In the news

FLY ME TO THE MOON

Credit: NASA/JPL/USGS

What better way to celebrate 50 years since the Apollo 11 landing than going back to the Moon? But this time there will be no humans setting foot on the Moon. Instead, two robotic missions will explore the unchartered southern lunar hemisphere, sending back a wealth of information about the surface and composition of the Moon, and perhaps even more.

Early December last year, the China National Space Administration Chang'e 4 mission launched, set to land in the Von Kármán crater in the South Pole–Aitken Basin on the far side of the Moon. This is the first landing on the far side of the Moon and the targeted region is the largest known impact crater in the Solar System. The rover is equipped with various instruments to investigate the lunar morphology and subsurface. In addition, it will carry a tin with air, water, soil and seeds to see if they will grow in the harsh environment. In order for the Chang'e 4 lander and rover to be able to communicate with Earth, last year a relay satellite named Queqiao was put in orbit around the Lagrange Point 2, a gravitationally stable spot beyond the Moon.

Chang'e 4's mission aims higher than the Moon. It also carries the Netherlands–China Low-Frequency Explorer, which will listen for whispers from the early Universe. Taking advantage of the radio silence on the far side, where the Earth's electromagnetic noise does not reach, the instrument will attempt to detect the faint signal emitted a few hundred million years after the Big Bang by the hydrogen gas in the earliest stars.

Scheduled to launch this month, the Indian Space Research Organisation's Chandrayaan-2 mission is expected to be the first to land near the south pole. The mission includes an orbiter, a lander and a rover. Most data will be gathered during the daylight, lasting for 14 Earth days, as the lander and rover are not expected to survive the long night. The spectrometers, cameras and seismometer will gather information about the lunar geology and composition, the charged particles in its thin atmosphere and, perhaps most excitingly, about the amount of water on the Moon.

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PHOTONICS

Microresonator astrocombs

Tiny Doppler shifts in the light from a star can reveal the wobble in its position caused by a transiting planet. But to measure these shifts astronomers need to precisely calibrate their spectrometers, which is not easy. Help comes from photonics: two groups, both writing in *Nature Photonics*, report on microresonator laser frequency combs that enable spectrometer calibration with a precision high enough to potentially spot Earth-like planets.

Frequency combs are like rulers in frequency space: sources with spectra consisting of discrete, equally spaced frequencies that are known precisely. Ten years ago, laser frequency combs were first used for calibration in astronomy. However, they have not yet reached their full potential because of the complexity of coupling them to astronomical spectrometers. Due to the laser repetition rate, laser frequency combs typically have a comb spacing of a few GHz, too narrow for astronomical spectrometers to resolve. Although it's possible to work around this using techniques such as spectral filtering, doing so is complicated and introduces unwanted optical effects.

The new 'astrocombs', reported by Tobias Herr and co-workers and Kerry Vahala, Charles Beichman and co-workers, produce spectral lines with spacings close to 20 GHz, ideally suited for spectrometers. The combs use microresonators based on dissipative Kerr solitons, ultra-short optical pulses arising from the balance between dissipation and nonlinearity, and between parametric gain and loss. The solitons' short round-trip time in the laser cavity leads to a high repetition rate.

Although the potential of Kerr soliton microresonators for astronomical spectroscopy has been recognized for some time, their practical implementation has proved challenging. This is because it is not only comb spacing that matters: to be useful for spectrometer calibration, the combs must also be stable and robust. "Until now, operating a microresonator-based comb for precision spectroscopy outside the protected setting of a photonics research laboratory has not been attempted," says Herr. Their group tested the comb with the GIANO-B high-resolution near-infrared spectrometer at the Telescopio Nazionale Galileo in Spain. "This would not have been possible without the combined expertise of multiple groups in optical frequency metrology, microfabrication and astronomy," says Herr. At the Keck Observatory in Hawaii, Suh and co-workers used their microresonator astrocomb to calibrate the NIRSPEC near-infrared spectrometer.

Next-generation spectrometers will make it possible to take full advantage of the precision afforded by microresonator astrocombs. In addition, the astrocombs are power-efficient and can be miniaturized to a few cm^3 — small enough to be used in space-based telescopes.

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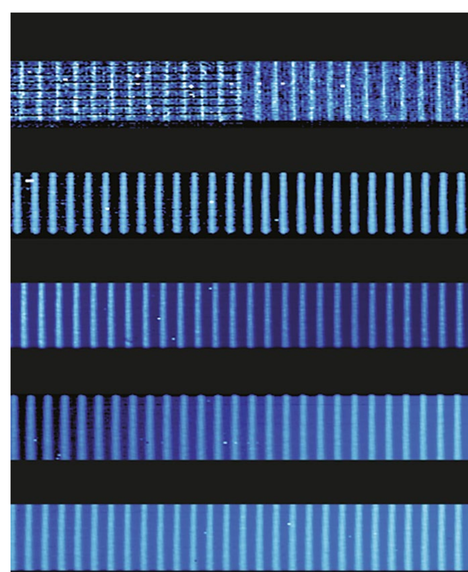
ORIGINAL ARTICLES Obrzud, E. et al. A microphotonic astrocomb. *Nat. Photon.* **13**, 31–35 (2019) | Suh, M.-G. et al. Searching for exoplanets using a microresonator astrocomb. *Nat. Photon.* **13**, 25–30 (2019)



Credit: Suh, M.-G. et al. (2019), Springer Nature Limited