

# China's Lunar Exploration Program Moves to the Next Level

by Marsha Freeman

Dec. 6—China began Phase 2 of its lunar exploration program, with the successful launch on Dec. 2 EST of the Chang'e-3 spacecraft. The first two Chinese lunar missions, comprising Phase 1, sent orbiters to do detailed mappings of the Moon. Chang'e-3 will deploy a lander, which will release the 300-pound Yutu rover, designed to explore the Moon in new dimensions, for three months. Although critics complain that China is merely repeating what the space superpowers did in the 1970s, it has not been done *since* the 1970s, and *neither* of the space superpowers can do it now.

China is not “racing” anyone to the Moon. Scientists and engineers have been working on the development of the lunar rover for ten years. China is methodically building a capability to reach its goal: to explore the Moon, map its resources, and exploit this near-by cache of riches, such as helium-3, which can power the fusion energy power plants of the future.

The development of the Moon has been a goal of not only China, but in the past, of every space-faring nation. This nearest neighbor to Earth is an efficient platform, with its reduced gravity, for travel to anywhere else in the Solar System. Astronomy from the Moon is a window to the universe without the interference from Earth's atmosphere, or mankind's activities.

The Moon itself contains a full range of metals and minerals, and even water ice, which can be the building blocks for the apparatuses and industrial processing to be placed there. And it is the nearest source in the Solar System for helium-3.

The question that is constantly asked of Chinese lunar scientists is whether, in the early 2020s, China plans to send astro-

nauts to the Moon. Space planners in China are waiting for a go-ahead from the government to answer that question. But whenever that decision is made, and whatever the timeline turns out to be, all of the pieces are being put into place. This includes not only what will be tested and demonstrated on this mission, but those that follow.

The investigations by the Yutu (Jade Rabbit) rover on the Chang'e-3 mission will include the location of prospective sites for the collection of samples of lunar rock that are promising for closer examination on Earth. Due to China's conservative approach to space exploration, there will most likely be another lander/rover mission during Phase 2, as a backup. But Phase 3 will include the launch of a small craft from the surface of the Moon, which will carry lunar samples back to Earth.

After these missions are completed, along with a new heavy-lift rocket and the manned spacecraft systems that are being developed and tested on the Shen-



*The Chang'e-3 lunar rover*

zhou Earth-orbital manned missions, China will be in a position to send people to the Moon.

### **Breaking New Ground**

Chinese space officials have stressed that they had no interest in simply repeating the missions of the 1970s. So while a very important purpose of this current mission is to test new engineering capabilities, such as intricate navigation maneuvers, precision landing, robotics, and improved Earth communications, China's approach was to equip the lander and rover with advanced scientific instrumentation, to increase our knowledge of the Moon.

Both the lander and rover are powered by solar panels, and to survive the two-week lunar nights, they house a small sample of radioactive plutonium, the decay of which provides heat to protect the scientific instruments. This is the first time that China has used a radioisotope in a spacecraft.

For the first time, ground-penetrating radar will provide an in-depth image of the structure of the lunar crust. The underbelly of the Yutu rover has a radar system which will "see" detailed structure 90 feet underground, and less detail down to several hundred feet. The rover's cameras will help it with autonomous maneuvering, and instruments mounted on a movable arm will carry out experiments to determine rock characteristics.

The lander has an ultraviolet telescope, a Moon-based cosmic observatory. Lunar scientist and the "father" of the Chang'e program, Oyang Ziyuan, explained in a CCTV interview after launch, that astronomy from the Moon "is the dream of many astronomers," because there is nothing to obstruct their view. "One day of observation on the Moon is equivalent to 14 days on Earth," he said. The lander has a second ultraviolet camera for studying the Earth's ionosphere.

### **Alone? Together?**

Chang'e-3 entered lunar orbit on Dec. 6. In mid-December, when the lander has been maneuvered to an orbit just tens of feet above the lunar surface, it will hover above the target Sinus Iridum region. Cameras on the bottom of the lander will photograph the terrain and relay the images to scientists on Earth. The lander will scout the area until it finds a suitable spot, and then, avoiding obstacles, will shut its engines and descend to the surface. It will be the first controlled soft landing on

the Moon in nearly 40 years, and the first unmanned lunar craft able to do active hazard avoidance on its own.

The mission has generated great excitement in China, where scale models of the Jade Rabbit have been offered for sale, similar to the toy "hot wheels" models of the Mars rovers, developed by the Mattel toy company along with NASA. The excitement about the mission has been worldwide, with lunar scientists in the U.S. sending congratulations to the Chang'e-3 team.

Scientists in Turkey interviewed by Xinhua expressed great interest in a wide range of cooperative efforts with China. "Turkey closely watches China's lunar exploration programs," said Onur Haliloglu of the Space Technologies Research Institute of the Scientific and Technological Research Council of Turkey. "Turkey and China should cooperate," he said, on satellite projects and lunar missions. Another suggestion was that Turkey could develop a partnership with China in manned flight. "Turkey needs an astronaut program," said Prof. Celal Sami Tufeci, who mentioned that China will have a space station early in the next decade, which would provide research opportunities for Turkish scientists.

From the launch until the lunar landing on Dec. 14, the European Space Agency (ESA) is providing tracking support to Chinese mission controllers, and providing telemetry for communications, so commands can be sent from Earth to the spacecraft. "Space exploration and space science research are great vehicles for international cooperation," said Karl Berquist from ESA. "By pooling the best researchers in Europe and China, we can achieve fabulous scientific results for the benefit of all."

When Chang'e-3 lands, NASA's LADEE orbital spacecraft, launched in September, will have carried out a detailed study of the very tenuous lunar atmosphere. The exhaust from Chang'e-3's landing engines and the disturbance of the surface dust when it lands, will give LADEE an opportunity to analyze the Moon's environment under those active conditions.

Although there is no cooperative agreement between the Chinese and American space agencies, NASA's Lunar Reconnaissance Orbiter (LRO) will be flying above the region where Chang'e-3 will land, once every month or so. LRO should be able to send back images of China's two craft sitting on the surface of the Moon.