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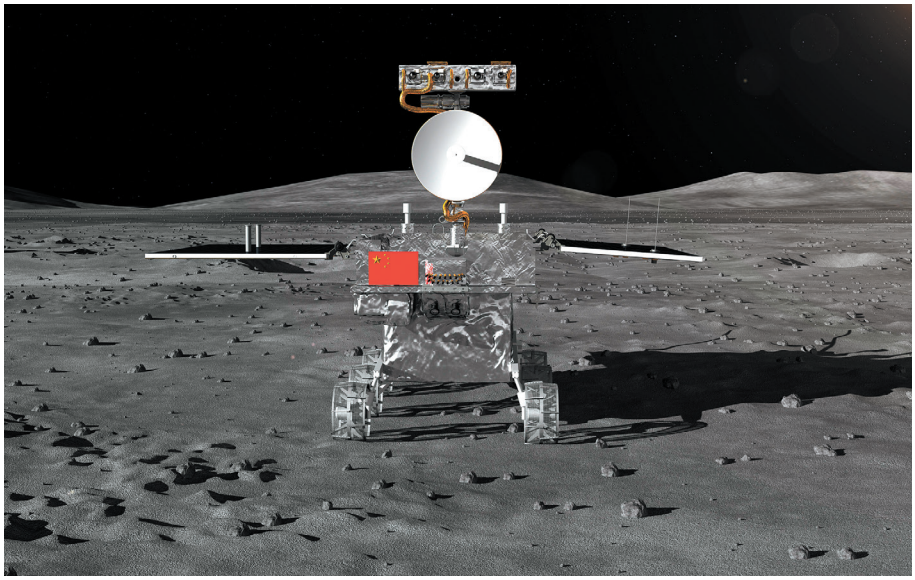

That's one small step for a rover, one giant leap for lunar science.

MOON EXPLORATION

Journey to the far side of the Moon

China is about to land on the Moon's dark side; experiments will include vegetable growing and radio astronomy.

BY ANDREW SILVER

Early in the New Year, if all goes well, the Chinese spacecraft Chang'e-4 will arrive where no craft has landed safely before: the far side of the Moon. The mission is scheduled to launch from Xichang Satellite Launch Centre in Sichuan province on 8 December.

The craft, comprising a lander and a rover, will then enter the Moon's orbit, before making a controlled landing on the surface. The mission's main job will be to investigate this side of the lunar surface, which is peppered with many small craters. The lander will also conduct the first radio-astronomy experiments from the far side of the Moon — and the first investigations to see whether plants will grow in the low-gravity lunar environment.

"This mission is definitely a significant and important accomplishment in lunar exploration," says Carolyn van der Bogert, a planetary geologist at Westfälische Wilhelms University in Münster, Germany.

The ultimate goal of the mission is to create a Moon base for future human exploration. Chang'e-4 will be the country's second craft to 'soft' land on the lunar surface, following Chang'e-3's touchdown in 2013.

The China National Space Administration (CNSA) has remained tight-lipped about many of the mission's details, including the landing site. The most likely location is inside a 186-kilometre-wide crater called Von Kármán, says Zongcheng Ling, who studies the formation and evolution of planetary bodies at Shandong University in Weihai, and is a member of the mission's science team. "We scientists are very happy" to have the chance to visit the far side, says Ling. The crater is part of the South Pole–Aitken basin, the largest known impact structure in the Solar System and the oldest on the Moon.

"It is a key area to answer important questions about the early history of the Moon."

"It is a key area to answer several important questions about the early history of the Moon, including its internal structure and thermal evolution," says Bo Wu, a geoinformatician at Hong Kong Polytechnic University, who helped to describe the topography and geomorphology of this site.

The Chang'e-4 rover will map the region surrounding the landing site. It will also measure the thickness and shape of the subsurface layers using ground-penetrating radar, and measure the mineral composition at the surface with a near-red and infrared spectrometer, which could help geologists to understand the processes involved in the Moon's early evolution.

Because the far side of the Moon never faces Earth, CNSA mission control won't be able to communicate directly with the craft once it has landed. In May, China launched a communications satellite called Queqiao to orbit beyond the Moon and act as a relay station.

The Chang'e-4 rover and lander will carry out some unique experiments. One of those will test whether potato and thale cress (*Arabidopsis*) seeds sprout and photosynthesize in a sealed, climate-controlled environment in the low gravity on the lunar surface.

"When we take the step towards long-term human habitation on the Moon or Mars, we will need greenhouse facilities to support us, and will need to live in something like a biosphere," says Anna-Lisa Paul, a horticultural scientist at the University of Florida in Gainesville.

The proposed test will seek to verify previous studies carried out on the International Space Station, says John Kiss, a space biologist at the University of North Carolina Greensboro. These found that potatoes and thale cress can grow normally in controlled ecosystems in lower gravity than that on Earth, but not in gravity as low as that on the Moon.

The lander's radio-astronomy experiments will target parts of the Milky Way that are poorly understood, such as the gases between stars, and the magnetic fields that propagate after a star's death. A radio spectrometer, built by the Chinese Academy of Sciences, will collect electromagnetic data between 0.1 and 40 megahertz to create a map of low-frequency radiation from the night sky.

Capturing these measurements from Earth is difficult because Earth's atmosphere mostly blocks such radiation, says Heino Falcke, a radio astronomer at Radboud University Nijmegen in the Netherlands, and a member of the Dutch team that has built a spectrometer carried on the Queqiao satellite. "We have completely blurred vision at low frequencies," he says. Astronomers will use these data to better understand how energy released by dying stars heats up the gases between them, which could affect how stars form, says Falcke.

They are also interested in this spectrum of radiation in order to study the first few hundred million years of the Universe, a time before the formation of galaxies and stars. The data could help the researchers filter out background noise that could be hiding a signal from this time period. If found, that signal could reveal information about the distribution of ordinary matter compared with dark matter in the Universe. But even with the help of the Moon lander, it is not certain that these experiments will detect the signal, says Falcke. "It is a first step."

China's next venture to the Moon will be even more ambitious. Chang'e-5, scheduled to launch in 2019, will try to bring samples from the Moon back to Earth. ■