

BBC *THE TOP NIGHT-SKY SIGHTS TO SEE IN 2024*

#224 JANUARY 2024

Sky at Night

THE UK'S BEST-SELLING ASTRONOMY MAGAZINE

Crash of the TITANS

Galaxy collisions wreak colossal carnage – so why does life in the Universe depend on them?



**COMET
KUSHIDA**

When to get the best
telescope views of
this celestial
visitor

**A BEGINNER'S GUIDE
TO ASTRO CAMERAS**

**SPACE SCIENCE & CREWED
MISSION LAUNCHES IN 2024**

**AMATEUR ASTRONOMER
FINDS LOST SUPERNOVA**

**THE DEMON STAR: THE MYTH
OF ALGOL EXPLAINED**

**ASKAR'S 2-IN-1 IMAGING
TELESCOPE TESTED**

SPACE IN 2024

From the Moon to Mars, **Ezzy Pearson** looks ahead to what space missions and science innovations the new year has in store

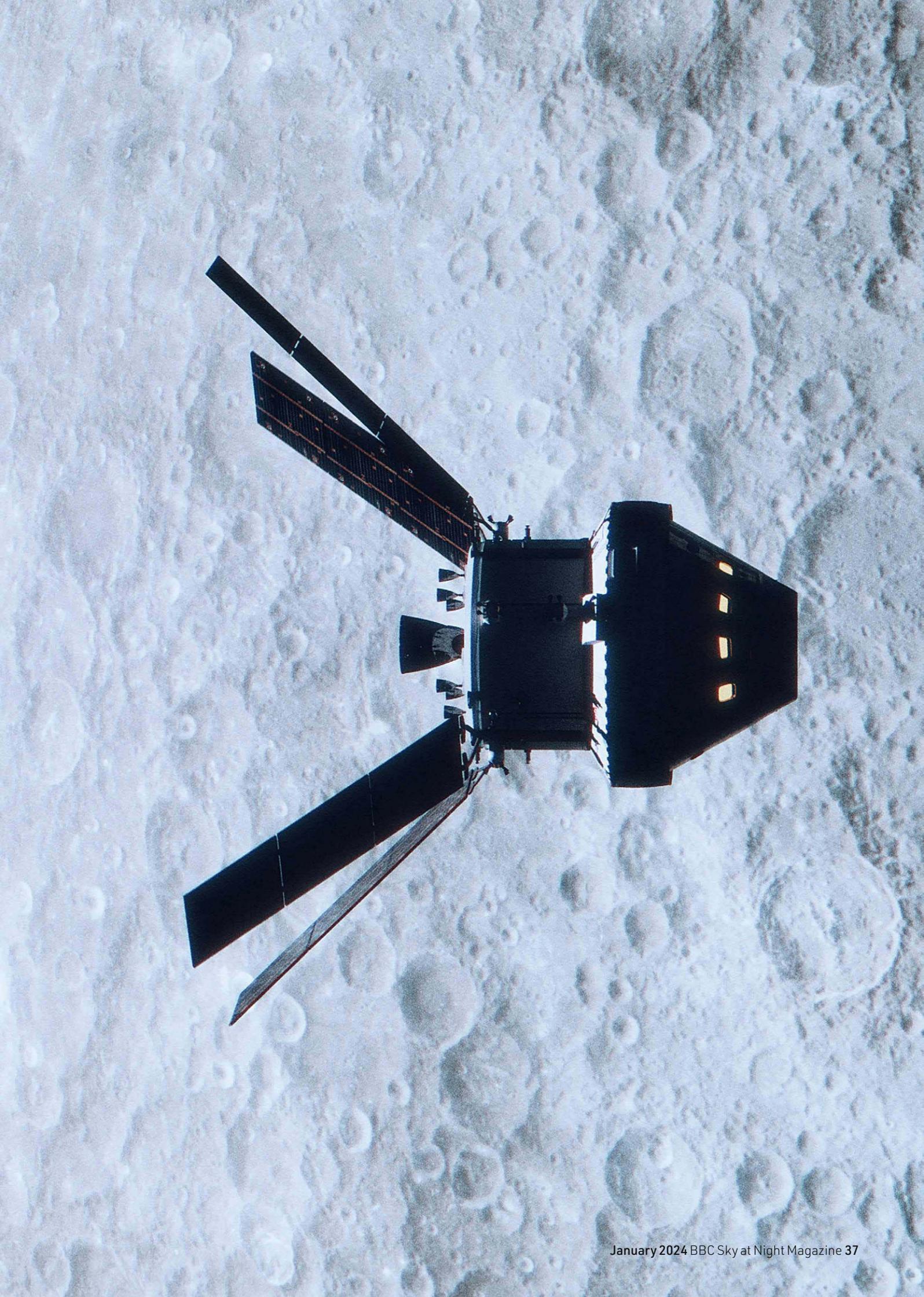


Ezzy Pearson is *BBC Sky at Night Magazine's* features editor. Her book *Robots in Space* is available through History Press



ILLUSTRATION
NASA/LIAM YANULIS

Back of beyond: NASA's Artemis II trip to the Moon's far side is just one of the missions in this spaceflight-packed year

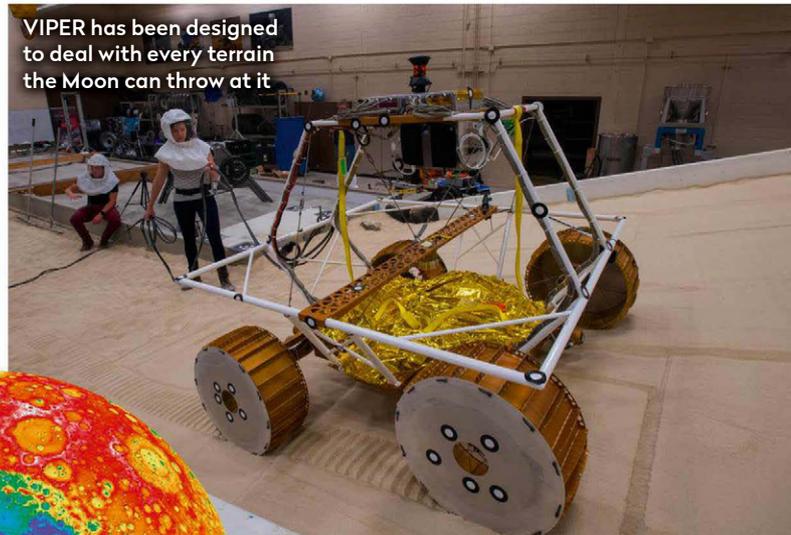


Roving the Moon

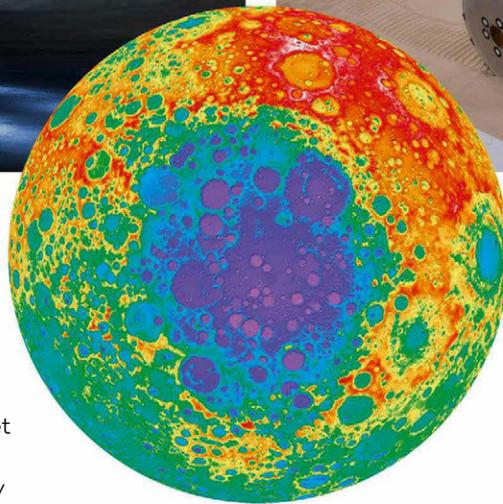
Two rovers are set to reveal a whole new side of the Moon in 2024



Slated for November, VIPER is NASA's first mobile robotic mission to the Moon



VIPER has been designed to deal with every terrain the Moon can throw at it



▲ Chang'e 6's landing site, the deep South Pole-Aitken Basin on the Moon's far side

The Moon has had something of a renaissance in the last decade, with more nations and even private companies setting their sights on its grey surface. Whereas missions in the 1960s and '70s focused on the well-lit equator and the relative safety of the lunar near side, these new missions are set for a more challenging time.

Around May, the Chinese space agency plans to send its **Chang'e 6** sample-return mission to the Moon's far side. Its landing site is in the South Pole-Aitken Basin, a 2,500km-diameter, 8km-deep impact crater formed over four billion years ago. Over its 53-day mission, Chang'e 6 will use a drill to bring up soil samples from up to 2m below the surface. These will then be stowed in an ascent vehicle, launched into orbit and caught by a lunar orbiter for return to Earth. This will be the first time planetary geologists have got a close look at rock from the lunar far side, and will help researchers understand the full context of how the Moon has grown and changed over history.

While great care will be taken to ensure samples remain uncontaminated, there are some substances that will melt or boil when brought back to the temperate climes found on Earth. These so-called volatiles cover a range of very important chemicals such as carbon dioxide, methane and – most critically – water.

Water is vital to both life and many geological processes on Earth, which is

why there was great excitement when India's Chandrayaan-1 orbiter found evidence of water lurking at the Moon's southern pole in 2009. The Sun shines low over this region, casting long shadows that create dark corners in craters, untouched by sunlight for billions of years, meaning they've been able to trap water from far into the Solar System's past.

Unfortunately, this means accessing

this water requires venturing into these dark shadowy regions. This is why NASA's latest rover, the **Volatiles Investigating Polar Exploration Rover (VIPER)**, due to head to the Moon in November, will be the first planetary rover equipped with headlights. The mission will also be NASA's first-ever venture to the southern pole, its first autonomous lunar rover and its first landing mission to the Moon since Apollo 17 in 1972.

Over its 100-day mission, VIPER aims to track down any water and assess its potential both as a scientific tool and as a resource for future lunar missions. As well as headlights, the rover has a novel drive system that allows each wheel to move independently. This will help VIPER navigate the loose-packed lunar soil and challenging terrains, change direction without turning and even 'swim' through the dust to free itself should it get stuck.

It's uncertain what form the water could take – ice, frost or mixed in with the lunar soil – but VIPER's cameras will assess the area for the most promising-looking spots. It will then drill to bring up material from up to 1m below the surface, using its spectrometers to examine it for water as well as other volatiles and minerals.

From the far side to its darkest corners, the Moon has kept parts of itself hidden for billions of years. In 2024, at least some of its secrets are set to be brought into the light.



Chang'e 6 will collect the first-ever samples from the far side of the Moon

The skies above Mars

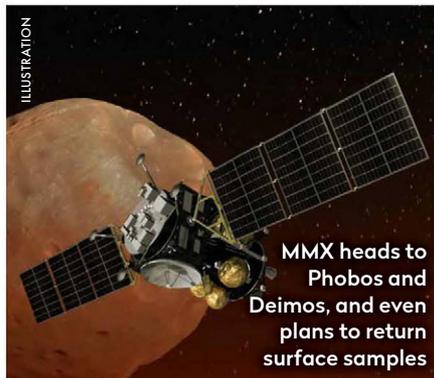
Two EscaPADE spacecraft will work in tandem to study the Martian atmosphere and magnetosphere

ILLUSTRATION

The missions will explore the skies and moons above the Red Planet

This August and September will see the latest launch window to Mars, an opportunity that comes around once every two years to send a mission to the Red Planet. This year several missions are taking advantage, but rather than focusing on the surface of the planet, they will look towards what happens above it.

NASA's **Escape and Plasma Acceleration and Dynamics Explorers (EscaPADE)** spacecraft will launch this year, set to enter into orbit in September 2025. The mission will consist of two spacecraft, orbiting and working in tandem to better understand how the planet's atmosphere and magnetosphere interact, both with each other and with the solar wind to guide the flow of particles and energy around the planet. One key area of study will be how the



MMX heads to Phobos and Deimos, and even plans to return surface samples

solar wind may have contributed to the loss of the planet's atmosphere.

They will be joined in their journey to the Red Planet by the Japanese Aerospace Exploration Agency's **Martian Moons eXploration (MMX)** mission, which will turn its gaze on Mars's two

diminutive moons. The spacecraft will spend much of its time keeping pace with 23km-wide Phobos, undertaking a detailed survey of its surface. Then in August 2025, it will perform the most daring part of its mission by touching-down on Phobos to collect up to 10g of material to bring back to Earth.

The craft will then conduct several fly-bys of 15km-wide Deimos, before leaving Mars orbit in August 2028, arriving back at Earth in July 2029. The data from both the flight and the returned sample will answer many questions about the moons, such as whether they were once a part of Mars that was chipped off during an impact, or whether they came from elsewhere before being captured by the planet's gravity.

A potential third mission from the Indian Space Research Organisation could also be on its way. **Mars Orbiter Mission-2** (also called Mangalyaan-2) was initially announced with a 2024 launch date, but little has been revealed since. Whether it flies this year or during the next launch window, the mission will consist of an orbiter looking at the planet's atmosphere, with a particular focus on dust in Mars's orbit, determining whether it originates from the planet or the moons.

Whatever missions do make it on their way this year, it's the skies above Mars that will take centre stage in 2024. ►



EscaPADE will throw light on how solar winds can strip planets of their atmosphere

Vera Rubin

The observatory will take its first look at the sky

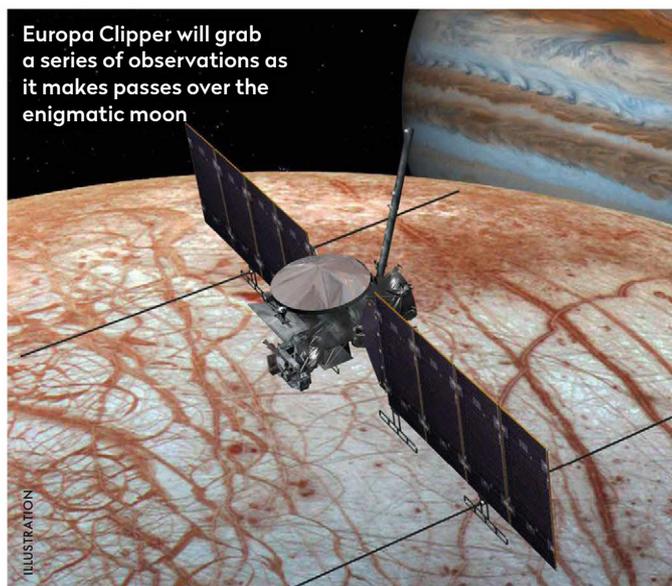
Over a decade after work began on the top of the Cerro Pachón ridge in Chile, the final touches are now being placed on the next great astronomical tool, the Vera C Rubin Observatory. Once complete, Rubin's 8.4m telescope and 3,200-megapixel camera will be large enough to fit 40 full Moons in a single frame. It will use this huge capacity to survey the entire sky once every three



The race is on for Rubin Observatory to go online by the end of this year

to four days for at least 10 years. These frequent, high-quality maps will be vital for tracking down supernovae, asteroids and all other manner of transient objects and events. In addition, this decade of data will create a map deep enough to uncover up to 20 billion new galaxies and a similar number of stars, creating a more complete catalogue of the heavens than ever before.

Construction of the telescope was completed in 2023 and attention now turns to installing its instruments. One of the most important milestones is set for the tail end of 2024, when the cameras will be exposed to the night sky for the first time. These initial observations will help the team perfect the telescope's focus and alignment, ready to begin science observations in the spring of 2025.



Europa Clipper will grab a series of observations as it makes passes over the enigmatic moon



We could soon know if liquid water lies beneath Europa's icy crust

Europa Clipper

This NASA mission will delve beneath the surface of Jupiter's mysterious moon

Here on Earth, where there's water, there's life, but is that true elsewhere in the Solar System? It's thought that one of Jupiter's icy moons, Europa, is home to a subsurface ocean of liquid water that could potentially be home to some kind of microbial life.

This year, NASA plans to send its **Europa Clipper** spacecraft to thoroughly investigate the moon and determine how likely it is that life might be hiding under the ice. The spacecraft will map the moon inside and out. Using its cameras and spectrometers it will create a detailed atlas of the entire surface, looking for signs

of organic chemicals that could form the building blocks of life, as well as gaining a better understanding of the geological processes that shape the moon's face. Meanwhile, radar, magnetometers and gravity measurements will allow Europa Clipper to look under the surface, finally confirming whether or not the subsurface ocean even exists. These measurements will be able to assess the thickness of the ice shell, the depth of the ocean and even its salinity. It will also keep an eye out for signs of water plumes erupting into the moon's atmosphere, which have been hinted at by other observations.

Europa Clipper is due to launch in October, but won't reach the Jupiter system until April 2030. Upon its arrival, the spacecraft won't be able to orbit the moon directly as it lies in an area of intense radiation created by Jupiter's strong magnetic field. Instead, the spacecraft will fly in a wide, looping orbit around the planet, swooping in past the moon to get as close as 25km from the surface. Europa Clipper will fly by the moon approximately 50 times in this way, building our fullest-ever picture of what lies beneath the surface of this mysterious moon.

RUBIN OBS./NSF/AURA/H. STOCKBRAND, NASA/JPL-CALTECH X2, NASA/KIM SHIFFLETT, NASA, NASA/ALBERTO BERTOLINI

Artemis II returns humans to the Moon



▲ Artemis II's Reid Wiseman, Victor Glover, Jeremy Hansen and Christina Koch will fly further from Earth than any human before

The crew will be the first humans to reach the vicinity of the Moon in over 50 years

NASA is returning to the Moon. By the end of the decade, the agency hopes to set the first woman and first person of colour on the lunar surface, and this year it takes another step towards this new giant leap with its **Artemis II** mission.

If the mission runs to schedule it will launch in November, with a crew consisting of commander Reid Wiseman, pilot Victor Glover and mission specialist Christina Koch from NASA, all of whom will be making their second spaceflights. They will be joined by Canadian astronaut Jeremy Hansen, making his first flight. The flight will mark the first time a crew has flown aboard either the Space Launch System (SLS) or the Orion crew capsule.

Initially, the crew will conduct a 90-minute orbit of Earth, followed by a longer 42-hour orbit. This will allow them time to test life-support systems through a full cycle of activity, exercise and rest. All being well, the capsule will then set course for the Moon, travelling along a free-return trajectory that will carry it in a figure-of-eight path around the Moon. The capsule will travel out 7,400km beyond the Moon's far side, the farthest distance a human has ever travelled around the back-side and far enough away that the crew will be able to see both the Moon and Earth together out of the capsule's window. The crew will then return home, splashing down 10 days after the mission began.

If all goes well with this mission then Artemis III will be the first landing



▲ Boeing's Starliner will take its first crewed test flight, docking with the ISS in April

mission, due to touch down next year. The goal with the Artemis programme is not merely to conduct 'flags and footprints' missions, but to establish a more meaningful and lasting presence on the Moon. At the same time, NASA will

be aiming to launch the first sections of a permanent space station orbiting the Moon, called **Gateway**. Once complete, future Artemis missions will be able to use this to conduct sojourns down to the lunar surface, establishing a much more long-term presence on the Moon.

NASA isn't abandoning low-Earth orbit, however. In April Boeing plans on conducting the first crewed test flight of its **Starliner** spacecraft. Veteran NASA astronauts Butch Wilmore and Suni Williams will pilot the craft, docking with the International Space Station for several days to test all systems are operational. If all goes well, Starliner will enter into regular rotation ferrying astronauts to and from the International Space Station. The next few years will certainly be busy ones in the realm of human spaceflight. 🚀



NASA could launch the first section of its milestone Gateway lunar space station