	Investigation	Carrier / Source
1	Combustion Science	BASS (Burning and Suppression of Solids)	ISS
2	Combustion Science	BASS-II (Burning and Suppression of Solids - II)	ISS
3	Combustion Science	CFI (Cool Flames Investigation)	ISS
4	Combustion Science	DAFT (Dust and Aerosol Measurement Feasibility Test)	ISS

5	Combustion Science	DAFT-2 (Dust and Aerosol Measurement Feasibility Test - 2)	ISS
6	Combustion Science	FLEX (Flame Extinguishment Experiment)	ISS
7	Combustion Science	FLEX-2 (Flame Extinguishment Experiment - 2)	ISS
8	Combustion Science	Quantitative Studies of Cool Flame Transitions at Radiation/Stretch Extinction Using Counterflow Flames (PSI NRA science)	PSI-A
9	Combustion Science	SAFFIRE I (Spacecraft Fire Experiment I)	Cygnus CRS OA-6
10	Combustion Science	SAFFIRE II (Spacecraft Fire Experiment II)	Cygnus CRS OA-5
11	Combustion Science	SAFFIRE III (Spacecraft Fire Experiment III)	Cygnus CRS OA-7
12	Combustion Science	SAME (Smoke Aerosol Measurement Experiment)	ISS
13	Combustion Science	SAME-R (Smoke Aerosol Measurement Experiment - Reflight)	ISS
14	Combustion Science	SLICE (Structure and Liftoff in Combustion Experiment)	ISS
15	Combustion Science	SPICE (Smoke Point in Coflow Experiment)	ISS
16	Complex Fluids	ACE-M1 (Advanced Colloids Experiment - Microscopy 1)	ISS
17	Complex Fluids	ACE-M2 (Advanced Colloids Experiment - Microscopy 2)	ISS
18	Complex Fluids	BCAT-3 (Binary Colloidal Alloy Test - 3)	ISS
19	Complex Fluids	BCAT-4 (Binary Colloidal Alloy Test - 4)	ISS
20	Complex Fluids	BCAT-5 (Binary Colloidal Alloy Test - 5)	ISS
21	Complex Fluids	BCAT-6 (Binary Colloidal Alloy Test - 6)	ISS
22	Complex Fluids	InSPACE (Investigating the Structure of Paramagnetic Aggregates from Colloidal Ellipsoids)	ISS

23	Complex Fluids	InSPACE-2 (Investigating the Structure of Paramagnetic Aggregates from Colloidal Ellipsoids - 2)	ISS
24	Complex Fluids	InSPACE-3 (Investigating the Structure of Paramagnetic Aggregates from Colloidal Ellipsoids - 3)	ISS
25	Complex Fluids	InSPACE-3+ (Investigating the Structure of Paramagnetic Aggregates from Colloidal Ellipsoids - 3+)	ISS
26	Complex Fluids	PCS (Physics of Colloids in Space)	ISS
27	Complex Fluids	PHaSE (Physics of Hard Spheres Experiment)	STS-94
28	Complex Fluids	SHERE (Shear History Extensional Rheology Experiment)	ISS
29	Complex Fluids	SHERE II (Shear History Extensional Rheology Experiment II)	ISS
30	Complex Fluids	SHERE-R (Shear History Extensional Rheology Experiment - Reflight)	ISS
31	Complex Fluids	Structure Evolution During Phase Separation in Colloids Under Microgravity, (PSI NRA science)	PSI-B
32	Fluid Physics	CCF-EU1-CV (Capillary Channel Flow - Experiment Unit 1 - Critical Velocities)	ISS
33	Fluid Physics	CCF-EU2-CV (Capillary Channel Flow - Experiment Unit 2 - Critical Velocities)	ISS
34	Fluid Physics	CCF-EU2-PS (Capillary Channel Flow - Experiment Unit 2 - Phase Separation	ISS
35	Fluid Physics	CFE (Capillary Flow Experiment)	ISS
36	Fluid Physics	CFE-2 (Capillary Flow Experiment – 2)	ISS
37	Fluid Physics	Computational Framework for Capillary Flows, (PSI NRA science)	PSI-A
38	Fluid Physics	CVB (Constrained Vapor Bubble)	ISS
39	Fluid Physics	CVB-2 (Constrained Vapor Bubble – 2)	ISS
40	Fluid Physics	Gravity Scaling of Pool Boiling Heat Transfer: Numerical Simulations and Validation with MABE and NPBX, (PSI NRA science)	PSI-B
41	Fluid Physics	MABE (Microheater Array Heater Boiling Experiment)	ISS
42	Fluid Physics	NPBX (Nucleate Pool Boiling Experiment)	ISS

43	Fluid Physics	PBE (Pool Boiling Experiment)	STS-47, STS-57, STS-60, STS-72, STS-77
44	Fluid Physics	PBRE (Packed Bed Reactor Experiment)	ISS
45	Fluid Physics	STDCE-1 (Surface Tension Driven Convection Experiment) - First United States Microgravity Payload on Columbia (USML-1)	STS-52
46	Fundamental Physics	DECLIC-ALI (Device for the Study of Critical Liquids and Crystallization - Alice Like Insert)	ISS
47	Fundamental Physics	GRADFLEX (Gradient Driven Fluctuation Experiment)	Free Flyer
48	Fundamental Physics	PKE-Nefedov & PK-3+ (Plasma Kristall Experiment; Dusty Plasma)	ISS
49	Materials Science	CSLM (Coarsening in Solid-Liquid Mixtures)	STS-83, STS-94
50	Materials Science	CSLM-2 (Coarsening in Solid-Liquid Mixtures - 2)	ISS
51	Materials Science	CSLM-2R (Coarsening in Solid-Liquid Mixtures - 2 Reflight)	ISS
52	Materials Science	CSLM-3 (Coarsening in Solid-Liquid Mixtures - 3)	ISS
53	Materials Science	CSLM-4 (Coarsening in Solid-Liquid Mixtures - 4)	ISS
54	Materials Science	DECLIC-DSI (Device for the Study of Critical Liquids and Crystallization - Directional Solidification Insert)	ISS
55	Materials Science	IDGE-STS-62 (Isothermal Dendritic Growth Experiment) - Second United States Microgravity Payload on Columbia (USMP-2)	STS-62
56	Materials Science	IDGE-STS-75 (Isothermal Dendritic Growth Experiment) - Third United States Microgravity Payload on Columbia (USMP-3)	STS-75
57	Materials Science	IDGE-STS-87 (Isothermal Dendritic Growth Experiment) - Fourth United States Microgravity Payload on Columbia (USMP-4)	STS-87
58	Materials Science	ISSI (In-Space Soldering Investigation)	ISS

59	Materials Science	MICAST/CSS (Microstructure Formation in Casting of Technical Alloys under Diffusive and Magnetically Controlled Convective Conditions/Comparison of Structure and Segregation in Alloys Directionally Solidified in Terrestrial and Microgravity Environments)	ISS
60	Materials Science	PFMI (Pore Formation and Mobility Investigation)	ISS
61	Materials Science	Strata-1	ISS
62	Materials Science	SUBSA (Solidification Using a Baffle in Sealed Ampoules)	ISS
63	Materials Science	TEMPUS (Tiegelfreies Elektromagnetisches Prozessieren Unter Schwerelosigkeit; Electromagnetic Containerless Processing in Microgravity)	STS-65, STS-83, STS-94

5) **Proposers must review the data in the PSI system before preparing their proposal. The proposal must clearly demonstrate how the PSI data will be used in the project.** Furthermore, prior to the submission of the proposal, it is highly recommended that the proposers take at least one representative sample set of PSI data to perform numerical modeling or sample experiments and present the findings as part of the proposal.

   Research results from proposals selected under this call for proposals will be entered into the PSI system for use by future investigators.

6) **NASA Contact**
   a. Name: Francis Chiaramonte, Ph.D.
   b. Organization: NASA Headquarters Space Life and Physical Sciences, Physical Sciences Program
   c. Work Phone: 202-358-0693
   d. Email: francis.p.chiaramonte@nasa.gov

7) **Commercial entity:**
   a. Company Name: na
   b. Contact Name: na
   c. Work Phone: na
   d. Cell Phone: na
   e. Email: na

8) **Partner contribution**
   No NASA Partner contributions

9) **Intellectual property management:**
   No NASA Partner intellectual property concerns

10) **Additional Information:**
   All publications that result from an awarded EPSCOR study shall acknowledge NASA Space Life and Physical Sciences Research and Applications Division.

NASA Space Life and Physical Sciences and Research Applications (continued)

1) **Research Title:**
Bioinformatic Analysis of Space Biology Data in the NASA GeneLab Data System

2) **Research Overview:**
With humans pushing to live further off Earth for longer periods of time, it is increasingly important to understand the changes that occur in biological systems during spaceflight --- whether these be astronauts, their microbial commensals, or their plant-based life support systems.
The NASA GeneLab data system contains decades of genomic, metabolomic, proteomic, transcriptomic, and microbiome profiling data from biological experiments performed in space or exposed to spaceflight-like conditions. Curation and aggregation of this data within GeneLab enables re-use and cross comparison of these rare opportunities for experimentation in space.
NASA is requesting proposals from investigators who wish to perform bioinformatic analyses of the data within GeneLab. These analyses could include single or multiple datasets. Investigators are encouraged to include data from other databases. Investigators are encouraged to utilize pre-processed data provided on GeneLab when possible, but are welcome to suggest improvements to this data to the GeneLab team.
All proposers are required to interact with various GeneLab Analysis Working Groups (AWGs) to receive input on their work and to strengthens these communities with new ideas (https://genelab.nasa.gov/awg/charter).
Proposals must translate the spaceflight derived data in the GeneLab database into new knowledge that addresses the objectives of NASA's Space Biology Program and its principal scientific elements (https://www.nasa.gov/sites/default/files/atoms/files/16-03-23_sb_plan.pdf).

3) **Organization:**
NASA Space Biology Program

4) **Contact:**
Jonathan Galazka
GeneLab Project Scientist
NASA Ames Research Center
jonathan.m.galazka@nasa.gov
650-604-3950

5) **Intellectual property rights:**
No NASA partner intellectual property concerns

6) **Additional Information:**
NASA welcomes communication with the GeneLab team, as necessary, to discuss approaches to the data analysis. All publications that result from the EPSCOR study shall acknowledge NASA Space Biology Program and GeneLab. Publications using GeneLab data: https://genelab.nasa.gov/publications

NASA Space Life and Physical Sciences and Research Applications (continued)

1) Program: Space Biology Program

2) Research Title: Biofilms and the Built Environment

3) Research Overview:

NASA needs to optimize the design of future human-occupied space craft for exploration to manage the microbial environment for sustained human utilization. Exploration missions include destinations to the moon and Mars as well as enabling a better understanding of continued long duration occupation of the International Space Station. Included in this design are. To identify and understand key factors required to optimize spacecraft and habitat design, an in-depth understanding of how the healthy and disease-causing microbes of this enclosed and sealed space will evolve and interact with the crew and plants over the mission duration is required. Areas for potential biofilm interactions include: life support subsystems, such as water recovery, spacecraft structural materials, and chambers for growing crops for crew food and nutrition. Additional microbiology research is needed to expand our understanding of spaceflight environmental factors that impact microbial growth, physiology, reproduction, evolution, community dynamics, and virulence.

Early studies with microorganisms showed that they reached higher population densities when grown under microgravity conditions than were obtained from cultures grown under similar conditions on the ground. The higher cell densities were likely due to a more homogeneous distribution of cells in the culture medium, as opposed to the crowded and more nutrient– depleted conditions that occurs at 1g as the cells settle (Klaus et al., 1997; PMID 9043122). Additional studies also showed that spaceflight caused some bacterial species to become more resistant to common antibiotics. (Klaus and Howard, 2006: PMID 16460819). Other studies demonstrated that spaceflight or simulated microgravity promoted biofilm formation (Kim et al., 2013; PIMD 23658630, Searles et al., 2011; PMID 21936634). These biofilms have been found to cause significant biofouling of water recovery system fluidic systems and serve as potential agents for biocorrosion of spacecraft materials.

4) Research Focus

The goal of this NASA Space Biology Program research emphasis is to build a better understanding of fungal and bacterial biofilm biology, its development, and interactions with spacecraft materials and hardware through hypothesis-driven experiments that will answer basic questions about how individual and mixed microbial biofilms respond to changes in gravity and other environmental factors (e.g., radiation) associated with spaceflight and methods for mitigating their development. Overall, the results of the proposed investigations should contribute to a broader, systems level understanding of biofilm biology in the spaceflight environment and its interaction with the built environment.

For this research emphasis, NASA requests proposals to determine the effect of simulated microgravity on microbial biofilm biology and community dynamics to advance findings and hypotheses derived from spaceflight investigations. Such studies are expected to generate and test specific ground-based hypotheses that will lead to hypotheses testable in spaceflight.

The proposed investigation is expected to simulate elements of the spaceflight conditions, such as microgravity, in ground-based analogs such as clinostats, High Aspect Rotating Vessels (HARVs), or other Low- Shear Model-Microgravity (LSMM) systems. Studies that investigate combine microgravity and radiation are encouraged, but the proposal must adhere to the funding and duration requirements of this EPSCoR CAN. Ground-based investigations should be proposed that will study one or more of the following topics:

a. Develop fundamental knowledge about how simulated microgravity influences biofilm biology. Space Biology studies will determine the effects of this environment on the dynamics of microbes in mono or mixed microbe biofilms with respect to cell processes (including biofilm development, biofilms structural and functional changes, and virulence and antibiotic resistance). The proposed investigation may study fungal- and/or bacterial-based biofilms.
b. Determine how biofilms interact with and affect built environment surfaces in simulated microgravity. The built environment is defined as spacecraft hardware and materials. Space Biology studies will determine the role different material types and surface features play in facilitating or inhibiting biofilm formation (including microbe-to-surface interactions and biocorrosion). The proposed investigation may study fungi, bacteria, or mixed microbe communities. It is encouraged that the studies use materials or hardware subsystems that are representative of those used on ISS and its hardware, such water recovery systems and material surfaces exposed to high humidity.
c. Develop fundamental knowledge to develop methods for mitigating biofilm formation on built surfaces and hardware systems, such as the ISS water recovery system and other fluidics systems. Methods for preventing biofilm formation may consider, but are not limited to, surface coatings, material surface topology, biocides, UV radiation, chemicals, mechanical disruption, bio-based antimicrobial treatments. It is anticipated that the studies will examine individual methods or combination of methods.

Proposers are expected to be familiar with the Decadal Survey Priorities (http://www.nap.edu/catalog/13048.html) and the NASA Space Biology Plan (https://www.nasa.gov/sites/default/files/atoms/files/16-05-11_sb_plan_2.pdf) to understand the specific space bioscience research topics that can be affected by non-space-associated variables.

5) NASA Contact

e. Name: David Tomko, Ph.D.
f. Organization: NASA Headquarters Space Life and Physical Sciences Space Biology Program
g. Work Phone: 202-358-2211
h. Email: dtomko@nasa.gov

6) Commercial entity:

a. Company Name: na
b. Contact Name: na
c. Work Phone: na
d. Cell Phone: na
e. Email: na

7) Partner contribution

No NASA Partner contributions

8) Intellectual property management:

No NASA Partner intellectual property concerns

9) Additional Information:

All publications that result from an awarded EPSCOR study shall acknowledge NASA Space Biology Program. If the NASA GeneLab Data Systems (genelab.nasa.gov) is used, GeneLab shall be referenced in the resulting publication and included in the keyword list All omics data obtained from this study shall be uploaded to the NASA GeneLab Data System.

1) **Program:** Space Biology Program

2) **Research Title:** Plant and Microbial Interactions

3) **Research Overview:**

Fundamental discoveries made by NASA researchers over the last 50 years has helped enable successful growth of plants in space, as is demonstrated through current work being done on the ISS using Veggie and the Advanced Plant Habitat. In spite of these forward advances, and the potential of this work to lead to the creation of space life-support systems, additional fundamental plant biology research is still needed. There still much to learn about how plants respond to the spaceflight environment, and what it will take to support long-duration, multiple generation plant growth and cultivation during extended space exploration missions.

One area of fundamental research that NASA wishes to focus on is the impact of the spaceflight environment on plant and microbial interactions. While the microbial contamination of plants grown in the closed environment of a spacecraft is always a potential concern, the interactions of these plants with beneficial microbes, such as those between leguminous plant and nitrogen fixing bacteria, may also be altered in spaceflight-environment (Foster et. al., 2014: PMID: 25370197). The goal of this NASA Space Biology Program research emphasis is to build a better understanding of the effects of spaceflight on microbial and plant ecosystems found spacecraft such as the ISS, which in turn will help us prepare for future exploration missions to the moon and Mars.

4) **Research Focus**

This Space Biology Research Emphasis requests proposals for hypothesis-driven experiments that will help determine: 1) the effects of the spaceflight-like environment on plant-microbial interactions; 2) the long-term, multigenerational effects of the spaceflight-like environment on plant-microbial population dynamics; and 3) how to optimize plant-microbial systems for growing and sustaining plants in space. Fundamental plant-microbial biology research is needed to specifically identity the driving space environmental factors or combination of factors that impact plant-microbial interactions. Applicants should consider at least one of the following questions in the preparation of their proposal:

- How do space-environmental conditions influence the development and diversity of microbial communities associated with plants? How do microbial population from plant surfaces or plant growth media change over time in a spaceflight-like environment?
- Which plant-microbial interactions effect important processes (e.g., commensalisms, symbioses, nitrogen fixation, biodegradation) and how do the processes change in response to the multiple stimuli encountered in space environments?
- What environmental conditions are needed for optimal plant-microbial interactions in spacecraft (e.g., temperature, humidity, light wavelengths, light intensity, concentration and ratio of gases)? What is the optimal microbial composition for plant growth media needed to sustain plants in space environments?
- Can beneficial microbes in plant growth media be grown successfully through multiple life cycles in a space environment?

Proposers are encouraged to incorporate the use of microgravity analogs that simulate the effects of spaceflight (or partial gravity) on their plant/microbial system in their experimental design, or to use centrifuges to conduct hyper-gravity studies that characterize how their proposed system(s) responds to a downshift in gravity levels from 2g to 1g (as a surrogate for a 1g to 0g downshift). Investigators may also propose studies that characterize the long terms effects of isolation similar to those experience in a closed built environment such as a spacecraft on plant/microbial ecosystems.

Proposers are expected to be familiar with the Decadal Survey Priorities (http://www.nap.edu/catalog/13048.html) and the NASA Space Biology Plan (https://www.nasa.gov/sites/default/files/atoms/files/16-05-11_sb_plan_2.pdf) to understand the specific space bioscience research topics that can be affected by non-space-associated variables.

5) NASA Contact

a. Name: David Tomko, Ph.D.
b. Organization: NASA Headquarters Space Life and Physical Sciences Space Biology Program
c. Work Phone: 202-358-2211
d. Email: dtomko@nasa.gov

6) Commercial entity:

a. Company Name: na
b. Contact Name: na
c. Work Phone: na
d. Cell Phone: na
e. Email: na

7) Partner contribution

No NASA Partner contributions

8) Intellectual property management:

No NASA Partner intellectual property concerns

9) Additional Information:

All publications that result from an awarded EPSCOR study shall acknowledge NASA Space Biology Program. If the NASA GeneLab Data Systems (genelab.nasa.gov) is used, GeneLab shall be referenced in the resulting publication and included in the keyword list All omics data obtained from this study shall be uploaded to the NASA GeneLab Data System.

NASA Space Life and Physical Sciences and Research Applications (continued)

1) **Program:** Physical Sciences Program

2) **Research Title:** Extraction of Materials from Regolith

3) **Research Overview:**
With NASA's renewed efforts to put astronauts on the moon and to develop a persistent human presence on the moon, the ability to utilize in-situ resources is paramount to the success of these future missions. Extraction of materials (e.g. metals, glasses and water ice) from extra-terrestrial regolith is necessary for NASA to be successful in the long term. The extracted materials could be used as feedstock for additive manufacturing processes, to construct habitats and/or other structures, to build infrastructure, for example, roads, walls, and landing pads, or to fabricate tools or other hardware. The water ice from regolith material could be used to augment life support systems for extended stay missions or produce liquid hydrogen and liquid oxygen for propellant production.

4) **Research Focus**
The goal of this NASA Physical Sciences Program research emphasis is to develop and increase understanding of extraction techniques to generate useful materials (e.g. metals, glasses, water ice) from Lunar or Martian regolith.

Proposed studies are expected to generate and test specific hypotheses to the extent possible in a terrestrial lab or reduced gravity aircraft. Investigations should be proposed that would study one or more of the following topics:

a. Refinement of existing techniques to extract materials from regolith.
b. Development of new techniques for extraction of materials from regolith.
c. Studies of the extracted material to determine its properties or to investigate novel ways of utilizing it to support NASA's exploration goals.

It is expected that regolith simulant will be used for the proposed experiments. Proposals are encouraged to use existing hardware.

More information on NASA's exploration goals can be found in the Decadal Survey (http://www.nap.edu/catalog/13048.html), specifically Translation to Space Exploration Systems (TSES) number 16 (TSES16).

5) **NASA Contact**

a. Name: Fran Chiaramonte, Ph.D.
b. Organization: NASA Headquarters Space Life and Physical Sciences Research and Applications (SLPSRA)
c. Work Phone: 202-358-0693
d. Email: francis.p.chiaramonte@nasa.gov

6) **Commercial entity:**

a. Company Name: na
b. Contact Name: na
c. Work Phone: na
d. Cell Phone: na
e. Email: na

7) Partner contribution
No NASA Partner contributions

8) Intellectual property management:
No NASA Partner intellectual property concerns

9) Additional Information:
All publications that result from an awarded EPSCOR study shall acknowledge NASA Space Life and Physical S

NASA Space Life and Physical Sciences and Research Applications (continued)

1) Program: Space Biology Program

2) Research Title: In-Situ Food Safety Monitoring

3) Research Overview: (General overview – no more than a couple of paragraphs)
NASA has identified in situ crop production as a technology gap that needs to be filled to enable deep space exploration. Current solutions to this technological gap utilize growing "pick and eat" crops during missions in plant growth chambers that are exposed to the cabin environment and crew interaction. Produce grown in situ is consumed without cooking or other processing techniques, leaving the produce susceptible to contamination during growth or post-harvest handling. Produce grown on ISS is currently cleaned post-harvest with produce sanitizing wipes to minimize crew exposure to potentially harmful pathogens. This procedure of cleaning produce post-harvest on-orbit is time consuming for the crew and requires the use of consumable sanitizing wipes that may be burdensome to stow on long-duration exploration missions.

There are currently no in situ techniques or procedures in place to detect or identify potential pathogens and opportunistic pathogens in crop production systems on spacecraft. This is especially concerning in the microgravity environment, where numerous changes in microbial behavior in response to microgravity are documented, such as findings of higher microbial population densities when grown under microgravity conditions (Klaus et al., 1997; PMID 9043122) and increased virulence in space-grown cultures of the pathogen *Salmonella* enterica serovar Typhimurium (Wilson et al., 2007; PMID 17901201).

There are numerous microbial monitoring programs on ISS that utilize molecular techniques to identify microbial populations on ISS (e.g. Venkateswaran et al., 2014: PMID 25130881). In their current form, none of these techniques are employed as a diagnostic tool for in-situ food safety monitoring of freshly grown produce. Molecular techniques could be employed as a diagnostic tool to detect specific human pathogens on produce prior to crew consumption. Current research at NASA and USDA into hyperspectral and multispectral imaging is advancing the capability to detect plant stress in real-time, which could be useful for identifying potential food safety concerns as plants are cultivated. Additionally, these advanced imaging systems are able to detect microbial growth, though it is still to be determined at what level of sensitivity microbes can be detected (i.e. colony size). It is likely a multi-faceted in-situ food safety monitoring approach may ultimately be deployed in space crop production systems on spacecraft. One where advanced plant health imaging systems are able to detect biofilm growth or changes in plant health that are most conducive to pathogen and opportunistic pathogen establishment, which is then followed up with targeted molecular techniques capable of detecting pathogens to the genus or species levels.

4) Research Focus:
The goal of this NASA Space Biology Program research emphasis is to build a better understanding of non-destructive in situ techniques that can be deployed to advance food safety specific microbial monitoring on spacecraft such as ISS to prepare for future exploration missions far from Earth.

The proposed investigation is expected to simulate elements of spaceflight crop production, to include use of light emitting diode (LED) lighting systems, controlled environmental conditions, and analogous water and nutrient delivery systems. Studies that use simulated microgravity are welcomed but may not be feasible with larger crops and must adhere to the funding and duration requirements of this EPSCoR CAN. Ground-based studies should be proposed that will:

a. Grow a range of "pick and eat" crops similar to those proposed to support future deep space exploration missions, including leafy greens, tomatoes, and peppers, and demonstrate the effectiveness of the proposed In-Situ Food Safety Monitoring technology to detect and measure the amount of microbes associated with these crops. An effective system will provide a visual cue for measurements that exceed a specific user defined quantity, which may be user adjustable based on health requirements.
b. Determine the false positive and false negative rate of the technology for different crop types and measure what other factors, such as gravity environment, humidity levels, ambient lighting, etc, may have on the false detection rates.
c. Determine microbial detection capabilities of food safety monitoring technique. Beyond knowing total microbial levels, differentiating individual strains of pathogens and beneficial microbes can enable targeted reduction of pathogens to ensure Food Safety while minimizing the negative impact of any sanitation techniques on the healthy microbiome of the grow system or potentially beneficial probiotic effect of the produce for the crew.

Proposers are expected to be familiar with the Decadal Survey Priorities (http://www.nap.edu/catalog/13048.html) and the NASA Space Biology Plan (https://www.nasa.gov/sites/default/files/atoms/files/16-05-11_sb_plan_2.pdf) to understand the specific space bioscience research topics that can be affected by non-space-associated variables.

5) NASA Contact

a. Name: David Tomko, Ph.D.
b. Organization: NASA Headquarters Space Life and Physical Sciences Space Biology Program
c. Work Phone: 202-358-2211
d. Email: dtomko@nasa.gov

6) Commercial entity:

a. Company Name: na
b. Contact Name: na
c. Work Phone: na
d. Cell Phone: na
e. Email: na

7) Partner contribution

No NASA Partner contributions

8) Intellectual property management:

No NASA Partner intellectual property concerns

9) Additional Information:

All publications that result from an awarded EPSCOR study shall acknowledge NASA Space Biology Program. If the NASA GeneLab Data Systems (genelab.nasa.gov) is used, GeneLab shall be referenced in the resulting publication and included in the keyword list All omics data obtained from this study shall be uploaded to the NASA GeneLab Data System.