



THE
PLANETARY REPORT

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HUMANS IN DEEP SPACE

DARING TO LEAVE THE COSMIC SHORE

Christina Koch views Earth from Orion

NASA astronaut and mission specialist Christina Koch looks at Earth from the window of the Orion spacecraft on its way to the Moon during the Artemis II mission. At the time, Koch was already farther away than any woman has ever been from our planet.

NASA



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On the cover

This view shows the Space Launch System rocket lifting off from Cape Canaveral, Florida, in November 2022. It was the precursor to the Artemis II mission, which sent a four-person crew around the Moon in April 2026.

NASA/Chris Coleman/Kevin Davis

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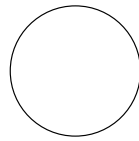
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AMBASSADORS OF EARTH



Celebrating the spirit of exploration

by Jennifer Vaughn

Humans explore. We are curious. We ask questions about what lies beyond our immediate reach. We build strategies and tools, and we take risks to help us answer them.

Humans have the key attributes that make exploration possible: curiosity, ingenuity, and perseverance. You'll probably notice that those are also the names of three NASA spacecraft that are on Mars. That's no coincidence. When we send robotic missions into the Solar System, we are extending some of our best qualities outward. These spacecraft are our surrogates — doing work we cannot yet do directly and expanding human knowledge in places too distant or dangerous for us to go.

When humans leave Earth to explore space, they are also exploring for all of us. They embody the hopes and dreams of so many of us who are bound to Earth. Unlike our robotic emissaries, they bring judgment, adaptability, and the uniquely human capacity to observe, decide, and respond in real time. They also bring something else: human perspective. When humans leave Earth, they carry our stories with them and return with new ones. This exchange has shaped how generations think about our planet and our place in the Cosmos.



▲ A crowd watches the Artemis II mission lift off. NASA/Keegan Barber

Artemis II marks more than a technical milestone. It is part of a broader effort to extend human presence beyond low Earth orbit for the first time in more than 50 years. For a generation that did not experience Apollo firsthand, Artemis offers a new chapter in our story of exploration.

While humans have orbited the Moon before, the success of Artemis II is extraordinary. The capability to send people safely beyond low Earth orbit does not simply lie dormant over decades. Rebuilding that capacity requires sustained investment, engineering rigor, and hard-earned experience. Artemis II's success is an important step in that work — one that echoes Apollo 8's first journey into lunar orbit in 1968.

In this issue of The Planetary Report, we examine the context in which the Artemis II mission took place: the policy drivers of human space exploration, the challenges that humans must overcome to extend our reach farther into the Solar System, and the technological advances that will get us there. 🚀

Let's keep exploring,

Jennifer Vaughn

Chief Executive Officer — The Planetary Society

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COMMUNITY COMMENTS

Members' reactions to major milestones for The Planetary Society

In January, we announced that the United States Congress had unambiguously rejected extreme cuts to NASA's science program that were proposed by the White House. This represents a major victory for space advocates like you. Here are some comments shared by Planetary Society members in reaction to that news.

Hopefully it continues. We all gotta keep writing and advocating. And sharing. The more knowledge that's spread is net positive in every way, even if it's a simple astrophotography photo! We live in scary times. But when voices band together, whispers become shouts. And this is immense in its importance.

– **Jeremiah, USA**

Fantastic news and congratulations. As an Australian who has been a member for many decades, I firmly believe that the U.S. must continue to lead in science and space exploration for the good of everyone. Looks like you will now be able to do so again.

– **Richard, Australia**

Absolutely delighted and relieved that common sense has prevailed. Congratulations to Casey [Dreier, head of The Planetary Society's Space Policy & Advocacy program], The Planetary Society policy team, and everyone who supported and kept the pressure on the U.S. Senate and Congress. Thank you from this international Planetary Society member!

– **Catherine, U.K.**

I have retired after 40 years of teaching elementary school in Canada and frequently showed Bill Nye the Science Guy to my students. They loved every episode and often asked to see more. Bill's impact on children, many of whom have already grown into adults, is immeasurable. As N.D. Tyson would say, "Keep looking up!" Thank you, Bill! Good luck in your new role!

– **Michèle, Canada**

That same month, we announced that after 15 years at the helm, Bill Nye would be retiring from the role of CEO and stepping into the positions of chief ambassador and vice chair of the board of directors. Jennifer Vaughn was announced as the new CEO. Members shared these reactions to the announcement.

As a retired middle school science teacher and Planetary Society member who utilized Mr. Nye's teaching tools on a regular basis, I cannot express enough appreciation for his skills and passion. I'm ready and willing to assist in any new efforts Bill Nye has in store for the organization. Thank you, Mr. Nye!

– **Thea, USA**

I'm so grateful for all of Bill Nye's contributions and the impact he has had on my life. I'm also SO EXCITED to see Jennifer take on this role. It has been so great to meet her and talk with her at several TPS events!

– **Jeffrey, USA**

Congrats, Bill! What a legacy of leadership you leave, and it's great you'll remain engaged. I can't wait to see how you'll use the extra time. And congrats to Jennifer! TPS is in great hands.

– **Bill, USA**

These comments were all shared in The Planetary Society's members-only online community. Members can log in at community.planetary.org.

THE SPACE TECH CONTINUUM



The old and new in NASA's return to the Moon

by Dr. Asa Stahl

When NASA astronauts touch down on the Moon for the first time in over 50 years, it will mark both a breakthrough and a sequel. The agency's new lunar program, called Artemis, aims to bring humanity back to the Moon for the long run. By establishing a sustained base at the lunar south pole, Artemis could forever change our place in the Solar System.

This is all daring — but Artemis is not the first of its kind. NASA has been to the Moon before, and this new chapter follows in the footsteps of the Apollo program. Look more closely, and Artemis actually draws on the technology and experience of all of NASA's major crewed programs, from the Space Shuttle to the International Space Station.

Between its history and its ambition, Artemis is a patchwork of the old and new. One of its components (a booster, say) might be the culmination of decades of careful improvements, while another might be brand new and unprecedented. Unpacking how much of Artemis is tried and true — and how much is newly innovative — all depends on where you look.

On the shoulders of giants

Start with Apollo. The crew capsule for Artemis, called Orion, is in part based on the Apollo program's command module: Both have

the same blunt shape and similar coatings for their heat shields. NASA is also using Apollo mission trajectories to help plan future Artemis landings, while efficiency lessons from the Apollo moonwalks will help future crews get science done more quickly on the lunar surface.

Other Artemis tech goes back to the Space Shuttle. The Space Launch System (SLS), the rocket that sends Orion to the Moon, uses an upgraded version of the Shuttle's solid rocket boosters and the same main engines. The design of those engines, in turn, traces back to the Saturn V rocket that once launched all of NASA's Apollo Moon landing missions.

Perhaps the biggest influence is the International Space Station (ISS). Since the retirement of the Space Shuttle, the ISS has been NASA's only major in-situ testing ground for human spaceflight technology. Lessons learned there are woven throughout Artemis: Everything from Orion's docking technology to its toilet is similar to those on the ISS. An ISS cargo vehicle serves as the base design for the European Service Module, which propels Orion from low-Earth orbit to the Moon.

What's new

All of these legacy technologies make Artemis more dependable. But to

achieve completely new feats and make long-term stays on the Moon realistic, Artemis must incorporate the cutting edge.

Unlike Apollo, the spacecraft that will land Artemis astronauts on the Moon will aim to be reusable, making the program cheaper and more sustainable in the long run. These landers (contracted to Blue Origin and SpaceX) will also be bigger and more powerful. They should be able to stay on the Moon for at least a week and eventually more than a month, while the Apollo landers maxed out at three days. They will also be able to carry four astronauts instead of two.

During Apollo, astronauts literally looked out the window to finalize a safe landing site and then could manually adjust their course to match. Artemis intends to do better, especially since it plans to send the first-ever crews to the lunar south pole, where lighting conditions make landing especially difficult. New landers will scan the lunar surface, compare their images to ultra-precise maps taken by an orbiter, and adjust themselves automatically. This approach was proven on Mars with the landing of Perseverance in 2021, but Artemis will mark the first crewed application.

Artemis' most dramatic upgrade may be its relationship with the Moon itself. Instead of bringing everything from Earth, crews will eventually try to



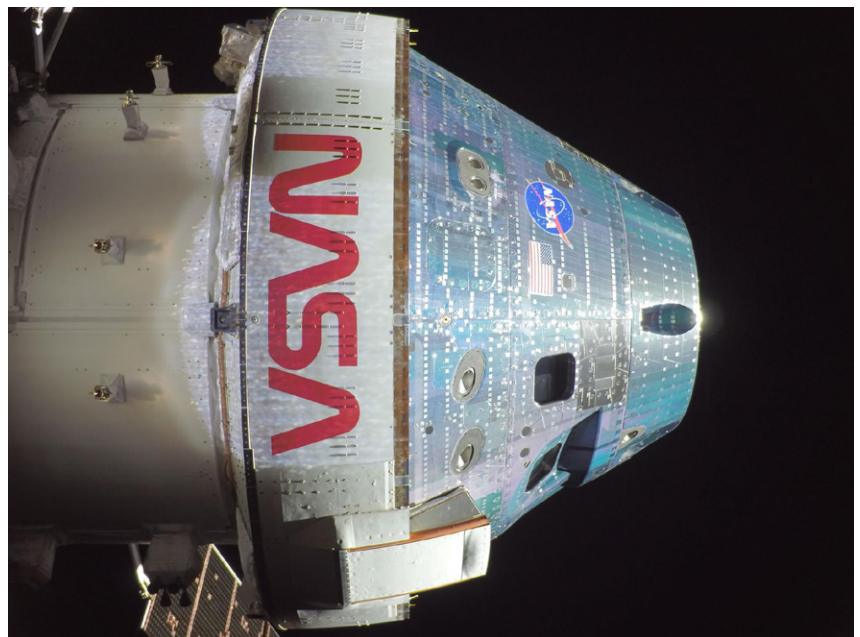
▶ The core stage of NASA's Space Launch System rocket.
NASA/Michael DeMocker

▶ The Orion spacecraft snapped this selfie while on its way to the Moon using a camera mounted on one of its solar array wings during a routine external inspection.
NASA

harvest rocket fuel components (liquid oxygen), water, and metal from the lunar surface. The long-term goal is for later Artemis missions to be churning out tons, if not hundreds of tons, of some of these resources per year.

There are other less obvious innovations. Digital infrastructure will allow Artemis mission teams to devise much more sophisticated exploration plans on the fly. Laser communications will turn the grainy static of the Apollo landing videos into full HD, and new spacesuits will make for longer spacewalks.

These technologies, combined with NASA's proven workhorses, could make Artemis' unprecedented goals a reality. If they work, the Moon won't just be a destination we return to. It will be a place we stay. 🌕



ARE WE READY TO SEND HUMANS TO MARS?

HiRISE imagery of craters on Mars in 2019 (modified).
NASA/JPL-Caltech/University of Arizona



**The physiological
challenges of a
mission to the
red planet**

by Dr. Mark Shelhamer

Around the time of Apollo 11, when Wernher von Braun was asked about what stood in the way of sending humans to Mars, he reportedly answered, “political will.” But recent events (including a medical evacuation from the International Space Station in January) suggest that politics might not be the greatest impediment. Instead, it may be the ability to maintain human health and performance at a level sufficient to make the trip worth the effort.

Could we send humans to Mars today? Yes, given the right rocket capability and spacecraft. Would the crew survive and return to Earth to tell the story? Probably — but not certainly. Would they be able to engage in a vigorous program of exploration and discovery worthy of the personal and national effort and sacrifice that it took to make the mission possible? Almost certainly not.

To understand why, consider the scale of what we are attempting.

The ISS orbits about 400 kilometers (250 miles) above Earth, protected from deep-space radiation by our planet’s magnetic field, within easy and rapid abort distance, and with instantaneous communication with mission control. ISS missions are typically six months, with occasional journeys of up to a year.

Lunar missions — Apollo and now Artemis — are at least an order of magnitude more challenging. The Moon lies roughly 1,000 times farther away than the ISS, so radiation protection is minimal, and abort options take days, not hours. Communication with mission control is delayed, though only by seconds. Missions last a few weeks at most. Apollo was extraordinarily ambitious — and incredibly dangerous.

Mars is another leap entirely. On average, it is about 500 times farther from Earth than the Moon. There

is no abort capability and little to no assistance from Earth due to distance and communication delays of up to 20 minutes one-way. A Mars mission would last roughly three years. It is most assuredly not just “more of the same” of what it took to get people to the Moon.

Various specific aspects of this type of mission are already under study. ISS missions provide data on long-duration weightlessness. Extended time in closed habitats, such as NASA’s HERA or CHAPEA, mimics the isolation and confinement of spaceflight. Antarctic winter-overs simulate these same conditions, with the added factor of an extreme environment. Weeks or months of bed rest with the head tilted down by 6 degrees can even replicate some of the effects of extended weightlessness, such as muscle atrophy and fluid shift toward the head.

But an actual trip to Mars will be the first time all of these stressors are present at the same time, for a long period of time, with no way to exit early, and with no chance for help from mission control. A Mars mission has the additional factor of extensive deep-space radiation, which is not a factor in other spaceflights. It is the interaction of multiple stressors across multiple body systems and spacecraft systems that defines the true challenge of sending humans to Mars and demands new ways of thinking.

Many of the medical risks are understood, even if not fully solved.

The body is efficient and clever. If it does not need a certain capability, the body will shed that capability and the metabolic cost of maintaining it. In the weightlessness of space, the body does not have to fight against gravity to stand upright, maintain blood flow to the head, and keep strong bones and muscles. So, bones lose calcium

and get weaker, muscles atrophy, and the heart weakens. Astronauts aboard the ISS exercise for about two hours daily, partially offsetting these effects, but a Mars spacecraft may not accommodate that level of exercise. Even on the planetary surface, it’s not yet known whether Mars’ 0.38g gravity would sufficiently mitigate these same medical issues.

The immune system also changes in space, as does the human microbiome (the microorganisms that live on our skin and in our gut). Immune changes include “viral shedding” — the reactivation of latent viruses like chickenpox and shingles. Studies show that spaceflight stressors such as workload, isolation, and confinement can lead to similar effects; it is not spaceflight per se that causes the problem. Even though viral shedding has not yet led to serious illness in space, extrapolating from six-month missions to a three-year Mars expedition is not comforting.

Vision changes present another concern. Since around 2011, astronauts returning from the ISS have reported altered visual acuity. In weightlessness, body fluids such as blood and cerebrospinal fluid tend to shift toward the head, which increases intracranial pressure. Some research suggests that cerebrospinal fluid can flow down the optic nerve from the brain to the eye, pushing on the back of the eye, distorting it, and even damaging the retina. This is an alarming situation for high-performing individuals in a demanding environment far from home. More alarming is the possibility that after three years, this increased fluid pressure might cause damage to brain tissue. In fact, some slight but (so far) reversible changes like this have been seen in ISS astronauts after flight. No body system is unaffected. There are also cognitive and psychological impacts.

Astronauts are very special people — rigorously screened and trained, highly motivated, mission-oriented — yet they are still people. Even rigorously selected, highly trained astronauts experience periods of depression, loss of motivation, and interpersonal conflict. Astronauts might be different in their ability to work through these problems in support of the mission no matter how challenging, but the effects of these psychological burdens can still take a toll on health and well-being.

Some astronauts describe the “space stupids,” where concentration and task performance in space become generally harder. Interestingly, standardized in-flight cognitive tests often fail to capture these perceived deficits. Nevertheless, given the many stressors inherent to spaceflight, even subjective effects can make it hard to perform normal work. And none of this would be any better on a mission to Mars.

Dealing with these known medical effects is hard enough, and there are countermeasures for some. But there are also unpredictable issues, and we don’t know how to deal with those yet.

Take a recent example: an episode of deep-vein thrombosis (a blood clot in the jugular vein) in an astronaut on the ISS. After 60 years of sending people into space, this was the first time this phenomenon happened, and it was discovered by accident. The condition was managed through consultation with medical experts and rapid delivery of medical supplies to the station, but on Mars, that would not have been an option; the situation could have been fatal.

What can we learn from this? No matter how well prepared, the unexpected will happen. Mars crews must be ready to not only deal with known problems but to develop new approaches to



▲ HERA is a unique 650-square-foot habitat split among two floors and a loft, designed to serve as an analog for isolation, confinement, and remote conditions in exploration scenarios.

NASA



▲ View of the Destiny module from the point of view of ESA project astronaut Marcus Wandt.

ESA/M. Wandt

unforeseen emergencies in real time with no immediate help.

This challenge extends beyond medicine. A Mars expedition is a complex, interdependent system of systems: crew, spacecraft, procedures, operations, and mission goals. The mission must be resilient. When things start to break down, when the crew faces the unexpected, and when anomalies that were not anticipated occur, the mission must go on, even with reduced capability and changed goals.

That means developing onboard systems capable of detecting when subsystems are not working properly and when they are not working together in harmony. Artificial intelligence and machine-learning tools can detect anomalies, alerting the crew and, if possible, diagnosing the problem, providing early warnings of later, larger problems.

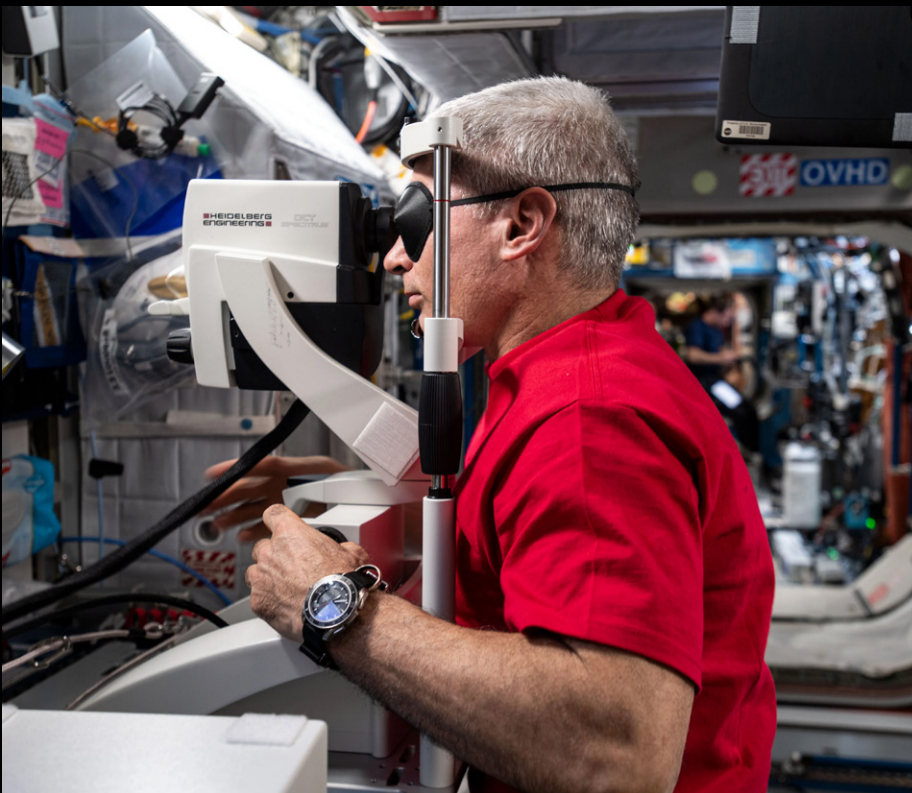
Such approaches push beyond the traditionally conservative culture of spaceflight planning and engineering. But this is not

grounds for despair. Building multisystem resilience for Mars will not only enable safer exploration; it will deepen our understanding of complex human systems on Earth.

Designing missions to promote this type of multisystem resilience is not easy. It depends on, among other things, understanding the functional interplay among the many mission subsystems — not only how different body systems interact but how the crew interacts with each other, with mission control, with the spacecraft, and with the mission plan. There are, unfortunately, all too few organizations making efforts to break down the disciplinary silos that impede this type of thinking. NASA is not there yet, but hopefully, recognizing the need for this in human spaceflight will provide the impetus for a more rigorous and widespread approach across many fields where we depend on complex human-machine systems: air traffic control, nuclear power, and medical infrastructure.

NASA likes to highlight the terrestrial spin-offs from space travel, such as microelectronics and biomonitoring. Still, astronauts don't risk their lives for mere technological advancements. They do so for exploration, including, just perhaps, a mission to Mars that would push the boundaries of not only planetary science but also human knowledge — about physiology, psychology, resilience, and what it truly takes to live and thrive beyond Earth.

Dr. Mark Shelhamer is a professor in the Johns Hopkins University School of Medicine, where he studies various aspects of human adaptation to spaceflight. He served as chief scientist of the NASA Human Research Program from 2013 to 2016. This article draws on the author's book "Are We Ready for Mars?", to be released in October 2026 by The Johns Hopkins University Press. 🐦



▶ NASA astronaut and Expedition 65 flight engineer Mark Vande Hei peers into near-infrared medical-imaging gear, or optical coherence tomography, for detailed views of his retina as part of regularly scheduled eye checks aboard the International Space Station on May 12, 2021.

NASA





The Moon and Earth from Orion

Earth sets over the Moon's curved limb in this photo captured by the Artemis II crew during their journey around the far side of the Moon.

NASA



THE CONSENSUS PROBLEM



Why space science has goals and human exploration has funding but neither has both

by Casey Dreier

The success of Artemis II firmly entrenched the Moon as the central focus for the United States' human spaceflight program. Mars, which briefly captured the attention of the president last year, has once again faded into the background. The billion dollars NASA requested for a rapid humans-to-Mars program was met with polite indifference from Congress, which never so much as acknowledged the request in its final appropriations legislation.

A presidential executive order in December put any uncertainty to rest: The United States shall land humans on the Moon by 2028 and begin the initial build-out of a permanent lunar base by 2030.

The policy whiplash of the Moon to Mars to the Moon in the space of a single year, while unusual for its speed, was nonetheless a familiar dance for longtime observers of human exploration policy. For decades after Apollo, the Moon and Mars have taken turns enjoying the rhetorical attention of various presidents, but real money only started flowing after the end of the

Space Shuttle, when the Space Launch System (SLS) rocket program was written into law in 2011 and paired with the vestigial Orion program.

Fifteen years and more than \$100 billion in inflation-adjusted dollars later, Artemis is now showing real results but is still at least two years away from the first Moon landing attempt. What the United States and its international partners will actually do on the lunar surface remains unclear, certainly to the broad public, who has been largely relegated to the sidelines of these deliberations over the past year.

The latest shift came in late February when NASA administrator Jared Isaacman, prodded by a presidential directive, outlined a complete restructuring of the Artemis program, changing flight dates and missions objectives for Artemis III through V, all to take place before the end of 2028 at the earliest. What we do on the Moon beyond then remains unclear — plans may change again. The money continues to flow nonetheless, and NASA's human

exploration program has hit funding highs not seen in decades.

NASA's space science program, in contrast, is a model of consistency. Each of the five major space science divisions is guided by a once-per-decade set of priorities provided by the National Academies of Sciences through a deliberative, consensus-based process. Ask a planetary scientist about the top-priority mission in their field, and they will respond with sample return from Mars. An astrophysicist? Habitable Worlds Observatory. The answers would be the same no matter who was president or whether China was making a play for the Moon.

Why, then, does space science struggle to secure funding? In the best of times, NASA's science program rarely exceeds a third of the agency's annual budget. Within the last year, it faced near extinction with draconian cuts proposed by the White House. And why does human spaceflight struggle to secure stable policy goals but still enjoys the majority of NASA's funding?



Magnificent desolation

Apollo 16 mission commander John Young moves the lunar rover into its final parking spot prior to his return to Earth.

NASA

To answer this, we need to examine an extrinsic, structural distinction in the forces that drive consensus in human and scientific exploration activities as well as the shifts in parochial politics that have dominated funding debates in the United States since the end of Apollo.

Reaching consensus between two people can be difficult. To reach it among thousands or tens of thousands often requires an external force to drive a variety of viewpoints toward a single outcome. For space science, this force is the objective reality of the Cosmos that the activity aims to understand. Get hundreds of scientists together in a single room and eventually, they will identify the most immediate questions that need focus, the theories that need reinforcement or testing, and the potential benefits to the wider field. The desire to understand reality independent of culture is the consensus-making mechanism that enables the decadal survey process to succeed time after time. Nature itself acts as an external tiebreaker. Open any decadal report and you will

find the most important questions that the scientific community wants to answer; the missions themselves are the tools to achieve that.

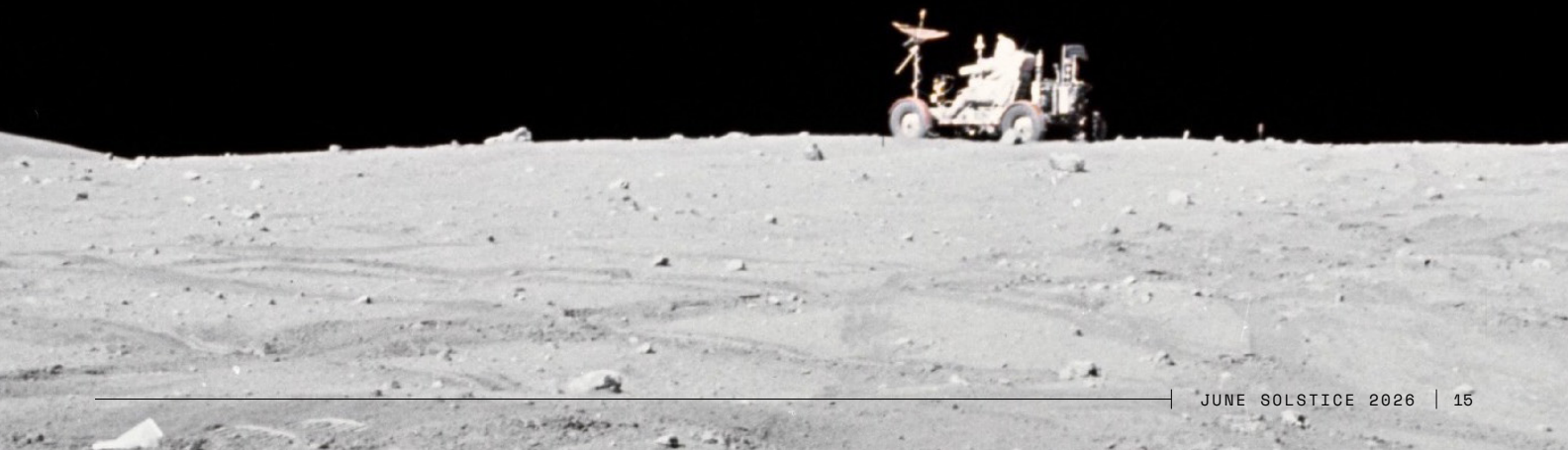
But science, as organized in the United States, is distributed and largely implemented via academic and private research institutions that receive individual grants for specific work. Robotic spacecraft became the specialty of two NASA centers and cost far less than their human-occupied counterparts. Being cheaper, they employ fewer people. This dilutes the political impact of these activities.

Human spaceflight has no consensus driver. The Moon, Mars, low Earth orbit, an asteroid — all priorities are functionally a product of opinion, however passionate. There is no objective reason why one should be the goal over any other. Engineering and cost serve as the primary constraints on near-term human exploration goals. But nothing anchors horizon goals, so they tend to drift.

What human spaceflight lacks in long-term consensus is made

up for in political strength. It is no easy feat to launch a human and a small bubble of Earth's atmosphere into the unforgiving environment of space. These costs and large support workforces are concentrated at several NASA centers and major contractors, some of which have worked on the same multibillion-dollar contracts for decades.

Furthermore, due to random accidents of history, the NASA centers that specialize in science and those that specialize primarily in human spaceflight are both geographically and politically distinct. The extensive testing, training, and operations facilities necessary for Project Apollo spurred infrastructure build-outs almost entirely located in the southern United States — a product of a domestic southern-state investment initiative and the southern Democratic senators who controlled key committees within Congress in the 1960s. The political transformation of the South over the subsequent 50 years made the political representation of



these centers, located in Alabama, Florida, Texas, and Louisiana, overwhelmingly Republican. The states hosting NASA's science centers, California and Maryland, went in the opposite direction and became much more Democratic.

So, while partisanship (at least at the congressional level) remains largely absent from human exploration and space science programs, the parochial political interests of both activities now fall along party lines.

This, then, can explain the surges of funding for human spaceflight,

particularly in the past year under unified Republican control of Congress and the White House. Even in years when the politics are inverted, the concentrated quality of the human exploration program's workforce and spending makes it politically stronger. Science, more distributed and currently represented by members of the minority party, lacks the concentrated political force needed to protect its funding in lean times.

Space exploration, ultimately, is a human endeavor. Despite its idealism, it is a product of politics, with all

of the messiness and motivations that this entails. With the Artemis program, we are moving into a period of potential alignment between human spaceflight's goals and near-term achievements. At the same time, the near-death experience of space science in 2025 created a bipartisan coalition of support in Congress rarely seen in modern politics. Perhaps a fusion is the path forward: a tighter integration of science into Artemis that provides helpful constraints on the future of the program and increases the parochial salience of space science itself. 🚀



Apollo 17 LRV on EVA 3

The Apollo 17 lunar rover is seen here during Gene Cernan and Harrison Schmitt's third and final EVA on Dec. 13 and 14, 1972. The rover covered a distance of 35.7 kilometers (22.2 miles) in total.

NASA

A STEP GRANT UPDATE



Growing our understanding of deep-space agriculture

by Kate Howells

The Planetary Society's Science and Technology Empowered by the Public (STEP) Grants provide funding to innovation projects that advance space science and exploration. The 2023 round of STEP Grants awarded \$50,000 USD to a team led by Dr. Andrew Palmer of the Florida Institute of Technology to study deep-space agriculture to address the challenge of feeding astronauts on long-duration missions.

"The Planetary Society's funding has been transformative in a variety of ways," said Palmer. "It has fueled science, created new projects, and helped strengthen the space agriculture network." The team has published three scientific papers based on the research enabled by the grant, with another two to three expected this year.

The main goal of the CHRGE (Comparing Hydroponics and Regolith Growth and Evolution) project was to compare plant growth in lunar regolith simulant versus hydroponic systems. Measuring growth across multiple generations of plants, the team has collected comprehensive data on metrics like edible biomass yields as well as practical considerations like water usage, power requirements, and crew time. They are also working to improve the development of Martian regolith simulants, testing various factors that might affect plant growth.

Palmer and his research team also did background research to contextualize

their project and better document the field in which it is situated. This included a thorough study of the current state of research on using regolith simulants, including the history to date of regolith-based agriculture. They also collected and analyzed data about the lunar and Martian regolith simulants they were using, including their organic content, existing microbiome, and how different sterilization and preparation methods impacted the mineralogical composition of the material. The insights yielded by this research will benefit any future researchers who want to study regolith-based agriculture.

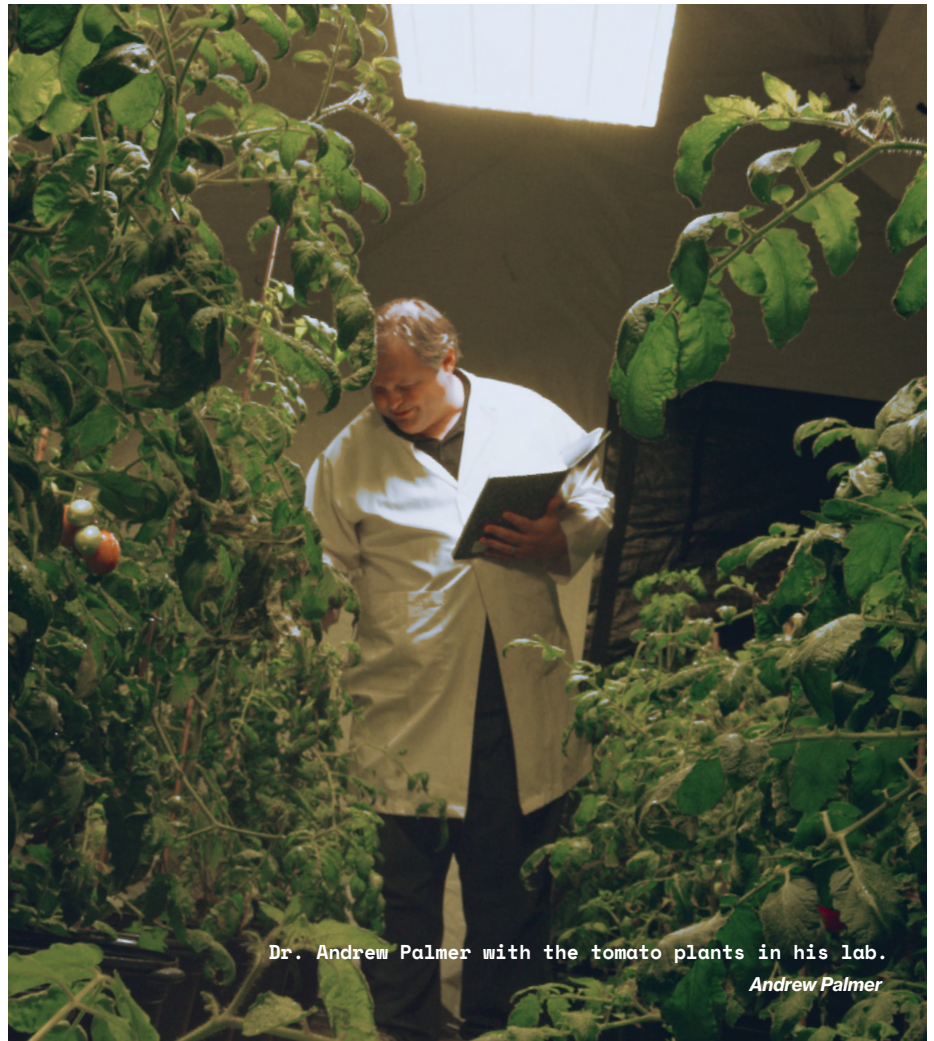
"The support of The Planetary Society helped us acquire the data we needed to

LEARN MORE

Information about our STEP Grant program can be found at planetary.org/sci-tech/step-grants.

actually convince NASA to fund a space agriculture project that brings elements of regolith-based agriculture and hydroponics together for an additional pilot study. While this is a small grant, it will allow us to bridge work begun by CHRGE with other projects."

Planetary Society members like you directly support projects like this that are advancing humanity's efforts to extend exploration into deep space. 🚀



Dr. Andrew Palmer with the tomato plants in his lab.

Andrew Palmer

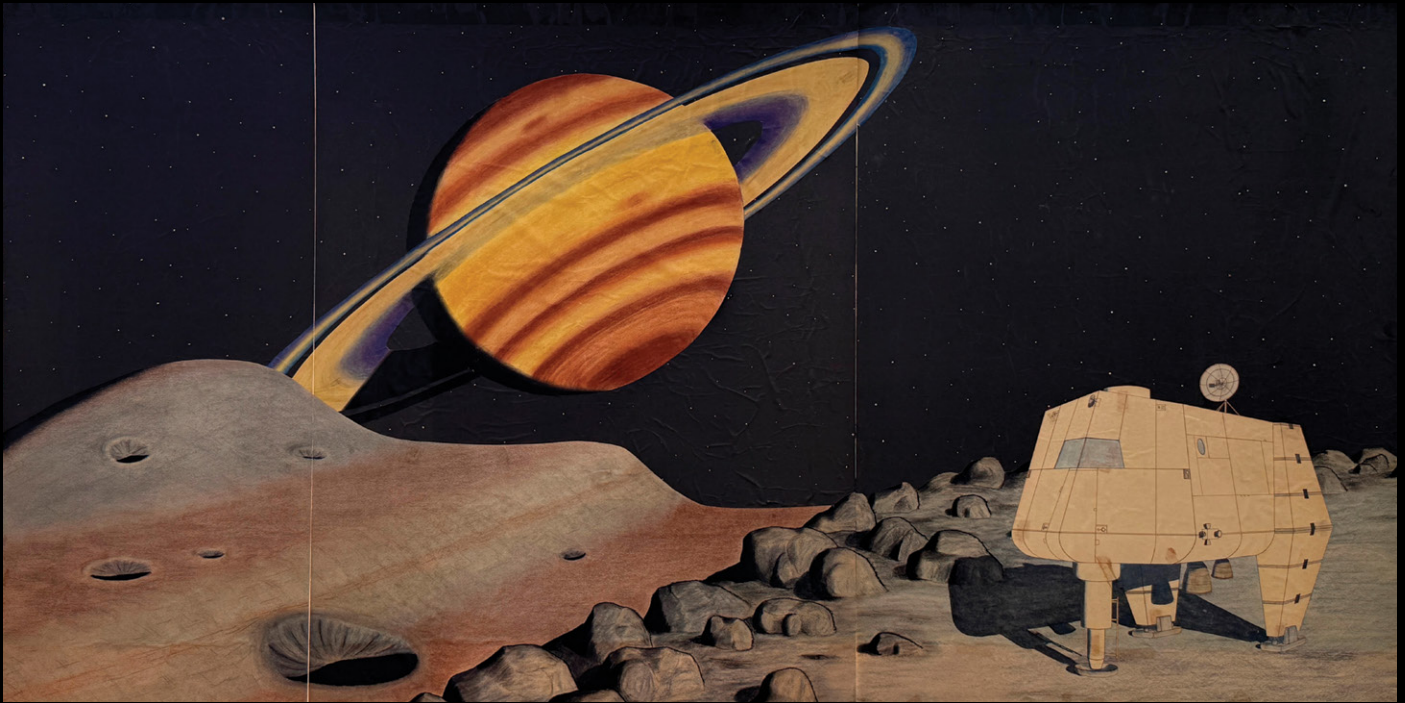
**The Artemis II
launch up close**

A close-up view shows the immense power of NASA's Space Launch System rocket as it took off, beginning the Artemis III mission to the Moon.

NASA/John Kraus







Mike Mackowski

KEEPING THE FUTURE FRONT OF MIND



Planetary Society charter member Mike Mackowski sent in this photo of a mural depicting the Rockhopper, a spacecraft he imagined carrying astronauts to a moon of Saturn. Using pastel chalk on poster paper, Mike created this 50 years ago to decorate his dorm room while attending the University of Arizona in Tucson. In the years following the Apollo program's successful exploration of the Moon, many people like Mike had faith that humanity would soon extend its presence deeper into the Solar System. Mike kept this mural as decoration in subsequent apartments and his home today to remind himself of that forward-looking vision of continuing exploration. 🚀

DO YOU WANT TO SEE YOUR ARTWORK HERE?

We love to feature our members throughout this magazine.

Send your original, space-related artwork to connect@planetary.org.

FROM THE CHIEF SCIENTIST



A cosmic roundup from The Planetary Society's chief scientist

by Bruce Betts, PhD

IN THE SKY

Super-bright Venus dominates the evening west for months. Very bright Jupiter will rise in the predawn east starting in July and rise earlier as the weeks pass. Reddish Mars is in the east before dawn. Yellowish Saturn rises in the middle of the night in June, then rises earlier until September, when it begins rising around sunset. In early July, Mercury will be low in the west at dusk. The Perseid meteor shower, usually one of the top meteor showers of the year, peaks Aug. 12-13, with increased activity several days before and after. Viewing will be ideal this year with a new Moon, which will not interfere with visibility. From a very

dark site, there are typically 50 to 75 meteors per hour at the peak. On Aug. 12, a total solar eclipse will be visible from portions of Greenland, Iceland, Portugal, and Spain. Much of Europe will see a partial eclipse (wear safety glasses!). On Aug. 28, a partial lunar eclipse with 96% of the Moon in Earth's umbral shadow will be visible from North and South America, with some of the eclipse visible in Africa, Europe, and the Middle East.

For more night sky tips, you can always check out planetary.org/night-sky.

TRIVIA CONTEST

Our December Solstice contest winner is Chris Larkner of Pekin, Illinois, USA. Congratulations!

The question was: *Three astronauts traveled to the Moon twice. One of those did not land on the Moon either time. Who was it?*

The answer: *Jim Lovell (on Apollo 8 and Apollo 13).*

Try to win a copy of the book "Saturn: The Ringed Planet with The Planetary Society" by Bruce Betts and a Planetary Radio T-shirt by answering this question:

What is the largest moon in the Solar System to orbit retrograde – in other words, opposite the direction of its planet's spin?

Email your answer to planetaryreport@planetary.org or mail your answer to The Planetary Report, 60 S. Los Robles Ave., Pasadena, CA 91101. Make sure you include the answer and your name, mailing address, and email address (if you have one). By entering this contest, you are authorizing The Planetary Report to publish your name and hometown. Submissions must be received by Oct. 15, 2026. One entry per person. The winner will be chosen in a random drawing from among all the correct entries received.



The Moon's shadow covers portions of the Canadian provinces of Quebec and New Brunswick and the American state of Maine in this image from the International Space Station as it soared into the solar eclipse on April 8, 2024.

NASA

RANDOM SPACE FACT

The Trojan asteroids, which orbit ahead of and behind Jupiter in its orbit, are named after characters from Homer's "Iliad," a tale of the Trojan War. With only a few exceptions, those ahead of Jupiter are named after Greek characters and those behind are named after Trojan characters.

THE 2026 DAY OF ACTION



Save NASA Science returns to Capitol Hill

by Jack Kiraly

On Monday, April 20, 2026, more than 130 space advocates from 34 states and the District of Columbia came to the nation's capital for The Planetary Society's annual Day of Action. Over the course of the day, these volunteer advocates held 280 meetings with House and Senate offices to deliver a simple message: Save NASA Science, again.

And this time, we are confident that Congress will act swiftly to reject the White House's proposed 46% cut to NASA's Science Mission Directorate



Advocates came from across the country to Washington, D.C., on April 20 to speak with their representatives about the importance of NASA science. *Stephen Bobb for The Planetary Society*

(SMD). The House and Senate rejected a carbon-copy budget proposal in January, and all signs point to a repeat as soon as this summer. And so our message for this Day of Action wasn't a plea for help but instead an expression of gratitude and a call to keep moving. Our topline ask, beyond rejecting the White House's proposal, was to grow NASA's topline budget and increase the SMD budget to its inflation-adjusted peak of \$9 billion.

We're not alone in pushing for this increase. In March and April, a bipartisan group of 125 congressional lawmakers, led by the Planetary Science Caucus, called on appropriators to protect and embrace an ambitious, balanced, and fully funded space science program.

Our momentum is real, and we have our members to thank for that. For the latest updates on this campaign and how you can help, visit planetary.org/save-nasa-science.

PLANETARY EXPERIENCE CONSULTING

planex.space/planetarysociety
kirby@planex.space

OCT. 15 - 19, 2026

Do you sometimes feel that pictures just aren't enough? You want to truly feel what it must be like to explore the alien landscapes of Mars, the Moon, Io, and other worlds, right? Same here!

That's why planetary geologist and long-time Planetary Society member Dr. Kirby Runyon co-created the Earth and Space Experience with space educator and philosopher Dr. Mark Wagner. We've led dozens of space enthusiasts, educators, students, and commercial astronauts on educational geology tours of New Mexico's planetary analog terrain and compared it to other worlds. We pair that planetary science with visits to Virgin Galactic's launch site at Spaceport America, the Museum of Space History, and the Challenger Learning Center, where you can fly simulated space missions.

Come join our next expedition in southern New Mexico with other curious minds from Oct. 15-19, 2026.

Visit planex.space/planetarysociety or email kirby@planex.space.



Aden crater in southern New Mexico.
Kirby Runyon

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BETCHART EXPEDITIONS

Feb. 28 - March 6, 2027

ALASKA AURORA BOREALIS EXPEDITION

Explore the vast beauty of Alaska in winter and experience the aurora borealis, the greatest light show on Earth! Enjoy a rail journey passing Denali; the Ice Art Festival; the Poker Flat Research Range; a sled dog demonstration; a wildlife conservation center with birds of prey, moose, and muskox; and more.

July 28 - Aug. 7, 2027

MALTA, SICILY, AND CAPRI BY YACHT: TOTAL SOLAR ECLIPSE EXPEDITION

Visit the impressive sites and beaches of Malta, Syracuse, Catania, Lipari, and Capri, with scenic cruising along the Amalfi coast and the volcanic island of Stromboli! On Aug. 2, 2027, we will position the yacht in the center of the Moon's shadow approximately 135 nautical miles from Valetta to observe the total solar eclipse with almost six minutes of totality.

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September/October 2026

Whether you're drawn by the northern lights in Iceland or ancient astronomy in Scotland, Sirius Travel designs immersive, small-group experiences for curious explorers.

In September 2026, travel to Scotland for "Standing Stones and Archaeoastronomy of Scotland" (Sept. 19-30), where Neolithic monuments, dramatic Highland landscapes, and centuries of sky-watching tradition converge. Explore ancient stone circles aligned to the heavens and uncover how early civilizations understood the Cosmos long before modern telescopes.

From Oct. 5-10, 2026, travel to Iceland's remote countryside for an unforgettable aurora borealis experience led by professional astronomers. Away from light pollution, venture to dark-sky locations where northern lights dance vividly overhead. Expert guides explain the science – solar winds, atmospheric chemistry, ethereal colors – and teach aurora photography techniques you'll treasure forever. Sirius Travel selects dates optimized for peak



The Skógafoss waterfall in Iceland.
 Luke Arnhols

auroral activity and enough daylight to explore Iceland's stunning landscapes.

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It's up to us.

YOU HELP DEFEND EARTH AND HUMANITY

Thanks to members like you, The Planetary Society is able to work with partners around the world to advance the science, technology, and advocacy needed to protect our planet and safeguard humanity's future.

Asteroid impacts are rare — but catastrophic. And they're one of the only natural disasters we can actually prevent. Your support makes that possible.

Thank you for being a Planetary Defender. Give today by visiting planetary.org/defendearth.

