



MEMORANDUM OF UNDERSTANDING
BETWEEN
THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
AND
THE NATIONAL SCIENCE FOUNDATION
REGARDING
ACHIEVEMENT OF MUTUAL RESEARCH ACTIVITIES ADVANCING SPACE, EARTH,
AND BIOLOGICAL SCIENCES

The National Aeronautics and Space Administration (“NASA”) and the National Science Foundation (“NSF”), through this Memorandum of Understanding (“MOU”), affirm their intent to continue their longstanding partnership on mutually beneficial research activities advancing space, Earth, biological, and physical sciences in furtherance of U.S. national space policy and to promote the progress of science. In this MOU, NASA and the NSF may be individually referred to as a “Party” and collectively referred to as the “Parties.”

I. Background

NASA and NSF have enjoyed a successful and longstanding relationship in support of both Parties’ efforts to further research and understanding on space, Earth, biological, and physical science activities. Over the years, the Parties have collectively engaged in astrophysics, astrochemistry, planetary science, astrobiology, and heliophysics research, including activities to understand space weather, exoplanets, gravitational waves, and the origins of life. The Parties have collaborated on field work and research activities in Antarctica and Greenland, through NSF-managed stations and facilities, including research on Antarctica’s ice sheet, investigations using high-altitude scientific balloon platforms launched from McMurdo Station, the collection and profiling of ancient meteorites that have impacted the Antarctic ice sheet, and communications infrastructure support for Antarctic research stations. Moreover, the Parties have collectively engaged in a number of field campaigns to address fundamental Earth system science, as well as Earth system modeling, remote sensing, and ocean and climate monitoring activities. Collaborations have also included activities related to the National Robotics, Cyber-Physical Systems, and Digital Library Initiatives, as well as supporting educational engagement activities such as the Global Learning and Observations to Benefit the Environment program and the Center for Chemical Evolution. NASA and NSF, as members of the Established Program to Stimulate Competitive Research Interagency Coordinating Committee, have a pilot collaboration opportunity for teams of junior investigators to further develop their individual research potential through extended fellowships at NASA Centers and the Jet Propulsion Laboratory in the United States. Additionally, the Parties have previously supported training for small businesses in their

respective Small Business Innovation Research (“SBIR”) and Small Business Technology Transfer (“STTR”) Programs.

In space, the Parties have collaborated in partnership for exoplanet research, activities in astrophysics, astrochemistry, planetary science, and heliophysics optimizing the scientific return and the administrative efficiency of joint or coordinated programs. NASA and NSF have collaborated in the responses to scientific community input from decadal survey, ad hoc studies, and input from the Astronomy & Astrophysics Advisory Committee. NASA and NSF have also engaged in research aboard the International Space Station (“ISS”) addressing a wide variety of areas of inquiry including biological and physical research in microgravity, plasma physics and joint solicitations in transport phenomena, tissue engineering, and mechanobiology through ISS National Laboratory (“ISSNL”)’s manager, Center for the Advancement of Science in Space. From these solicitations, 29 grant awards were enabled by ISSNL resources which focused on important discovery science questions with direct science outcomes for terrestrial applications and implications for microgravity science, in areas including cardiac function, liver tissue engineering, fire safety, and sediment particle behavior.

II. Objectives

Mutually beneficial opportunities for collaboration continue to emerge. The ISS occupies a unique role for continuing and expanding biological, physical, space, and Earth sciences in a routinely accessible and repeatable manner. Science activities related to NASA’s ongoing programs in the space, Earth, biological, and physical sciences often complement and extend those undertaken through NSF support, while NSF-supported projects often can benefit from activities underway at NASA to study the Earth and to use Earth environments to prepare for future space exploration activities. Moreover, basic research activities including neuroscience and behavioral modeling, as well as Earth-based observatories supported by NSF have important and even essential roles in providing for the scientific underpinnings of NASA missions.

The broad categories in which NASA and NSF intend to work together to continue their fruitful cooperation and pursue new collaborations include, but are not limited to:

- Space Science;
- Earth System Science;
- Human Exploration and Operations;
- Space Life Sciences;
- Space Physical Sciences;
- Space Technology;
- Citizen Science; and
- Science, Technology, Engineering, and Mathematics Education.

NASA and NSF intend to engage in a number of areas of specific interest including, but not limited to:

- Continue working together to advance NASA and NSF-sponsored science programs in astrophysics, planetary science, astrobiology, heliophysics, and Earth science, with special emphasis on those that make use of the NSF-managed facilities, including those in the Antarctic.
- Continue the NASA-NSF partnership for exoplanet research (“NN-EXPLORE”). Explore expanding this partnership to include new opportunities, especially in extreme precision radial velocity measurements needed to discover and characterize Earth-sized planets around Solar-like stars.
- Coordinate program planning activities in astrophysics, planetary science, and heliophysics to optimize both the scientific return and the administrative efficiency of joint or coordinated programs. Discuss and develop responses to scientific community input from decadal survey, ad hoc studies, and especially input from the Astronomy & Astrophysics Advisory Committee (which provides advice on interagency programs).
- Coordinate efforts to enable a full integration of Earth’s ecosystem and biodiversity observations from ground-based, aerial, and space-based sensing systems.
- Continue collaboration between the NSF and the ISSNL, and work together, along with the ISSNL manager CASIS, to potentially develop a strategy for increased use of the ISSNL by NSF. Areas to explore, in particular, include dedicating ISSNL and NASA resources to support new and/or existing NSF efforts in materials research, biological sciences, electrical, communications, quantum technology, cyber-systems, and other areas of science and engineering that can benefit from the unique micro-gravity environment provided by ISS.
- Continue discussing the use of the Cold Atom Laboratory and Flow Boiling and Condensation Experiment apparatus on the ISS to advance understanding of atomic physics and transport systems, respectively.
- Discuss extraterrestrial operation of electronics in radiation hard environments. NSF funds research projects that seek to understand and mitigate these effects, particularly on electronic and optoelectronic devices, though use of novel structures and materials.
- Discuss funding research with support, among others, of the National Space Quantum Laboratory program which plans to use a laser system on the ISS to exchange quantum information between two ground-based quantum communication networks without a physical link and to accelerate the development of photonic integrated circuits and other devices to improve size, weight, and power.

- Collaborate on the broadening participation in science and engineering. The NSF Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (“NSF INCLUDES”) initiative is focused on broadening participation at scale through the development of collaborative networks of organizations. NASA’s Science Activation (SciAct) community-based program is focused on the active participation of learners of all ages to advance knowledge. NSF specifically intends to collaborate with SciAct program staff and awardees, as appropriate. NASA specifically intends to support the aims of the NSF INCLUDES initiative by leveraging the talents of students and researchers at Minority Serving Institutions through its Minority University Research and Education Project in the Office of STEM Engagement.
- Continue interagency collaboration on the Established Program to Stimulate Competitive Research program which seeks to enhance research competitiveness of targeted jurisdictions (states, territories, and commonwealths) by strengthening STEM capacity and capability.
- Continue collaboration on diversifying the science, technology, engineering, and mathematics workforces through NSF INCLUDES, and other programs, as appropriate.
- Discuss the potential for NSF-supported CubeSats to launch with NASA’s Geospace Dynamics Constellation, which will study the Earth’s upper atmosphere, to complement the mission science investigation.
- Continue interagency efforts to develop a space weather research-to-operations-to-research framework to establish principles for interagency collaboration on advancing and predicting Sun-Earth space weather. Within this framework, NSF and NASA intend to continue supporting a number of DRIVE (Diversify, Realize, Integrate, Venture, Educate) Science Centers that will focus on grand challenge goals in space weather.
- Continue interagency efforts through citizen science initiatives.
- Continue interagency efforts through the National Robotics Initiative.
- Continue interagency efforts through the Cyber Physical Systems program.
- Identify and characterize potential NSF research activities that could be flown on commercial suborbital transportation vehicles via either NASA’s Flight Opportunities program or NASA’s Suborbital Crew project.
- Explore potential future partnering between NASA’s and NSF’s respective SBIR, STTR, and I-Corps programs.
- Collaborate on efforts to engage the general public and inspiring the next generation of scientists, engineers, and STEM educators.
- Coordinate efforts to counter foreign influence on Federal-supported research at U.S. academic institutions.
- Prepare strategic plans to identify, prioritize, and develop technology and applications common to Earth systems and space science and space technology needs.
- Continue working together to support and advance seismic and geodetic instrumentation and research that makes use of NSF-managed geophysical facilities.
- Support collaborations in research examining possible long-term and short-term impacts of the ISS environment on human cognition and behavior.

III. Administrative Points of Contact

Administration of this MOU and coordination of subsequent NASA-NSF agreements for activities identified in section II of this MOU will be the responsibility of the individuals below:

NASA

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IV. Miscellaneous

- A. This MOU is strictly for the management and planning purposes of each of the Parties.
- B. This MOU does not support an obligation of funds, nor does it constitute a binding commitment upon either Party or create any legal rights or obligations for either Party.
- C. Nothing in this MOU shall be interpreted as limiting, superseding, or otherwise affecting a Party from conducting normal operations or making decisions in carrying out its mission and duties.
- D. This MOU does not limit or restrict the Parties from participating in similar activities or arrangements with other entities.
- E. Each Party shall be responsible for any and all expenses incurred by that Party relating to this MOU, and neither Party will be responsible for any expense incurred by the other Party unless specifically agreed to in writing, separate from and independent of this MOU.
- F. In the event the Parties wish to conduct additional activities under this MOU, or enter into binding obligations in connection with the activities described in this MOU, the Parties will negotiate and enter into separate agreements fully independent of this MOU and as permitted by and in accordance with law and the respective Parties' policies and processes.
- G. This MOU supersedes the Joint Statement between the National Aeronautics and Space Administration and the National Science Foundation, signed September 30, 2018. This MOU does not supersede nor modify other agreements between the Parties.
- H. Either Party may unilaterally terminate this MOU upon ninety (90) calendar days written notice to the other Party.
- I. This MOU becomes effective upon the date of the last signature below ("Effective Date") and shall remain in effect until either (a) a Party decides to terminate its

participation according to section IV (H) of this MOU, or (b) ten (10) calendar years from the Effective Date, whichever comes first.

- J. Any modification to this MOU will be executed in writing and signed by an authorized representative of NASA and the NSF.

V. Signatures

The respective authorized officials of each organization hereby execute this MOU on the date set forth below.



Mr. James Bridenstine
Administrator
National Aeronautics and Space Administration

Date: 01/05/2021



Dr. Sethuraman Panchanathan
Director
National Science Foundation

Date: 01/06/2021