Lower-cost space missions like NASA's ESCAPADE are starting to deliver exciting science – but at a price in risk and trade-offs

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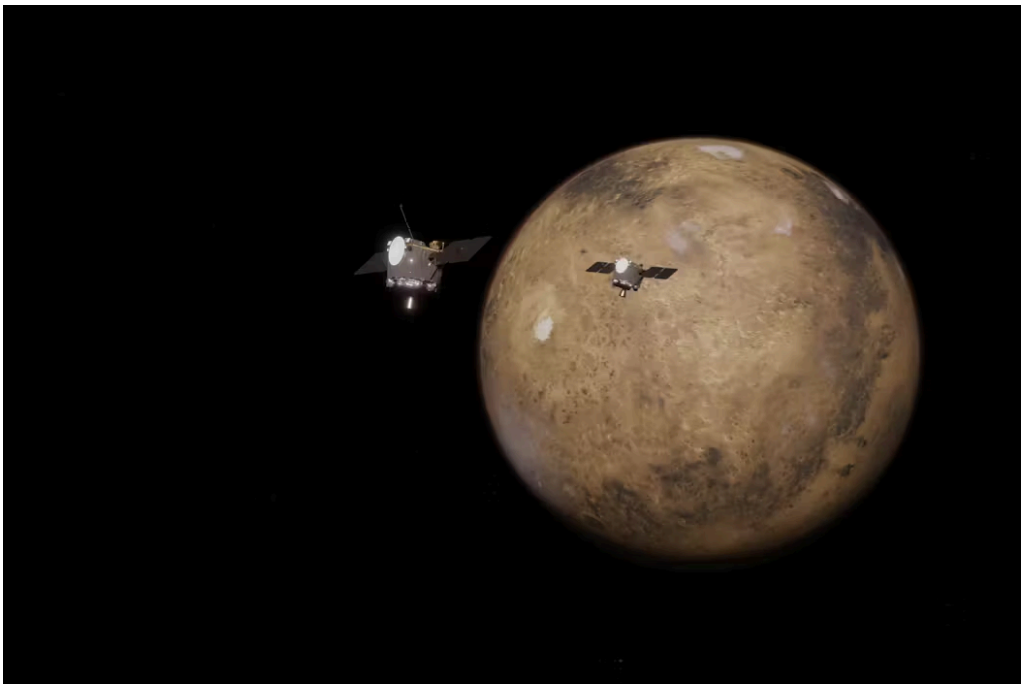


This artist's rendering shows the ESCAPADE probes near Mars.

NASA

After a yearslong series of setbacks, NASA's Escape and Plasma Acceleration and Dynamics Explorers, or ESCAPADE, mission has finally begun its roundabout journey to Mars.

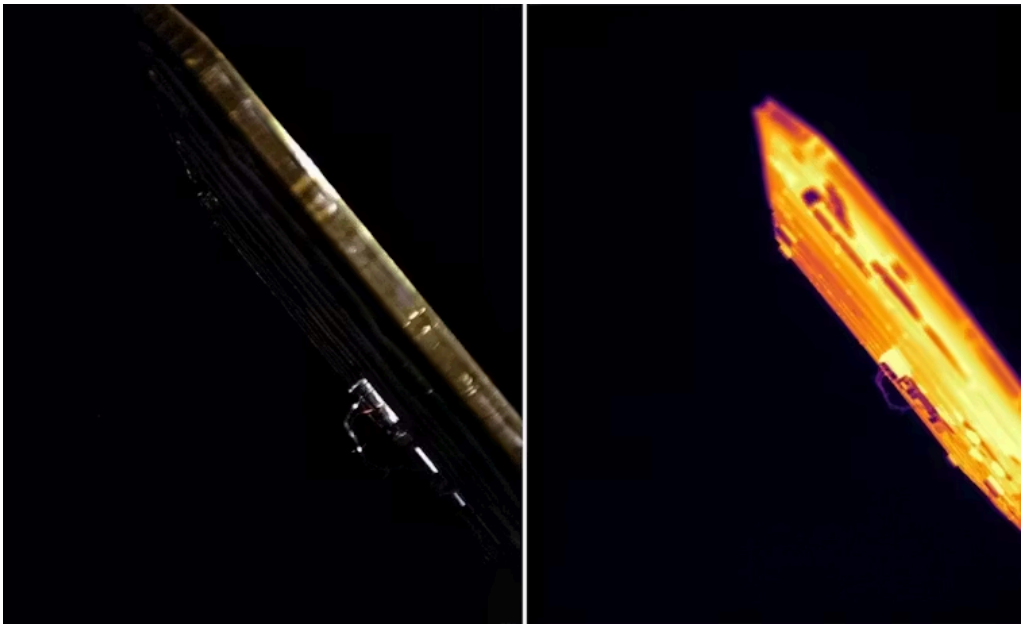
Launched on Nov. 13, 2025, aboard Blue Origin's New Glenn rocket, ESCAPADE's twin probes will map the planet's magnetic field and study how the solar wind – the stream of charged particles released from the Sun – has stripped away the Martian atmosphere over billions of years.

When I was a doctoral student, I helped develop the VISIONS camera systems onboard each of ESCAPADE's spacecraft, so I was especially excited to see the successful launch.

But this low-cost mission is still only getting started, and it's taking bigger risks than typical big-ticket NASA missions.

ESCAPADE is part of NASA's Small Innovative Missions for Planetary Exploration, or SIMPLEx, program that funds low-cost, higher-risk projects. Of the five SIMPLEx missions selected so far, three have failed after launch due to equipment problems that might have been caught in more traditional, tightly managed programs. A fourth sits in indefinite storage.

ESCAPADE will not begin returning science data for about 30 months, and the program's history suggests the odds are not entirely in its favor. Nonetheless, the calculus goes that if enough of these missions are successful, NASA can achieve valuable science at a reduced cost – even with some losses along the way.



First light taken Nov. 21, 2025, from the VISIONS camera aboard Gold, one of NASA's ESCAPADE spacecraft, showing the side of a solar panel. The left image is the visible-light camera, sensitive enough to image Mars' green aurora. The right image is from an infrared camera and shows temperature differences, from warmer (yellow and orange) to cooler (purple and black), that can distinguish geologic features on Mars.

NASA/UCB-SSL/RL/NAU-Radiant/Lucint

Lower cost, higher risk

NASA classifies payloads on a four-tier risk scale, from A to D.

Class A missions are the most expensive and highest priority, like the James Webb Space Telescope, Europa Clipper and the Nancy Grace Roman Space Telescope. They use thoroughly proven hardware and undergo exhaustive testing.

ESCAPADE is at the other end. It's a class D mission, defined as having "high risk tolerance" and "medium to low complexity."

Of the 21 class D missions that have launched since the designation was first applied in 2009, NASA has not had a single class D mission launch on schedule. Only four remained under budget. Four were canceled outright prior to launch.

ESCAPADE, which will have cost an estimated US$94.2 million by the end of its science operations in 2029, has stayed under the $100 million mark through a series of cost-saving choices. It has a small set of key instruments, a low spacecraft mass to reduce launch costs, and extensively uses generic commercial components instead of custom hardware.

NASA also outsourced to private companies: Much of the spacecraft development went to Rocket Lab and the trajectory design to Advanced Space LLC, with tight contract limits to make sure the contractors didn't go over budget.

Additional savings came from creative arrangements, including the university-funded VISIONS camera package and a discounted ride on New Glenn, which Blue Origin wanted to fly anyway for its own testing objectives.

Commercial space

ESCAPADE launched at a moment of transition in space science.

NASA and other science agencies are facing the steepest budget pressures in more than 60 years, with political winds shifting funding toward human spaceflight. At the same time, the commercial space sector is booming, with long-imagined technologies that enable cheap space travel finally entering service.

That boom has, in part, led to a resurgence in NASA's "faster, better, cheaper" push that originated in the 1980s and '90s – and which largely faded after the 2003 Columbia disaster.

In theory, leaner NASA oversight, greater use of off-the-shelf hardware and narrower science goals can cut costs while launching more missions and increasing the total science return. If ESCAPADE succeeds in delivering important science, it will be held up as evidence that this more commercial, risk-tolerant template can deliver.

The trade-offs

A concept put forward by Jared Isaacman, the Trump administration's nominee to lead NASA, is that 10 $100 million missions would be better than one $1 billion flagship – or top-tier – mission. This approach could encourage faster mission development and would diversify the types of missions heading out into the solar system.

But that reorganization comes with trade-offs. For example, low-cost missions rarely match flagship missions in scope, and they typically do less to advance the technology necessary for doing innovative science.

With a narrow scope, missions like ESCAPADE are unlikely to produce the most transformative discoveries about, for instance, the origins of life or the nature of dark matter, or the first chemical analyses of oceans on a new world. Instead, they focus on more specific questions.

Early in ESCAPADE's development, my role was to help create a planning document for the VISIONS cameras called the Science Traceability Matrix, which defines an instrument's scientific goals and translates them into concrete measurement requirements.

My colleagues and I systematically asked: What do we want to learn? What observations prove it? And, critically, how precisely does the instrument need to work to be "good enough," given the budget? Loftier goals usually demand more complex instruments and operations, which drive up costs.

ESCAPADE's broader goals are to create a clearer picture of Mars' magnetic field, how the solar wind interacts with it, and figure out what that process does to Mars' atmosphere. That is valuable science. But it is more modest than the $583 million predecessor mission MAVEN's more extensive scope and richer suite of instruments. It was MAVEN that determined how and when Mars lost its once-dense atmosphere in the first place.

Both ESCAPADE and MAVEN are dwarfed again by the open-ended potential of an operation like the James Webb Space Telescope, which observes a limitless slate of astronomical objects in the infrared light spectrum with a higher resolution than any combination of prior smaller telescopes.

Flagship missions like the James Webb Space Telescope push the state of the art in new technologies and materials. These innovations then filter into both future missions and everyday life. For example, the Webb telescope advanced the medical tools used in eye exams. Smaller missions rely more heavily on existing, mature technologies.

And when systems are built by private companies rather than NASA, those companies keep tight control over the patents rather than openly spreading the technology across the scientific community.

A tense road to launch

ESCAPADE's principal investigator, Rob Lillis, has joked that it is the mission with 11 lives, having survived 11 near-cancellations. Problems ranged from being late in reaching the technology readiness levels that helped ensure the probes wouldn't malfunction after launch, to the loss of its original free ride, with NASA's Psyche mission.

In 2024, ESCAPADE received support from NASA to ride on New Glenn's maiden flight, only to face delays as Blue Origin worked through technical hurdles. At last, in October 2025, ESCAPADE reached the launchpad.

I traveled to Cape Canaveral for the launch and felt the tension firsthand. The first window was scrubbed by bad weather and issues with ground equipment. Then a strong solar storm — ironically, a key driver of the very processes ESCAPADE will study — shut down the second window.

Concurrently, the Federal Aviation Administration imposed new launch restrictions due to the government shutdown that would have postponed the launch further if not for a last-minute exemption.

Finally, on Nov. 13, after repeated setbacks, New Glenn lifted off to cheers around the country. ESCAPADE reached orbit, and after a nervous few hours of receiver misalignment, mission controllers established communication with the spacecraft.

What's next

While in Florida, I also watched another milestone in commercial spaceflight: the record-breaking 94th launch from Cape Canaveral in 2025, marking the most launches from Florida in a single year. It was a SpaceX Falcon 9 carrying Starlink satellites.

Like New Glenn, SpaceX's Falcon 9 saves money by landing and reusing rockets. If multiple providers like SpaceX and Blue Origin compete to keep launch prices low, the economics of small science missions will only improve.

On Nov. 10, SpaceX launched a Falcon 9 rocket from Cape Canaveral, the record-breaking 94th launch of 2025.

SpaceX

If ESCAPADE's twin spacecraft reach Mars and deliver new insights as planned, they will demonstrate how minimalist, commercial-forward approaches can expand the planetary knowledge base.

But even then, a string of future SIMPLEx successes would likely not be a substitute for the uniquely capable, technology-advancing flagship missions that answer the most far-reaching questions. ESCAPADE can instead help test whether a broader mix of small missions – leaning on commercial partners and a few big, ambitious flagships – can together sustain planetary science in an era of tight budgets.

For now, that balance remains an open experiment, and only time will tell whether ESCAPADE is a lone bright spot or the start of a real shift.

Ari Koeppel was a team member on ESCAPADE's VISIONS cameras and has previously received funding from NASA research grants. He currently works with The Planetary Society.