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# Eos

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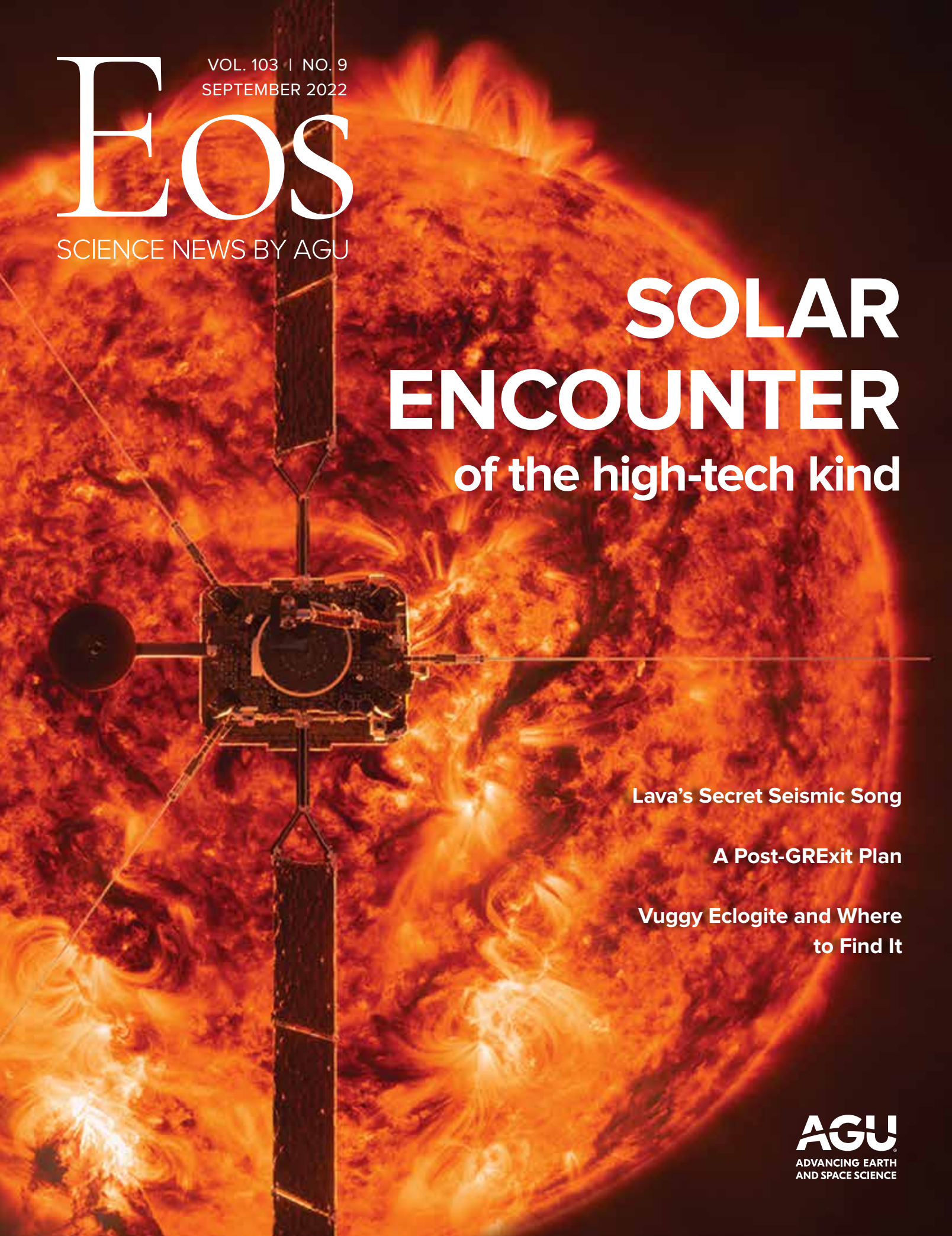

# SOLAR ENCOUNTER

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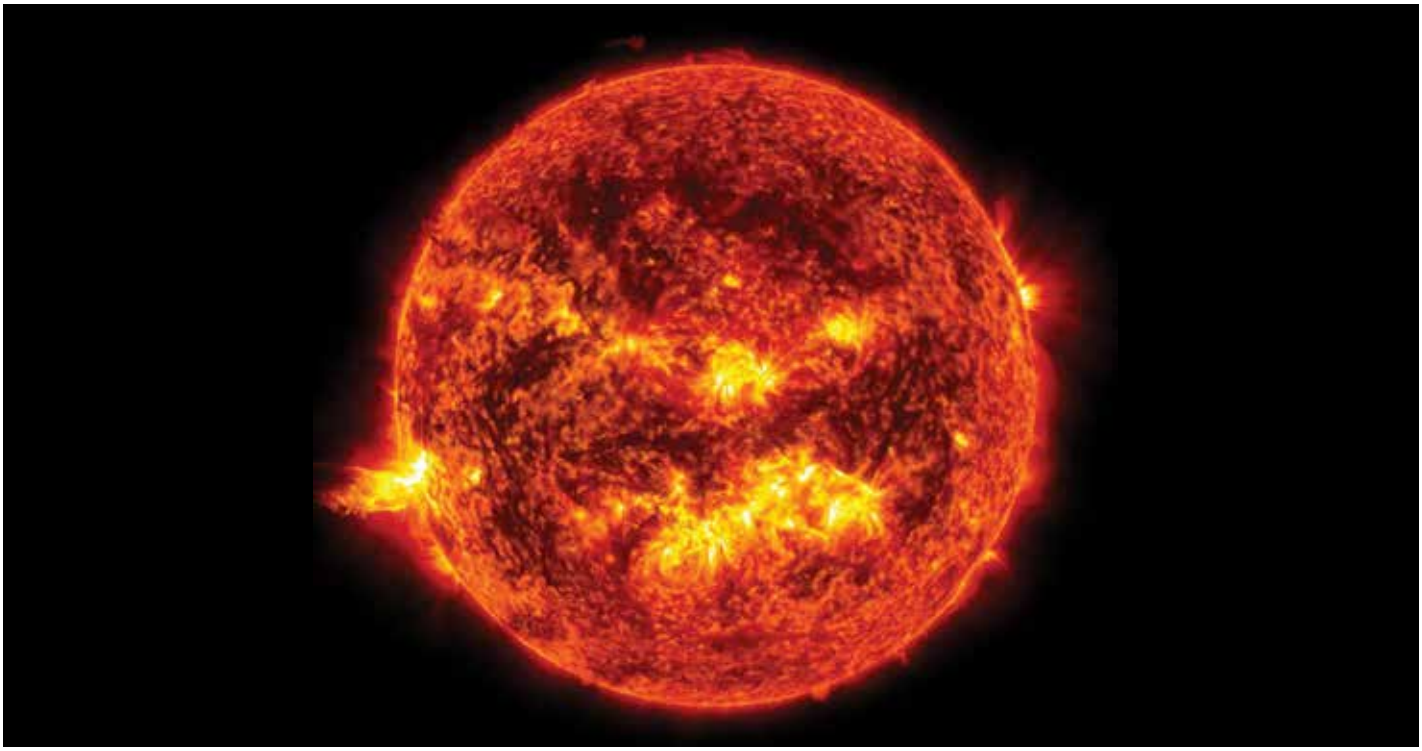
# Chinese-Led Solar Research Is Looking Bright



*On 20 June 2013, the Sun produced a large solar flare—seen in this image at the roughly nine o'clock position—and launched a coronal mass ejection toward Earth. Credit: NASA/Goddard/SDO*

Life on our planet is possible because of the Sun, but the relative proximity of our nearest star comes with risks, too. Intense outpourings of radiation and matter from the Sun, for instance, can cripple electronics and even damage human tissue. A cadre of spacecraft is actively monitoring our star, and now several new Chinese-led missions are joining the hunt to better understand the Sun.

### A Payload and Then a Satellite

In July of last year, a red and white rocket rumbled off the launchpad at Jiuquan Satellite Launch Center in northern China.

Its payload—the Fengyun-3E meteorology satellite—included China's first space-based instrument designed to study the Sun in the X-ray and ultraviolet regimes: the Solar X-ray and Extreme Ultraviolet Imager. The primary scientific objective of this instrument is to improve forecasts of space weather near Earth, said Bo Chen, the engineer at the Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences, in charge of the design and development of the instrument. To that end, the Solar X-ray and Extreme Ultraviolet Imager observes events such as solar flares, which can launch electromagnetic waves toward Earth.

In 2021, China also launched its first satellite dedicated entirely to solar observations. The Chinese H-Alpha Solar Explorer (CHASE) satellite is currently in a Sun-synchronous orbit roughly 500 kilometers above Earth. Its scientific payload is an imaging spectrograph that observes Hα, a spectral line produced by hydrogen in the visible part of the electromagnetic spectrum. One of CHASE's key capabilities is that it can scan the entire disk of the Sun in less than a minute. That high scanning cadence allows researchers to trace the rapid evolution of areas of the Sun known as active regions.

These areas of the Sun are of particular interest, said Li Feng, a solar physicist at the Purple Mountain Observatory, Chinese Academy of Sciences, in Nanjing. That's because events like solar flares and coronal mass ejections—which potentially can be dangerous to astronauts and even electronic equipment here on Earth—tend to originate from active regions. "Most solar eruptions are from active regions," said Feng.

> **"We can get a deeper diagnostic of the eruption process."**

And CHASE's spectral observations reveal a lot more about active regions than could be gleaned from imaging alone. The temperature and velocity of these regions can be studied in detail, said Feng. "We can get a deeper diagnostic of the eruption process."

### A Multi-instrument Mission

Later this year, another Chinese-led solar mission, the Advanced Space-based Solar

Observatory (ASO-S), is slated to launch. Like CHASE, ASO-S will be in a Sun-synchronous orbit, but it'll be a bit farther from Earth—roughly 700 kilometers in altitude. ASO-S will be the first Chinese solar mission to carry multiple instruments: a magnetograph for measuring the Sun's magnetic field, a hard X-ray imager for recording the Sun's most energetic electrons, and a telescope sensitive to Lyman-alpha, a spectral line of hydrogen in the ultraviolet part of the electromagnetic spectrum.

The scientific goals of ASO-S center around studying solar eruptions and understanding how they relate to the Sun's magnetic field, said Feng, who is one of ASO-S's assistant chief scientists. With the observatory's Lyman-alpha Solar Telescope, for instance, it will be possible to measure the direction and speed at which a coronal mass ejection—an outpouring of high-energy material, including such particles as protons and electrons—is heading toward Earth.

It's important to predict when a coronal mass ejection will arrive in the near-Earth environment, said Jingnan Guo, a space physicist at the University of Science and Technology of China in Hefei. That's because such an event can change the shape of Earth's magnetosphere, potentially rendering satellites vulnerable to a barrage of particles capable of harming delicate electronics. "If the magnetosphere is compressed, those satellites might be exposed," said Guo.

Scientists around the world are looking forward to analyzing the new measurements from ASO-S—all of the mission's data will be made public following the observatory's commissioning phase, several team members reported earlier this year in *Nature Astronomy* (bit.ly/China-ASO-S).

### Watch for the Ring

In the coming years, another Chinese-led mission will aim to observe the Sun in an unprecedented way: from all sides simultaneously. The Solar Ring mission, currently in its planning stages, is slated to consist of three identical spacecraft orbiting the Sun, at the Earth-Sun distance, separated by 120°. The first spacecraft will be located 30° upstream of Earth, a configuration that allows for a variety of angles between Earth and the various Solar Ring spacecraft. That's an important design characteristic, said Quanhao Zhang, a solar physicist at the University of Science and Technology of China and a member of the Solar Ring team. "We can use the observations from different angles to reconstruct the three-dimensional configuration of the solar wind."

One of the primary scientific goals of the Solar Ring mission is to determine how the solar wind—a constant outflow of solar plasma—propagates outward into the solar system. Ten instruments are planned for the Solar Ring mission, including payloads to study radiation and particles emitted by the Sun and our nearest star's magnetic field and surface vibrations.

It's an exciting time to be doing solar research, said Feng. The Sun affords us a unique glimpse of a star up close, and new and upcoming technologies will be able to best exploit that vantage point, she said. "It's a natural laboratory."

By **Katherine Kornei** (@KatherineKornei), Science Writer