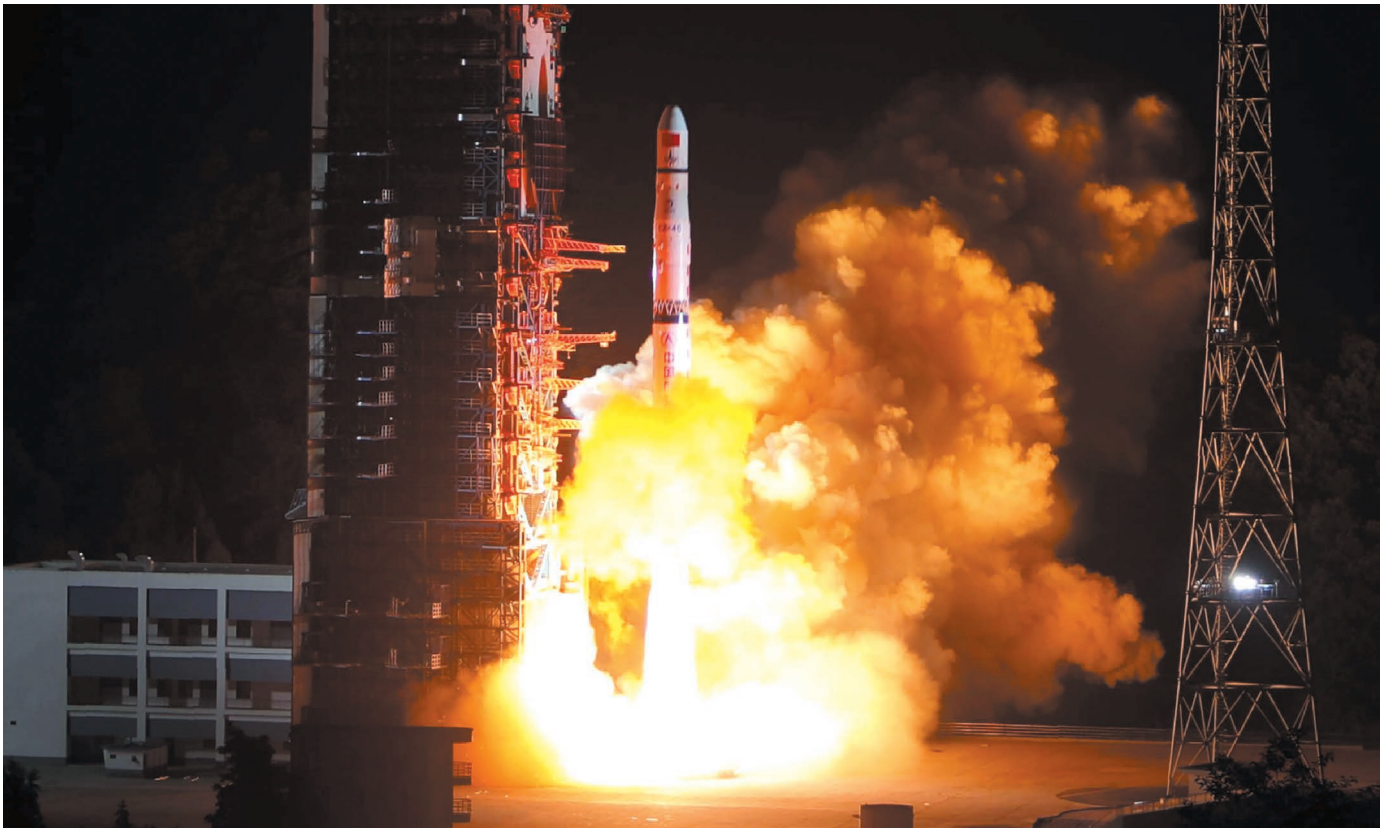

AFP/GETTY

The Queqiao spacecraft and two radio-astronomy experiments launched from the Xichang Satellite Launch Centre in western China on 21 May.

SPACE

# China shoots for Moon's far side

*Queqiao probe carries technologies that could one day explore the Universe's dark ages.*

BY DAVIDE CASTELVECCHI

China has taken its first major step in a groundbreaking lunar mission. On 21 May, a probe launched from Xichang Satellite Launch Centre to head beyond the Moon, where it will lie ready to act as a communications station for the Chang'e-4 lunar lander. The nation hopes that the lander will, later this year, become the first craft to touch down on the far side of the Moon.

The relay probe, named Queqiao and designed by the Chinese Academy of Sciences, also carries two pioneering radio-astronomy experiments. Both are proof-of-principle missions designed to test technologies for exploring a period in cosmic history known as the dark ages. These first few hundred million years of the Universe's existence, before galaxies and stars began to form, are all but impossible to study from Earth. But the spectrum of radiation from this age — when matter was distributed nearly uniformly across space as a thin, cold haze — could reveal information about the distribution of ordinary matter compared with dark matter in the Universe.

The first of the two experiments is the Netherlands–China Low-Frequency Explorer (NCLE). It will remain attached to Queqiao, which will linger around 'Earth-Moon L2' — a gravitational resting point about 60,000 kilometres beyond the Moon that tracks the Moon's orbit around Earth. The Dutch-built NCLE experiment will try to exploit the relative quiet there to measure radio waves with frequencies between about 1 megahertz and 80 megahertz, coming from the Solar System, the Galaxy and beyond.

***"The experiment is an important first step toward investigating the dark ages and cosmic dawn."***

Much of this frequency band is blocked by Earth's atmosphere, but cosmologists expect it to contain information from the dark ages. Around the upper end of this band also fall the 'cosmic-dawn' signals from the first stars, which lit up around 200 million years after the Big Bang, and were apparently detected for the first time in Australia earlier this year. Other experiments are trying to replicate those results — but the NCLE is testing technologies for identifying lower-frequency signatures from the dark ages.

For at least part of its orbit, Queqiao will be eclipsed by the Moon, as seen from Earth, which could benefit the NCLE because its antennas will be further shielded from the radio noise that constantly leaks from our planet. Still, observation time and the bandwidth for sending data back to Earth will be limited. And because Queqiao is designed primarily as a data-relay station (its name comes from a folktale about magpies that form a bridge across the sky), it is not optimized for radio astronomy. That means it will be challenging, if not impossible, for this demonstrator mission to detect the dark-ages signal, says Heino Falcke, a radio astronomer at Radboud University Nijmegen in the Netherlands who is the experiment's science leader. Nonetheless, the NCLE "is pioneering and an important first step toward investigating the dark ages and cosmic dawn", says Jack Burns, an astrophysicist at the University of Colorado Boulder who is leading a proposal for a NASA mission with similar objectives.

To avoid jeopardizing the Queqiao probe, mission control will deploy the NCLE's antennas only after the Chang'e-4 lander's

mission is completed, says Marc Klein Wolt, a Radboud astronomer who is NCLE's manager. But the NCLE might go on collecting data for several years, he says.

### SATELLITE BREAK-OFF

The second experiment that launched with Queqiao consists of two smaller satellites called Longjiang-1 and Longjiang-2, which will detach from the mothership and orbit the Moon. Built by researchers at the Harbin Institute of Technology in China, the instruments will test technology for a radio-astronomy technique called very-long baseline interferometry (VLBI). This approach combines data from multiple radio antennas to create images of much higher resolution than would be possible with a single dish.

Falcke and others have long studied the possibility of doing VLBI with a large array of lunar orbiters — or on the lunar surface — to map variations across the sky in signals from the dark ages and cosmic dawn. Klein Wolt says that his team might experiment with combining data from NCLE with those from the two lunar orbiters, and even from a radio antenna on the Chang'e-4 lander itself.

The Chang'e-4 mission is another step in China's ambitious lunar-exploration programme, which aims to establish a Moon base in the next decade, and to begin human exploration in the 2030s. The lunar lander will carry a rover and was originally designed as a back-up for Chang'e-3, which in 2013 became the first craft since 1976 to soft-land (rather than crash-land) on the Moon. Chang'e-4 has now been repurposed, and the mission's main scientific goal is to study the geology of the hidden side of the Moon, which is pockmarked with many more small craters than the familiar near side.

The lander carries several experiments, including a sealed ecosystem, built by Chongqing University, which will test whether potato and thale-cress (*Arabidopsis*) seeds sprout and photosynthesize as silkworm eggs hatch and the worms produce carbon dioxide. Another experiment will measure the radiation that will confront future astronauts who visit the lunar surface. The rover, which will separate from the lander to move around the surface of the Moon, will carry instruments such as a solar-wind detector built by a Swedish team. ■

PUBLISHING

# Open-access drive spreads in Europe

*Negotiators share tactics to broker new deals with publishers.*

BY HOLLY ELSE

Bold efforts to push academic publishing towards an open-access model are gaining steam. Negotiators from libraries and university consortia across Europe are sharing tactics on how to broker new kinds of contracts that could see more articles appear outside paywalls. And inspired by the results of a stand-off in Germany, they increasingly declare that if they don't like what publishers offer, they will refuse to pay for journal access at all. On 16 May, a Swedish consortium became the latest to say that it wouldn't renew its contract, with publishing giant Elsevier.

Under the new contracts, termed 'read and publish' deals, libraries still pay subscriptions for access to paywalled articles, but their researchers can also publish under open-access terms so that anyone can read their work for free. Advocates say such agreements could accelerate the progress of the open-access movement. Despite decades of campaigning for papers to be published openly — on the grounds that the fruits of publicly funded research should be available for all to read — scholarly publishing's dominant business model remains to publish articles behind paywalls and collect subscriptions from libraries (see 'Growth of open access'). But if many large library consortia strike read-and-publish deals, the proportion of open-access articles could surge.

"There is a serious ground for change across Europe," says Koen Becking, chief negotiator for the VSNU, a consortium of 14 institutes in the Netherlands. In 2014, the VSNU was the first national group to negotiate a subscription deal that included rights for its scholars to publish all of their work openly. It has since agreed several more that include varying levels of open publishing. Consortia in Austria, the United Kingdom, Sweden and Finland have struck similar deals, and Switzerland will start to negotiate its first open-access contracts this year. A survey by the Brussels-based European University Association, published in April, reported that, last year, 11% of negotiating consortia in Europe made deals that took into account open-access publishing costs, but 63% planned to do so in the future.

On 2 May, negotiators from countries across Europe agreed to align their bargaining strategies at a closed meeting in Berlin attended by the European Commission's special envoy for open access, Robert-Jan Smits. According to Gerard Meijer, one of the German negotiators present, consortia are "frustrated" by the lack of progress in talks and feel the limits of partnerships between institutions and large publishers "have been reached. It is up to us now to act, and to step out of these negotiations if these are going nowhere," he says.

The meeting was the latest in a string of events in which negotiators from different countries swapped tactics. "More and more people are willing to share their experiences," says Matthijs van Otegem, director of the library at Erasmus University in Rotterdam, and chair of the open-access working group at the Association of European Research Libraries (LIBER) in The Hague, the Netherlands.

In September last year, LIBER published a list of principles to guide negotiators seeking to change their deals. These include ending non-disclosure agreements that publishers customarily place on contracts (which would enable negotiators to compare deals in different countries) and not agreeing to price hikes without open-access agreements in place.

A key driver behind the activity in Europe is the European Commission's goal that, by 2020, all research will be freely accessible as soon as it is published. Dutch negotiators have been tasked with brokering a deal that meets ▶

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