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Space exploration

Return to the moon to start with test of lunar space station orbit

Alex Wilkins

NASA'S mission to go back to the moon is set to begin in the next few weeks with the launch of a craft to test the orbit of a planned lunar space station. It is the first step in the Artemis programme, which aims to put a man and the first woman on the moon by 2025.

The Cislunar Autonomous Positioning System Technology Operations and Navigation Experiment (CAPSTONE) is due to blast off between 13 and 22 June, depending on weather conditions, from the Māhia peninsula in New Zealand. It will do so using an Electron rocket and Lunar Photon upper stage, both created by the firm Rocket Lab.

CAPSTONE will take around three months to reach the moon. It will then spend six months in a near-rectilinear halo orbit, which ranges from just 1600 kilometres above the lunar surface at its nearest point to 70,000 km at its furthest. Such an orbit is planned for the Lunar Gateway space station being built by NASA and its partners for a launch in 2024, but has never been used before.

"They have this theoretical

orbit that they want to use for Gateway that means it can fulfil its objectives, but it's not been tested yet," says David Brown at the University of Warwick, UK. "Obviously, they'd like to test it with something slightly cheaper and smaller before they put a space station there."

A team on Earth will precisely measure CAPSTONE's fuel usage during the mission and gauge

Illustration of the CAPSTONE probe orbiting the moon



NASA/DANIEL RUTTER

how well ground-based sensors can track the satellite.

NASA also hopes to test a new navigation and communication system between CAPSTONE and the Lunar Reconnaissance Orbiter (LRO), which has been circling the moon since 2009. The system will eventually allow future spacecraft operating around the moon to track their own position. "This isn't easy because LRO was never designed for this," says Brown.

NASA contracted out the management of CAPSTONE's launch to private company

Advanced Space, while its design, propulsion systems and housing were also contracted out to other private companies. This marks a shift from the crewed Apollo-era moon missions of the 1960s, which were designed by NASA and used rockets such as the Saturn V that cost over \$1 billion per launch in today's money.

"Now, we're headed to the moon with a small, carbon-fibre rocket and our Photon spacecraft that's no bigger than a fridge, and for a fraction of the cost, and size, of those earlier launches," says Rocket Lab chief executive Peter Beck.

Though CAPSTONE was delayed from 2021 due to the coronavirus pandemic and had several pushbacks this year, it has a fairly high chance of success once it launches, thanks to a reliable rocket and an orbit that is pretty well mapped, says Brown. "While some of the manoeuvres it needs to make to get into this orbit are quite precise, they're also quite well mapped out," he says. "If it does go slightly wrong, they'll have some extra fuel on there to be able to try and correct it." ■

Evolution

Chickens were domesticated later than we thought

THE first domestic chickens we have found lived no earlier than 3670 years ago, suggesting they have a far shorter history than we thought. These birds don't seem to have been raised for their meat, making it unclear what drove domestication.

The chickens alive today descend from a wild bird native to South-East Asia called the red junglefowl (*Gallus gallus*), but exactly when domestication occurred was unclear.

Some researchers have estimated that the first domestic chicken lived more than 6000 years ago, while others claim to have found chicken bones at 10,000-year-old sites.

An analysis by Ophélie Lebrasseur at the Centre for Anthropobiology and Genomics of Toulouse in France and her team concludes that the earliest clear evidence of domestic chickens appears between 1650 BC and 1250 BC at a site called Ban Non Wat in central Thailand. Not only are chicken bones superabundant at the site, there are signs people were buried with the birds, which Lebrasseur says makes a domestic

relationship clear (*PNAS*, doi.org/hxsr).

Lebrasseur and her team suspect chicken domestication might have been triggered by the appearance of cereal farming in South-East Asia. "This created a more open, less [tree-covered] environment, which is actually an environment where red junglefowl thrive," she says. "And they could have fed on the waste from human societies."

"The earliest clear evidence of domestic chickens appears between 1650 BC and 1250 BC"

This suggests the birds were attracted to human settlements, and natural selection may have had a role in domesticating them. Dog domestication is thought to have occurred in a broadly similar way.

Why humans encouraged chicken domestication is less clear. Julia Best at Cardiff University, UK, says there is little evidence that chickens were killed for meat when first introduced to Europe. Lebrasseur thinks this indicates domestication wasn't based on a desire for meat. She says we still don't really understand what drove the process. ■
Colin Barras