Appendix E: NASA Fellowship Activity Research Opportunities by Center

NASA Internships and Fellowships (NIFs) Leads

---Armstrong Flight Research Center (AFRC) --------------------------------------
If you have questions about any of the following opportunities at Armstrong Flight Research Center, please contact Krisstina Wilmoth at krisstina.wilmoth@nasa.gov or (650) 604-6137.

---Ames Research Center (ARC) ---
If you have questions about any of the following opportunities at Ames Research Center, please contact Krisstina Wilmoth at krisstina.wilmoth@nasa.gov or (650) 604-6137.

--Glenn Research Center (GRC) ---
If you have questions about any of the following opportunities at Glenn Research Center, please contact Mark D. Kankam Ph.D. at mark.d.kankam@nasa.gov or (216) 433-6143.

---Goddard Space Flight Center (GSFC) ---
If you have questions about any of the following opportunities at Goddard Space Flight Center, please contact Raquel Marshall at raquel.h.marshall@nasa.gov (301) 286-1976.

---Jet Propulsion Lab (JPL)---
If you have questions about any of the following opportunities at Jet Propulsion Lab, please contact Petra Milanian at petra.a.kneissl-milanian@jpl.nasa.gov or (818) 354-0726.

---Johnson Space Center (JSC) --
If you have any questions about the following opportunities at Johnson Space Center, please contact Kamlesh Lulla at kamlesh.p.lulla@nasa.gov or (281) 483-5066.

--Kennedy Space Center (KSC) --
If you have questions about any of the following opportunities at Kennedy Space Center, please contact Priscilla Moore at priscilla.m.moore@nasa.gov or (321) 867-8507.

---Langley Research Center (LaRC) ---
If you have questions about any of the following opportunities at Langley Research Center, please contact Garnise A. Dennis at garnise.a.dennis@nasa.gov or (757) 864-2335.

---Marshall Space Flight Center (MSFC) --
If you have questions about any of the following opportunities at Marshall Space Flight Center, please contact Tracey Washington at tracey.washington@nasa.gov or (256) 544-1783.

--Stennis Space Center (SSC) ---
If you have questions about any of the following opportunities at Stennis Space Center, please contact Mitch Krell at mitch.krell@nasa.gov or (228) 342-7462.

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
AFRC-000		**Student Proposed with Concurrence of NASA Technical Adviser**	The student can submit a NASA relevant, independently conceived research proposal with the concurrence of a university principal investigator and a NASA Technical Adviser.	Master's or Ph.D.	
ARC-000		**Student Proposed with Concurrence of NASA Technical Adviser**	The student can submit a NASA relevant, independently conceived research proposal with the concurrence of a university principal investigator and a NASA Technical Adviser.	Master's or Ph.D.	
ARC-001	SMD	**Studying transiting planets with the James Webb Space Telescope**	Planets that transit their host stars are amenable to characterization of their atmospheres via transmission or emission spectroscopy. Observations with the James Webb Space Telescope (JWST) will determine the temperatures, compositions, chemical abundances, and cloud properties of exoplanets with much better precision than ones characterized to date with the Hubble and Spitzer Space Telescopes. We are seeking a student researcher to help analyze JWST guaranteed time observations of the infrared spectra of several warm transiting exoplanets that mostly have masses between Earth and Jupiter. Experience in pipeline processing, systematic noise removal, and analysis of high precision time-series exoplanet data would be beneficial. The student should be able to produce results quickly and efficiently and be able to work effectively in a modest-sized team that is distributed in the US and Europe. There also will be opportunities for independent research.	Ph.D.	**Technical Advisor** Thomas Greene tom.greene@nasa.gov (650) 539-5244
ARC-002	SMD	**Studying protostars and brown dwarfs with the James Webb Space Telescope**	JWST observations will determine or constrain the temperatures, surface gravities, compositions, and chemical abundances of the most embedded protostars and the coldest, least-massive brown dwarfs that have ever been observed. We are seeking a student researcher to participate in the data analysis, and information retrieval of JWST observations of the infrared spectra of several protostars and brown dwarfs. Experience in data reduction and analysis of stellar, brown dwarf, protostellar, or other similar infrared spectra would be beneficial. Ideally this would include experience in applying statistical Bayesian analysis techniques to astronomical spectra. The student should be able to produce results quickly and efficiently and be able to work effectively in a modest-sized team that is distributed in the US and Europe. There will also be opportunities for independent research.	Ph.D.	**Technical Advisor** Thomas Greene tom.greene@nasa.gov (650) 539-5244 **Co-Technical Advisor** Mark Marley mark.s.marley@nasa.gov (650) 604-0805
ARC-003	ARMD	**Setting up a molecular Rayleigh scattering system in a wind tunnel to study shock-boundary layer interaction**	We are trying to advance molecular Rayleigh scattering to measure turbulence parameters in large transonic and supersonic wind tunnels. Time-averaged values and fluctuations spectra of velocity, temperature and density in such tunnels are difficult to measure. The goal of the project is to demonstrate such a capability in a small tunnel. The candidate is expected to work with a small team to setup a system, address various engineering challenges using innovative approaches, create hardware setup and software programs for data analysis.	Ph.D.	**Technical Advisor** Jay Panada jayanta.panda-1@nasa.gov (650) 604-1553

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
ARC-004	SMD	**Aerobiological Investigations**	Soliciting independently conceived research proposals on the microbiology of the atmosphere (fog water, cloud water, dust, etc.). Student focus may be direct biological study (e.g. population identification), the relevant environment (e.g. biochemical energy availability, origin tracking by dust mineral identification), supporting instrumentation (e.g., sterile sampling, in situ characterization), or a combination. Extension to other worlds (e.g., defining requirements for life on Venus or cloudy exoplanets) is within scope, but not required.	Master's or Ph.D.	**Technical Advisor** Diana Gentry diana.gentry@nasa.gov (650) 605-5441
ARC-005	SMD	**Bioengineering for Astrobiology and Space Biology**	Soliciting independently conceived research proposals in bioengineering with applications to astrobiology or space biology. Topic areas include technology (sensors, fluidics, etc.) for life detection, habitability assessment, microbial health or function in a space mission environment, and related benchtop capabilities (e.g., characterizing microbial culture in off-world analogue environments or under experimental evolution). Please note that human health and medicine are NOT included in this scope.	Master's or Ph.D.	**Technical Advisor** Diana Gentry diana.gentry@nasa.gov (650) 605-5441
ARC-006	SMD	**Computational Laminar-Turbulent Transition Models and Methods for Severe Weather Forecast and Climate Change Prediction**	Soliciting independently conceived research proposals on the development of models and/or methods for the simulation of atmospheric boundary layer laminar-turbulent transition that aim to significantly improve the prediction accuracy of extreme weather phenomena and of climate change. Areas of interest include for instance models accounting for friction-affecting surface topology, soil composition, temperature, moisture and chemistry as a result of deforestation, intensive agriculture, wild fires, urban or industrial pollution, and their application in the simulation of weather events or climate drift. Of interest are also models for off-ground effects such as transition and mass transport at the transient interface of convective clouds relevant to weather dynamics. Models and methods could for example include Large Eddy Simulations (LES), Reynods-Averaged Navier-Stokes (RANS) simulations, statistical inference, Machine Learning (ML) or Projection-based Reduced-Order Models (PROMs). Exploitation of supercomputing capabilities such as GPU and big data reduction can be contributing elements to the research.	Ph.D.	**Technical Advisor** Marie Denison marie.f.denison@nasa.gov (650) 605-5588
GRC-000		**Student Proposed with Concurrence of NASA Technical Adviser**	The student can submit a NASA relevant, independently conceived research proposal with the concurrence of a university principal investigator and a NASA Technical Adviser.	Master's or Ph.D.	Student identified NASA Technical Adviser

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
GRC-001	ARMD	**Addressing Challenges in Shape Memory Alloy Actuators: Cycling Time and Controls**	The unique ability of shape memory alloys (SMAs) to remember and recover their original shape after large deformation offers vast potential for their integration in advanced engineering applications. One such example is compact, lightweight, high-force, solid-state actuators that enable improved air vehicle designs and adaptive structures that can reconfigure shape, form and/or properties according to need. However, before they can integrate into flight structures, the methods in which they are used to convert the thermal energy into mechanical work must be quantified. One of the challenges in working with SMA actuators is "long actuation time". Since heat transfer is the driving mechanism during heating and cooling, it typically means long actuation times particularly for large actuators. Improving actuation times to few seconds compared to minutes is desirable and can be achieved via material design and/or mechanism design. A material can be engineered with very low hysteresis where the heating and cooling cycles can be limited to seconds (without a dead-band). Otherwise, the heating and cooling cycles can be decoupled via mechanisms. The goal of this opportunity is to come up with methods to speed the actuation times of large form SMA devices. This entails determining the mechanical work efficiency compared to convention motors (electric, hydraulic, pneumatic) as a function of load capacity (e.g., normalized energy density), and determining the thermal energy required to transform an actuator and hold it in position throughout a simulated mission (e.g., flight conditions, deployment...).	Ph.D.	**Technical Advisor** Othmane Benafan othmane.benafan@nasa.gov (216) 433-8538
GRC-002	ARMD	**High-Throughput Synthesis and Processing of Shape Memory Alloys**	Development of shape memory alloys remains largely an empirical approach accomplished via conventional melting (e.g., arc, vacuum induction melting, etc.) followed by secondary processing (e.g., hot working, heat treatments, etc.), and finally testing and evaluation. While this approach has worked and resulted in several breakthroughs, the time-consuming process associated with it is often prohibitive in exploring a wider range of compositions, hence resulting in missed opportunities and often unoptimized alloys. To mitigate this issues, combinatorial materials science has emerged as a potential rapid synthesis process. However, even using such methods create other issues around translating findings from thin films to bulk alloys. Additionally, initial screening via thermal analysis alone does not provide indications towards the alloy work output, particularly functional responses needed for actuation purposes. Thus, there is a need for high-throughput synthesis and processing of shape memory alloys that provide a link between small-scale syntheses to large-scale processability. Of particular interest, is streamlined screening of alloys and process control from alloy solidification rates to time-temperature-transformation(TTT) diagrams. Accompanying theories can provide links from first order testing (e.g., thermal and resistivity) to functional and mechanical performance, with emphasis on scalability and workability.	Ph.D.	**Technical Advisor** Othmane Benafan othmane.benafan@nasa.gov (216) 433-8538

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
GRC-003	ARMD & STMD	**Development, Testing, and Characterization of Lightweight Conductor Cable**	Development, testing, and characterization of high conductivity, lightweight and durable conductive wires are critical for enabling aero and space electrified propulsion applications. The first step of this project is to design the wire processing setup and then fabricate several batches of wires under a variety of processing parameters. Several processing techniques should be used and compared. All fabricated wires should be drawn to the desired uniform diameter. Next, the wires should be tested using standardized wire testing methods to characterize the wire tensile strength, bend fatigue endurance, and electrical conductivity at various temperatures in the interest of creating lightweight, durable power transmission cables. Concurrently, the wires' strength, bend fatigue endurance and the electrical conductivity should be modeled at the selected temperatures. Additionally, imaging with scanning electron microscopy (SEM) and in-depth chemical analysis should be performed to assess the wires' microstructures. Theories explaining improved intrinsic conductivity need to be discussed, with a focus on electrical, chemical and mechanical interactions. Moreover, validating any or all these theories will require extensive work replicating data, collecting and analyzing electron micrographs, and conducting chemical analyses. The work would support ongoing efforts in NASA's Transformational Tools and Technologies (TTT). NASA Glenn Research Center Core Competencies supported by this fellowship are Power, Energy Storage, and Conversion and Materials and Structures for Extreme Environments.	Ph.D.	**Technical Advisor** Amjad Almansour amjad.s.almansour@nasa.gov (216) 433-2971 **Co-Technical Advisor** Maricela Lizcano maricela.lizcano@nasa.gov (216) 433-3637

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
GRC-004	ARMD & STMD	**Additive Manufacturing of Multi-materials for Energy Systems**	Additive manufacturing of engineered 3-dimensional lightweight complex architectures enables next generation of high power and energy densities advanced batteries and thermal management systems for aero and space electrified propulsion applications. Additive manufacturing can precisely control the shape and thickness of desired complex architectures. Solid-state battery electrodes and electrolytes and thermal management components can be designed and fabricated using several additive manufacturing techniques which allow for a high degree of dimensional accuracy. Materials' processing parameters such as particle size, composition, solid loading, rheology and printing speed can be controlled and tailored in order to optimize material characteristics of the final structures. Battery components will be manufactured by leveraging the sub-micron accuracy of additive manufacturing techniques. Next, manufactured components will be sintered and assembled to build one or more representative battery cells combined with thermal control system. The battery cells will then be tested to measure the battery capacity retention and columbic efficiency as a function of charge/discharge cycles. The effectiveness and efficiency of the battery thermal management system will be evaluated during cycling. Furthermore, the battery specific power and energy densities will be estimated. This work supports ongoing efforts in NASA's Transformational Tools and Technologies (TTT). NASA Glenn Research Center core competencies supported by this fellowship are Electric Propulsion and Advanced Power Systems and Materials and Structures for Extreme Environments.	Ph.D.	**Technical Advisor** Amjad Almansour amjad.s.almansour@nasa.gov (216) 433-2971 **Co-Technical Advisor** Mrityunjay Singh mrityunjay.singh-1@nasa.gov (216) 433-8883

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
GRC-005	ARMD	**Testing and Characterization of High Temperature Ceramic Matrix Composites (CMCs)**	Silicon carbide (SiC) based ceramic matrix composites (CMCs) offer an excellent combination of properties at high temperature such as high specific strength, chemical inertness, and creep resistance. Those superior properties make SiCf/SiC CMCs beneficial for use in high-temperature structural applications that are exposed to extreme environments such as hot-zone components of next-generation advanced turbine engines at target operating temperatures above 2200°F. Environmental barrier coatings (EBCs) are applied to CMCs to protect them from oxidation and recession, which can occur in a jet engine steam-rich, high temperature environment. The objective of this study is to provide a thorough assessment of damage initiation and progression in EBC/CMC systems, which is critical for assessing durability and identifying the major life limiting damage mechanisms. To achieve this goal, thermomechanical loading of microscale ceramic matrix minicomposite specimens and ceramic matrix composite (CMC) coupons that are coated with EBCs should be performed, and damage evolution at the microscale will be observed using high-resolution imaging systems such as scanning electron microscopy (SEM) and/or X-ray microtomography (µCT) and nondestructive evaluation techniques (NDEs) such as acoustic emission (AE) and electrical resistance (ER). Further, results from this study will be analyzed and critical life limiting damage mechanisms will be identified. In addition, stress-, time-, and temperature- dependent damage evolution should be compared with available damage prediction models to validate and improve current models and create new models that are sensitive to variation in EBC/CMC systems local microstructure. The work would support ongoing efforts in NASA's Transformational Tools and Technologies (TTT) and Advanced Air Transport Technology (AATT) projects to reduce jet engines' weight, fuel consumption, and emissions and improve the efficiency of jet engines. The NASA Glenn Research Center Core Competency supported by this position is Materials and Structures for Extreme Environments.	Ph.D.	**Technical Advisor** Amjad Almansour amjad.s.almansour@nasa.gov (216) 433-2971 **Co-Technical Advisor** James Kiser james.d.kiser@nasa.gov (216) 433-3247

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
GRC-006	ARMD	**Characterization Procedures for Advanced Polymer Composite Impact Model**	An orthotropic macroscopic three-dimensional material model designed to simulate the impact response of composites has recently been developed and implemented in the commercial transient dynamic finite element code LS-DYNA. The material model is a combined plasticity, damage and failure model suitable for use with both solid and shell elements. The deformation/plasticity portion of the model utilizes an orthotropic yield function and flow rule. A key feature of the material model is that the evolution of the deformation response is computed based on input tabulated stress-strain curves in the various coordinate directions. The damage model employs a semi-coupled formulation in which applied plastic strains in one coordinate direction are assumed to lead to stiffness reductions in multiple coordinate directions. The evolution of the damage is also based on tabulated input from a series of load-unload tests. A tabulated failure model has also been implemented in which a failure surface is represented by tabulated single valued functions. Current limitations of the model are that several of the key parameters are currently characterized either through correlation with structural level impact and/or crush tests or by ad-hoc trial and error techniques. In particular, the input utilized for the damage and failure components of the material model required for the accurate simulation of the post-peak stress degradation response is currently characterized by correlation with structural level tests. Alternatively, the input parameters should be systematically characterized by an appropriate combined experimental/analytical approach based on lower scale tests, ideally coupon level tests. Furthermore, the flow rule coefficients in the plasticity law used in the deformation model are currently characterized by either trial and error approaches or simplified optimization techniques. A more systematic approach to characterize these parameters based on additional coupon level tests is desirable. The overall goal of this opportunity would be to develop these advanced characterization techniques and to verify that these techniques would facilitate more predictive simulations.	Ph.D.	**Technical Advisor** Robert Goldberg robert.goldberg@nasa.gov (216) 433-3330 **Co-Technical Advisor** Trenton Ricks trenton.m.ricks@nasa.gov (216) 433-6431

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
GRC-007	ARMD	**Advanced Modeling of Ceramic Matrix Composites (CMCs)**	A micromechanics-based model based on a fiber shear lag analysis has been developed to analyze the fast fracture response of uncoated ceramic matrix minicomposites. In the analysis approach, the average matrix crack spacing is assumed to be known as a function of applied stress. This crack spacing information is currently obtained by using acoustic emissions techniques selectively combined with in-SEM measurements. From these experimental studies, cracks have been found to initiate at relatively low stress levels, and the cracks that do form tend to have an irregular shape with variable spacing between cracks. Interfacial shear stresses are assumed to transfer load from the fiber to the matrix over a distance defined as the slip length. An incremental approach is employed in which the strains within and outside the slip length are computed and combined to determine the overall composite strain for a particular load step. Applying information found from the preliminary experimental studies, the analysis does not require any restrictions on the width of the cracks and does not automatically assume the cracks extend across the entire width of the minicomposite. The method is currently being expanded to analyze the creep response of minicomposites. The overall goal of the effort is to develop an increased understanding of the effects of local material mechanisms and microstructure on the tensile and creep response of minicomposites and full macrocomposites. There are several identified areas for advancements in the developed methods. First, the crack spacing between cracks and the distribution of cracks within a cross section are currently assigned in a simplified deterministic fashion. A need exists to develop a method to account for the variability in both the crack spacing, the crack distribution and the crack path as the cracks initiate and propagate. Given that the stresses at which cracks initiate in the matrix are not deterministic, the variability in the crack initiation stresses also needs to be accounted for within the analysis. The initiation and propagation of failure within the individual fibers and fiber tows also need to be accounted for within the analysis. The methods need to be applicable for the tensile and creep response of both minicomposites and macrocomposites. Furthermore, the effects of the environment such as degradation due to oxidation need to be incorporated within the developed models. From the experimental point of view, the use of advanced methods such as synchrotron X-ray computed micro-tomography combined with nondestructive evaluation techniques (NDEs) such as acoustic emission (AE) is required in order to evaluate the real time, in-situ initiation and propagation of matrix cracks throughout the interior of the composite cross-section as loading is applied. The improved experimental methods will facilitate improved understanding of the actual structure and growth of damage within the composite as well as providing improved, more accurate data that can be used in the characterization and validation of the developed models.	Ph.D.	**Technical Advisor** Robert Goldberg robert.goldberg@nasa.gov (216) 433-3330 **Co-Technical Advisor** Amjad Almansour amjad.s.almansour@nasa.gov (216) 433-2971

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
GRC-008	ARMD	**Automating transposition of natural systems to technology for thermal management systems**	Thermal management systems (TMS) are critical components at multiple levels in aircraft design. There is an urgent need to make them lighter and less costly and to enable multifunctionality with shorter design time. Currently, designing TMS takes a long time and improvements are incremental rather than revolutionary. A revolutionary approach is to make use of designs from natural systems that incorporate thermal management systems into their architectures. The goal of this work is to automate the process of identifying suitable biological models and to extract relevant information from them to apply to and enable the design of engineering solutions to a well-defined engineering problem (including constraints, boundary conditions). The process will include using computer vision, natural language processing and machine learning to identify topologies or processes from natural and synthetic databases and literature that can be applied to the problem. Then, suitable or appropriate processes or natural systems need to be identified. The relevant analogs in the parameter space and structure space to the natural system or biological model must then be identified to transpose the salient biological features or processes to engineering solution. For example, what are the analogs between a vascular system and thermal management system? Can a vascular system be 'built' using known technology? What is this technology and how does it need to be adapted to made it analogous to the biological model? What is the cost/time associated with this process? What other metrics would drive decision making relevant to selecting the appropriate model? Section 4 of this paper describes the process at a high level, https://www.mdpi.com/2411-9660/3/3/43/htm. Specific to the fellowship, questions that need to be answered through automation are 1) given the massive amount of papers and data describing natural systems, how to determine what natural systems are appropriate based on objective metrics? 2) what human technology can be used to build the bio-inspired system? 3) How can you extract the relevant information from papers and data sets to make the determination? 4) can ontologies and knowledge graphs be used to determine metrics for the biological models and apply them to human technology given the parts available.	Ph.D.	**Technical Advisor** Brandon Ruffridge bruffridge@nasa.gov (216) 433-2887 **Co-Technical Advisor** Herbert Schilling hschilling@nasa.gov (216) 433-8955

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
GRC-009	ARMD	**Modeling of Thermal Components using Machine Learning**	Current modeling efforts for thermal management systems, or components, involve the coupling of different areas of physics. These areas typically include fluid dynamics, heat transfer, structural mechanics, and thermodynamics. The most aggressive designs, to be used on future electric aircrafts, will be even more tightly coupled due to their anticipated multifunctionality. This presents a challenge in typical modeling approaches. While current techniques may be accurate enough for good designs, they are certainly not fast enough to allow for a comprehensive study of the entire design space. The approach in this project is to use machine learning to construct surrogate models for analyzing designs, and generative design methods for developing new concepts. These models can be data-driven or physics-based, but the ultimate goal is to construct a framework general enough to apply to an arbitrary geometry and combination of boundary conditions.	Ph.D.	**Technical Advisor** Ezra McNichols ezra.o.mcnichols@nasa.gov (216) 433-8013 **Co-Technical Advisor** Vikram Shyam vikram.shyam-1@nasa.gov (216) 433-3511
GRC-010	STMD	**Multiscale and Multiphysics Modeling of Damage Evolution in Woven Thermal Protection Systems in an Atmospheric Re-entry Environment**	A thermal protection system (TPS) is used to protect the integrity of spacecraft from the extreme environment encountered upon re-entry into Earth's atmosphere. Ablative heat shields are attractive TPS for reducing the thermal loads induced on the underlying spacecraft structure. However, damage growth, in the form of material fracture due to impact from debris and the high thermomechanical loads, in combination with material recession due to pyrolysis upon re-entry, may jeopardize the integrity of the TPS. Composite systems, containing a woven carbon fiber preform impregnated with phenolic resin, have emerged viable candidates for re-entry TPS due to the improved strength and damage tolerance of these systems. Moreover, the preforms can be woven into complex shapes allowing for manufacturing spacecraft TPS in one piece, avoiding seams or joints which serve as stress concentrators. However, designing these materials can be challenging because the current multiscale and multiphysics computational tools cannot accurately predict the evolution of damage in an atmospheric re-entry environment. Commercial, NASA, and other existing computational tools should be utilized, to the maximum extent possible, to develop framework for predicting damage evolution in TPS under re-entry conditions. Gaps in the existing computational tools should be identified and additional software should be developed to close these gaps. Ultimately, the computational framework will be used to evaluate performance (strength and damage tolerance) and reduce the mass of novel TPS designs.	Ph.D.	**Technical Advisor** Evan Pineda evan.j.pineda@nasa.gov (216) 433-5563

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
GRC-011	ARMD & STMD	**Novel Methods for Integrating Progressive Damage and Failure Analysis with Design of Composite Structures**	Typically, design of composite structures relies on rudimentary ply-by-ply failure criteria with strength allowables obtained from coupon testing of simple layups. Unfortunately, the damage modes observed in the simple coupon experiments do not fully represent those that may occur in the actual laminates used in-service. This can lead to error and uncertainty in the results of the failure criteria. A design alternative is to evaluate the failure criteria, and measure the allowables, at the laminate level. Both strategies require large factors of safety to be imposed on the design. Moreover, the design space is usually limited to quasi-isotropic laminates only. This is a major hinderance because current automated manufacturing methods are capable of fabricating structures that containing spatially non-uniform layups with arbitrary stacking sequences. Significant research into improving the strength predictions of composite materials has led to the field of progressive damage and failure analysis (PDFA). PDFA methods often lead to improved strength predictions, compared to traditional failure criteria, but come at an additional computational cost. Thus, the scope of the analysis is usually limited to simple notched and unnotched coupons. Currently, there exists a technological gap in bridging the design of composite structures and PDFA. The objective of this fellowship opportunity is to develop novel methods for integrating PDFA into structural design in a computationally tractable manner, and development of a cost-effective test campaign for characterization and validation of the methods.	Ph.D.	**Technical Advisor** Evan Pineda evan.j.pineda@nasa.gov (216) 433-5563
GRC-012	ARMD	**Bio-inspired organizational health, development and best practices**	Organizations are complex systems. Small changes can lead to profound impacts. These impacts may relate to the way we perform research and development or the way we determine strategic focus. We are looking to infuse best practices from natural systems into the organization. In addition, there is a need to model the system and establish best practices or principles and ways to track sensitivities in the system to change from both inside and out. The fellow will be embedded within the project team and will interact with team members from various disciplines, conduct workshops and prototype various elements of the system model. Disciplines of interest include but are not limited to organizational development, sociology, psychology, systemology, biomimicry.	Ph.D.	**Technical Advisor** Vikram Shyam vikram.shyam-1@nasa.gov (216) 551-8447
GSFC-000		**Student Proposed with Concurrence of NASA Technical Adviser**	The student can submit a NASA relevant, independently conceived research proposal with the concurrence of a university principal investigator and a NASA Technical Adviser.	Master's or Ph.D.	Student identified NASA Technical Adviser

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
GSFC-001	SMD	**Improving Earth science data search through citation management system**	Project Description: 1. Conduct research on the automated labeling of scientific publications with Earth Science datasets. Develop Python scripts for automated citation labeling pipeline. 2. Assist in maintenance and development of an online citation management system (CMS). 3. Work on solutions for automated import of publications citations from on-line search engines, journals and science teams. 4. Extend citation metadata to include specific keywords or tags enhancing data discovery.	Master's	**Technical Advisor** Jennifer Wei jennifer.c.wei@nasa.gov (301) 614-6558
GSFC-002	SMD	**Astrophysics: Galaxy Evolution & Morphologies**	Field galaxy surveys have taught us much of what we know about galaxy evolution. Conducted with a wide variety of telescopes and techniques, and using both imaging and spectroscopy, galaxy surveys have introduced and addressed such divergent topics as the faint blue galaxy problem, ultra-luminous infrared galaxies (ULIRGs), the starburst-AGN connection, morphological studies of galaxies, and the star formation history of the Universe. Our research currently uses data from the Hubble, Spitzer, and Chandra Deep Fields, HST legacy and treasury surveys, and ground-based follow-up to study galaxy evolution. The successful applicant will take on a project focused on galaxy morphology, star forming properties of galaxies, or other studies related to how the properties of galaxies change over time using data from NASA missions.	Ph.D.	**Technical Advisor** Amber Straughn amber.n.straughn@nasa.gov (301) 286-7098
GSFC-003	SMD	**Microwave remote sensing of Soil Moisture**	This research involves development of soil moisture retrieval algorithms using microwave measurements from NASA's Soil Moisture Active Passive (SMAP), NASA ISRO Synthetic Aperture Radar (NISAR) and ESA's Soil Moisture and Ocean Salinity (SMOS) missions. The research may also include developing methodologies to improve the spatial resolution of accurate soil moisture retrievals from L-band missions in space, and to develop soil moisture products and procedures of value to a variety of applications and end users.	Ph.D.	**Technical Advisor** Rajat Bindlish rajat.bindlish@nasa.gov (301) 286-8753
GSFC-004	SMD	**Development and evaluation of data product algorithms for a global imaging spectroscopy mission**	The planned Surface Biology and Geology (SBG) designated observable will include the first ever set of repeat global visible-shortwave infrared imaging spectroscopy observations. Compared to existing imaging spectroscopy observations, which are primarily from targeted airborne campaigns, the global SBG observations will involve new challenges for product generation due to much greater variability in surface targets (e.g., ecosystem types for vegetation products) and observing conditions (e.g., atmospheric conditions, sun-sensor geometry). Broadly, the objective of this project is to synthesize in-situ and airborne spectroscopy data, satellite observations, modeling, and statistical approaches to develop and evaluate algorithms for level 3 and 4 data products related to one or more SBG science focal areas (e.g., plant functional traits, mineral classification, chlorophyll content in coastal waters, snow grain size).	Master's or Ph.D.	**Technical Advisor** Alexey N. Shiklomanov alexey.shiklomanov@nasa.gov (301) 614-6683

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
GSFC-005	SMD	**Spectroscopic Sublimation Studies of Processed Interstellar/Planetary Ice Analogues**	This project will include studying the submillimeter/millimeter pure rotational spectra, the chemistry, and the physical properties of sublimated species from interstellar/cometary/planetary ices. This will constrain the chemical complexity of the ices, the amount of processing that occurs, and interpret past and present data from missions that observe ice features. Experimental studies on the formation of complex organic species, such as prebiotic molecules, will be conducted for interstellar/planetary/cometary ice analogues.	Ph.D.	**Technical Advisor** Stefanie Milam stefanie.n.milam@nasa.gov (301) 614-6902
GSFC-006	SMD	**Analysis of Air Quality Episodes and Improving Profiling Capabilities using Ozone Lidar**	Analysis of air quality episodes in the eastern U.S. are needed with high resolution observations of ozone and its precursors. Prior studies have identified the formation of high levels of pollution over water bodies, such as the Chesapeake Bay, that can potentially recirculate back over land to significantly impact populated areas. A motivated graduate student is needed to investigate air quality and public health throughout the Chesapeake Bay Region. With the acquisition of large data sets, across multiple platforms (TOLNet/Ozone Lidar, Pandora, Ceilometer, Wind Profiler, in situ sampling), there is the need for a motivated and inter-disciplinary research effort to meet the current needs of NASA's decadal survey and the upcoming TEMPO mission.	Ph.D.	**Technical Advisor** John Sullivan john.t.sullivan@nasa.gov (301) 614-5549
GSFC-007	SMD	**Understanding the processes that regulate the distribution of trace gases like ozone, methane, nitrogen oxides, and CO in the troposphere**	The goal of my group's research is to understand processes regulating the distribution of trace gases like ozone, methane, nitrogen oxides, and CO in the troposphere. One activity consists of analysis and validation of satellite observations of atmospheric constituents from platforms like Aqua, Aura, Suomi-NPP. We also use models to compare to data, including Goddard chemistry-transport and chemistry-climate models like GMI and the GEOS-5 Chemistry model. Major emphasis is placed on interpreting data collected in ground-based networks, e.g., NDACC, SHADOZ (Southern Hemisphere Additional Ozonesondes; http://croc.gsfc.nasa.gov/shadoz), Pandora, AERONET, and from aircraft and ground field experiments like DISCOVER-AQ (Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality; http://discover-aq.larc.nasa.gov), SEAC4RS (Studies of Emissions and Atmospheric Composition, Clouds and Climate Coupling by Regional Surveys; https://espo.nasa.gov/home/seac4rs/), KORUS-AQ. There may be an option to participate in field data collection or forecasting.	Master's or Ph.D.	**Technical Advisor** Ryan Stauffer ryan.m.stauffer@nasa.gov (301) 614-5552

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
GSFC-008	SMD	**Investigating Exoplanet Host Star Habitability with Optical, Ultraviolet and X-ray Observations**	A wealth of data has now been collected to discover planets transiting their host stars. NASA's Kepler, K2 and TESS missions have discovered thousands of exoplanets, some of which can be further explored with powerful telescopes to determine if they have atmospheres. Many of these same stars can be investigated through a wealth of archival data collected by, for example, NASA's Swift and NICER missions. The high-energy output of flaring stars can be explored through their variability in the Ultraviolet and X-ray, potentially helping identify which stars may be suitable environments for live, versus which generate inhospitable conditions.	Master's or Ph.D.	**Technical Advisor** Padi Boyd patricia.t.boyd@nasa.gov (301) 286-2550
GSFC-009	SMD	**Properties of Wildfire Smoke, Desert Dust, and Volcanic Plumes, and Impacts on Climate and Air Quality**	We make innovative use of spacecraft and sub-orbital data to better understand the impact of airborne particles on the climate of the Earth and on regional-scale air quality. Our main resource is the two-decade-long data record from the NASA Earth Observing System's Multi-angle Imaging SpectroRadiometer (MISR), from which we can derive the heights and wind vectors associated with wildfire, volcano, and dust plumes, as well as constraints on particle properties using the MISR Research Aerosol retrieval algorithm. We also bring to bear other satellite and suborbital data and collaborate with modelers to create a deeper understanding of environmental conditions, and the underlying mechanisms responsible for creating them.	Master's or Ph.D.	**Technical Advisor** Ralph Kahn ralph.a.kahn@nasa.gov (301) 614-6193
GSFC-010	SMD	**Studies of Magnetosphere-Atmosphere Coupling**	Earth's magnetosphere and atmosphere are closely coupled, with two-way feedback. This project will utilize a variety of satellite, sounding rocket, and ground-based studies, in conjunction with numerical models, to analyze various aspects of this coupling. These aspects will include such topics as: 1) better refining estimates for ionospheric conductivity and its drivers; 2) energization and acceleration of low-energy ionospheric ions to gravitational escape energies and beyond, where they can have dramatic impacts on magnetospheric dynamics; 3) wind-driven electric dynamos, and electric dynamo-driven winds that dramatically modify neutral and plasma transport throughout the system.	Ph.D.	**Technical Advisor** Doug Rowland douglas.e.rowland@nasa.gov (301) 286-6659

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
GSFC-011	SMD	**Planetary Origins and Evolution Multispectral Monochromator (POEMM)**	The POEMM is a long duration balloon-borne observatory that is being proposed to NASA's Pioneer Program during 2021. It is designed to obtain high resolution (3-6 km/s) spectra of ~100 protoplanetary and debris disks in emission lines of HD (J=1-0, and 2-1), [O I] 3P1 – 3P2, H2O vapor (J= 818-707, 808-717, and 431-322) and ice (amorphous and crystalline bands at 43, 47, and 63 microns) to reveal gaseous disk masses during planet formation, chemistry of water around the snow line, surface energy balance in disks, and the D:H ratio in the outer planets of our solar system. Graduate student participation is welcome in mission relevant disk science investigations involving POEMM or other facilities. Graduate student participation is also welcome in engineering aspects of the mission including development of a prototype far-infrared Virtually Imaged Phase Array (VIPA) spectrometer.	Ph.D.	**Technical Advisor** Matthew Greenhouse matt.greenhouse@nasa.gov (301) 286-4517
GSFC-012	SMD	**Student Proposed with Concurrence of NASA Technical Adviser**	The Astrophysics Science Division at NASA Goddard Space Flight Center conducts a broad program of research in astronomy, astrophysics, and fundamental physics. Individual investigations address issues such as the nature of dark matter and dark energy, which planets outside our solar system may harbor life, and the nature of space, time, and matter at the edges of black holes. Observing photons, particles, and gravitational waves enables researchers to probe astrophysical objects and processes. Researchers develop theoretical models, design experiments and hardware to test theories, interpret and evaluate the data, archive and disseminate the data, provide expert user support to the scientific community, and publish conclusions drawn from research.	Master's or Ph.D.	Applicant should work with their campus PI to identify a specific research area and NASA GSFC scientist of interest from https://science.gsfc.nasa.gov (for general questions email: gsfceducation@mail.nasa.gov)
GSFC-013	SMD	**Student Proposed with Concurrence of NASA Technical Adviser**	Computational and Information Sciences and Technology The Computational and Information Sciences and Technology Office (CISTO) at NASA Goddard Space Flight Center provides applied information system research and services to support the research programs of the Science and Exploration Directorate (SED). The office provides high performance computing and networking, mass storage and information systems technologies, computational science expertise, software engineering and performance optimization services, information technology (IT) security services, scientific visualization services, and research in information science and technology.	Master's or Ph.D.	Applicant should work with their campus PI to identify a specific research area and NASA GSFC scientist of interest from https://science.gsfc.nasa.gov (for general questions email: gsfceducation@mail.nasa.gov)

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
GSFC-014	SMD	**Student Proposed with Concurrence of NASA Technical Adviser**	The Earth Sciences Division at NASA Goddard Space Flight Center plans, organizes, evaluates, and implements a broad program of research on our planet's natural systems and processes. Major focus areas include climate change, severe weather, the atmosphere, the oceans, sea ice and glaciers, and the land surface. To study the planet from the unique perspective of space, the Earth Science Division develops and operates remote-sensing satellites and instruments. We analyze observational data from these spacecraft and make it available to the world's scientists.	Master's or Ph.D.	Applicant should work with their campus PI to identify a specific research area and NASA GSFC scientist of interest from https://science.gsfc.nasa.gov (for general questions email: gsfceducation@mail.nasa.gov)
GSFC-015	SMD	**Student Proposed with Concurrence of NASA Technical Adviser**	The Heliophysics Science Division at NASA Goddard Space Flight Center conducts research on the Sun, its extended solar-system environment (the heliosphere), and interactions of Earth, other planets, small bodies, and interstellar gas with the heliosphere. Division research also encompasses geospace -- Earth's uppermost atmosphere, the ionosphere, and the magnetosphere -- and the changing environmental conditions throughout the coupled heliosphere (solar system weather). Scientists in the Heliophysics Science Division develop models, spacecraft missions and instruments, and systems to manage and disseminate heliophysical data. They interpret and evaluate data gathered from instruments, draw comparisons with computer simulations and theoretical models, and publish the results.	Master's or Ph.D.	Applicant should work with their campus PI to identify a specific research area and NASA GSFC scientist of interest from https://science.gsfc.nasa.gov (for general questions email: gsfceducation@mail.nasa.gov)
GSFC-016	SMD	**Student Proposed with Concurrence of NASA Technical Adviser**	The Solar System Exploration Division at NASA Goddard Space Flight Center conducts theoretical and experimental research to explore the solar system and understand the formation and evolution of planetary systems. Laboratories within the Division investigate areas as diverse as astrochemistry, planetary atmospheres, geochemistry, geophysics, geodynamics, space geodesy, extrasolar planetary systems, and comparative planetary studies. To study how planetary systems form and evolve, Division scientists develop theoretical models as well as the investigations and space instruments to test them. The researchers participate in missions; collect, interpret, and evaluation measurements; and publish conclusions based on this research. The Division archives and disseminates the data, and provides expert user support.	Master's or Ph.D.	Applicant should work with their campus PI to identify a specific research area and NASA GSFC scientist of interest from https://science.gsfc.nasa.gov (for general questions email: gsfceducation@mail.nasa.gov)

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
GSFC-017	SMD	**A NICER View of Galactic Compact Objects**	Neutron stars and black holes consolidate within and around them some of the most extreme physical environments imaginable: intense gravity, relativistic motion, ultra-dense matter, and the strongest magnetic fields known. In X-ray light, their emissions offer unique insights into the relevant physics, with spectroscopy and timing being the key measurement approaches. The NICER mission (www.nasa.gov/nicer), NASA's astrophysics facility on the International Space Station, is designed for this purpose, revealing variations of X-ray intensity and energetics on timescales as short as microseconds. This project aims to exploit new and archival NICER data to probe the accretion, magnetic, and nuclear processes that power neutron star and black hole systems in our Galaxy. Through analysis and interpretation of observational data, the Graduate Fellow will generate new understanding of the interplay of fundamental physics that exists only within these exotic systems.	Master's or Ph.D.	**Technical Advisor** Zaven Arzoumanian zaven.arzoumanian-1@nasa.gov (301) 286-2547
GSFC-018	SMD	**Astrophysics investigations with current and future ultraviolet instruments**	Ultraviolet light from astrophysical objects reveals unique insights, letting us probe the environments near supermassive black holes in distant active galaxies, the potential habitability of exoplanets around their host stars, and other intriguing scientific questions. NASA's past (IUE, GALEX, FUSE) and currently operating missions (HST, Swift) offer a wealth of archival ultraviolet data for such investigations, and pave the way for future mission concepts at the SmallSAT, Explorer, Probe and large strategic mission size scales. Proposals focused on 1) mining the rich NASA ultraviolet data archives for new science insights, and/or 2) technology development for future ultraviolet astrophysics missions are encouraged."	Master's or Ph.D.	**Technical Advisor** Patricia Boyd patricia.t.boyd@nasa.gov (301) 286-2550
JPL-000	SMD, STMD, ARMD	**2020 NASA Fellowship Opportunities at JPL**	JPL's technical competencies revolve around end-to-end implementation of unprecedented robotic space missions that study Earth, the solar system, and the universe. We are soliciting student-proposed NASA-relevant and independently conceived research proposals in STEM fields addressing topics that fall within the following areas: Earth Sciences, Astrophysics and Space Sciences, Spacecraft and Robotic Technologies, Planetary Sciences, Communications and Computing Software and Instrument Technologies. Students are encouraged to review open literature to identify and communicate with JPL researchers who investigate topics in the proposer's area of interest to determine if a collaboration is mutually desirable and beneficial. To learn more about research conducted at JPL please visit: http://www.jpl.nasa.gov	Master's or Ph.D.	**Technical Advisor** Petra Kneissl petra.kneissl@jpl.nasa.gov (818) 354-0726 **Co-Technical Advisor** Adrian Ponce adrian.ponce@jpl.nasa.gov (818) 354-8196
JSC-000		**Student Proposed with Concurrence of NASA Technical Adviser**	The student can submit a NASA relevant, independently conceived research proposal with the concurrence of a university principal investigator and a NASA Technical Adviser.	Master's or Ph.D.	Student identified NASA Technical Adviser

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
JSC-001	STMD	**3D Printing Space Hardware using Thermoset Resins**	New materials and cost-effective manufacturing techniques are needed for future spacecraft to support NASA's Exploration goals. Highly filled thermoset resin mixtures are a class of materials that can be used to produce thermal protection for spacecraft or other spacecraft components. The objective of this research is to improve current thermoset resin mixture properties and advance the capability of 3D printing and curing parts. The avenues of study with this effort include: 1) Modulation of thermoset resin properties (such as thermal expansion and modulus) using additives to better suit application requirements; 2) Enhance print quality through parametric study of nozzle design and toolpath; 3) Refine printer and extruder design to upgrade feed system and upstream raw material mix technology; 4) Investigate option for curing parts and material during and after deposition.	Master's or Ph.D.	**Technical Advisor** Stan Bouslog stan.a.bouslog@nasa.gov (281) 483-3327 **Co-Technical Advisor** Emily Hacopian emily.f.hacopian@nasa.gov (281) 483-2472
JSC-002	STMD	**Experimental Studies of Planetary Accretion, Differentiation, and Magmatism**	The origin and evolution of planetary interiors, though remote from us both temporally and spatially, can be elucidated through high-pressure and temperature laboratory experiments. This research is conducted in Johnson's high-pressure experimental petrology facility, which features hydraulic presses fitted with multiple anvil and piston cylinder devices that can achieve high pressures (0.1 to 25.0 GPa) and high temperatures (up to 2,500 C) in relatively large sample volumes. This capability allows the laboratory observation of mineral and magma properties at conditions equivalent to a depth of 700 km in the Earth and Venus, 2,000 km in Mars, and pressures exceeding the Moon's central core at 1,700 km. Current research includes studies of the physics and chemistry of accretion and core formation in Earth and its Moon, Mars, and asteroids; the timing of differentiation of terrestrial planets; the geochemistry of the platinum group elements; and the nature of planetary basaltic magmatism.	Ph.D.	**Technical Advisor** Kevin Righter kevin.righter-1@nasa.gov (281) 483-5125 **Co-Technical Advisor** Justin Simon justin.i.simon@nasa.gov (281) 484-6408
JSC-003	STMD	**Isotopic and Elemental Studies of Stardust, Interstellar Matter, and Extraterrestrial Materials**	Isotopic and elemental studies of extraterrestrial materials are performed at submicrometer scales by NanoSIMS 50L ion microprobe. Current research areas include the characterization of circumstellar and interstellar grains, and molecular cloud matter and isotopic and trace element studies of calcium, aluminum-rich inclusions and chondrules in primitive meteorites. Isotopic compositions are used to constrain models of stellar nucleosynthesis, galactic chemical evolution, the histories of interstellar grains in the galaxy, and chemical processes in the interstellar medium and the early solar system.	Ph.D.	**Technical Advisor** Eileen Stansbery eileen.k.stansbery@nasa.gov (281) 483-5540 **Co-Technical Advisor** Justin Simon justin.i.simon@nasa.gov (281) 484-6408

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
JSC-004	STMD	**Mars Surface Chemistry and Mineralogy**	The objectives of this research are to search for and identify chemical weathering and/or aqueous alteration products on the surface of Mars using data returned from past, current, and future missions (e.g., Mars Exploration Rovers, Mars Reconnaissance Orbiter, Phoenix Mars Lander, and Mars Science Laboratory). Studies are also underway to establish datasets on the mineralogical, chemical, spectral, magnetic, and physical properties of Mars analog materials to aid in the interpretation of data returned from Mars robotic missions. The overall intent of this research is to provide a better understanding of the geological processes responsible for the formation of Martian soils and other potential chemical weathering or aqueous alteration products (e.g., phyllosilicates, sulfates, Fe-oxyhydroxides, carbonates, zeolites). The identification and understanding of the formation processes for chemical weathering are keys to defining the environmental conditions under which these phases formed and aid in the characterization of the environment as a habitable zone. Research projects in Mars surface mineralogy and chemistry are encouraged, especially phyllosilicates, carbonate, sulfate, and Fe-oxyhydroxide mineralogy and mineral synthesis studies. Experimental and analytical facilities include X-ray diffraction analysis, infrared spectroscopy, Mossbauer spectroscopy, electron microscopy (SEM, TEM, EMPA), thermal analysis, and wet chemistry analysis (AAS, IC).	Ph.D.	**Technical Advisor** Douglas W. Ming douglas.w.ming@nasa.gov (281) 483-5839 **Co-Technical Advisor** Justin Simon justin.i.simon@nasa.gov (281) 484-6408
JSC-005	STMD	**Mineralogy of Fine-Grained Extraterrestrial Materials**	The early history of the solar system is being explored through detailed characterization of the minerals and noncrystalline phases composing primitive extraterrestrial materials. As these materials are typically very fine grained, this research is being performed principally by analytical electron microscopy, high-resolution transmission electron microscopy, electron back-scattered diffraction, and synchrotron X-ray microdiffraction. We are currently examining carbonaceous chondrites, interplanetary dust particles, asteroid Itokawa and comet Wild 2 grains, and fluid inclusions and primitive organics in meteorites.	Ph.D.	**Technical Advisor** Michael Ewing Zolensky michael.e.zolensky@nasa.gov (281) 483-5125 **Co-Technical Advisor** Justin Simon justin.i.simon@nasa.gov (281) 484-6408

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
JSC-006	STMD	**Physicochemical State of the Martian Surface**	The general objective of this continuing research program is to understand the mineralogical and elemental composition of surficial material on Mars and to determine the weathering processes that evolved the surface to its current state. Specific tasks include studies of geologic samples that have been weathered in terrestrial environments considered to be analogous in some important respects to those on Mars and theoretical and experimental studies of the optical properties of pure and substituted iron-bearing compounds, including nanophase materials. Emphasis is placed on multidisciplinary analyses of samples to maximize comparison with the data base available for Mars from the Viking, Phobos-2, Mars Pathfinder, and Mars Global Surveyor missions and telescopic observations. Experimental and analytical facilities include ferromagnetic resonance spectroscopy, vibrating sample magnetometer, Mssbauer spectroscopy, ultraviolet-visible-infrared spectroscopy, and x-ray diffraction.	Ph.D.	**Technical Advisor** Richard Van Morris richard.v.morris@nasa.gov (281) 483-5125 **Co-Technical Advisor** Justin Simon justin.i.simon@nasa.gov (281) 484-6408
JSC-007	STMD	**The Origin of Modified Optical Properties of Natural and Experimental Space-Weathered Materials**	Space weathering is a term used to include all of the processes that act on material exposed at the surface of a planetary or small body. In the case of the Moon, it includes a variety of processes that have formed the lunar regolith, caused the maturation of lunar soils, and formed patina on rock surfaces. The processes include micrometeorite impact and reworking, implantation of solar wind and flare particles, radiation damage and chemical effects from solar particles and cosmic rays, interactions with the lunar atmosphere, and sputtering erosion and deposition. Understanding these effects is critical in order to fully integrate the lunar sample collection with remotely sensed data from recent robotic missions (e.g., Lunar Prospector, Clementine, Galileo). A major objective of this research is to analyze lunar breccias for evidence of preserved space weathering effects in component grains and clasts. The main research techniques include optical and electron microscope analysis for chemical compositions, mineralogy, and petrography. In addition to the lunar breccia studies, parallel research will be undertaken on gas-rich meteorite breccias, interplanetary dust particles, and experimental analogues using the same suite of analytical techniques in order to understand space-weathering effects on chondritic materials.	Ph.D.	**Technical Advisor** Lindsay P. Keller lindsay.p.keller@nasa.gov (281) 483-6090 **Co-Technical Advisor** Justin Simon justin.i.simon@nasa.gov (281) 484-6408

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
JSC-008	STMD	**Isotopic and Chemical Studies of Meteorites and Rocks to Probe the Origin and Early History of the Solar System and Formation of the Rocky Planets**	In my research group we develop and employ state-of-the-art analytical methods to address research in isotope cosmochemistry and geochemistry. Our research links sample studies to astrophysics, the evolution of the early solar system, and terrestrial planet formation. Our team measures a wide variety of elements and their isotopes to understand the origin of our Solar System, the processes that transformed nebular dust and gas into the building blocks of planets, and planet formation (accretion & differentiation). Investigations include the measurement of: (1) Short- and long-lived radionuclides for chronology studies, (2) Fractionation of stable isotopes to study the formation mechanisms of these planetary materials, and (3) Isotopic analyses that utilize extinct radioactivity and traditional ways that radiogenic isotopic compositions can be used to study interaction among different reservoirs within the protoplanetary disk and terrestrial planets. We strive to integrate all of these isotopic measurements into a petrological context. We perform both micro-analytical in situ approaches (LA-MC-ICPMS and ion microprobe) and bulk sample methods (e.g., chemical separation solution analyses by TIMS & MC-ICPMS) to achieve high spatial resolution and higher precision measurements, respectively. This research is carried out in the mass spectrometry laboratories in the Center for Isotope Cosmochemistry and Geochronology at NASA Johnson Space Center and often in collaboration with other NPP principal investigators residing in the Astromaterials Research and Exploration Science (ARES) Division.	Ph.D.	**Technical Advisor** Justin Simon justin.i.simon@nasa.gov (281) 4846408

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
JSC-009	STMD	**Isotopic and Chemical Studies of Aqueous Environments**	Research is centered on understanding and interpreting the geologic conditions of past aqueous environments on Earth, Mars, and meteorite parent bodies. We seek to answer questions regarding the temperatures, time scales, nature of water-rock interaction, and chemical characteristics of these ancient aqueous systems with the final goal of assessing their suitability for sustaining life. The approach to the problem encompasses analysis of data returned from planetary missions (such as MSL, Phoenix, and the MER rovers), geochemical analysis of samples, laboratory experiments, and field work. Sample analysis includes mineralogy and bulk chemistry with an emphasis on light stable isotope measurements. Laboratory experiments are used in conjunction with theoretical calculations to better understand complex systems where kinetic processes may be dominant. Field work has primarily focused on terrestrial analogs to planetary environments. Our recent focus has been centered on Mars including analysis of data returned from the SAM instrument on the Curiosity rover, analysis of martian meteorites (e.g. ALH84001), laboratory experiments exploring the weathering of minerals in cryogenic environments, laboratory experiments on abiotic methane synthesis and oxidation, and field work at continental hot springs in Nevada and California. Besides the other available analytical laboratories at JSC, our research primarily utilizes a gas source isotope ratio mass spectrometer (MAT 253) equipped with a gas bench and GC-C/TC-Pyroprobe allowing for stable isotope analysis of water, carbonates, gases, and any combustible material.	Ph.D.	**Technical Advisor** Paul B. Niles paul.b.niles@nasa.gov (281) 483-7860 **Co-Technical Advisor** Justin Simon justin.i.simon@nasa.gov (281) 484-6408
JSC-010	STMD	**The Nature of Early Solar System and Presolar Materials**	Mineralogical and petrographic studies of extraterrestrial materials are performed at nanometer scales using primarily transmission electron microscopy techniques. Current research focuses on the studies of primitive early solar system materials preserved in meteorites and interplanetary dust particles, circumstellar and interstellar grains, and molecular cloud matter. These analyses are pursued in a coordinated fashion with other analytical instruments in our facilities including isotopic and spectroscopic analysis techniques. Our research is focused on gaining a better understanding of the conditions and processes that affected these primitive materials from their formation through their evolution.	Ph.D.	**Technical Advisor** Lindsay P. Keller lindsay.p.keller@nasa.gov (281) 483-6090 **Co-Technical Advisor** Justin Simon justin.i.simon@nasa.gov (281) 484-6408

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
JSC-011	STMD	**Spacecraft and Instrument Development for Planetary Science and Exploration**	The Astromaterials Research and Exploration Science (ARES) Directorate at NASA Johnson Space Center supports NASA's Solar System exploration and research goals through participation on various spacecraft missions. ARES personnel are actively engaged in missions such as the Mars rovers Opportunity and Curiosity, the DAWN spacecraft to asteroid Ceres, and the OSIRIS REx sample return spacecraft to the near-Earth asteroid Bennu. I am currently seeking qualified individuals with degrees in Planetary Science or Aerospace Engineering with career interests in areas of, but not limited to, instrument and spacecraft development, modeling and computational analyses, observational and experimental design, and systems engineering. My current research interest is focused on the development of concept designs and feasibility studies of science instruments and engineering experiments to be flown on robotic and human spacecraft missions. These activities will support planetary science investigations for the Science Mission Directorate (SMD) and the Human Exploration and Operations Mission Directorate (HEOMD). Ideally the goal is to refine these initial designs and studies so that they will be selected for upcoming NASA missions. I am specifically interested in participating in missions that will investigate the Moon, Earth's Orbital Environment, Near-Earth Objects, Mainbelt Asteroids, Comets, Mars and its Satellites, and the Trojan Asteroids. Selected candidates will be intimately involved with the entire process of concept formulation and will participate in further development in areas related to instrument design/fabrication, computational/experimental modeling, and system engineering tests. The goal of this "hands on" approach is to develop and design hardware at relatively low technology readiness levels that can be upgraded for inclusion into future flight missions.	Ph.D.	**Technical Advisor** Paul Abell paul.a.abell@nasa.gov (281) 483-0293 **Co-Technical Advisor** Justin Simon justin.i.simon@nasa.gov (281) 484-6408

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
JSC-012	STMD	**Prebiotic Chemical Evolution in the Solar System**	The analysis of organic molecules found in meteorites and other astromaterials has provided invaluable authentic samples with which we can study prebiotic chemistry. The discovery of biologically important classes of organic molecules including amino acids, nucleobases, and sugar acids provides concrete evidence of the types and diversity of molecules that were likely around during the origins of life on Earth. Our goal is to understand how these prebiotic molecules could have evolved under conditions relevant to early Earth (or other terrestrial bodies) and the role they could have played in the origins of life. This is accomplished through the study of meteorite organics and laboratory experiments simulating relevant chemical and physical processes. Research is carried out in the Soluble Organics in Astomaterials Laboratory (SOAL) within the Astromaterials Research and Exploration Science (ARES) directorate at the NASA Johnson Space Center. The SOAL contains a variety of gas and liquid-chromatography instrumentation with mass spectrometry, FID, fluorescence and absorbance detection. Also within ARES are a number of instruments for geochemical analysis that are also available for use.	Ph.D.	**Technical Advisor** Aaron Burton aaron.s.burton@nasa.gov (281) 244-2773 **Co-Technical Advisor** Justin Simon justin.i.simon@nasa.gov (281) 484-6408
JSC-013	STMD	**Chemical and Physical Origin and Evolution of Primitive Extraterrestrial Materials**	Amorphous silicates are associated with the most primitive solar system bodies such as cosmic dust, comets, and the most primitive meteorites. Amorphous materials (including insoluble organic matters) will be key components in the returned samples of the future planetary robotic sample return missions. Mineralogical and experimental studies of extraterrestrial amorphous materials and their analogs are performed at nanometer to sub-micrometer scales using transmission electron microscopy techniques. Current research focuses on the studies of early solar system materials preserved in primitive meteorites, cosmic dusts and Stardust mission samples. These analyses are pursued in a coordinated fashion with other analytical instruments in our facilities including isotopic and spectroscopic analysis techniques. Our research is to constrain origin and formation models of primitive amorphous materials and their precursor and post products by evaporation, thermal and hydrous experiments.	Ph.D.	**Technical Advisor** Keiko Nakamura-Messenger keiko.nakamura-1@nasa.gov (281) 244-5027 **Co-Technical Advisor** Justin Simon justin.i.simon@nasa.gov (281) 484-6408

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
JSC-014	STMD	**Mineralogy and aqueous alteration of the martian surface**	Surface mineralogy and geochemistry of Mars are key to characterizing geological processes on ancient and modern Mars. Mineralogical and geochemical measurements from Mars show that the ancient surface was altered by liquid water. The types of minerals and geochemical trends observed on the surface can help determine the characteristics of these ancient aqueous environments and whether or not they would have been habitable to microbial life. The goal of this research is to reconstruct the history of liquid water on Mars through mineralogical and geochemical measurements of the martian surface and analog materials. These analog materials can be synthesized in the laboratory or collected from Mars analog sites on Earth. Studies of phyllosilicate, iron oxide, sulfate, and carbonate minerals and amorphous or poorly crystalline phases are encouraged. Studies of mineral sorting and segregation in fluviolacustrine and aeolian environments on Earth as a means to interpret the mineralogy of martian surface deposits are also of great interest. Analytical instruments available at JSC include X-ray diffraction, infrared spectroscopy, thermal and evolved gas analysis, laser-induced breakdown spectroscopy, ion chromatography, scanning electron microscopy, transmission electron microscopy, and electron microprobe. JSC also has test bed instruments for the CheMin X-ray diffractometer on the Mars Science Laboratory Curiosity rover, the Sample Analysis at Mars (SAM) instrument on Curiosity, the Thermal and Evolved Gas Analyzer (TEGA) on Phoenix, ChemCam on Curiosity, and the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) on the Mars Reconnaissance Orbiter, and data collected on these instruments are directly comparable to those collected on Mars. Scientists with experience analyzing weathering products or amorphous materials using Synchrotron techniques are also encouraged to apply.	Ph.D.	**Technical Advisor** Elizabeth B. Rampe elizabeth.b.rampe@nasa.gov (281) 483-0216 **Co-Technical Advisor** Justin Simon justin.i.simon@nasa.gov (281) 484-6408

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
JSC-015	STMD	**Multidisciplinary Studies on the Formation and Evolution of Solar System Geomaterials**	Understanding the processes responsible for the formation and evolution of rocks from different planetary bodies requires a diversity of tools, including (but not limited to) stable and radiogenic isotope geochemistry, experimental petrology, numerical modeling, and thinking outside the box. Projects often link experts in multiple fields and at multiple institutions in order to solve complex problems beyond the capabilities of any individual group. Of particular current interest are projects related to various aspects of volatile elements, and the formation and evolution of rocky bodies such as the Moon and Mars. You are encouraged to reach out to the PI as well as to other scientists in the Astromaterials Research and Exploration Science (ARES) group to discuss proposal opportunities. We are especially interested in projects involving secondary ion mass spectrometry (SIMS) or Isotope Ratio Infrared Spectroscopy (IRIS) techniques (e.g. Cavity Ring Down Spectroscopy, CRDS) of volatile stable isotope systems. Applications welcomed from all candidates with doctoral degrees in geoscience, chemistry, planetary sciences, or related fields who are interested in pursuing cutting-edge planetary science problems in a supportive, inclusive atmosphere.	Ph.D.	**Technical Advisor** Jeremy W Boyce kevin.righter-1@nasa.gov (281) 483-1275 **Co-Technical Advisor** Justin Simon justin.i.simon@nasa.gov (281) 484-6408
JSC-016	STMD	**Microbial Alteration of Astromaterials**	Bacteria, Archaea, and Fungi are capable of altering terrestrial materials as a way to acquire organic carbon and or trace nutrients. This alteration includes mineral dissolution and precipitation reactions, stable isotope fractionation and the production and consumption of a variety of organic compounds. Similar alteration of extra-terrestrial materials has been observed in meteorites. This opportunity is to understand the physical, chemical and microbiological signatures associated with microbial action on astromaterials. The goal is to characterize the metabolic pathways employed to alter astromaterials under anaerobic conditions like those encountered in the Astromaterials Curation labs. An alternate goal is to quantify the extent of alteration that has occurred to NASA meteorites. These goals could be accomplished with DNA and RNA sequencing as well as identification and quantification of biosignatures. The geomicrobiology group has access to a fully functional BSL-2 (Biosafety Level) laboratory for aerobic and anaerobic culturing experiments as well as a molecular biology lab containing: an Illumina MiSeq, an Applied Biosystems 3500 Sanger sequencer, and Oxford Nanopore MinIon sequencers. The ARES (Astromaterials Research and Exploration Science) division also has scanning electron microscopes, a transmission electron microscope, a Raman microscope, an isotope ratio mass spectrometer, and several different types of gas and liquid chromatography that could be used to characterize biosignatures produced during astromaterial alteration.	Ph.D.	**Technical Advisor** Aaron B. Regberg aaron.b.regberg@nasa.gov (281) 483-7243 **Co-Technical Advisor** Justin Simon justin.i.simon@nasa.gov (281) 484-6408

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
JSC-017	STMD	**Planetary Mineralogy and Petrology**	I am currently seeking highly motivated postdoctoral candidates interested in pursuing research in planetary mineralogy and petrology through the analysis of astromaterials and/or through experimental petrology. Specifically, I seek candidates interested in determining the abundances and roles of volatiles (H_2O, F, Cl, S, C, N) in magmatic systems within terrestrial planetary bodies, including Earth, Moon, Mars, Venus, Mercury, and asteroids. Additionally, I seek candidates interested in determining the thermal and magmatic evolution of terrestrial planets under a variety of conditions relevant to planet formation from core formation to crust formation.	Ph.D.	**Technical Advisor** Francis M. McCubbin francis.m.mccubbin@nasa.gov (281) 483-5126 **Co-Technical Advisor** Justin Simon justin.i.simon@nasa.gov (281) 484-6408
KSC-000		**Student Proposed with Concurrence of NASA Technical Adviser**	The student can submit a NASA relevant, independently conceived research proposal with the concurrence of a university principal investigator and a NASA Technical Adviser.	Master's or Ph.D.	Student identified NASA Technical Adviser
KSC-001	HEOMD	**Lunar Lander Plume Surface Impingement Studies**	The study will assess risks due to lunar lander plume interactions with surface regolith. Risks may include the effects of high speed dust particles impacting the vehicle during and after landing, risks to existing lunar surface and orbital systems resulting from multiple lunar landings, and the effectiveness of mitigation technologies (pads, berms, etc) to minimize ejecta impact hazards.	Ph.D.	**Technical Advisor** James Mantovani james.g.mantovani@nasa.gov (321) 867-1870 **Co-Technical Advisor** Beverly Watson Kemmerer beverly.a.watson@nasa.gov
KSC-002	HEO-SLPSRA/AES/HRP	**Plants for Food and Human Life Support**	Long missions in space will require sufficient supplies of food and other life support commodities for human crews. The use of plants to supplement these supplied foods could provide key nutrients and improve the acceptability of the diet for early missions, and expand to cover more of the life support (total food and oxygen supplies) for future missions. To achieve this requires an understanding of horticultural approaches and agricultural engineering for growing plants in space, as well as plant responses to space environmental factors. These latter factors could include different types of lighting, CO_2 levels, and water/nutrient delivery concepts envisioned for space. These challenges are similar to challenges for controlled environment agriculture (CEA) on Earth, but could also include unique aspects of space, such as elevated radiation levels, reduced gravity environments (micro and fractional g), tightly closed atmospheres where organic volatiles like ethylene can accumulate, and even reduced atmospheric pressures, which have been considered for future missions. NASA is interested in research that addresses these questions at the molecular, metabolite, and phenotype / whole plant level, as well as the supporting engineering to optimize the system performance.	Master's or Ph.D.	**Technical Advisor** Dr. Gioia Massa gioia.massa@nasa.gov (321) 861-2938 **Co-Technical Advisor** Dr. Raymond Wheeler raymond.m.wheeler@nasa.gov (321) 861-2950

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
KSC-003	HEO-SLPSRA	**Microgravity Simulation Studies**	Microgravity is the most significant stress factor experienced by living organisms during spaceflight. The spaceflight environment is known to influence biological processes ranging from stimulation of microbial metabolism, impacts on cellular damage repair, suppression of immune functions, and muscle plus bone loss in astronauts. While there have been reports on these and other physiological and functional changes, no mechanism by which these changes occurs has been fully elucidated. Therefore, understanding cellular responses to altered gravity at the molecular level is critical for expanding our knowledge of life in space. Since the opportunity to conduct experiments in space is scarce, various microgravity simulators or techniques, such as 2-D/3-D Clinostats, Synthecon HARV/RWV bioreactors, 3-D Random Positioning Machines, and hindlimb suspension, have been developed and widely used in microgravity research on the ground. These simulated microgravity conditions have produced some, but not all of the biological effects observed in the true microgravity environment. Research topics of interest for this opportunity focus on evaluating: (1) The similarities and the differences between biological responses in living organisms (cells, 3D tissue models, microbes, or model/crop plants) to simulated microgravity and those to true microgravity as revealed in previous ISS studies; (2) The biological effects of simulated microgravity in combination with other space environmental factors (e.g. radiation). Hypothesis driven approaches for evaluating physiological changes combined with state-of-the-art omics and imaging analyses targeting mechanisms are highly encouraged.	Ph.D.	**Technical Advisor** Dr. Ye Zhang ye.zhang-1@nasa.gov (321) 861-3253 **Co-Technical Advisor** Dr. Howard Levine howard.g.levine@nasa.gov (321) 861-3502
LaRC - 000		**Student Proposed with Concurrence of NASA Technical Adviser**	The student can submit a NASA relevant, independently conceived research proposal with the concurrence of a university principal investigator and a NASA Technical Adviser.	Master's or Ph.D.	Student identified NASA Technical Adviser

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
LaRC-001	ARMD/HEOMD/STMD	**Advanced Discontinuous Galerkin Techniques for High-Speed Flow Applications**	A critical aspect for determining the environment of high-speed vehicles with complex configurations is an accurate prediction of solution gradients, such as shear stresses, heat fluxes, pressure gradients, and density gradients. These quantities are required in reducing uncertainties in predicting turbulent flows, separation and reattachment points, and surface heat fluxes of spacecraft and hypersonic vehicles, to name a few. Furthermore, analysis of boundary layer instabilities also requires a nearly pristine set of solution gradients. The vehicles' geometrical complexities such as wings, protuberances, cavities, thermal protection systems, compression pads, reaction control surfaces, as well as complexities in the flowfield such as shocks, shock-boundary layer interactions, shock-shock interactions, separations, and vortices are the main reasons for using purely simplex (triangle and tetrahedral) elements. The high-order Discontinuous Galerkin method is one of the attractive high-order schemes that is mathematically sound and combines the benefits of both finite-volume and finite-elements schemes. In addition, DG schemes are suitable for h/p adaption, and can be numerically very efficient and scalable due to its compact stencil. The research opportunity seeks an independent original proposal in either of the following two general topics: 1) novel numerical algorithms for robust, efficient, and accurate prediction of high-order solution gradients on simplex elements for compressible Navier-Stokes equations with subtopics including but not limited to a) robust, high-order discontinuity capturing, b) efficient, robust, and convergent implicit DG, c) efficient, robust, and convergent explicit DG d) efficient, robust, and convergent implicit-explicit DG e) efficient h/p adaptation, f) robust boundary condition treatment for reacting hypersonic external flow applications, g) efficient and robust entropy stable, kinetic energy preserving numerical fluxes for thermochemical nonequilibrium (TCNEQ) flows, h) efficient and robust DG for Large Eddy Simulations (LES), and 2) novel, parallel, and scalable C++ metaprogramming techniques for development of efficient backend for compressible DG.	Ph.D.	**Technical Advisor** Alireza Mazaheri ali.rmazaheri@nasa.gov (757) 864-7013

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
LaRC-002	ARMD	**Low-Complexity Solutions for Quiet and Efficient Advanced Air Mobility Aircraft**	Advanced Air Mobility (AAM) refers to the movement of passengers and cargo through integrated air and ground segments where the customer dictates the origin, destination, and timing of the transportation, which is similar to how cars or ride hailing services (e.g., Uber, Lyft) are used today. The AAM concept typically relies on air vehicles designed for one to nine passengers or cargo from small packages up to approximately 2000 lb, and AAM encapsulates urban air mobility (UAM), "thin-haul," and "regional" air mobility (RAM) concepts. AAM aircraft may utilize vertical, short, and/or conventional takeoff and landing (VTOL, STOL, and/or CTOL) modes to provide travelers or cargo with a rapid mode of transportation that improves door-to-door transport time for existing trips and enables new trips to become practical. This novel concept of operations introduces a number of inherent challenges to vehicle and mission design, such as affordability, community noise signature, ride quality, safety, near-all-weather operations, scalability, and emissions.	Master's or Ph.D.	**Technical Advisor** Siena Whiteside siena.k.whiteside@nasa.gov (757) 864-4637 **Co-Technical Advisor** Beau Pollard beau.p.pollard@nasa.gov (757) 864-4637

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
LaRC-003	ARMD	**Flow Control for Safe, Quiet, and Efficient Advanced Air Mobility Aircraft**	Advanced Air Mobility (AAM) refers to the movement of passengers and cargo through integrated air and ground segments where the customer dictates the origin, destination, and timing of the transportation, which is similar to how cars or ride hailing services (e.g., Uber, Lyft) are used today. The AAM concept typically relies on air vehicles designed for one to nine passengers or cargo from small packages up to approximately 2000 lb, and ODM encapsulates urban air mobility (UAM), "thin-haul," and "regional" air mobility (RAM) concepts. AAM aircraft may utilize vertical, short, and/or conventional takeoff and landing (VTOL, STOL, and/or CTOL) modes to provide travelers or cargo with a rapid mode of transportation that improves door-to-door transport time for existing trips and enables new trips to become practical. This novel concept of operations introduces a number of inherent challenges to vehicle and mission design, such as affordability, community noise signature, ride quality, safety, near-all-weather operations, scalability, and emissions. In order to achieve successful characteristics in the design of these aircraft, it is necessary to consider the use of additional technologies which may alleviate some of these challenges. One such technology may be flow control. Students are requested to conduct research in to the application of one or more types of flow control to AAM vehicles, with particular regard for aerodynamics, acoustics, and/or structural characteristics. Flow control may be especially useful for transitioning VTOL vehicles (for example, tilt wing, tilt duct, deflected slipstream), which typically experience adverse flight characteristics, such as buffeting and pitching moment changes, when transitioning between hover and wing-borne cruise flight. Students are invited to include vehicle-level design/analysis of the application of their flow control technique(s) to AAM vehicles, and development of conceptual design tools for aircraft incorporating flow control. Original ideas outside of the examples given here are also welcomed. Some background to current NASA interests in AAMvehicle technologies is available in references: https://doi.org/10.2514/6.2019-0528; https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20190033155.pdf	Master's or Ph.D.	**Technical Advisor** Siena Whiteside siena.k.whiteside@nasa.gov (757) 864-4637 **Co-Technical Advisor** Beau Pollard beau.p.pollard@nasa.gov (757) 864-4637

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
LaRC-004	ARMD	**Modeling and Simulation of AAM Network Operations**	Urban air mobility (UAM) is an emerging aviation market that seeks to revolutionize mobility around metropolitan areas via a safe, efficient, and accessible on-demand air transportation system for passengers and cargo. Such revolutionary mobility could fundamentally change how transportation networks operate and bring aviation into people's daily lives. Advanced air mobility (AAM) is an emerging aviation market that seeks to revolutionize mobility for trips of up to a few hundred miles via a safe, sustainable, affordable, and accessible air transportation system for passengers and cargo. Such transformational mobility could fundamentally change how transportation networks operate and bring aviation into people's daily lives. Because AAM represents a paradigm shift in aviation capabilities, existing assumptions about aircraft operations and the requirements derived from the current operations are likely invalid; consequently, new concepts of operation are needed that consider new aircraft with different capabilities, new techniques for air traffic management (ATM), and potentially new or modified infrastructure to and from which operations will occur. Many fundamental questions about AAM operations that could have first-order impacts on requirements for aircraft, future ATM, and infrastructure remain relatively unexplored. The objective of this topic is to develop non-proprietary modeling approaches for an overall AAM transportation system that is capable of modeling the operations in AAM networks throughout entire days/weeks and/or some of the "sub-models" that must also be developed for the network modeling to provide accurate results, such as demand models and dispatch models. Ideally the overall network modeling could be tied to models for existing ground transportation networks, be able to accommodate various sub-models (including those of varying fidelity), and be developed to run at varying levels of fidelity. Similar sort of network modeling for urban air mobility, a subset of AAM, is described in the following references: https://arc.aiaa.org/doi/abs/10.2514/6.2018-3677 and https://ntrs.nasa.gov/search.jsp?R=20190001282. Additionally, a vision concept of operations for future urban air mobility operations can be found here: https://ntrs.nasa.gov/citations/20205011091.	Master's or Ph.D.	**Technical Advisor** Michael Patterson michael.d.patterson@nasa.gov (757) 864-9258 **Co-Technical Advisor** Kevin Antcliff kevin.r.antcliff@nasa.gov (757) 864-4826

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
LaRC-005	STMD/ SMD/ HEOMD	**Developing Novel, Wear-Resistant Materials for Lunar Exploration**	In order to enable long duration missions to the moon's surface, materials resistant to the harsh lunar environment are critically needed. Lunar dust poses a significant threat to the durability of components and vehicles operating on the lunar surface. The fine, jagged morphology and highly abrasive nature of the dust enable particles to adhere and embed into surfaces of components and devices potentially leading to premature failure. The objective of this project is to examine properties of candidate material systems, including but not limited to ceramics and composites, that are highly wear resistant and/or resistant to lunar dust adhesion for lunar applications as coatings and/or bulk components. New coating chemistries and architectures could be designed and implemented to meet the lunar dust mitigation requirements of lunar vehicles. This investigation could be accomplished via experimentation, simulation, or a combination of the two approaches.	Master's or Ph.D.	**Technical Advisor** Valerie Wiesner valerie.l.wiesner@nasa.gov (757) 864-4384 **Co-Technical Advisor** Chris Wohl c.j.wohl@nasa.gov (757) 864-8074
LaRC-006	STMD/ SMD/ HEOMD	**Active Strategies to Mitigate Lunar Dust Adhesion for Moon Missions**	A return to the lunar surface presents a number of familiar and new challenges, especially when considering mission planning and requisite technologies to support an extended or even sustained presence. In addition to the expected difficulties that come with operating in a harsh lunar environment, preventing lunar dust adhesion to components is widely considered a significant design hurdle to overcome. Lunar dust consists of fine, highly abrasive particulates that readily adhere and embed into surfaces. The aim of this work is to develop novel active mitigation strategies, including but not limited to chemical surface and topographical modifications, in order to produce coatings and/or components resistant to lunar dust adhesion. The investigation could be accomplished via experimentation, simulation, or a combination of the two approaches.	Master's or Ph.D.	**Technical Advisor** Valerie Wiesner valerie.l.wiesner@nasa.gov (757) 864-4384 **Co-Technical Advisor** Chris Wohl c.j.wohl@nasa.gov (757) 864-8074

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
LaRC-007	STMD SMD HEOMD ARMD	**Multifunctional Structural Materials for Extreme Space Environments**	Multifunctional materials can enable revolutionary design schemes for future aerospace vehicles and structures for NASA missions such as Artemis Space Program for Moon and Mars exploration especially in extreme space environments. Recent studies of nanocomposite materials have shown the potential for both structural integrity and multifunctional capabilities; such as wear resistance, corrosion resistance, sensing/actuating, health monitoring, radiation shielding, energy harvesting, thermal management, and thermal protection. For example, small loadings of nano-inclusions such as carbon nanotubes (CNT), boron nitride nanotubes (BNNT), 2D nanomaterials, transition metal chalcogenide (TMC), or combinations of these inclusions in a polymer, ceramic, or metallic matrix may result in improving mechanical and thermal properties significantly while offering sensing/actuating/energy harvesting and radiation shielding functionalities. To explore the potential of emerging multifunctional materials, new composites, fibers, and yarns with nano-inclusions will be developed experimentally and computationally to study their mechanical, thermal, electrical, sensing/actuation, radiation shielding, and exotic electromagnetic properties systematically for aerospace applications in extreme environments to protect crew and electronic devices. A gifted student is sought to research and develop new multifunctional nanocomposite materials that will be used for future aerospace applications.	Ph.D.	**Technical Advisor** Cheol Park cheol.park-1@nasa.gov (757) 864-8360 **Co-Technical Advisor** Sang-Hyon Chu sang-hyon.chu-1@nasa.gov (757) 864-8215
LaRC-008	STMD, SMD, HEOMD, ARMD	**Advanced Modeling of Turbulence for Combustion Applications**	One of the most challenging problems preventing accurate predictive simulations of turbulent reacting flows is the complexity associated with the modeling of the chemical reaction source terms in the governing transport equations. These terms are in general highly non-linear, and depend on both aero- and thermo-dynamic flow properties. Flow turbulence further introduces a wide range of interacting flow scales over which these source terms must be accurately evaluated. All models to date have largely failed to demonstrate accurate and robust prediction of turbulent combustion, except under limited range of flow conditions. The problem is further aggravated in simulations of supersonic combustion, where the flow and chemistry time scales could be on the same order, and the models are least accurate. The objective of the current opportunity is to investigate and further develop for supersonic combustion a class of probabilistic models for turbulent combustion simulations. These models use novel approaches to describe the physical interactions that are not accessible to conventional combustion models. However, computational affordability has been of primary concern and must be considered in the proposed work.	Ph.D.	**Technical Advisor** Tomasz Drozda tomasz.g.drozda@nasa.gov (757) 864-2298

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
MSFC-000		**Student Proposed with Concurrence of NASA Technical Adviser**	The student can submit a NASA relevant, independently conceived research proposal with the concurrence of a university principal investigator and a NASA Technical Adviser.	Master's or Ph.D.	Student identified NASA Technical Adviser
MSFC-001	HEOMD	**Non-Contact Measurements in Structural Dynamics Applications**	Structural dynamics vibrations testing has traditionally relied upon sensors that must be in contact with the test article to collect data. However, installation of these sensors on large structures is a time-consuming task; and the use of these sensors on smaller, lighter structures could change the dynamics of the test article. Therefore, a system is needed for non-contact measurements in structural testing, particularly in vibrations testing. NASA Marshall Space Flight Center uses a method called "motion magnification" to visualize mode frequencies and mode shapes of structures from video collected by off-the-shelf cameras. Current efforts to improve Motion Magnification revolve around using a multi-camera configuration to capture motion in three dimensions, rather than the in-plane motion seen by a single camera. The successful proposal should address one of the following research areas for a multi-camera system: algorithms for three-dimensional mode identification, analysis of large photogrammetry data sets, and methods to reduce the data.	Master's or Ph.D.	**Technical Advisor** Eric C. Stewart eric.c.stewart-1@nasa.gov (256) 544-3162

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
MSFC-002	SMD	**Investigating Computer Algorithms and Systems to Optimize NASA Systems and Communication**	Barriers in communication via NASA internal systems have constantly been an issue across the agency based on acquisition history, resulting in an increase in workload and delayed milestones, jeopardizing the agency's missions and goals. In recent analysis of NASA internal systems, it has become apparent that systems across Engineering, Procurement, and CFO, just to name a few, are not in sync, causing an increase in transactional costs and a delay in the completion of missions. Individual organizations within NASA, such as Engineering, Procurement, and CFO have their own internal systems; however, such systems do not properly communicate with each other, negating the importance of Systems Engineering and Systems thinking practices. Based on acquisition history, the necessity of a system that can employ and sync individual organizations' systems, enabling cross-functional communication, is imperative to the reduction of costs and the fluidity and success of NASA's goals and missions. For example, a system that will enable CFO to notify and provide Procurement with the status of purchase requisitions for the procurement of subsystems and parts is needed. Likewise, a system is needed that will enable Engineering to provide Procurement with statuses and real time modifications of Statement of Works and Performance Work Statements, and further enable Procurement to provide real time changes and statuses to contractual documents and contract awards. The student will support the investigation of algorithms and systems in order to create one system that will optimize communication across organizations at NASA, using NASA/MSFC as a testbed. The successful proposal should delineate specific tasks as to how to achieve the objectives of the proposed research.	Master's or Ph.D.	**Technical Advisor** LaBreesha B. Batey labreesha.b.batey@nasa.gov (256) 544-6085

NASA Center	Mission Directorate	Opportunity Title	Opportunity Description/Objective (Specific student assigned)	Desired Student Academic Level	NASA Technical Advisor and Co-Technical Contact Information
MSFC-003	HEOMD	**Performance Characteristics of Auxetic Foams in Neuropathy Treatments and Space Endeavors**	Peripheral neuropathy refers to the condition that result when nerves that carry messages to and from the brain and spinal cord and to the rest of the body are damaged or diseased. The condition of neuropathy and limited mobility has consumed more than 20 million people, inclusive of diabetics, cancer victims and survivors, athletes, people suffering from severe injuries, and even astronauts returning from space. It is hypothesized that auxetic foam material is conducive in the alleviation of neuropathic symptoms and feasible for space endeavors. The student will be responsible for the analysis of the material characteristics of an auxetic foam material, attributing that material to space endeavors and astronauts' suits. Additionally, the intern will be responsible for analyzing the foam's material and its applicability in the mitigation and management of neuropathic symptoms. This project also includes the analysis of gait cycles and ground reaction forces utilizing an auxetic foam technology and data from prior test and analysis as a baseline. The student will be responsible for attributing the project's outcomes to the alleviation of neuropathic symptoms in returning astronauts, and exploring ways in which the outcomes of the project could enhance longer duration in space missions. The student should be familiar with material characterization techniques such as Thermo Mechanical Analysis (TMA), Dynamic Mechanical Analysis (DMA), etc.	Master's or Ph.D.	**Technical Advisor** LaBreesha B. Batey labreesha.b.batey@nasa.gov (256) 544-6085
SSC-000		**Student Proposed with Concurrence of NASA Technical Adviser**	The student can submit a NASA relevant, independently conceived research proposal with the concurrence of a university principal investigator and a NASA Technical Adviser.	Master's or Ph.D.	Student identified NASA Technical Adviser