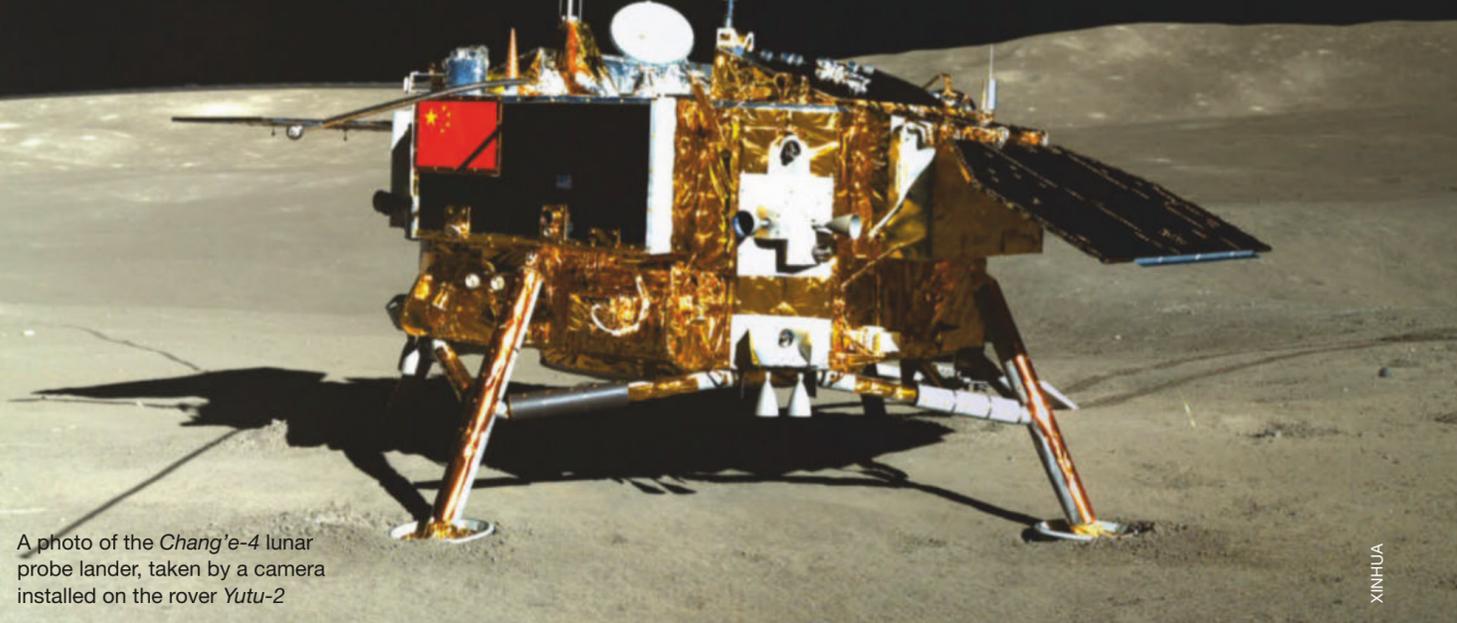


A Bold New Step

China's lunar rover *Yutu-2* makes the first imprint on the far side of the Moon

By Wang Hairong



A photo of the *Chang'e-4* lunar probe lander, taken by a camera installed on the rover *Yutu-2*

XINHUA

Tender leaves sprouting from cotton seeds in a container aboard the *Chang'e-4* probe to the far side of the Moon add vitality to the otherwise desolate celestial body.

"These are the first biological experiments on the Moon. Scientists have done biological experiments on space stations and other spacecraft before, but never on the Moon," said Xie Gengxin, chief designer of *Chang'e-4*'s biological experiment payload and Dean of the Institute of Advanced Technology at Chongqing University.

The tests are of great significance for future research and the establishment of a lunar base for human beings, Xie said at a press conference in southwest China's Chongqing on January 15.

Fruit fly pupae, yeast, potato seeds, *Arabidopsis* and rape-seeds were also carried to the Moon to create a mini lunar biosphere, according to Xie. The plants were designed to produce oxygen and food, the fruit flies and yeast to inhale oxygen and exhale carbon dioxide so plants could carry out photosynthesis, while yeast will decompose waste and also serve as food for the fruit flies. The same experiment is being carried out simultaneously on Earth for comparison data, he said.

From January 3, when the experiment was started on the Moon, to January 12, when the container was powered off as the lunar probe went into "hibernation" during the cold lunar night, more than 170 photos as well as soil, temperature and pressure data have been transmitted back to Earth, Xie said, adding that the experiment's targets have been reached or exceeded.

During the Moon's night, the creatures will freeze and then decompose in the sealed container during the next moon day without polluting the environment, Xie added.

China's *Chang'e-4* lunar probe made the first ever soft-landing

by a spacecraft on the far side of the Moon on January 3 after 26 days in space.

After the lander touched down, the rover *Yutu-2* inched down the ramp of the lander and made its first imprint on the lunar surface. With its arms stretched out on either side, the rover set out to explore the Moon like a curious toddler embracing a new playground.

On January 11, the China National Space Administration (CNSA) announced that the *Chang'e-4* lunar probe mission was a success, as indicated by the normal functioning of both the lander and the rover, their photographing of each other and the transmission of images to Earth with the help of *Queqiao*, or *Magpie Bridge*, a satellite launched in May to relay data transmission between Earth and the far side of the Moon.

While watching the lander touch down on the Moon on a giant screen at the Beijing Aerospace Control Center, Zhang He, Executive Director of the *Chang'e-4* probe project, could not hold back her tears of joy. "The moon landing is the most critical stage of the whole mission because the process is rife with risks and challenges," she said.

Jia Yang, the probe's deputy chief designer from the China Academy of Space Technology (CAST), said, "It is a perfect display of human intelligence."

Upgraded rover

Not long after descending on the pockmarked moon surface, *Yutu-2* took a "nap" amid the searing noon temperature of over 100 degrees Celsius to prevent overheating. The rover "woke up" on January 10 and resumed activities, snapping pictures and beaming back data.

Mainly powered by solar energy, *Yutu-2* is designed to work during moon days and "hibernate" during cold and dark moon nights. A night or day on the Moon is equivalent to about 14 days on Earth.

Yutu-2 is the second lunar rover launched by China. The first rover *Yutu* landed on the Moon on December 14, 2013, on board *Chang'e-3*.

Zhang said that *Yutu-2* is smarter because it can enter into a dormant state automatically at the beginning of the Moon night according to light levels; moreover, after "waking up," it can switch into a stable working mode independently. Compared with its predecessor, *Yutu-2* is 2 kg lighter at 137 kg, making it the lightest rover on the Moon, said Jia.

Both rovers have a designed lifespan of three months, can climb over 20-cm-high rocks and travel at a maximum speed of 200 meters per hour. "*Yutu-2* is stronger and more capable of coping with difficulties," said Shen Zhenrong, one of the designers of the rover from CAST.

Collaborative efforts

After declaring the mission a success, Wu Yanhua, Deputy Director of the CNSA, said at a press conference in Beijing on January 14, that *Chang'e-4* will survey lunar topography and landforms, explore shallow lunar surface structure, analyze mineral composition and observe space environment.

To complete its scientific tasks, the probe carries 13 scientific payloads including four developed by scientists from Germany, the Netherlands, Saudi Arabia and Sweden, said Wu.

The CNSA attaches great importance to international cooperation and exchanges in aerospace advancement. China has always upheld the principle of openness and cooperation in developing space programs. To date, the CNSA has signed bilateral agreements with 39 countries and joined 18 space-related international organizations, said CNSA's spokesperson Li Guoping at the press conference.

In April 2015, the CNSA solicited payloads from the international community, and received 20 applications from over 10 countries, with four eventually selected, said Li. Chinese and relevant foreign scientists will form teams to carry out joint research using data obtained from these payloads.

Moreover, the CNSA is willing to share data from the nine scientific payloads independently developed by China with foreign space agencies, research institutes and individuals interested in space exploration, Li said.

The lunar probing mission also involves other international collaborative efforts. Wu said a ground station that China built in Argentina has played an important role in the monitoring and control of the mission; the radioisotope heat source jointly developed by Chinese and Russian scientists will support the probe through the lunar night; and China and the European Space Agency have offered support to each other in deep space probing.

Chinese and U.S. scientists have also actively engaged in cooperation, with the Lunar Reconnaissance Orbiter (LRO) of the U.S. National Aeronautics and Space Administration (NASA) observing *Chang'e-4*, Wu added.

"NASA told us that it hopes to use the LRO satellite in lunar orbit to observe the lunar dust during *Chang'e-4*'s landing for study. Scientists from both countries communicated through a videoconference. The U.S. side told us about their satellite, and China informed the U.S. side in a timely manner of the longitude, latitude and the time of the *Chang'e-4* landing. Because the LRO was not overhead when *Chang'e-4* landed, it could not monitor the lunar dust in real

time. Later, when the LRO passed overhead, it monitored the lunar probe and NASA published the photos online," Wu explained.

The CNSA welcomes the participation of foreign space scientists from all countries in its ensuing lunar and deep-space exploration projects through various means, Wu stated.

Three-step plan

China has a three-step plan for its lunar probing program: to send a spacecraft to fly around the Moon in 2007, land on the Moon in 2015 and return with lunar samples in 2020. Around the end of 2019, he said, *Chang'e-5* is going to bring lunar samples back to Earth, which will mark the completion of the three-step plan.

Wu disclosed that currently the CNSA is organizing experts to deliberate future plans, and three tasks have been preliminarily decided. *Chang'e-6* will return with lunar samples collected from the lunar South Pole, while *Chang'e-7* will carry out a comprehensive exploration of the lunar South Pole, including surveying its topography and landforms, chemical composition and space environment. *Chang'e-8* will continue to probe the Moon and carry out lunar-based experiments, including experiments on the technologies needed to build a lunar scientific and technological research base.

During the upcoming lunar landing mission to the Moon's South Pole, Wu said, China will provide the international community with 10 kg of payload-carrying capacity on orbiters and landers.

In addition, the *Queqiao* relay satellite has a three to five-year lifespan left, he said, thus, the CNSA welcomes foreign scientists to conduct scientific research using the satellite.

"Cooperation is the common aspiration of scientists since the data gathered during lunar or deep-space probing is for unraveling the mysteries of the universe, a common responsibility of all the countries of the world," Wu said. Countries with strong space programs, in particular, should focus more on cooperation and make more contributions to the exploration of the universe for humanity, he said.

RECORDS SET BY CHANG'E-4

- First soft-landing and probing on the far side of the Moon
- First relayed communication between the far side of the Moon and Earth
- First ultra-low frequency scientific experiment on the far side of the Moon
- First laser ranging experiment beyond the Earth-Moon distance
- First biological experiment on the lunar surface
- First international cooperation in scientific-payload carrying and lunar probing



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