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# Rover solves 'mystery hut' lunar puzzle

Panoramic color pictures from Yutu 2 show object is a rabbit-shaped rock

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China's Yutu 2 lunar rover has traveled more than a kilometer on the moon and is still working well, according to the China National Space Administration.

The administration said on Saturday that the distance traveled by the rover reached 1 km on Thursday evening. By late that night, the robot had moved about 1,004 meters on the lunar surface.

It added that Yutu 2, the second Chinese rover on the moon, has been in its 38th lunar-day working session since Dec 27 and "is in normal condition".

A lunar day equals 14 days on Earth, and a lunar night is the same length. During the lunar night, the temperature falls below -180 C, and there is no sunlight to provide power to the craft.

During the 38th working session, mission controllers uncovered the truth behind a "mystery hut" that was spotted by Yutu 2 in its 36th working session and appeared to be a gray cube looming on the silver sphere's horizon.

A picture of the object published by engineers at the Beijing Aerospace Control Center in early December immediately attracted attention from the media and space fans around the world.

Chinese scientists were also intrigued by the object and told controllers to drive the rover toward it.

After overcoming several obstacles in its path, the robot approached the "hut" and used its panoramic camera to take color pictures of it.

Based on the pictures transmitted back to Earth, ground controllers found that the object is a rabbit-shaped rock. Nevertheless, they have decided to move the rover close to the object during its next lunar-day working session to

further investigate the rock and a nearby crater, the space administration said.

By Sunday, Yutu 2 had been operating for 1,102 Earth days, cementing its status as the longest-working rover on the moon. The record was previously held by its predecessor — Yutu — which worked on the moon for 972 days, far outliving its designed life span of three months.

Yutu 2 is part of the ongoing Chang'e 4 robotic probe mission, humanity's first endeavor to land on and closely observe the far side of the moon. The mission was launched by a Long March 3B carrier rocket in December 2018 at the Xichang Satellite Launch Center in Sichuan province.

The probe made a soft landing on the far side on Jan 3, 2019, and released Yutu 2 to roam and survey the landing site in the South Pole-Aitken Basin, the largest and deepest known basin in the solar system.

In late November, Chinese scientists at the State Key Laboratory of Space Weather, which is run by the Chinese Academy of Sciences' National Space Science Center, published a major scientific finding enabled by Yutu 2 in that month's issue of *Nature Astronomy*.

They said that they had found remnants of carbonaceous chondrites on the moon's far side in hyperspectral images in the visible and near-infrared range taken by the rover.

Carbonaceous chondrites are meteorites that originated in the asteroid belt near Jupiter and are believed to be among the oldest objects in the solar system. Their existence on the moon may still act as a source of water on its barren surface, according to the researchers, who were headed by Liu Yang.

# CHINA



China's space industry made several remarkable accomplishments last year.

The highlights were a massive space station, which is now orbiting Earth, and a rover that landed on Mars in a historic interplanetary adventure for the nation.

The country embarked on its ambitious space station program in late April — after decades of preparations and about three years of delays caused by rocket malfunctions. The aim was to complete an engineering marvel before the end of the year.

On April 29, the first, and central, component of the Tiangong space station — the Tianhe core module — lifted off from the Wenchang Space Launch Center in Hainan province atop a Long March 5B heavy-lift carrier rocket.

The biggest and heaviest spacecraft China has ever constructed, Tianhe is 16.6 meters long and 4.2 meters in diameter. At 22.5 metric tons, the craft equals the combined weight of 15 standard-sized automobiles. It has three parts: a connecting section; a life-support and control section; and a resources section.

The module is Tiangong's most important element, given that astronauts will live there for long periods and control the entire station from inside. It is also the station's main platform for scientific experiments and technological tests.

When completed, by the end of this year, Tiangong will consist of three main components — a core module attached to two space labs — with a total weight of nearly 70 tons.

The station will operate for about 15 years in a low-Earth orbit, about 400 kilometers above the planet.

Yang Hong, the module's chief designer at the China Academy of Space Technology, said Tianhe is designed to accommodate long-term visits and support workspaces, which will be essential for assembly of the station and its assessment of its external integrity and repair of broken parts.

The astronauts' living and working space is about 50 cubic meters, much larger than that of previous Chinese manned spacecraft. Once the space station is completed, the occupants will have as much as 110 cu m of usable space, Yang said.

By comparison, the usable space in a crewed spaceship in the Shenzhou series is about 7 cu m.

Zhang Hao, a senior designer at the academy who took part in the module's development, said that compared with previous Chinese manned spaceships, the module features better living conditions.

"There are separate quarters for working, sleeping, personal hygiene, dining, healthcare and physical exercise," he said.

Each astronaut has their own bed and they share a dedicated washroom, the first to feature on a Chinese spacecraft. We installed many appliances to make the stay easier, such as an air conditioner, microwave oven, refrigerator and water dispenser, as well as a treadmill.

Each astronaut has a specially designed smartphone capable of not only making calls between the crew and people on the ground, but also of remotely controlling the capsule's internal equipment, he added.

### First occupants

In mid-June, the Shenzhou XII spacecraft, carrying a three-strong crew — Major General Nie Haisheng, Major General Liu Boming and Senior Colonel Tang Hongbo — was launched by a Long March 2F rocket from the Jiuquan Satellite Launch Center in the Gobi Desert in Northwest China.

The craft docked with Tianhe just hours after reaching the module's orbit and the crew quickly entered the facility, becoming the first occupants of the Tiangong space station.

During the crew's 90-day stay, they verified plans and equipment designed for long-term spaceflight, performed a number of scientific experiments and technological tests, and made two spacewalks to use a large robotic arm and other equipment to install and adjust apparatus outside the station.

They also made video calls with President Xi Jinping and hundreds of researchers, teachers and students in Hong Kong.

The Shenzhou XII crew finished their 90-day mission in mid-September and then returned to Earth.



From left: Astronauts (from left) Ye Guangfu, Zhai Zhigang and Wang Yaping, the crew of Shenzhou XIII, wave during a video from the Tianhe core module in October. TIAN DINGYU / XINHUA Members of the crew return to the module after a spacewalk on Dec 27. GUO ZHONGZHENG / XINHUA



# Nation's space program sees new age of achievement

In the past 12 months, scientists have landed a rover on Mars and moved closer to completion of an orbiting laboratory. Zhao Lei reports.



Clockwise from top: The Tianhe core module lifts off from the Wenchang Space Launch Center in Hainan province atop a Long March 5B heavy-lift carrier rocket on April 29. JIN LUWANG / XINHUA Tianwen 1 has completed the scheduled tasks for the world's 46th Mars exploration mission, but the Zhurong rover continues to work on the planet's surface. XINHUA A photo sent back to earth by Tianwen 1 on Jan 1. XINHUA

## China tops global list of rocket liftoffs as Long March family hits 400th mission

Last year was China's busiest in terms of orbital launches, topping the global list of rocket liftoffs for the third time.

Early on the morning of Dec 30, a Long March 3B carrier rocket roared into life at the Xichang Satellite Launch Center in Sichuan province, transporting the Communication Technology Demonstrator 9 experimental satellite into a geosynchronous orbit.

The launch was the 48th flight of the Long March rocket family last year, and it signaled the completion of the country's annual launch schedule for the year.

Last year, Long March rockets carried out more orbital launches than any other rocket family in the world, and all were successful.

In addition, China Aerospace Science and Industry Corp conducted four launches of its Kuaizhou 1A rocket, while two private rocket companies in Beijing carried out three launches.

As a result of the Long March family's frequent flights, China became the year's biggest user of carrier rockets, with 55 orbital launches, while the United States launched 45 rockets, ranking second in liftoffs.

Also last month, the Long March family hit its 400th flight mission, with a Long March 4B rocket lifting off from the Jiuquan Satellite Launch Center in the Gobi Desert in the country's northwestern region.

In April 1970, China launched its first carrier rocket — a Long March 1 that was based on a ballistic missile — to send its first satellite, Dongfanghong 1, or the East is Red 1, into

space. The mission made China the fifth country capable of building and launching its own carrier rocket capable of reaching Earth orbit.

Since then, the country has developed and launched more than 20 types of Long March-series rockets, with about 15 types still in active service.

Chinese engineers are designing many new types of carrier rockets, including a super-heavy model tasked with carrying the nation's astronauts to the moon.

Hao Chun, director of the China Manned Space Agency, said his team's goal is to ensure that the best use will be made of the station to advance space science, technology and applications.

Scientists are using the facility's unique environment to conduct breeding experiments, produce special medicines and create new materials, thus generating scientific, technological and economic benefits, he added.

During handovers to new groups, the station will accommodate as many as six astronauts.

Shenzhou XIV and XV manned missions and two robotic cargo flights will also be undertaken and will dock with Tianhe, carrying astronauts for shifts and ferrying supplies and mission payloads.

Following the Shenzhou XIII mission, Tiangong will be manned regularly by three-strong groups of astronauts in six-month shifts.

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He also said that China is open to cooperation with foreign nations in the space station project, adding that after the Tiangong station starts formal operations, there will be more than 20 cabinets onboard reserved for international-standard scientific instruments.

Moreover, Hao said foreign astronauts will definitely work on the station.

### Martian journey

After deploying a robot on the far side of the moon and bringing fresh lunar soil back to Earth, China achieved its newest feat in deep-space exploration by placing a rover on Mars.

On May 15, Zhurong, named after a Chinese god of fire, was released from the Tianwen 1 robotic probe and pierced the Martian atmosphere in an extremely risky landing procedure.

It quickly touched down safely on the southern part of Utopia Planitia, a large plain on the Red Planet.

On May 22, Zhurong left its landing platform and traveled on the Martian soil, becoming the sixth rover on Mars, following five predecessors from the United States.

The 185-meter-high, 240-kilogram rover has now worked on the Martian surface for more than seven months — far outliving its three-month life expectancy.

It has traveled more than 1.4 km and transmitted a number of video clips and photos taken en route for its destination, an ancient coastal area on Utopia Planitia.

Tianwen 1, the nation's first interplanetary exploration endeavor, was launched on July 23, 2020, from the Wenchang launch center.

It was the world's 46th Mars exploration mission since October 1960, when the former Soviet Union launched the first Mars-bound, albeit unsuccessful, spacecraft.

The Chinese craft consisted of two major components — the Zhurong rover and an orbiter. It traveled more than 470 million km and carried out several maneuvers before entering Martian orbit on Feb 10 last year.

Before releasing Zhurong for its landing, the Tianwen 1 probe circled Mars for more than three months, mainly to collect information about the rover's planned landing site for ground controllers to analyze and make decisions.

There are three operational rovers on the Red Planet — Curiosity and Perseverance of the US and China's Zhurong.

In the Martian skies, the Tianwen orbiter is staying in an orbit to conduct remote-sensing and signal-relay operations.

The mission has obtained nearly 540 gigabytes of data and transmitted them back to Earth, according to mission controllers at the China National Space Administration.

They added that the rover and orbiter have plentiful energy resources and are in good condition.

### Aiming at the sun

Following the moon and Mars, China has set its exploratory sights on the core of our solar system.

In mid-October, the country launched its first solar observation satellite, aiming to deepen scientists' knowledge of the star.

The 508-kg Chinese H-Alpha Solar Explorer satellite was launched by a Long March 5B rocket from the Jiuquan Satellite Launch Center in Shaanxi province, before entering a sun-synchronous orbit, about 517 km above Earth.

The mission is expected to provide scientists with the first high-quality observation data of the source area of a solar eruption and will help the China's research capability in solar physics, according to program officials at the administration.

Wang Wei, the satellite's project manager, said it is China's first space-based solar telescope and is designed to study the sun's activity.

"Scientifically speaking, the H-alpha imaging spectrograph on the satellite is able to observe and record changes in the sun's physical elements, such as temperature and speed, facilitating scientists' studies on dynamics and physics during a solar eruption," he said.

Zhao Jian, a senior official in charge of the satellite program, said it is important to study the sun because solar activities have many effects on life on Earth.

Studying the sun also allows scientists to deepen their research on the origins and evolution of celestial magnetic fields, the acceleration and distribution of energetic particles and other physical phenomena, he said.

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