

## SPACE SCIENCE

# Chinese Mission Ushers in New Era of Lunar Exploration

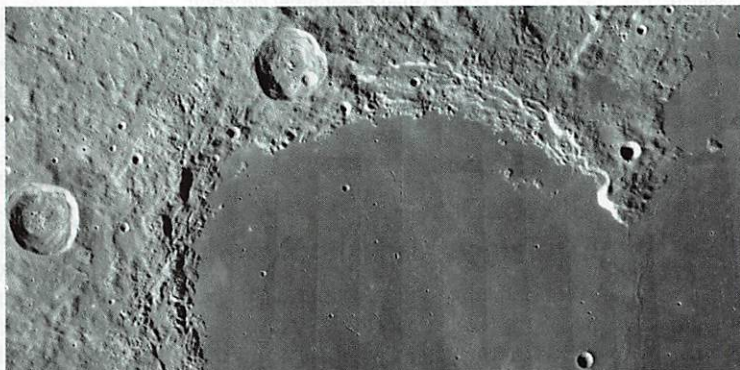
**BEIJING**—Shortly after the sun rises next month over the Bay of Rainbows, a lava plain on the moon's near side, a Chinese spacecraft will seek out a safe landing spot, cut its engines 3 meters above the surface, and settle onto a carpet of 3-billion-year-old dust. If all goes well, Chang'e-3 will be the first spacecraft to make a soft landing on the moon since the Soviet Union's Luna-24 in 1976.

Chang'e-3 is "an important milestone" on China's quest to send a crewed mission to the moon by 2030, says David Kring, a geologist at the Lunar and Planetary Institute in Houston, Texas. A robotic rover, the first of its ilk in 40 years, is the mission's showiest technology. But Chang'e-3 has a "robust" science mission as well, Kring says. Managed by the National Space Science Center of the Chinese Academy of Sciences (CAS) in Beijing, the science payload will study the lunar crust underfoot and the Earth and stars overhead. Center Director General Wu Ji was at the Xichang Satellite Launch Center in Sichuan province last week, overseeing final tests of the instruments. "They all work very well," he says.

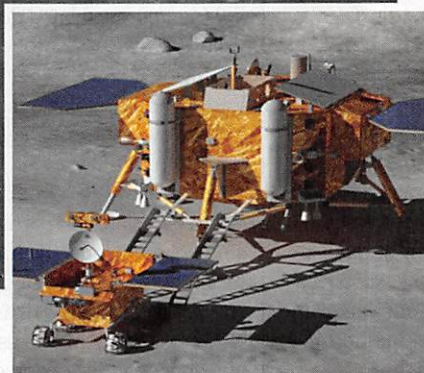
The lander's premier instrument is a wide-angle extreme ultraviolet camera that will continuously observe Earth's plasmasphere—its halo of ionized gases—and the tail of comet ISON as it swings by next month. Because the sun is in an active phase, regularly unleashing flares and coronal mass ejections, "we may have good chance to see a dynamic plasmasphere," Wu says. The lander also has a near-ultraviolet telescope, expected to make the first detailed observations of stars and galaxies from the moon's surface.

China has not announced the launch date, but analysts say liftoff is likely on 2 December, which would set up the most favorable approach to the Bay of Rainbows,

also known as Sinus Iridum. After the lander sets down around 16 December, the rover will detach from its side and roll down a metal gangway. During a lunar day, which lasts about two Earth weeks, the solar-powered, 140-kilogram rover (*Yutu*, or jade hare, is leading in a public naming contest) will perambulate up to 200 meters an hour on its six wheels, snapping photos and probing surface geochemistry with a particle



**One giant leap.** The Chang'e-3 mission to Sinus Iridum would be the first soft landing on the moon in 37 years.



excitation x-ray spectrometer and an infrared spectrometer attached to a robotic arm.

Mounted on its undercarriage is a ground-penetrating radar—another lunar first—that will record echoes in the very high frequency and ultrahigh frequency bands from as much as 100 meters deep, Wu says. This imaging could help shed light on Sinus Iridum's complex history, says Xiao Long, a lunar geologist at the China University of Geosciences in Wuhan. Forged from ancient impacts and lava flows, the 235-kilometer-wide basin may include rock blasted from the mantle, he says. Chang'e-3, Xiao says,

should "get a glimpse of the moon's past and deep structure."

For a mission with a bevy of firsts, "the challenges are immense," says Ouyang Ziyuan, senior adviser to China's lunar exploration program. One is surviving the long lunar night, when temperatures plummet as low as  $-180^{\circ}\text{C}$ . The rover will "go to sleep," using the radioactive warmth of a plutonium-238 generator to keep vital circuits from freezing, says Jia Yang, the spacecraft's deputy chief engineer at the Beijing Institute of Spacecraft System Engineering. The rover "is like a child to me," says Jia, who has been working on the project since its conception a decade ago. "Now it has grown up and is going to make its mark on the world."

Jia and others hope the lander and rover will survive beyond their design lives of 6 months and 3 months, respectively. If the lander makes it to August, its cameras could image a total eclipse, as Earth passes between our sun and the moon. Only the outer corona will be visible during the eclipse, providing "a superb opportunity to study solar winds," says Ping Jinsong, an astronomer here at CAS's National Astronomical Observatories.

Chang'e-3 may also spark a bit of unorthodox Chinese-U.S. cooperation. The two nations don't have any formal joint space projects. But as the landing and the rover kick up clouds of dust, NASA's Lunar Atmosphere and Dust Environment Explorer, or LADEE, now in orbit, should get a bird's eye view—and some insights into the moon's mantle of dust.

If Chang'e-3 goes well, Ouyang says, China will "speed up the next phase of lunar exploration." Chang'e-4 will reprise the current mission possibly in 2016. The next major event would be Chang'e-5, which aims to return dust and rock samples to Earth as early as 2018, he says. Meanwhile, U.S. lunar scientists admit to feeling envious. "China," Kring says, "will gain a capability the United States no longer has."

—JANE QIU AND RICHARD STONE

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