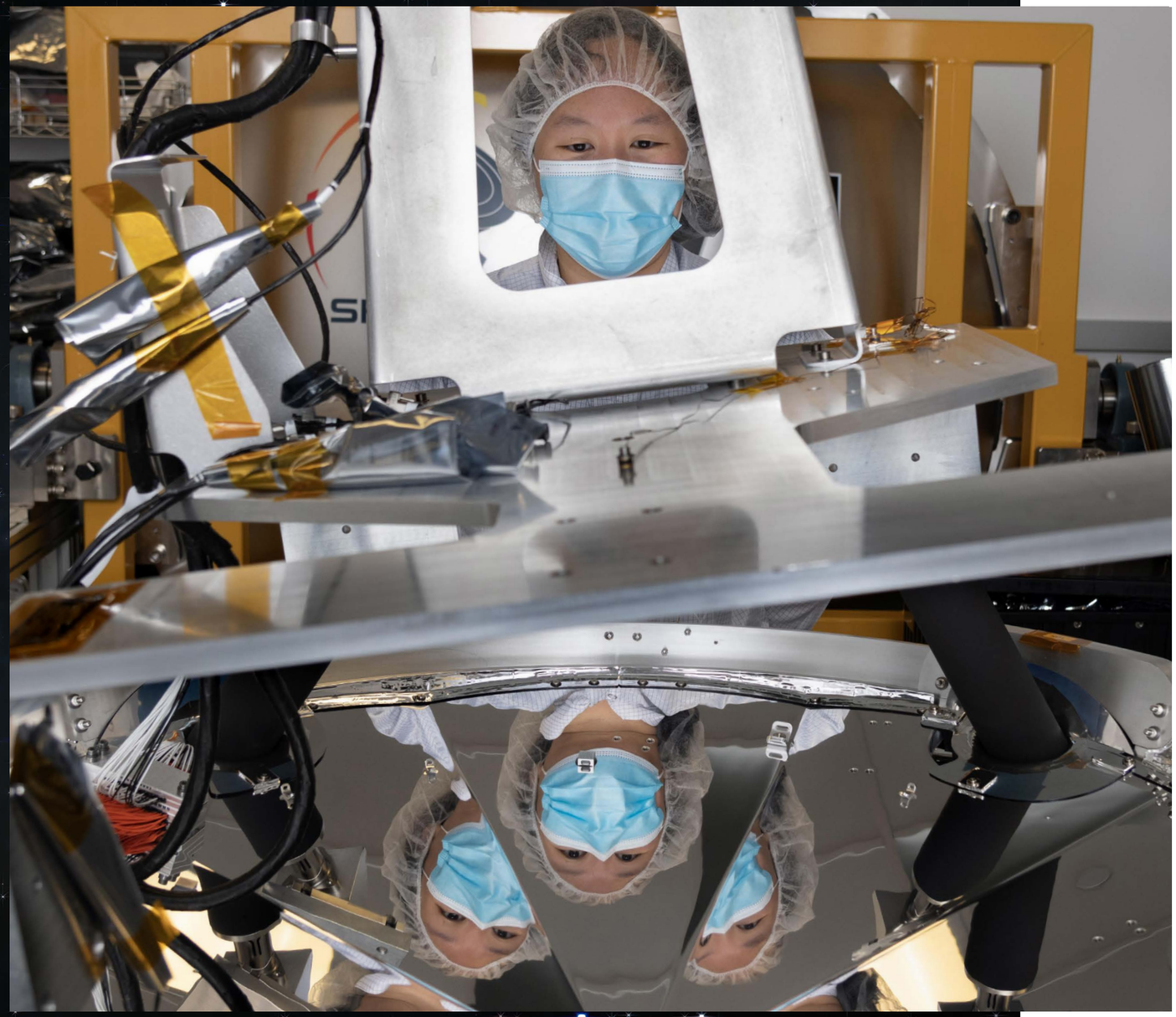
"The ingenuity and perseverance necessary to explore the outer reaches of our solar system, to track the changes wrought by a warming climate on our home planet, and to peer deep into the cosmos, can only be achieved by scientists, engineers, and staff who think big, are dedicated to the long term, and work together seamlessly as a team. This is the JPL that inspires all of us at Caltech and uplifts billions of people across the globe."

Thomas F. Rosenbaum
President, Caltech

CAMPUS & LAB



Left: *To ready SPHEREx for its journey, scientists and engineers at Caltech and JPL have been busy testing the spacecraft's detectors and optics at Caltech's Cahill Center for Astronomy and Astrophysics.*

Whether testing the first telescope to map the near-infrared universe, catching a star swallowing a planet, planning to map deposits of water on the Moon, or discovering the true extent of local methane emissions, researchers on campus and on Lab worked together in 2023 to enable the fundamental leaps in knowledge for which Caltech and JPL are known worldwide.

Right: *SphereX during testing at Caltech*

Mixology for SPHEREx

SPHEREx is getting something like the martini treatment from a grumpy bartender: shaken violently and chilled aggressively.

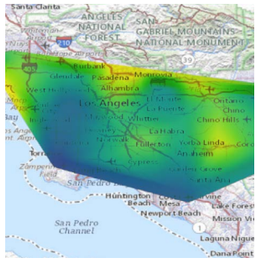
The future space telescope has been shuttling between JPL and campus for hardiness testing: bolted to a large mechanical shaker on Lab to mimic the vibrations of launch, and cooled to minus 350 degrees Fahrenheit in an SUV-sized chamber at Caltech's Cahill Center for Astronomy and Astrophysics to simulate the permafrost of space.

Once thoroughly tested, the telescope will be shipped back to Ball Aerospace in Boulder, Colorado, where it was built, for integration with the rest of the spacecraft in March 2024. Launch is scheduled for no later than April 2025.

The bullhorn-shaped telescope will create the first map of the entire sky that extends into the near-infrared spectrum, capturing both visible images and unseen structural details for hundreds of millions of stars and galaxies. The telescope also will study the abundance of water and other ices in regions where stars and planets form — to better understand how water arrived on Earth.

SPHEREx is managed by JPL for NASA's Astrophysics Division within the Science Mission Directorate. Mission data will be processed, archived, and made available to scientists and the public by Caltech's IPAC.

Local Methane Emissions Far Greater than Estimated



Above: *Map of average methane enhancements from local emissions in the Los Angeles Basin from January-March, 2023*

Below: *The CLARS facility overlooks the Los Angeles basin.*

Photo credit: R. Duren

You can try to measure gas emissions in a city by adding up all the leaks you find, or you can go to an overlook and sweep the whole basin. Caltech and JPL researchers have found that counting leaks misses a ton — or many tons — of methane emissions.

Their study, published in *Nature Communications* in September 2023, shows that methane emissions in the Los Angeles region have decreased 1.6 percent per year over the past decade. The local gas company had estimated that emissions were going down nearly 6 percent a year, but that estimate was based on ground-level measurements that likely missed many sources.

The discrepancy matters not only for environmental reasons, but because a 2014 California law requires a 40 percent reduction in statewide methane emissions by 2030 from 2013 levels. The study shows that the measurement method is of critical importance in determining compliance with the law.

Caltech and JPL researchers used the California Laboratory for Atmospheric Remote Sensing-Fourier Transform Spectrometer to scan the atmosphere over the Los Angeles basin from the Mount Wilson Observatory. Seeking to identify molecular signatures in the air, CLARS-FTS spent the last decade collecting data on the area's fluctuating levels of methane, a powerful greenhouse gas and key contributor to climate change.

By measuring methane levels across the whole basin from a higher vantage point, the researchers were able to provide a powerful check on the sum of ground-station point measurements.

"It's not enough for an industry to regulate itself," the researchers concluded. "As the country's leader in setting environmental standards, the state needs to expand its current work in the measurement, reporting, and verification of natural gas emissions from all sectors of the economy."

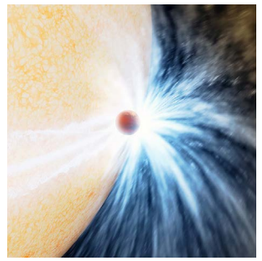
An Interstellar Feast

For the first time, astronomers have caught a star in the act of swallowing a planet whole. The sun-like star lies about 12,000 light-years away in our galaxy and appears to have engulfed a Jupiter-sized gas giant.

The star was spotted by the Zwicky Transient Facility, which scans the skies every night from Caltech's Samuel Oschin Telescope at Palomar Observatory near San Diego. ZTF observations showed that the star brightened greatly and then began to fade in a matter of days. Parallel observations on JPL's NEOWISE space observatory showed that the star's infrared radiance increased steadily about nine months before ZTF caught the visible flash of light.

The astronomers realized that NEOWISE was detecting dust created as a planet spiraled into the star's atmosphere and skimmed the star's surface, pulling hot gas off the star that drifted outward and cooled. The planet then plunged into the core of the star, triggering the flare of optical light registered by ZTF. NEOWISE is still detecting the infrared glow of the new dust, which continues to escape the star.

Astronomers had theorized that older stars could swallow their inner orbiting planets, but direct evidence for such an event had been lacking. The confirmation helps clarify scientists' understanding of the fates of solar systems, including our own.



Above: *This artist's impression shows a doomed planet skimming the surface of its star.*

Below: *In 2017, ZTF team members installed the 605-megapixel, wide-field camera at the prime focus of the 48-inch Samuel Oschin Telescope at Palomar Observatory.*

Left: *Lunar Trailblazer undergoes testing at Lockheed Martin*

Photo credit: Lockheed Martin Space

Lunar Trailblazer to Lead Humans to Water

NASA's Lunar Trailblazer mission will fill out the sparse inventory of water ice on the Moon, potentially aiding future explorers and settlers.

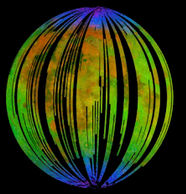
The small satellite will carry two instruments: JPL's High-resolution Volatiles and Minerals Moon Mapper, and the Lunar Thermal Mapper, built by the University of Oxford and contributed by the U.K. Space Agency. Once orbiting the Moon, Lunar Trailblazer will use HVM³ to map the spectral fingerprints of the different forms of water over the lunar landscape. LTM will scan those regions to characterize their surface temperatures. Together, the instruments will enable scientists to determine the abundance, location, and form of lunar water, building upon current knowledge of the presence and distribution of water on the Moon.

Scientists will also use Lunar Trailblazer to detect other potential icy volatiles. The chemical makeup of these ices could provide additional clues about the origin of the Moon's water.

Applications from any obtainable water would range from purifying deposits for drinking to processing them for fuel and breathable oxygen.

Having undergone final assembly and system-level testing at Lockheed Martin Space in Littleton, Colorado, Lunar Trailblazer is on schedule to ship to Florida for final preparations and launch in late 2024.

Lunar Trailblazer is one of five missions of NASA's Small Innovative Missions for Planetary Exploration. SIMPLEx selects high-risk, low-budget small spacecraft to explore other planets, moons, and asteroids. The mission is managed by JPL, and its science investigation and mission operations are led by Caltech. JPL also provides project systems engineering, as well as mission assurance, trajectory design, and navigation.



Above: *NASA's Moon Mineralogy Mapper found small amounts of water and hydroxyl (blue) on the surface of the Moon.*

Above: *Illustration of the type of orbit paths Lunar Trailblazer will take over the surface of the Moon*