National Aeronautics and
Space Administration

Headquarters
Washington, DC 20546-0001

March 10, 2025

I am pleased to share with you the 2025-2026 update to the NASA Science Plan: A Vision for Scientific Excellence, which reflects several important updates to our activities in the Science Mission Directorate (SMD). As the Associate Administrator of NASA's Science Mission Directorate, I supervise a large portion of the Nation's Earth and space science research program. From this perspective, I see the unique interconnections and synergies across our 100+ science missions and our research programs. While each discipline is focused on a particular area of science, all of our work is interdisciplinary and cross-cutting.

The updates to this existing plan are focused on the inclusion of recent accomplishments rather than significant structural changes. These refinements ensure the plan remains current and reflects recent progress while planning begins for a more comprehensive 4-year update. The forthcoming update will align with the development of the next agency-wide NASA Strategic Plan in 2026, ensuring a cohesive approach to our future priorities and goals.

The past year was another busy and successful year for NASA Science. We saw new corners of the universe in stunning detail with the James Webb Space Telescope, analyzed samples from asteroid Bennu, and captured images of our Earth in a new spectrum of colors with the launch of PACE. We advanced a mission to Jupiter's icy moon Europa to seek out markers indicating it could be compatible with sustaining life, and studied how a space environment impacts plants on the International Space Station. The entire continental United States was treated to a solar eclipse, and we observed our Sun through a period of intense activity that is continuing into 2025. Together, NASA's missions are helping us understand life and its possibilities, near and far.

We use these data, the collective ingenuity of our science community, and advanced technology like artificial intelligence (AI) large language models to forecast and respond to emergency situations and improve the daily lives of people around the world. From single cells to entire galaxies, NASA uses data at many scales to help solve problems. I'm so proud of the NASA team and science community, and I'm looking forward to a great 2025, filled with more learning and discovery.

As noted in previous updates to this plan, we remain steadfast in measuring success through our ability to:

- Implement recommendations of Decadal Surveys in concert with national priorities and needs through creative partnership models that go beyond traditional ways of developing and executing missions;
- Challenge assumptions about what is technically feasible and enable revolutionary scientific discovery through a deliberate focus on innovation, experimentation, and cross-disciplinary research;
- Create a more collaborative culture within the Science Mission Directorate and across the science community, encouraging diversity of thought, sharing best practices, and informed risk-taking to improve operations; and
- Develop future leaders and inspire learners of all ages through new opportunities and hands-on experiences.

Our priorities, like this plan, continue to evolve in close collaboration with our partners. The SMD leadership team, NASA Center Directors, and advisory bodies at NASA and the National Academies of Sciences, Engineering and Medicine will all continue to empower each other as we move into another year of groundbreaking scientific strides. I am so thankful for the countless contributions and steadfast dedication from NASA Science, our stakeholders, and our extended communities.

Sincerely,

Nicola J. Fox, Ph.D.
Associate Administrator, Science Mission Directorate

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Who We Are

NASA VISION

Exploring the secrets of the universe for the benefit of all.

NASA MISSION

NASA explores the unknown in air and space, innovates for the benefit of humanity, and inspires the world through discovery.

SMD VISION

To lead a globally interconnected program of scientific discovery that encourages innovation, positively impacts people's lives, and is a source of inspiration.

SMD MISSION

Discover the secrets of the universe. Search for life elsewhere. Protect and improve life on Earth and in space.

Since 1958, NASA has led the way in Earth and space science research with a team of world-class scientists and engineers dedicated to its mission. Success in the harsh, unforgiving environment of space requires an unwavering commitment to excellence to build and operate our missions and to develop cutting-edge technologies to further our fundamental research. In turn, investments in fundamental research enable new mission concepts and transform data into knowledge. Prioritization of these activities is guided by National Academies of Sciences, Engineering and Medicine (NASEM) Decadal Surveys and other national priorities, which provide effective focus to the programs.

From decades of experience, we have learned the importance of taking small steps to accomplish big goals. We seek to reach beyond our current knowledge by investigating our home the Earth, the Sun, the Moon, other worlds of our solar system, the stars, and the deep universe. As NASA's mission evolves, the Science Mission Directorate (SMD) continually strives to be innovative and drive discovery by studying biological and physical phenomena in space. SMD utilizes technological advances and new partnership opportunities, including public-private partnerships that leverage commercial investments to further NASA's science objectives. The key to our success is fulfilling our commitment to improve people's lives today and to inspire and engage the workforce of tomorrow.

As an organization, SMD incorporates the five NASA core values in all aspects of its work, as well as a sixth value of leadership. Through these values, we can drive towards a future in which we continue to expand the frontiers of human knowledge and our understanding of Earth and space.

SMD Core Values

LEADERSHIP

From studying the origin and evolution of the universe to seeking to understand the Earth as an interconnected system, SMD's leadership has advanced scientific knowledge and has had a direct positive impact on the quality of life on Earth. We know that scientific discovery is achieved through collaboration and diverse teams, and therefore we seek to create space for people to come together to continue expanding our understanding of Earth and space for the benefit of all.

EXCELLENCE

The work of SMD is at the forefront of scientific discovery and innovation. The questions we seek to answer affect humanity on a global scale and focus on our place in the universe—Where did we come from? Are we alone? Achieving excellence by tackling such difficult questions requires courage and dedication. It requires a culture where there is a willingness to learn and change and to take risks in the interest of science. We do not identify these opportunities in a vacuum; rather, the science community guides our prioritization through decadal surveys, competitive processes, and peer review. Our commitment to excellence requires us to challenge ourselves and learn from both our successes and our failures. We must dig deep for lessons, be willing to adjust, and continually expand our knowledge.

INTEGRITY

SMD is committed to ensuring that all decisions are made with integrity and transparency, believing in the importance of living up to our commitments. To be successful, we must establish clear guidelines and criteria for decision-making processes and communicate these expectations in a timely manner to all stakeholders so that there is a common understanding. Such processes should allow us to make timely, appropriate decisions to reduce unnecessary administrative burden.

TEAMWORK

SMD believes in the importance of strong teams to tackle strategic problems and maximize scientific return most effectively and innovatively. Internally, we seek to grow our workforce by providing opportunities for personal and professional development and cross-divisional collaboration. Externally, we are working to promote opportunities for collaboration across and between disciplines, as well as to develop and inspire the next generation of science and engineering leaders to carry our work into the future.

SAFETY

NASA has a strong safety culture which extends to all aspects of SMD's work. Not only are we concerned about protecting life and property, but we also recognize the importance of psychological health and safety. We strive to create an environment where everyone can contribute to our work. People must feel comfortable bringing up issues and concerns without fear of retribution or reprisal. This extends to all members of the science community who work with us.

INCLUSION

Inclusion and the cultivation of inclusive teams are pivotal for fostering innovation, enhancing decision-making, and improving organizational performance. Strong teams where everyone's opinion counts drive innovation, contribute to a more comprehensive understanding of complex issues, and ultimately lead to more creative solutions with a competitive edge for Earth and space science. SMD recognizes that success is only achieved through full participation of inclusive teams where everyone can bring their best to the mission.

Introduction

Since the successful launch of Explorer 1 in January 1958, research in and from space has broadened our view of the world we live in and has created public value. Our impact has been two-fold: *we discover the secrets of the universe,* and we *protect and improve life on Earth and in space*. Whether near our home in space or all the way to the deepest reaches of the universe, we explore the world around us, constantly questioning what we know; we have learned how to make missions successful both at Earth and traveling into deep space.

Photo Credit: ***NASA, ESA, CSA, STScI***
This composite image of Arp 107, created with data from the James Webb Space Telescope's NIRCam (Near-Infrared Camera) and MIRI (Mid-Infrared Instrument), reveals a wealth of information about the star-formation and how these two galaxies collided hundreds of million years ago.

NASA's strategy for the future is built upon our strong legacy of innovation: the idea that we can and must continue to adapt and improve our operations while remaining conscientious stewards of public resources.. This vision outlines the major drivers of our program. We celebrate achievements, assess and apply lessons learned, and look to current and future opportunities to deliver groundbreaking science and practical benefits to humanity.

NASEM sets high-level science priorities through their decadal surveys. Not only does SMD support scientific discovery for the sake of new knowledge, but we also advance fundamental science that improves life on Earth and serves as the foundation for future exploration, as well as the technologies that will enable this fundamental science.

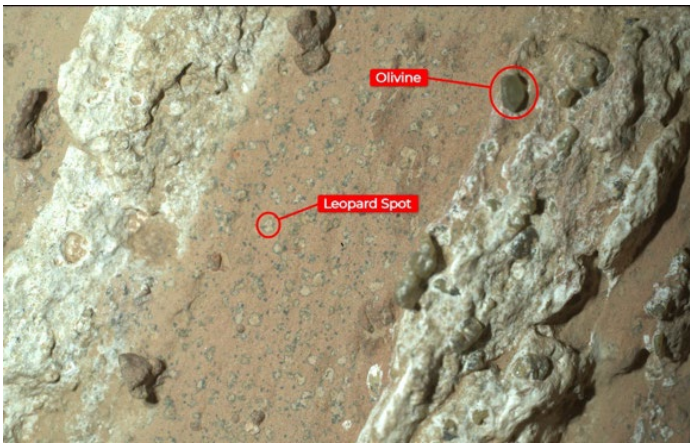

Photo Credit: ***NASA/JPL-Caltech/MSSS***
This annotated version of the image of "Cheyava Falls" indicates the markings akin to leopard spots, which have particularly captivated scientists, and the olivine in the rock. The image was captured by the WATSON instrument on NASA's Perseverance Mars rover on July 18.

Some of the most important questions we address cut across the traditional boundaries of the decadal surveys. The fundamental science quest to search for life elsewhere is one that requires advances in each scientific division. For example, Astrophysics requires an understanding of how planets form and how to find and study them around other stars. Studying biological and physical systems in the extreme environment of space enables us to make scientific breakthroughs not possible on Earth. Earth Science provides the understanding behind atmospheric emission measurements so these can be used to search for signs of life on other worlds. Understanding how stellar activity and stellar magnetospheres affect planetary atmospheres and climate is addressed by Heliophysics, and Planetary Sciences requires an understanding of how geologic processes on Mars and on ocean worlds in our solar system might give rise to habitable environments.

SMD does not conduct research in isolation; it relies on strong partnerships. These strategic partnerships can influence the unique strengths of each contributor to drive scientific progress on behalf of the greater good. By partnering with other space agencies, universities, industry, and others, we can generate informed ideas, technology, research and scientific processes, all while developing a resilient, talented workforce.

Photo Credit: ***PlanetScope/NASA***
Phytoplankton in the Sea of Marmara, Turkey. 10 June, 2021.

SMD actively looks for opportunities to build on private sector investments and to utilize innovative public-private partnerships to advance SMD objectives. Building an entrepreneurial ventures-based perspective not only enables us to achieve a fundamentally new understanding of our home planet and the star that sustains us, but also propels significant improvements in predictive capability that protects life, health, and property. Our strategy, combined with closely working with international partners, drives both innovative technology and science to synergistically address global challenges that no one nation or organization can address alone. Additional opportunities are unlocked through the engagement of our cross-agency partners, as well as private sector partners within the United States and other governments.

The challenge to any successful enterprise such as SMD is to continually test its own assumptions and create new opportunities. Collaboration, within SMD and across our community, promotes open science and more effectively optimizes resources.

Science Leadership Priorities

To achieve our goals, SMD relies on four cross-cutting priorities: Exploration and Scientific Discovery, Innovation, Interconnectivity and Partnerships, and Inspiration. Our core purpose is to explore and make scientific discoveries on behalf of the world, making innovation and collaboration essential for success in our pursuit. Our work inspires and encourages future leaders to contribute their ideas in pursuit of new science questions and means of discovery.

The following sections detail the strategies associated with each priority area and the high-level implementation approach. These strategies are designed to be ambitious new pursuits for SMD, going above and beyond the current program of record to drive action and make progress in specific directions.

PRIORITY 1
EXPLORATION AND SCIENTIFIC DISCOVERY

STRATEGY 1.1: Execute a balanced science program based on discipline-specific guidance from the National Academies of Sciences, Engineering, and Medicine, Administration priorities, and direction from Congress.

STRATEGY 1.2: Participate as a key partner and enabler in the agency's exploration initiative, focusing on scientific research of, on, and from the Moon, lunar orbit, Mars, and beyond.

STRATEGY 1.3: Advance discovery in emerging fields by identifying and exploiting cross-disciplinary opportunities between traditional science disciplines.

STRATEGY 1.4: Develop a Directorate-wide, target-user focused approach to applied programs, including Earth Science Applications, Space Weather, Planetary Defense, and Space Situational Awareness.

SMD seeks to discover the secrets of the universe, to search for life elsewhere in the Universe, and to protect and improve life on Earth and in space. To be successful, we have a balanced portfolio approach that includes flight missions, research and analysis, technology development, and applications as critical components of our work. The relative balance across these efforts is informed by NASEM through their Decadal Surveys and is responsive to Administration priorities and direction in the law.

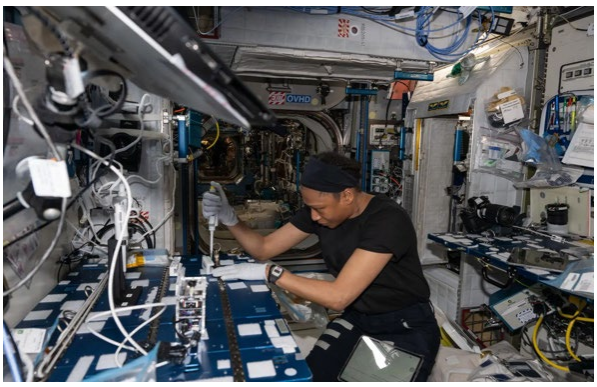

Photo Credit: *NASA*
Astronaut Jeanette Epps extracts DNA samples from bacteria colonies for genomic analysis aboard the International Space Station's Harmony module.

We regularly undertake new work that builds on our past success in individual science disciplines to enable a more collaborative environment at the forefront of science and science applications. For example, NASA's Astrobiology Program collaborates across astrophysics, biological and physical sciences, heliophysics, and planetary sciences to further the search for life beyond Earth.

To go farther and stay longer in space, the Biological and Physical Sciences Division is focusing on fundamental research that will be instrumental in ensuring the health, safety, and productivity of humans during long-duration missions. Through our open science databases, critical insights from this research are used by other government agencies, academic researchers, international partners, and commercial industry to benefit humanity as well.

Closer to home, our science program pioneered the use of SMD data to inform decision-makers and has expanded data usage to support other national needs, including space weather prediction and planetary defense, among others. As SMD data is used in support of such capabilities, new users and user needs will be identified, which will drive fundamental research that is likely to yield even more advances in modeling and new tools.

Finding answers to these profound science questions requires continued progress on the scientific priorities identified by NASEM through their Decadal Surveys. Furthermore, support for national priorities in science and exploration will enable new opportunities for cross-disciplinary science. In addition to responding to guidance provided by the scientific community, national priorities can also be defined by the Administration and Congress.

STRATEGY 1.1

Execute a balanced science program based on discipline-specific guidance from the National Academies of Sciences, Engineering, and Medicine, Administration priorities, and direction from Congress.

The 2021 U.S. Space Priorities Framework states, "The United States will maintain its leadership in space exploration and space science. The United States will remain a global leader in science and engineering by pioneering space research and technology that propels exploration of the Moon, Mars, and beyond." NASEM provides guidance that helps SMD achieve a balanced portfolio built on the pillars of scientific and technical excellence. Through the Decadal Survey process, the scientific community provides input on key science drivers and recommends the balance between strategic-scale missions, competitively selected small and mid-scale missions, technology programs, and research and analysis programs. This guidance is designed to lead the science community by focusing on the highest priority science questions the Nation should be addressing and highlighting areas of opportunity to grow the scientific community’s capabilities, helping SMD execute the strategy. Each division director within SMD is responsible for managing the division’s portfolio in accordance with this guidance, with NASEM assessing progress against the Decadal Surveys through mid-term reviews. Implementation of Decadal Survey recommendations is modified to reflect existing budgets, particularly when funding for new missions is different from assumed levels in the Decadal Surveys.

Astrophysics

Photo Credit: ***NASA, ESA, CSA, STScI, Olivia C. Jones (UK ATC), Guido De Marchi (ESTEC), Margaret Meixner (USRA)***
This is a James Webb Space Telescope image of NGC 346, a massive star cluster in the Small Magellanic Cloud, a dwarf galaxy that is one of the Milky Way's nearest neighbors. With its relative lack of elements heavier than hydrogen and helium, the NGC 346 cluster serves as a nearby proxy for studying stellar environments with similar conditions in the early, distant universe. Ten, small, yellow circles overlaid on the image indicate the positions of the ten stars surveyed in this study.

Astrophysics is humankind's scientific quest to discover the origin of the universe and of life itself. Three questions — how does the universe work? how did we get here? are we alone? — form the basis of the three astrophysics science themes: Physics of the Cosmos (PCOS), Cosmic Origins (COR), and Exoplanet Exploration (ExEP). Basic research and flight missions combined advance the progress in these three areas. In this quest, astrophysics is guided by NASEM's *Pathways to Discovery in Astronomy and Astrophysics for the 2020s*, which identifies the science goals and technology priorities informing our investment decisions.

Basic research synthesizes the data from our missions to create new knowledge and advance our understanding of the universe; leading to new questions, which motivate new measurements and new missions. The Astrophysics Research Program includes competed programs in data analysis, theory, technology development, and suborbital projects. Small and medium missions are undertaken as competitively selected, Principal Investigator-led Pioneers, Explorers, and Probe missions. Large strategic missions are directed to NASA Centers for implementation and are managed within the Astrophysics Strategic Missions Program.

Biological and Physical Sciences

Photo Credit: ***NASA***
The C4 Photosynthesis in Space Advanced Plant Experiment-09 investigation will study how two grasses (Brachypodium distachyon and Setaria viridis), with different approaches to photosynthesis, respond to microgravity and high carbon dioxide levels during the spaceflight.

The Biological and Physical Sciences Division pioneers scientific discovery and enables space exploration by using space environments to conduct investigations not possible on Earth. Many of the results also benefit life on Earth. Examples include:

- Studying how prolonged exposure to extreme conditions, such as reduced gravity and space radiation, affects living things sheds light on human disease and aging
- Performing high-precision tests of General Relativity and Quantum Mechanics in near-absolute zero temperatures to inform the development of quantum technologies
- Studying dynamic colloidal systems—substances consisting of particles dispersed through another substance (such as gels, foams, etc.)—to aid the development of novel materials ranging from consumer products to computers that use light instead of electricity

To go farther and stay longer in space, we must understand the combined effects of deep space- stressors on humans, plants, and animals to protect life on long-duration missions. We must also be able to make, not take, supplies while probing the far reaches of our solar system. These endeavors can lead to advancements across a variety of sectors, from biomedicine and agriculture to power sources and construction, among others. We also frequently partner with academic institutions, commercial industry, international organizations, and other government agencies to conduct research, and share facilities, data, materials, and knowledge. BPS's broad range of research platforms spans ground-based facilities, suborbital, low Earth orbit (including the International Space Station and emerging commercial platforms), and eventually the lunar orbit and surface. This breadth of platforms allows investigators to progress technology development and refine experimental design. BPS research is currently guided by the National Academies of Sciences' "Thriving in Space – Ensuring the Future of Biological and Physical Sciences Research: A Decadal Survey for 2023-2032." The report includes recommendations to implement a comprehensive strategy and vision for transformative science at the frontiers of biological and physical sciences research in space across three key science themes: adapting to space, living and traveling in space and probing phenomena hidden by Earth. The report also recommends two new research campaigns: Bioregenerative Life support Systems (BLiSS) and Manufacturing mATeRials and ProcessEs for Sustainability in Space (MATRICES).

Earth Science

Photo Credit: ***NASA***
Vast numbers of phytoplankton color the Barents Sea in various shades. The brightest colors may indicate that coccolithophores are present. These tiny protists make and shed tiny calcite plates that reflect sunlight back to space. This image was taken by the Ocean Color Instrument (OCI) sensor aboard the PACE satellite on August 8, 2024.

NASA Earth Science explores our rapidly changing world, where natural and human influences interact. Today, NASA has over 25 Earth Science missions orbiting the planet with more to come in 2025. These missions have advanced our understanding of our home planet and are the foundation on which we are building our future suite of capabilities with the Earth System Observatory (ESO), which will help us address the most urgent needs identified by the National Academies 2017 Decadal Survey.Studying Earth in an integrated way is essential to understanding the cause and consequences of climate variability and other global environmental concerns. While much remains to be discovered about the natural and human induced- processes and the complex coupling at the heart of these shifts, one thing is clear: NASA's measurements are critical to understanding our interconnected Earth system.

Ultimately, NASA's goal is to deliver actionable Earth science information to decisionmakers at every level. In 2023 and 2024, NASA opened two Earth Information Centers (EIC), which are physical and virtual access points for people – anybody – to equitably access information about how their dynamic planet is changing.

Using the recommendations of the 2017 NASA Earth Science Decadal Survey (2017-2027 Decadal Survey for Earth Science and Applications from Space) as a compass, and associated Midterm Assessment released in 2024, NASA Earth Science is developing the observing systems that will answer the most important and pressing science and application questions of the next decade across the following areas:

- Coupling of the water and energy cycles
- Ecosystem change
- Extending and improving weather and air quality forecasts
- Reducing climate uncertainty and informing societal response
- Sea-level rise
- Surface dynamics, geological hazards, and disasters

Heliophysics

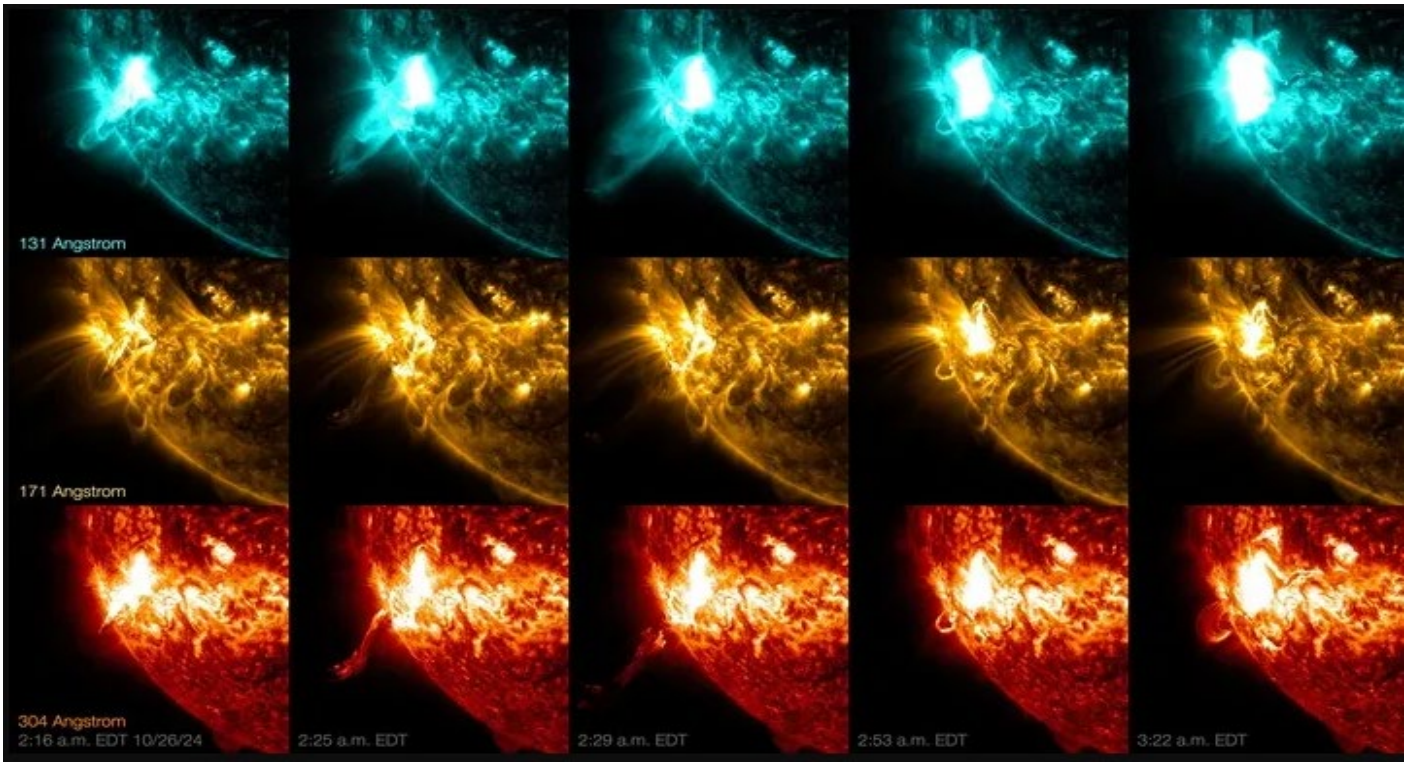

Photo Credit: ***NASA***
NASA's Solar Dynamics Observatory captured these images of a solar flare — seen as the bright flash in each of the three image panes — on Oct. 26, 2024. The images show three different subsets of extreme ultraviolet light that highlight the extremely hot material in flares and which are colorized in teal, gold, and red.

NASA's Heliophysics program embraces the original "first light" of scientific wonder - the Sun, and how it influences the very nature of space. Our nearest star sends out a steady outpouring of particles and energy, the solar wind, which forms an extensive and dynamic solar atmosphere impacting all the planets. This solar atmosphere extends far out to the edge of the heliosphere, shaping the protective bubble in which our solar system travels around the Milky Way. The scope of heliophysics is vast, spanning from the Sun's interior to Earth's upper atmosphere, throughout interplanetary space, to the edges of the heliosphere, where the solar wind interacts with the local interstellar medium.

Released in late 2024, a new National Academies' decadal survey, "The Next Decade of Discovery in Solar and Space Physics", presents a two-part vision: To discover the secrets of the local cosmos and to expand and safeguard humanity's home in space. The decadal survey identifies three science themes and a set of guiding questions for the next decade: Sun-Earth-Space, A Laboratory in Space, and New Environments. Heliophysics incorporates studies of the interconnected elements into a single system that produces dynamic space weather that evolves in response to solar, planetary, and interstellar conditions. Studying this system allows us to discover the fundamental physics governing how the universe works and helps protect our technology and astronauts in space from the impacts of space weather. The study of the coupled solar-terrestrial system can also teach us more about the habitability of planets in other stellar systems throughout the universe.

Planetary Science

Photo Credit: ***NASA/Johns Hopkins APL***
This illustration shows NASA's Dragonfly rotorcraft-lander approaching a site on Saturn's exotic moon, Titan. Taking advantage of Titan's dense atmosphere and low gravity, Dragonfly will explore dozens of locations across the icy world, sampling and measuring the compositions of Titan's organic surface materials to characterize the habitability of Titan's environment and investigate the progression of prebiotic chemistry.

Planetary science is a grand enterprise undertaken for the benefit of all humanity. Through the observation and discovery of complex planetary worlds and objects, we seek to understand our solar system and the distribution of life within it. The NASA Planetary Science strategic objective is to advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space. The scientific foundation of this endeavor is NASEM's 2022 planetary science decadal survey, *Origins, Worlds, and Life; A Decadal Strategy for Planetary Science and Astrobiology 2023–2032*. NASA pushes the limits of spacecraft, as well as robotic engineering design and operations, to implement this vision and manages a diverse portfolio of research and technology development that secures maximized science return for resources invested.

The excitement of venturing further with planetary science exploration is coupled with unique mission investigations spanning the full Solar System, from Mercury all the way to the Kuiper belt, where NASA's New Horizons spacecraft continues its journey. The OSIRIS-REx mission successfully completed sample collection at asteroid Bennu in 2020 and delivered samples to Earth in September 2023.Recent analyses of rock and dust from asteroid Bennu have revealed molecules that, on our planet, are key to life, as well as a history of saltwater that could have served as the "broth" for these compounds to interact and combine. The findings do not show evidence for life itself, but they do suggest the conditions necessary for the emergence of life were widespread across the early solar system, increasing the odds life could have formed on other planets and moons.

NASA is also currently operating spacecraft at Mars, Jupiter, and the Moon. The Perseverance Rover, which has been operating on Mars since February 2021 searching for evidence of past microbial life, has collected more than 20 scientifically selected and return-worthy rock core, regolith, and atmospheric samples as part of the preparations for NASA's bold Mars Sample Return campaign that will enable decades of science analysis. NASA also launched a mission to Jupiter's moon Europa, as its subsurface ocean has great potential to harbor extraterrestrial life. Our Moon holds important information about the formation of our planet, resources for living and

working in space, traveling farther into space, and strategic and economic opportunities. Knowledge gained by future human missions to the Moon will be utilized to visit Mars and possibly other solar system bodies, in concert with continued robotic missions. In the wake of the successful DART mission, continued efforts to detect, track, and characterize near-Earth objects will continue to improve planetary defense.

STRATEGY 1.2

Participate as a key partner and enabler in the Agency's exploration initiative, focusing on scientific research of, on, and from the Moon, lunar orbit, Mars, and beyond.

Exploration is a NASA staple. Space Policy Directive-1 calls on NASA to "lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities. Beginning with missions beyond low Earth orbit, the United States will lead the return of humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations." As its next step in human space exploration, NASA's Artemis program is preparing to send the first woman and first person of color to the Moon in mid-2027. SMD is a direct contributor to this national priority through ongoing investments in fundamental research and science and technology payloads, support for commercial landers and payloads, and lunar samples. Our active collaboration with commercial and international partners opens new opportunities of scientific exploration of the Moon.

Private lander blue Ghost's shadow is seen on the moon's surface after touching down on the moon with NASA payloads, March 2, 2025.

SMD is leading NASA's Commercial Lunar Payload Services (CLPS) initiative to enable rapid, frequent, and affordable access to the lunar surface and cislunar space. In addition to science investigations, early CLPS deliveries will include valuable technology demonstration payloads to inform the development of future exploration systems needed for humans to return to the lunar surface. NASA has already launched three payloads to the surface with additional landers, power sources, and science experiments to come. NASA is currently using the commercial providers to deliver over 40 payloads to five lunar surface destinations in the next several years and future annual solicitations will provide PI-led science payload suites for deliveries. NASA will soon maintain a cadence of approximately two CLPS deliveries per year, providing ample opportunities not only for SMD, but ESDMD, SOMD, STMD and our international partners for years to come.

SMD will continue to seamlessly collaborate with the Exploration Systems Development (ESDMD), Space Operations (SOMD), and Space Technology (STMD) Mission Directorates, as well as their partners, to further these mutual national objectives:

- Robotically assess environmental constraints that could impact crew safety and resource availability at the Moon, Mars, and beyond;
- Develop opportunities across all science disciplines that leverage investments in human exploration towards performing high-priority science, using novel platforms, and robotic and human-assisted research paradigms; and
- Engage across the Agency to ensure that its technological approaches are aligned with Agency investments in platform technologies, and feed forward towards science and human exploration goals, where appropriate.

STRATEGY 1.3

Advance discovery in emerging fields by identifying and exploiting interdisciplinary opportunities between traditional science disciplines.

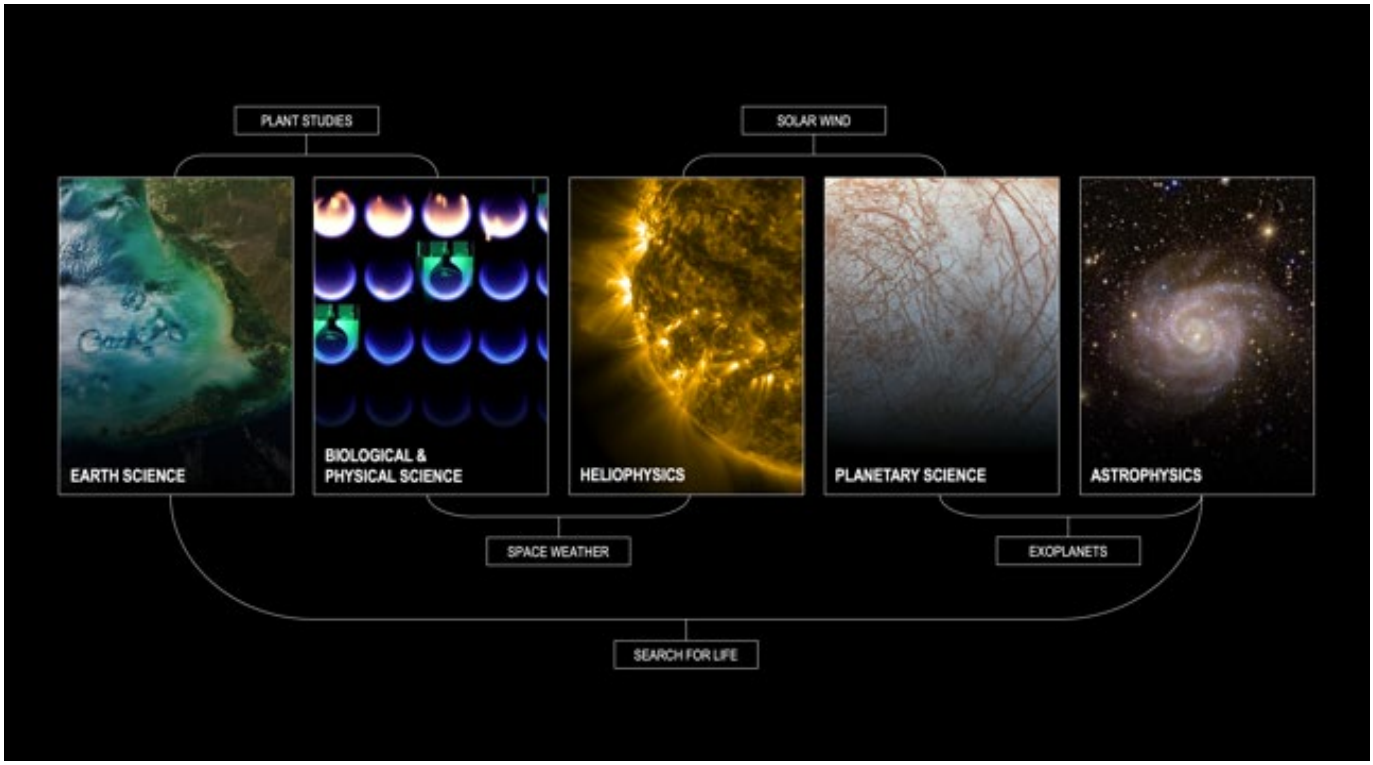

Illustration: Cross collaboration between disciplines within NASA's Science Mission Directorate

SMD has traditionally operated within the disciplines identified in Strategy 1.1. We recognize that there is tremendous potential to make revolutionary scientific advances, not just within these disciplines, but also at the interfaces between and among disciplines. SMD therefore seeks to provide opportunities for integrated, interdisciplinary research that encourages collaboration. To be successful, SMD must balance the ownership of these opportunities to ensure consistency and alignment to the program of record. For example, SMD restructured its Exoplanet Research Program to better function as a cross-divisional program involving personnel and funding from all science divisions. SMD also adopted a new process to evaluate these proposals by topic, with panels that are agnostic to the common funding sources of the Principal Investigators (PI).

There are many cross-cutting opportunities between disciplines within SMD, as well as across the agency. Within the directorate, synergies exist between astrophysics, biological and physical sciences, heliophysics, planetary science, and Earth science that could result in both fundamental and applied advancements.

The Exoplanet Research Program serves as a model for collaboration among disparate disciplines. For example, emerging opportunities exist to use Earth as a laboratory in support of habitability and to answer questions from the heliophysics domain. SMD surveys the scientific community for feedback on suggested research areas for cross-divisional collaboration not currently solicited by the existing grants programs.

STRATEGY 1.4

Develop a broadly applicable, target-audience focused approach to SMD's applied programs, including Earth Science Applications, Space Weather, Planetary Defense, and Space Situational Awareness.

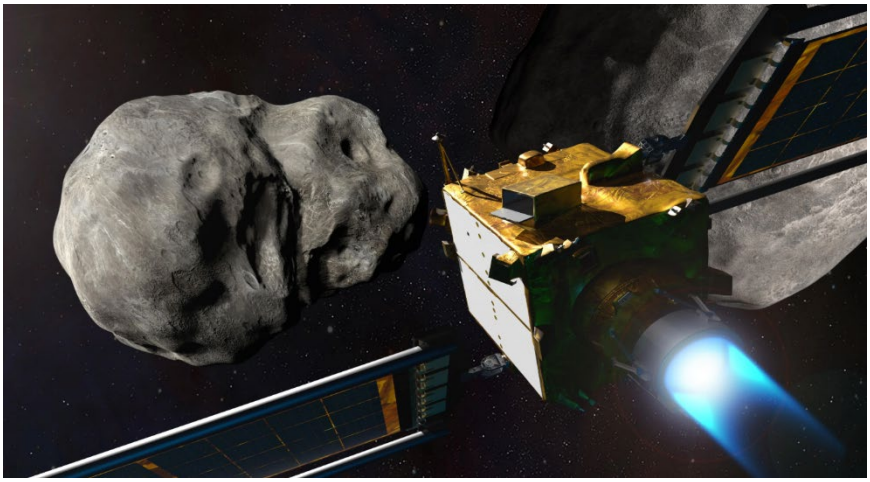

Illustration: NASA's Double Asteroid Redirection Test (DART), built and managed by the Johns Hopkins Applied Physics Laboratory (APL) for NASA's Planetary Defense Coordination Office (PDCO), was the world's first planetary defense technology demonstration that validated one technique of asteroid deflection using a kinetic impactor spacecraft. Launched November 24, 2022, on a SpaceX Falcon 9 rocket, DART traveled for over 10 months before intentionally colliding with the asteroid moonlet Dimorphos, a small celestial object just 530 feet (160 meters) in diameter.

One of SMD's goals is to protect and improve life on Earth. To accomplish this, we will build on our long-standing work on Earth Science Applications and expand our approach to providing applied information in the areas of Space Weather, Planetary Defense, and Space Situational Awareness. It is our intent to develop a NASA-wide strategy across these different research areas, engaging directly and through our partnerships with operational agencies and user communities, to influence best practices that meet the needs of the communities our data can positively affect. As these capabilities mature, there may be opportunities for commercialization that would increase the return on investment of NASA research and foster commercial innovation.

PRIORITY 2
INNOVATION

STRATEGY 2.1: Foster a culture that encourages innovation and entrepreneurship across all elements of the SMD portfolio.

STRATEGY 2.2: Foster a culture that encourages collaboration in pursuit of common goals.

STRATEGY 2.3: Enhance our focus on high intellectual risk/high impact research investments.

STRATEGY 2.4: Drive innovation in focused technology areas to capitalize on the rapid evolution of commercial capabilities.

STRATEGY 2.5: Ensure NASA's science data are accessible to all and produce practical benefits to society.

Excellence is achieved through continuous innovation and learning. SMD recognizes that innovation and measured risk-taking are the cornerstones of a forward-looking program of scientific discovery. This boldness in vision must be coupled with tailored management processes. To answer the science questions defined in Priority 1, we must rely on innovation. We currently have programs in place to identify and mature technologies in support of future missions, but we must also be ready to take advantage of revolutionary new capabilities as they are developed. Therefore, we have identified four innovation strategies to enable both incremental steps and giant leaps in knowledge.

STRATEGY 2.1

Foster a culture that encourages innovation and entrepreneurship across all elements of the SMD portfolio.

Measured risk-taking is a necessary part of progress and SMD seeks to create an environment in which risk-taking is encouraged and transparently managed. To do this, SMD operates a coherent and strategic directorate-wide innovation ecosystem, including early-stage technology identification, technology development and maturation, and ultimately transition to flight. We recognize that not all innovation will be successful, and that room for experimentation and failure should be allowed during the developmental process.

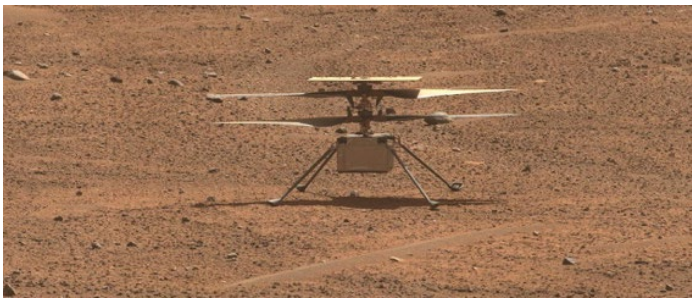

Photo Credit: ***NASA/JPL-Caltech***
This view of NASA's Ingenuity Mars Helicopter was generated using data collected by the Mastcam-Z instrument aboard the agency's Perseverance Mars rover on Aug. 2, 2023, the 871st Martian day, or sol, of the mission. The image was taken a day before the rotorcraft's 54th flight, and about a week and a half after Flight 53, which was cut short by an unexpected landing.

While the importance of innovation and experimentation is significant, proactive communication about the risks associated with a particular mission concept, early investments in technology development, and other risk reduction efforts are key components of this strategy.

We often think about risk-management in the context of a single project rather than the overall risk posture of the entire SMD enterprise. SMD is seeking to support innovation through both its competed and directed work by using a portfolio-level approach, allowing SMD to take varying risk postures between missions, depending on their scale, and tailor management processes accordingly. For competitive opportunities, SMD must encourage and reward proposers for novel approaches towards scientific discovery, when they are accompanied by realistic risk maturation processes. SMD recognizes that taking risks means accepting occasional failures. In addition, clear lines of authority and accountability for risk-related activities are necessary for proper management. SMD is also committed to foster a sense of entrepreneurialism in its research community and uses a combination of approaches, including citizen science opportunities and prize competitions and challenges.

STRATEGY 2.2

Foster a culture that encourages collaboration in pursuit of common goals.

Innovative management of an executable, compelling and exciting portfolio is accomplished by balancing both large and directed missions with medium to small-sized and competed missions. The selection of missions with a determined cadence and cost-cap encourages the scientific community to present impactful and diverse ideas to meet emerging priorities. Sound planning prevails as missions exist in various stages of formulation—development, prime operations, and extended operations—wherein high return on investment has been proven. Finally, coordination is promoted between missions, research and analysis, technology and supporting infrastructure.

SMD is committed to continual learning and improvement. We collect lessons learned and best practices and apply them to all elements of the organization as appropriate. While each division within the organization has been established to align with the needs of the communities they serve, areas of mutual interest that overlap between divisions do exist. This creates opportunities for one division to pilot new ways of doing business, and for the other divisions to adopt them. To the extent possible, SMD uses cross-divisional teams to respond to strategic opportunities or issues that impact the entire organization and uphold its mission toward excellence.

STRATEGY 2.3

Enhance our focus on high intellectual risk/high impact research investments.

SMD invests in research that can have transformational impacts on our understanding of the world around us. Our research programs provide opportunities for the science community to offer new ideas and new approaches towards scientific discovery. We recognize that the peer review process used to make investment decisions may inadvertently discourage innovative concepts, and therefore we regularly seek to be more proactive in encouraging high intellectual risk, high-impact research proposals.

STRATEGY 2.4

Drive innovation in focused technology areas to capitalize on the rapid evolution of commercial capabilities.

While NASA invests heavily in new technologies to meet its needs, there are also opportunities to translate technologies from outside entities into NASA concepts. In some cases, these technologies present opportunities for NASA to capitalize on the investments of others to reduce mission costs and yield more advanced science capabilities. SMD must remain flexible in its mission design approach to enable enhanced collaborations with other government agencies and the commercial sector to best take advantage of these new modalities.

Photo Credit: *Axiom Space*
A digital rendering of the completed Axiom Station, which includes the Payload, Power, and Thermal Module, Habitat 1, an airlock, Habitat 2, and the Research and Manufacturing Facility.

SMD also looks at opportunities to host science instruments on commercial satellites. These opportunities enable NASA to secure lower-cost access to space, such as Venture-Class Acquisition of Dedicated and Rideshare (VADR) missions, while leveraging existing commercial capacity, demand, and expertise. Similarly, SMD actively searches for opportunities where commercial entities enable different capabilities (new launches, research platforms, etc.) or new, service-based business models. The Commercial Lunar Payload Services (CLPS) initiative is one such endeavor that provides rapid, frequent, and affordable access to the lunar surface as the ultimate test bed for exploration and technology developments. As NASA plans to retire the ISS, SMD has been actively engaged in planning for future microgravity and low-earth orbit opportunities for science. This includes the NASA Low Earth Orbit (LEO) Strategy. In all cases, the criteria for collaboration include "enabling new science" or resulting in "more science per dollar." To find such novel partnerships, experimentation is key. Notably, SMD makes commercial suborbital platforms available to SMD-sponsored investigators alongside NASA-provided platforms. This allows investigators to propose nimble and innovative payloads to be flown on commercial suborbital platforms.

STRATEGY 2.5

Ensure NASA's science data are accessible to all and produce practical benefits to society.

To ensure NASA's science data are accessible to all and produce practical benefits to society, SMD undertakes investments and initiatives that accelerate the accessibility and use of SMD data by its user community. This entails the following: 1) capabilities to enable open science; 2) continuous evolution of data and computing systems; and 3) community and strategic partnerships for innovation. NASA is making a long-term commitment to building an open science community over the next decade. Open science is a commitment to the open sharing of software, data, and knowledge (algorithms, papers, documents, ancillary information) as early as possible in the scientific process. The principles of open science are to make publicly funded scientific research transparent, available, and reproducible. Advances in technology, including collaborative tools and cloud computing, help enable open science, but technology alone is insufficient. Open science requires a shift to a more transparent and collaborative scientific process, which will increase the pace and quality of scientific progress. The Office of the Chief Science Data Officer (OCSDO) works to advance transformative open science as part of its activities.

PRIORITY 3
INTERCONNECTIVITY AND PARTNERSHIPS

STRATEGY 3.1: Actively engage with the NASA Centers to make more informed strategic decisions that further NASA's scientific goals and are aligned with each Center's unique capabilities.

STRATEGY 3.2: Actively seek collaborations with international partners based on their unique capabilities and mutual scientific goals.

STRATEGY 3.3: Actively engage with other federal agencies to make more informed decisions, cooperate in scientific research, and pursue partnerships that further national interests.

STRATEGY 3.4: Provide increasing opportunities for research institutions, including academia and non-profits, to contribute to SMD's mission.

SMD directly supports researchers in their pursuit of knowledge because scientific discovery does not occur in isolation. SMD recognizes the important role that NASA Centers, other federal agencies, private industry, academia, non-profits, community- based organizations, and international partners play in helping make our scientific vision a reality.

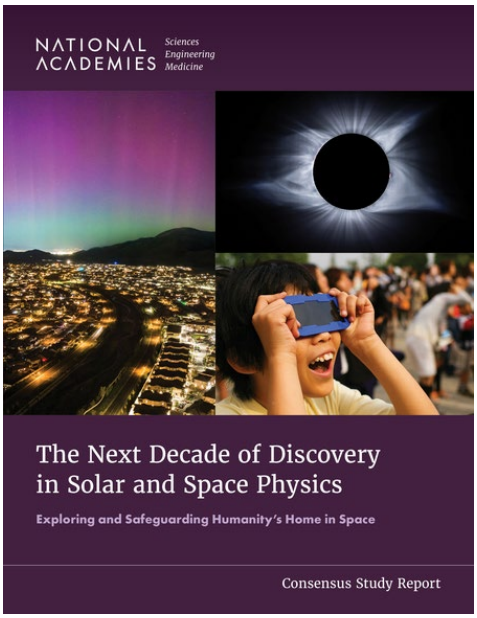

Photo Credit: ***National Academies of Sciences, Engineering, and Medicine***
The Next Decade of Discovery in Solar and Space Physics: Exploring and Safeguarding Humanity's Home in Space, a National Academies' decadal survey, presents a prioritized strategy for basic and applied research to advance scientific understanding of the heliosphere and the origins of space weather, the Sun's interactions with other bodies in the solar system, and the interplanetary and interstellar mediums.

Strategic partnerships that influence each contributor's strengths and interests can be an effective means of yielding advances in science and understanding for mutual benefit. Similarly, SMD has an opportunity to partner with other U.S. agencies to help further national interests in a coordinated and efficient manner. Building on a strong foundation of existing partnerships and relationships, SMD seeks to regularly leverage these relationships, and build new ones, to advance SMD and Agency goals.

STRATEGY 3.1

Actively engage with the NASA Centers to make more informed strategic decisions that further NASA's scientific goals and are aligned with each Center's unique capabilities.

SMD and NASA Center leadership will create a shared understanding of the important technical capability priorities for each center that are renowned within the community and work to implement SMD programs and projects, requiring knowledge of the health and capabilities at each NASA Center.

These prioritized capabilities will guide focused investment decisions at the portfolio level. SMD will ensure that roles and responsibilities are aligned with each NASA Center's unique strengths and ability to manage work. SMD is also engaged in activities that develop both talent and technical capabilities at the NASA Centers to ensure that future needs can be met.

NASA Centers should be seen as “employers of choice” that attract recent graduates, mid-career scientists and engineers, and provide exchange and career growth opportunities for employees.

STRATEGY 3.2

Actively seek collaborations with international partners based on their unique capabilities and mutual scientific goals.

Scientific discovery is a global endeavor and SMD empowers the scientific community worldwide. More than 2/3 of SMD’s missions are international collaborations. The directorate has nearly 350 active international agreements involving nearly 140 countries and regions. With growing international interest in space exploration, the competition for partnerships among space agencies is increasing. We are aware of, and informed by, the context of economic competitiveness and national security concerns in the areas in which we work.

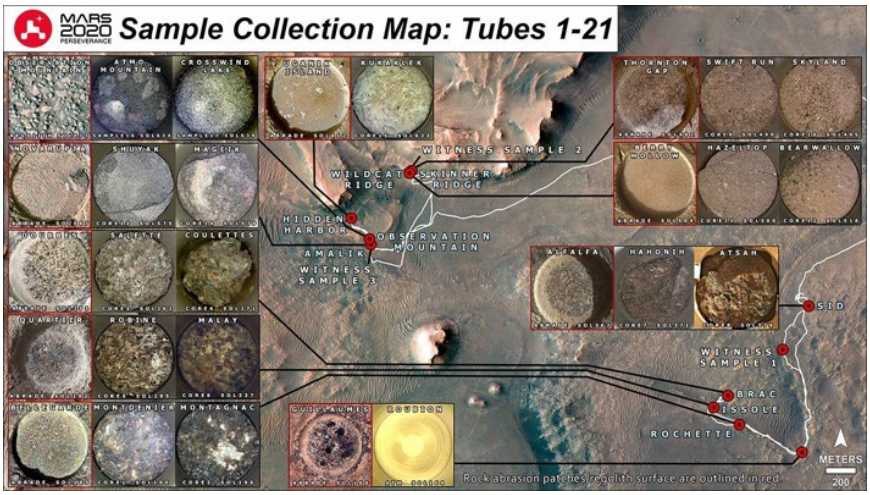

Photo Credit: ***NASA/JPL-Caltech***
Shown here is a representation of the 21 sample tubes (containing rock, regolith, atmosphere, and witness materials) that have been sealed to date by NASA’s Perseverance Mars rover. Red dots indicate the locations where each sample was collected.

We seek to be the partner of choice in Earth and space science, and to contribute to the nation’s diplomatic goals. SMD regularly seeks ideas for innovative programs that could, in advancing scientific objectives, help cultivate increased capacity in emerging partner nations and promote NASA best practices and values.

While demonstrating U.S. leadership in Earth and space science is vital for SMD, partner capabilities and resources should be weighed while mission leadership decisions are being made to advance scientific discovery. This strategic goal is assisted by SMD’s policy to initiate international partnerships strategically. SMD’s process for initiating NASA contributions to international partner-led missions are guided by a set of criteria contained in SPD-37, “Principles for Collaborations on Missions with International Partners.”

STRATEGY 3.3

Actively engage with other federal agencies to make more informed decisions, cooperate in scientific research, and pursue partnerships that further national interests.

SMD continues to strategically evolve our partnerships with other organizations across the federal government in pursuit of common interests and priorities. These partnerships can take different forms, from enabling new missions to improving our understanding of common areas of study to developing technology for each other’s missions. These partnerships also facilitate the transfer of knowledge between agencies to enhance our

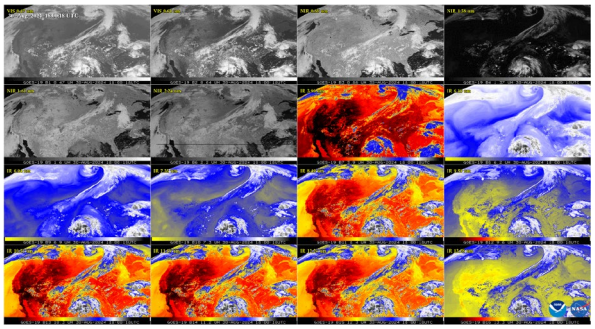

Photo Credit: ***NOAA/NASA***
This GOES-19 image shows the contiguous United States observed by each of the ABI’s 16 channels on Aug. 30, 2024. This 16-panel image shows the ABI’s two visible, four near-infrared and 10 infrared channels. The different appearance of each band is due to how each band reflects or absorbs radiation.

overall contribution to the Nation. Our interests may evolve over time to ensure continued alignment to national and Agency priorities, and to capitalize on each partner's unique strengths.

STRATEGY 3.4

Provide increasing opportunities for research institutions, including academia and non-profits, to contribute to SMD's mission.

NASA's missions and grants help fuel the vibrant research community across the United States and are already making significant contributions to answer the science questions defined in Priority 1. The research community is the major source of new science questions and innovative mission concepts. SMD regularly adjusts calls for proposals in response to the science community's feedback on alternative ways to make scientific measurements, in addition to emerging national needs and priorities.

We will also continue to make improvements to the scientific competition process to be responsive to researcher needs. The use of No Due-Date (NoDD) programs is a regular offering in SMD, affording greater flexibility to researchers and reviewers alike. NoDD programs can also enable healthier work-life balance strategies for individual PIs and provide institutions with less-robust proposal support systems greater flexibility in submitting proposals.

To continue our trajectory of scientific progress, we must recognize the role research institutions play in developing new talent, and be supportive of these efforts. SMD will increase that support by actively encouraging students and early career researchers to take a more hands-on approach with our missions and research. These efforts align to support the development of a talented future workforce directly advancing SMD's mission.

STRATEGY 3.5

Pursue public-private partnerships in support of shared interests with industry.

SMD seeks to foster an environment that allows for more cost-effective approaches to enable new scientific discovery and innovation. Consistent with the principles for commercial partnerships outlined below, we are committed to partnering with the U.S. aerospace industry and will continually assess partnership models, including traditional contractor relationships and emerging public-private partnerships, to advance important science objectives as well as to engage the public in our efforts. NASA's now regular use of SmallSats and CubeSats began with commercial engagement. Additionally, SMD leverages commercial data buys (and provides calibration and validation services to commercial providers) and leverages rideshare opportunities and commercial lunar payload transport services. Earth Science also engages with non-traditional partners in the commercial and NGO sectors, such as Conservation International, Google, Mercy Corps, and Microsoft. New partnership models will require opportunities for commercial providers to demonstrate their capabilities through targeted experiments that provide a more in-depth understanding of alternative mission architectures, data acquisition approaches, and data licensing agreements. Beyond influencing industry's expertise to meet the Agency's goal, SMD is also committed to working in tandem with private sector partners to address shared challenges, such as orbital debris mitigation and spaceflight safety coordination.

SMD Principles for Commercial Partnerships

1. Develop strategic partnerships that leverage the unique strengths of each contributor to drive scientific progress.
2. Actively pursue partnerships that innovate both in *what* we do with commercial partners as well as in *how* we do it.
3. Continually assess and evolve partnership models, recognizing that experimentation is key and that some experiments may fail.
4. Evaluate the success of traditional and nontraditional partnerships by determining if these result in “enabling new science” and in “more science per dollar.”
5. Encourage and assess potential obstacles to Principal Investigator adoption of commercial solutions to illustrate market demand from the science community.
6. Leverage existing commercial capacity, demand, and expertise, while exploring emerging business areas where early adoption can support domestic growth and competitiveness.
7. Build on investments in partnerships across NASA and other parts of the government, sharing NASA best practices.
8. Accept some additional risk responsibly in the interest of establishing affordable, high-value domestic capabilities.

PRIORITY 4
INSPIRATION

STRATEGY 4.1: Expand the range of expertise and perspectives across the entire SMD portfolio by fostering a collaborative and dynamic research environment.

STRATEGY 4.2: Optimize the scientific competition process to ensure the broadest participation of talent and ideas, enhancing the overall quality and impact of NASA Science.

STRATEGY 4.3: Purposefully and actively engage with audiences and learners of all ages to share the story of NASA's integrated science program.

SMD inspires the learners of today and develops the leaders of tomorrow. The success of these efforts not only benefits NASA, but also strengthens our partners identified in Priority 3. We understand that strong, well-rounded teams create better, faster, and more innovative solutions and breakthroughs. To that end, we are dedicated to fostering strong teams that deliver the best science.

STRATEGY 4.1

Expand and preserve the range of expertise and perspectives across the entire SMD portfolio by fostering a collaborative and dynamic research environment.

Photo Credit: ***NASA/Keegan Barber***
Guests learn about the total solar eclipse from NASA staff at the Dallas Arboretum, Monday, April 8, 2024, in Dallas, Texas.

Innovation in science is driven by the integration of diverse ideas, methodologies, and problem-solving approaches. This strategy focuses on enhancing the depth and breadth of expertise across the SMD by encouraging interdisciplinary collaboration, attracting talent from a wide range of scientific domains, and fostering environments where new ideas can thrive. By promoting diverse research approaches and encouraging fresh perspectives, NASA can strengthen its ability to tackle complex scientific challenges and push the boundaries of discovery.

STRATEGY 4.2

Optimize the scientific competition process to ensure the broadest participation of talent and ideas, enhancing the overall quality and impact of NASA Science.

The strength of NASA Science depends on its ability to attract the best ideas and research proposals from a wide and competitive pool. This strategy focuses on improving the scientific competition process to increase transparency, reduce barriers to entry, and expand participation across institutions and research communities. By streamlining proposal

Photo Credit: ***NASA/Bill White***
In the Swamp Works laboratory at NASA's Kennedy Space Center, student interns join agency scientists contributing to the area of Exploration Research and Technology.

processes, clarifying evaluation criteria, and supporting emerging research teams, NASA can ensure that its portfolio is continuously refreshed with high-impact ideas and innovative approaches, driving scientific excellence and long-term mission success.

SMD invests in students and early career faculty to help them grow into leaders of the future. SMD has been particularly focused on developing a new cadre of mission Principal Investigators through continuing workshops as part of the PI Launchpad initiative (https://science.nasa.gov/researchers/pi-launchpad), as well as hands-on training as part of existing mission teams. Long-duration missions, such as Hubble and Chandra missions, provide a unique opportunity to develop future leaders from within the team, and are assessed on the robustness of teams over the lifetime of the mission.

STRATEGY 4.3

Purposefully and actively engage with audiences and learners of all ages to share the story of NASA's integrated science program.

Photo Credit: ***NASA/Aubrey Gemignani***
Guests visit the "Explore Humans in Space" exhibit during the Kerrville eclipse festival in Kerrville, Texas, on Monday, April 8, 2024.

SMD creates value by transforming taxpayer investments into knowledge about the many worlds around us, and our place in them. This knowledge is used to solve problems and create a better future. But knowledge is only advanced when it is shared using the rigorous processes that science affords – replicability, peer-evaluation, publication, civil discourse, and the creation of new questions. The public should have confidence in NASA's findings, particularly when that information concerns them, their families, communities, and the world at large.

SMD's achievements inspire learners of all ages. NASA's Science Activation program's vision is for learners across the United States to become architects of their own life-long learning pathways. All learners. Through collaborations with community-based partnerships and using transdisciplinary, digital tools and real-world experiences, we enable learners to actively participate in the advancement of knowledge. For example, for the April 2024 Total Solar Eclipse across North America, over 400 NASA staff traveled across the path of totality to host various events across 7 states (Texas, Arkansas, Ohio, Indiana, Pennsylvania, New York, and Maine). 224 NASA engagement and Science Activation events were listed on the NASA eclipse website and Science Activation furthered NASA's message reaching all 50 states through public events, resource dissemination, and professional development programming for educators.

SMD reaches the American public and beyond by sharing our science and encouraging greater public understanding of our missions, research, and related activities. We disseminate science results to elevate awareness, excitement, and understanding. We do this using techniques such as storytelling to help connect the work that NASA does to people's everyday lives. We recognize that communication channels change and evolve with time, and thus our communication—just like our research—needs to be innovative and incorporate lessons learned into current practice and future

plans. SMD recently completed a website modernization effort to consolidate our public websites into an experience that not only shares our science but encourages visitors to actively participate in the excitement of discovery.

SMD also encourages opportunities for new engagements, as in citizen science projects. Volunteers can directly participate in data analysis, observations, and problem solving, thereby contributing to NASA’s science mission and the overall advancement of knowledge.

Implementation

SMD's deliberate focus on excellence is supported by governing processes and behaviors across the entire portfolio. As highlighted throughout this document, implementation efforts are ongoing and will continue to be evaluated for their success in advancing the priorities described. It is our intention to identify owners and implementation timelines to provide accountability and transparency for each of the strategies detailed in this vision. Internal processes will be used to help prioritize the strategies for implementation and communicated to the public regularly through NASA Science's many communication channels.

Appendix A: Acronym List

BPS	Biological and Physical Sciences Division
CLPS	Commercial Lunar Payload Services
COR	Cosmic Origins
ESA	European Space Agency
ESD	Earth Science Division
ESDMD	Exploration Systems Development Mission Directorate
ExEP	Exoplanet Exploration
GOLD	Global-scale Observations of the Limb and Disk
GPS	Global Positioning System
MRO	Mars Reconnaissance Orbiter
NASA	National Aeronautics and Space Administration
NASEM	National Academies of Sciences, Engineering, and Medicine
NSF	National Science Foundation
PCOS	Physics of the Cosmos
PI	Principal Investigator
PSD	Planetary Science Division
R&A	Research and Analysis
RainCube	Radar in a CubeSat
ROSES	Research Opportunities in Space and Earth Science
SMD	Science Mission Directorate
SOMD	Space Operations Mission Directorate
STScI	Space Telescope Science Institute
STMD	Space Technology Mission Directorate
TESS	Transiting Exoplanet Survey Satellite
USGS	United States Geological Survey


NASA
EXPLORE
with us