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# Sky at Night

THE UK'S BEST-SELLING ASTRONOMY MAGAZINE

## FLYING OVER TITAN

The first mission to fly on another world gets the green light



**HAS THE JWST BROKEN MODERN COSMOLOGY?**

**DISCOVER THE NEW ERA OF HUMAN SPACEFLIGHT**

**WATCH THE MOON COVER RINGED PLANET SATURN**

**WHY THE MILKY WAY IS LACKING ANCIENT STARS**

**ON TEST: UNISTELLAR'S ODYSSEY PRO SMART SCOPE**





*The new era of*  
**human  
spaceflight**

There's been a step-change in crewed space missions since the dawn of the 21st century. **Ben Evans** charts its course and looks ahead to future horizons



▲ From a low-Earth-orbit playground for the rich and famous (like Oliver Daemen, Wally Funk and Mark Bezos, pictured on Blue Origin) to a new space station in orbit around the Moon, we explore the vanguard of the new Space Race

Six decades ago, human spaceflight was a two-sided coin, as the United States and Soviet Russia competed for primacy in the Space Race during the Cold War. With global nuclear holocaust looming menacingly on the horizon, parallel space programmes arose on opposite sides of the Iron Curtain: Mercury versus Vostok, Gemini versus Voskhod, Soyuz versus Apollo and the Space Shuttle.

Today, this East/West duopoly has ceded a few grains of its dominance to newer players. National actors like China and India have emerged like a whirlwind, along with a growing chorus of commercial entities from Boeing to SpaceX, and Blue Origin to Virgin Galactic, all hungrily eyeing the space domain.

When Yuri Gagarin conquered space in April 1961, the door creaked ajar for others to follow. But initially, those 'others' were exclusively military; for the average person in the street, the chance to fly into space was a door that was firmly barred and bolted.

Today, fewer than 700 souls – less than 0.00001 per cent of the world's 8.1 billion population – have experienced microgravity and seen Earth as it truly is: a fragile, glowing oasis of colour set jewel-like against the ethereal darkness of the cosmos.

And when that minuscule number filters down to 'ordinary' people like you and me, the odds of reaching space are vanishingly remote. We humans are a long way from becoming a spacefaring species. Yet with new spacecraft taking shape, this status quo is on the cusp of monumental change.

Despite their decades-held duopoly, Russia and the United States have courted participation from other nations and walks of life in a highly visible example of politicised soft power. Between the 1960s and the close of the 20th century, the number of first-time space travellers quadrupled, from 45 individuals (including one woman) from two nations to 170 individuals (including 28 women) from 14 nations.

Differing faiths have been observed; a wider age, race and gender demographic has reached space, and languages other than Russian and English have travelled over the space-to-ground radio waves. From the Soviet bloc states of Czechoslovakia, Poland and East Germany in the 1970s to Turkey, Pakistan and Belarus in the 2020s, today more than 40 nations have flown their flags in space via Russian or US launches.

The spacefaring community's character has shifted too, to include married couples, journalists, royalty, film producers and stage actresses, politicians and self-financed tourists. Yet despite such progress, space remains the exclusive preserve of either the super-qualified or the super-wealthy.

## Space tourism

In a game-changing paradigm shift, commercial entities are now altering that character and driving access to sub-orbital and orbital space. Amazon billionaire Jeff Bezos's Blue Origin has carved a lucrative avenue into the sub-orbital market with its reusable New Shepard booster and crew capsule, launched from Corn Ranch in west Texas.

Since July 2021, it's flown people from 11 countries to altitudes over 100 kilometres (62 miles), crossing the Kármán line, which the Fédération Aéronautique Internationale (FAI) ►



Jeff Bezos's Blue Origin has taken 37 passengers to the edge of space...



...including 18-year-old Oliver Daemen in 2021, the youngest-ever astronaut...



► defines as the edge of space. New Shepard seized a clutch of Guinness World Records for the youngest and oldest people, and the first siblings to fly together (Bezos and his half-brother, Mark).

Most New Shepard passengers paid a hefty (undisclosed) buck for their 10-minute joyrides to altitudes 10 times higher than a commercial airliner, but were amply rewarded with a glimpse of Earth and a few moments of weightlessness before returning home.

Slowly, Blue Origin is 'democratising' space, hosting space tourists from Portugal and Egypt in January 2024, and making Dutch teenager Oliver Daemen the youngest astronaut in July 2021 and 90-year-old Ed Dwight the oldest in May 2024. Other passengers have included undersea explorers, a Brazilian raffle winner, media personalities, father-and-son duo Lane and Cameron Bess, *Star Trek*'s William Shatner – Captain Kirk himself, no less – and Laura Shepard Churchley, the daughter of Alan Shepard, America's first astronaut.

Sir Richard Branson's Virgin Galactic also created a sub-orbital niche in space tourism. Its sleek VSS Unity rocket-propelled spaceplane has flown 11 times since December 2018. Passenger flights attained altitudes up to 89.9 kilometres (55.9 miles), shy of the Kármán line, but enough to satisfy the Federal Aviation Administration's criteria; it confers astronaut status on people who reach an altitude of 80 kilometres (50 miles) above Earth's surface.

Virgin Galactic saw mother-and-daughter duo Keisha Schahaff and Anastatia Mayers win flight tickets in August 2023, becoming the first Antiguan and Barbudan spacefarers. Other fare-paying astronauts have included a man with Parkinson's

disease, Pakistan's first space traveller and planetary scientist Alan Stern.

## Commercial spaceflight

Space tourism is growing slowly but commercial orbital spaceflight is already here. In 2014, aerospace giant Boeing and billionaire Elon Musk's SpaceX won NASA contracts to build the Starliner and Dragon capsules to ferry astronauts to the ISS.

SpaceX's craft first flew NASA astronauts Doug Hurley and Bob Behnken on an ISS test mission in May 2020, before routinely rotating four-person crews – a mix of US astronauts, Russian cosmonauts and international partners – twice yearly. Eight long-duration missions and crew swaps have been done since November 2020, with six more planned between August 2024 and the decade's end.

But SpaceX is going further with its four-ship Dragon fleet, one of which is now on its fifth flight,

▲ ...celebrities like *Star Trek*'s Captain Kirk, William Shatner (second right)...

▼ ...and former NASA trainee astronaut Ed Dwight, who finally reached space at age 90





▲ Virgin Galactic's VSS Unity sub-orbital spaceplane being carried by the Eve mothership



Keisha Schahaff flew with her daughter after winning Virgin Galactic seats

Awaiting its own chance to fly crew to the ISS is Boeing's reusable Starliner. It made two test flights in 2019 and 2022 and had its first crewed test flight to the ISS, with NASA astronauts Barry 'Butch' Wilmore and Sunita Williams, in June 2024. But Starliner weathered a troubled genesis; its maiden flight was riddled with software glitches and it fell foul to parachute problems and propulsion system issues.

Even the first crewed flight ran into a few problems (see page 12), but as long as these can be overcome, NASA will certify Starliner for regular ISS missions. Boeing is booked for six annual flights, starting with Starliner-1 in 2025, although the spacecraft's potential uses when the ISS is decommissioned sometime after 2030 remain unclear.



▲ Inspiration4, the first all-civilian flight, took (left to right) Christopher Sembroski, Jared Isaacman, Sian Proctor and Hayley Arceneaux into space on SpaceX Dragon in 2021

with over 500 accrued space days. In March 2020, Musk contracted with the AxiomSpace firm to fly all-private crewed missions to the ISS for science, technology and education. Three such missions launched between April 2022 and February 2024, with a fourth scheduled later this year.

Elsewhere, billionaire Jared Isaacman purchased a Dragon flight (Inspiration4) to raise \$240 million for St Jude's Children's Hospital in Tennessee. He gave the other seats to Sian Proctor, winner of an entrepreneurship contest, engineer Chris Sembroski and bone cancer survivor and the first astronaut with a prosthesis, Hayley Arceneaux. After Inspiration4 flew triumphantly in September 2021, Isaacman announced plans for three 'Polaris' missions: two using Dragon, a third with SpaceX's Starship. Goals for the first flight, Polaris Dawn in summer 2024, include the first commercial spacewalk and reaching an altitude of 1,400 kilometres (870 miles). Aerospace firm Vast also booked two Dragon flights to its Haven-1 commercial space station after August 2025.

## Contracting to space

Meanwhile, glimmering mirage-like on the horizon is SpaceX's 120-metre-tall (394ft) Starship, launched four times with increasing success between April 2023 and June 2024 atop a Super Heavy booster from Boca Chica, Texas. With a liftoff thrust of 7.5 million kilograms (16.7 million pounds) – double that of NASA's Saturn V and Space Launch System (SLS) – it is the tallest and most powerful rocket ever built, and promises to be a game-changer.

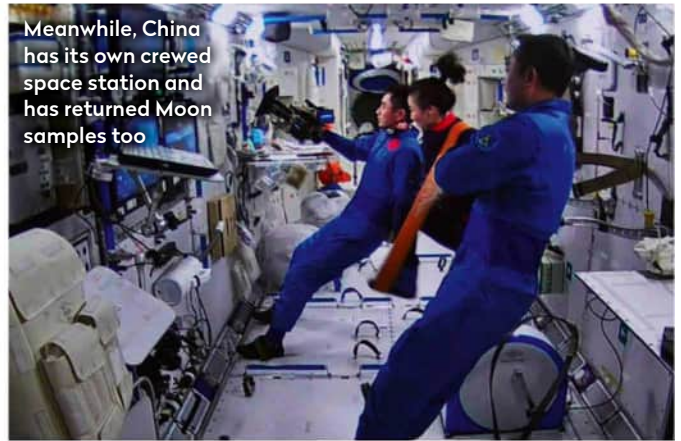
Starship's 1,000-cubic-metre (35,000ft<sup>3</sup>) payload capacity can launch more cargo and humans than ever before, with Musk already eyeing the colonisation of Mars. In April 2021, NASA picked Starship as its first Human Landing System (HLS) to land Artemis astronauts near the Moon's south pole. But with at least 10 Starships needed just to fuel the HLS in Earth orbit before it heads for the Moon, the complexities are immense.

Its four test missions up to June 2024 trialed a full-duration firing of the 33 Raptor engines on the Super Heavy booster and the six Raptors on Starship, plus an in-flight 'hot-staging' manoeuvre. SpaceX has tacked incremental gains onto each flight, with the latest Starship test achieving the first-ever soft ocean landing for the Starship vehicle.

But previous delays have exacted a toll. A proposal to fly around the Moon on Starship, funded by Japanese billionaire Yusaku Maezawa, was cancelled ►



SpaceX's Starship will be able to carry more cargo and humans than ever before



Meanwhile, China has its own crewed space station and has returned Moon samples too



ESA astronauts and Chinese taikonauts briefly trained together in 2017

► in June 2024. Called 'dearMoon', its crew included Maezawa and eight musicians, YouTubers, artists, photographers and filmmakers.

Setbacks like this also impact NASA's goal to return to the Moon. After a successful first mission for the SLS and Orion spacecraft on Artemis I in late 2022, an important next step will fly Artemis II astronauts Reid Wiseman, Victor Glover, Christina Koch and Jeremy Hansen around the Moon – the first humans to reach lunar distance in over 50 years.

Success on Artemis II will enable Artemis III to land at the lunar south pole with a Starship HLS. However, in January 2024 NASA announced that it would be delaying both missions by at least a year, with Artemis II postponed until September 2025, and Artemis III until late 2026 at the soonest. That decision was born out of the need to further flight-qualify Orion's life-support systems and address concerns regarding its all-important heat shield.

With these Orion worries set against a backdrop of Starship delays, it remains unclear if a Moon landing is possible on Artemis III and it may move to a later mission. NASA managers are under no illusions that a 2026 landing is a "very aggressive" target to meet.

## More space nations

All the while, China is rapidly pushing forward in its space ambitions, with the aim of launching its first crewed lunar mission before 2030. Since becoming the third nation to launch its citizens in 2003, its 'taikonauts' first spacewalked in 2008 and the first

***"It remains unclear if a Moon landing is possible on Artemis III and it may move to a later mission"***

Chinese woman went into space in 2012. In 2021–2022, the Tiangong space station was assembled in orbit and has been occupied continuously since June 2022. The station will remain in orbit for 10–15 years. In June 2024, the Chang'e-6 mission successfully returned the first-ever samples from the Moon's far side and included a lunar orbit rendezvous that tested the manoeuvres needed to return a crew from the surface of the Moon.

In 2017, Chinese taikonauts and European Space Agency (ESA) astronauts did joint water survival exercises off the Yantai coast and extreme environment training in the caves of Sardinia. But hopes that Tiangong might someday host a European astronaut stalled in 2023.

However, ESA maintains a regular cadence of ISS operations with members of its 2022 astronaut class already training for long-duration expeditions and short AxiomSpace visits. With a clear lack of commercial crewed flight options on this side of the Atlantic, if you're a hopeful European astronaut your choices are stark: either join a US mission or join ESA.

Gateway space station will orbit the Moon and host Orion crew modules and SpaceX's Dragon spacecraft

ILLUSTRATION

# In the longer term: longer-duration missions

How will human space missions look in the decades ahead?

With four sovereign nations and multiple commercial players set to ply their trade in space over the coming years, significant opportunities lie ahead. SpaceX's Dragon and Boeing's Starliner are tasked with exchanging crew members aboard the International Space Station until the sprawling orbital complex is retired and deorbited sometime after 2030. Additional plans call for Dragon to fly independent flights for Jared Isaacman's Polaris Program and resupply and visit Vast's commercial space station from 2025.

With AxiomSpace building a suite of pressurised modules for scientific research, educational outreach and entertainment, to be added to the ISS after 2026 and operated as an independent 'Axiom Station' beyond 2030, commercial providers will undoubtedly be called upon to deliver astronauts to and from the new outpost. SpaceX's Dragon is likely to be one of them, but the future of Starliner remains to be seen; Boeing has offered few insights into the spacecraft's potential missions after the ISS. Meanwhile, the future of China's

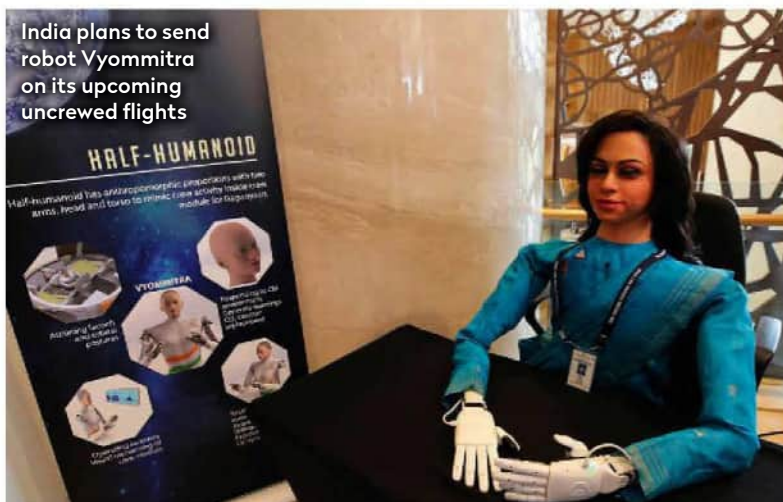
Tiangong extends into the mid-2030s.

The domain beyond low-Earth orbit offers a more challenging set of conditions, with NASA and its international partners – Europe, Japan and Canada – planning a Moon-orbiting space station called Gateway before the end of the decade. Supplied with cargo via Dragon and with crew via Orion, it will furnish an important staging point for human exploration of the lunar surface and, in future decades, Mars, with landing systems provided by SpaceX and Blue Origin.

Elsewhere, India stands primed to fly its own crew ship, Gaganyaan, translatable from Sanskrit as 'celestial vehicle'. Delayed since 2021 by the Covid-19 pandemic and safety concerns, it will lift three Indian astronauts to an altitude of 400 kilometres (250 miles) for up to seven days, then return to a splashdown in the Indian Ocean. Parachute drop-tests in November 2022 and trials of Gaganyaan's

propulsion system last August injected renewed optimism that orbital tests might occur in late 2024, with crewed flights maybe next year. The spacecraft has been developed with an on-board humanoid robot, the female-looking Vyommित्रा (translating as 'space friend'), which is capable of responding to queries, handling switch operations and providing crew updates.

With four nations and commercial entities at the vanguard, humanity's future in space carries great promise. It remains to be seen how fraught relations between Russia, China and the West will play out – perhaps igniting a new 21st-century space race – but one thing is certain: having more players on the scene surely will continue to democratise space and enable more of us to access what was previously accessible only to the few. 🚀



**Ben Evans** is an astronomy writer and the author of several books on human spaceflight