Biological and Physical Sciences

National Aeronautics and Space Administration

Lunar Science Objectives and Opportunities

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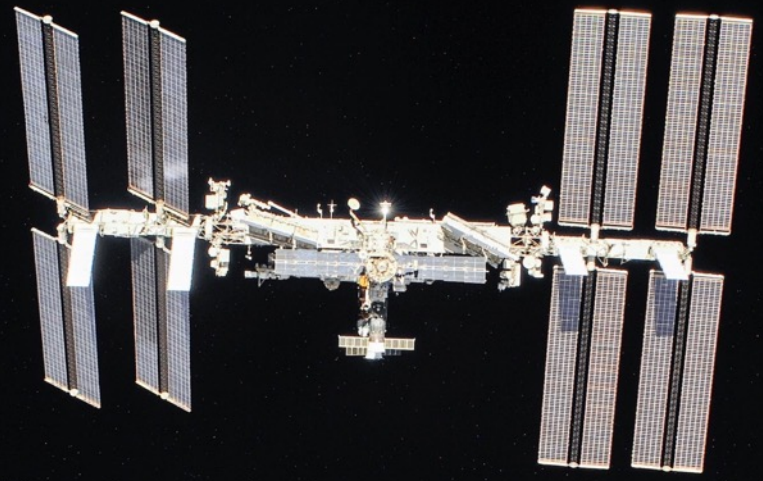
Lunar Biology Technology Workshop, April 2022



A convergence of science, technology and human innovation leading to research breakthroughs and demonstrates new capabilities **not possible on Earth**.

20 Years on the International Space Station

Lunar Exploration and BPS

Orion Capsule

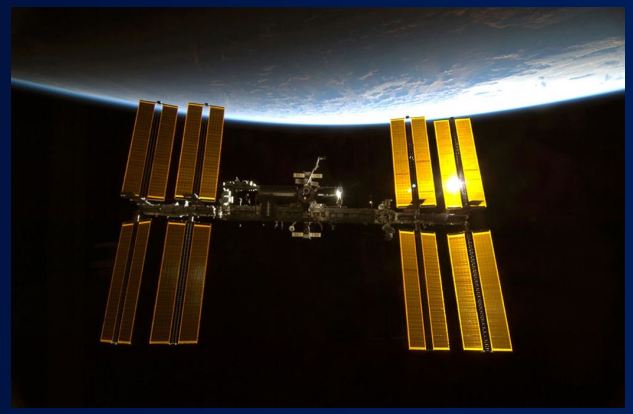
Human Landing Systems

BPS

Gateway

Base Camp

Commercial Lunar Payload Services Lander



Low Earth Orbit Platforms
- ISS, Free-Flyers, CLD, etc.

Ground-Based Research

Location-Specific and Continuum of Research Across All Platforms and Locations

NASA Strategic Plan 2022

(https://www.nasa.gov/sites/default/files/atoms/files/fy_22_strategic_plan.pdf)

Vision

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

Mission

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

BPS
Open Data Systems

Strategic Goals and Strategic Objectives

Theme	Goal Statement	Objective Statement
Discover	Expand human knowledge through new scientific discoveries	1.1: Understand the Earth system and its climate
		1.2: Understand the Sun, solar system, and universe
		1.3: Ensure NASA's science data are accessible to all and produce practical benefits to society
Explore	Extend human presence to the Moon and on towards Mars for sustainable long-term exploration, development, and utilization	2.1: Explore the surface of the Moon and deep space
		2.2: Develop a human spaceflight economy enabled by a commercial market
		2.3: Develop capabilities and perform research to safeguard explorers
		2.4: Enhance space access and services
Innovate	Catalyze economic growth and drive innovation to address national challenges	3.1: Innovate and advance transformational space technologies
		3.2: Drive efficient and sustainable aviation
Advance	Enhance capabilities and operations to catalyze current and future mission success	4.1: Attract and develop a talented and diverse workforce
		4.2: Transform mission support capabilities for the next era of aerospace
		4.3: Build the next generation of explorers

BPS

BPS
Cross-Cutting
Support

FUNDAMENTAL LUNAR SCIENCE

LIFE SCIENCES
Combined effects of fractional gravity & deep space radiation

PHYSICAL SCIENCES
Combustion, fluid dynamics, dust, material sciences

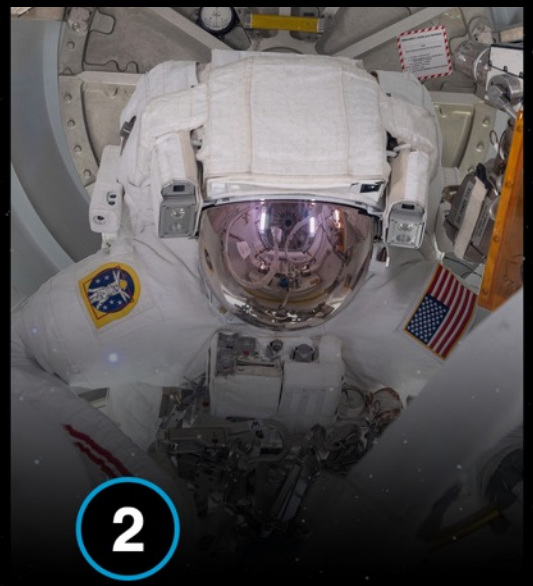
FUNDAMENTAL PHYSICS
General relativity, gravitational physics, quantum information science

FOOD/DRUG DEGRADATION

Hazards of Human Spaceflight

1 Space Radiation

Invisible to the human eye, radiation increases cancer risk, damages the central nervous system, and can alter cognitive function, reduce motor function and prompt behavioral changes.



2 Isolation and Confinement

Sleep loss, circadian desynchronization, and work overload may lead to performance reductions, adverse health outcomes, and compromised mission objectives.

3 Distance from Earth

Planning and self-sufficiency are essential keys to a successful mission. Communication delays, the possibility of equipment failures and medical emergencies are some situations the astronauts must be capable of confronting.

4 Gravity (or lack thereof)

Astronauts encounter a variance of gravity during missions. On Mars, astronauts would need to live and work in three-eighths of Earth's gravitational pull for up to two years.

5 Hostile/Closed Environments

The ecosystem inside a vehicle plays a big role in everyday astronaut life. Important habitability factors include temperature, pressure, lighting, noise, and quantity of space. It's essential that astronauts stay healthy and happy in such an environment.

Artemis III Science Definition Team Report

(available at www.nasa.gov/reports)

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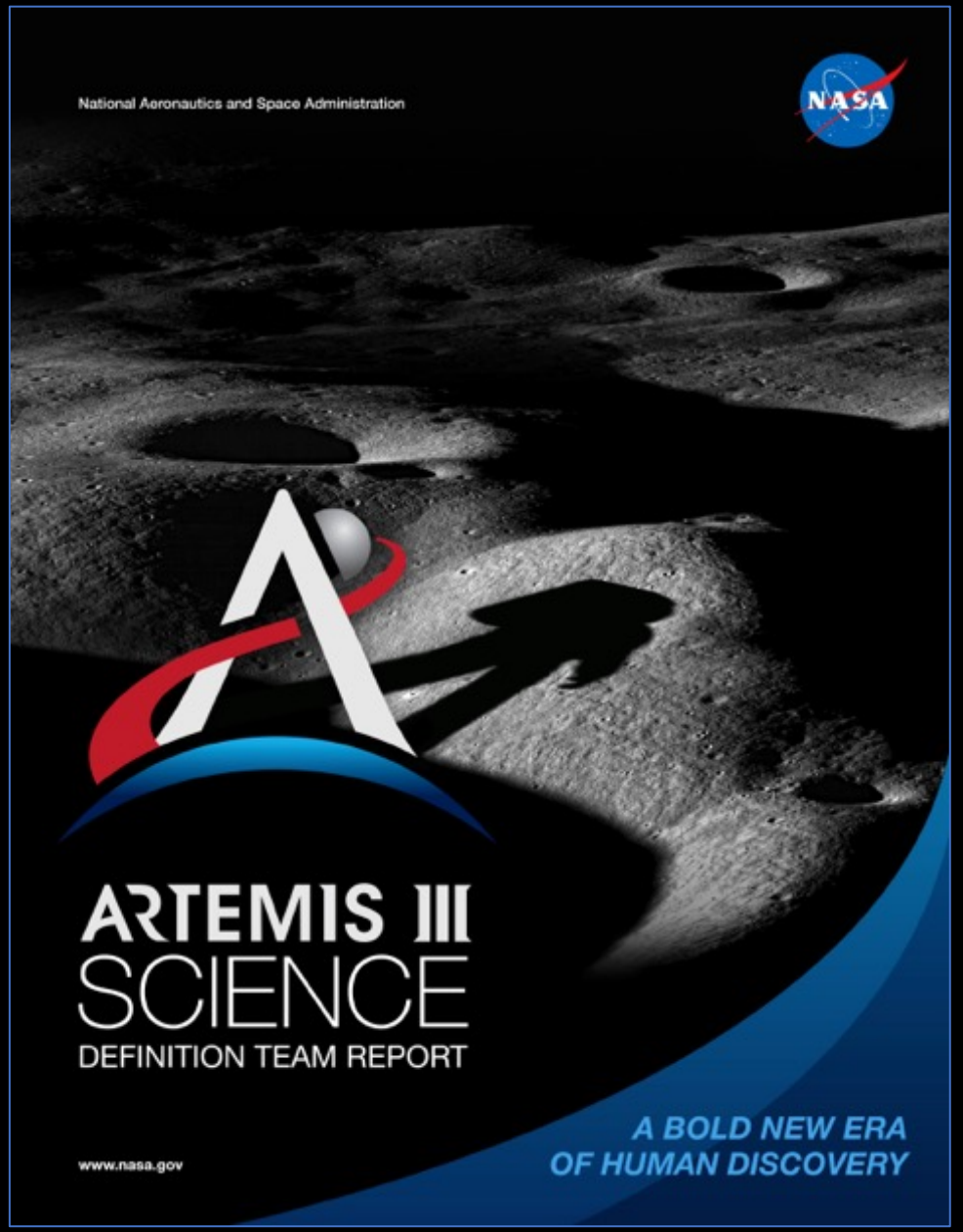

https://www.nasa.gov/sites/default/files/atoms/files/artemis-iii-science-definition-report-12042020c.pdf

Objective 7: Investigating and Mitigating Exploration Risks

- Study the fundamental biological and physiological effects of the integrated lunar environment on human health and the fundamental biological processes and subsystems upon which health depend
- Study the key physiological effects of the combined lunar environment on living systems and the effect of pharmacological and other countermeasures
- Evaluate consequences of long-duration exposure to lunar gravity on the human musculoskeletal system
- Study the effects of lunar radiation on biological model systems
- Use biological model specimens to conduct single and multigenerational studies on the long-term effects of the lunar environment and transportation to and from the Moon on biological processes
- Understand the effects/interactions of lunar gravity and the transitions between lunar gravity, microgravity, and Earth- normal gravity on reproduction and development, genetic stability, and aging
- Study the influence of the lunar environment and its effects on short- and long-term plant growth, productivity (as a food source), palatability, and nutrition
- Evaluate the use and effectiveness of model plants in ecological life support systems
- Study the effect on microbes of long-duration exposure to the lunar environment
- Assess the effect on plants of long-duration exposure to the lunar environment
- Understand lunar dust behavior, particularly dust dynamics

Funding Opportunities for Lunar Science in Cis-Lunar Orbit and on the Lunar Surface - NSPIRES

1) **Science Mission Directorate *Research Opportunities in Space and Earth Sciences* (ROSES)**
   - **Make sure you go into your NSPIRES account and subscribe any SMD Division Programs you may have an interest to receive relevant solicitation release notifications (subscribe to SMD's Space Biology, Physical Sciences, Planetary Sciences, and general subscription list at a minimum)**
2) Biological and Physical Sciences Division Solicitations – Call release and cadence is determined by the Space Biology Program
3) Payloads and Research Investigations on the Surface of the Moon (PRISM)
   - One call per year for 2 separate lunar missions through SMD Exploration Science Strategy and Integration Office
   - PRISM-3 (TBD likely mid-2022)
   - Instrument development and associated research for the Commercial Lunar Service Provider (CLPS) landers, only
   - Subscribe to Planetary Science Division (PSD) Notifications
4) Stand-Alone Landing Site Agnostic (SALSA) - CLPS-Based
5) Solar Systems Exploration Research Virtual Institute Cooperative Agreement Notices (SSERVI CAN)
6) Development and Advancement of Lunar Instrumentation (DALI)
7) Maturation of Instruments for Solar System Exploration (MatISSE) – Spacecraft instruments
8) Planetary Instruments Concepts for the Advancement of Solar System Observations (PICASSO) – Spacecraft instruments
9) Human Research Program – Human Exploration Research Opportunities (HERO)

Keep an eye out for other SMD Program solicitation notifications for lunar science research and instrument development

Important New Science Groups to Track and Participate In

1) Lunar and Planetary Institute (LPI) - https://www.lpi.usra.edu/
    - Lunar Surface Science Workshops

2) Lunar Exploration Analysis Group (LEAG) - https://www.lpi.usra.edu/leag/
    - Annual Meeting

Thank you