PISCES HAWAII'S PORTAL TO SPACE NEWSLETTER

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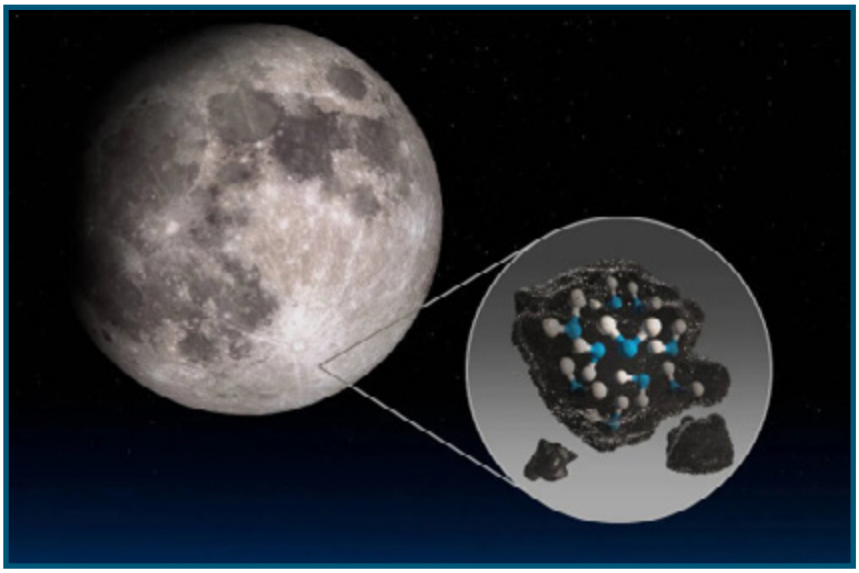
Groundbreaking Discovery Reveals Water on Sunlit Surface of Moon



Above: *An artist rendering shows the location of the sunlit crater on the moon where water molecules were recently discovered using a NASA telescope. Credit: NASA/Daniel Rutter*

For the first time ever, scientists have confirmed the presence of water on the sunlit surface of the Moon. Last month, NASA announced the unprecedented discovery, which challenged existing notions that H_20 could only exist in the sub-freezing temperatures of permanently shadowed lunar craters.

"We had indications that H_2O—the familiar water we know—might be present on the sunlit side of the Moon," said Paul Hertz, director of the Astrophysics Division in the Science Mission Directorate at NASA Headquarters in Washington. "Now we know it is there. This discovery challenges our understanding of the lunar surface and raises intriguing questions about resources relevant for deep space exploration."

Water is an essential resource in space, containing the molecular building blocks for drinking water, breathable air and rocket ...

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Letter from the Director

Rodrigo Romo

Aloha kākou,

While the COVID-19 pandemic is still causing havoc around the world, it is impossible not to be amazed at the advances and discoveries being made in the world of space exploration these days.

Late last month, NASA successfully executed a touch-and-go maneuver with their OSIRIS-Rex probe on an asteroid flying through space over 200 million miles away. The probe completed its mission of retrieving surface samples from the asteroid, which will be returned to Earth. More exciting news came the following week when scientists announced the discovery of water molecules on the sunlit surface of the moon for the first time. This suggests that water may be present throughout the lunar surface, not just in the permanently shadowed craters as previously thought.

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NASA Nails Historic Asteroid Landing for Sample Return Mission

Above: *Artist rendering of OSIRIS-REx readying itself for landing on Bennu. Credit: NASA Goddard/University of Arizona.*

NASA's first-ever sample return mission from an asteroid is on track to bring a handful of primordial rock dust back to Earth. The agency successfully landed a spacecraft on the surface of an asteroid on Oct. 20, achieving a historic milestone for NASA while exciting researchers who seek to better understand our solar system.

"This was an incredible feat ... we've advanced both science and engineering and our prospects for future missions to study these mysterious ancient storytellers of the solar system," said Thomas Zurbuchen, associate administrator for NASA's Science Mission Directorate at the agency's headquarters in Washington. "A piece of primordial rock that has witnessed our solar system's entire history may now be ready to come home for generations of scientific discovery, and we can't wait to see what comes next."

The spacecraft, named OSIRIS-REx (Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer), landed on Bennu, a well-preserved asteroid orbiting more than 200 million miles from Earth. Scientists are keen to study its composition for tell-tale signs of how our solar system formed billions of years ago and gave birth to life on Earth.

The mission took flight from Cape Canaveral on Sept. 8, 2016, and reached orbit around Bennu on Dec. 31, 2018. After a carefully orchestrated, four-hour descent from orbit, the craft maneuvered past a building-sized boulder (aptly named "Mt. Doom") and touched down in a clearing the size of a small parking lot. On the ground, OSIRIS-Rex fired a burst of nitrogen gas to stir up surface dust and pebbles, capturing more than two ounces in the collection head of an 11-foot robotic arm called the Touch-And-Go Sample Acquisition Mechanism (TAGSAM). Ahead of schedule, the sample was placed in a space capsule after concerns over the material leaking out of the TAGSAM head.

With its precious cargo secured, the return capsule now awaits a favorable alignment between Bennu and Earth. The return launch is anticipated in March 2021, with landing slated for Sept. 24, 2023, in the western desert of Utah.

"I'm proud of the OSIRIS-REx team's amazing work and success to this point," said NASA's Associate Administrator for Science Thomas Zurbuchen. "This mission is well positioned to return a historic and substantial sample of an asteroid to Earth, and they've been doing all the right things, on an expedited timetable, to protect that precious cargo."

Continued: *Discovery of Water on Sunlit Surface of Moon ...*

Above: *NASA's Stratospheric Observatory for Infrared Astronomy (SOfIA) was used in the discovery of water on the sunlit surface of the moon. The study was the first time SOFIA was used to observe the moon. Credit: NASA/ Daniel Rutter.*

Right: *Clavius is the second-largest lunar crater and the site where water molecules were discovered. Credit: NASA*

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propellant. It could theoretically be transformed into these resources through In-Situ Resource Utilization (ISRU) technology, and provide support for a permanent lunar base—a key goal in NASA's Artemis program.

The water, discovered in Clavius Crater, was a very small volume. In fact, the Sahara desert has about 100 times the concentration of water, according to NASA. But the finding is nonetheless significant and suggests the possibility of more water reserves strewn about the lunar surface.

Data for the study was gathered using NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA), an airborne observatory carried by a 747 aircraft. The telescope is a boon for astronomical data, flying up to 45,000 feet in altitude and bypassing about 99% of the water vapor in Earth's atmosphere.

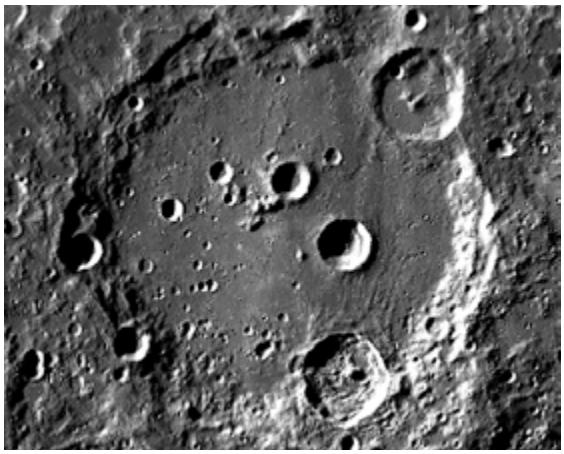
Dr. Casey Honniball, lead author of the study and a postdoctoral fellow at NASA's Goddard Spaceflight Center, published the data as part of her graduate thesis work at the University of Hawai'i at Mānoa. Before her work, scientists had good reason to doubt the presence of water on sunlit surfaces of the Moon.

"Without a thick atmosphere, water on the sunlit lunar surface should just be lost to space," said Dr. Honniball. "Yet somehow we're seeing it. Something is generating the water, and something must be trapping it there."

One explanation posits that micrometeorites carrying small amounts of water leave these deposits on the surface after impact. Another theory suggests solar winds are delivering hydrogen molecules to the lunar surface, which then fuse with minerals containing oxygen and become hydroxyl. Radiation from micrometeorite showers could then transform hydroxyl into water.

Dr. Honniball has requested follow-up observations with SOFIA, seeking additional sunlit areas where water might exist. She plans to create a water resource map on the moon that could support future human missions by NASA.

In an interesting coincidence, Clavius Crater is the same site where the first lunar base existed in Arthur C. Clarke's classic science fiction novel, *2001*. His imaginary settlement could become a reality in the coming decade.



WiSE Talks Series Highlights Leading Women in Space Exploration


Jessica Dempsey
EA Observatory/JCMT


Nagin Cox
NASA JPL


Emily Calandrelli
Science TV Host


Sara Langberg
AeroVironment


Amanda Hendrix
Planetary Institute


Barbara Belvisi
Interstellar Lab


Monsi C. Roman
NASA JSC


Miriam Fuchs
Astronomer/Host

Left: *(L-R) UH Mānoa engineering students Adam James Macalalag, Eric Takahashi, Efren Enriquez and Matthew Nakamura hold a rocket they built and launched as part of the Spaceport America Cup competition in 2019. Credit: UH*

When eight of the world's best and brightest women working in space exploration come together, magic happens. The first Women in Space Exploration (WiSE) Talks series hosted by PISCES featured a full week of virtual presentations covering our solar system, robotic exploration systems, closed-loop habitats for off-world living, and future plans for human space missions.

Sponsored by Microsoft and Hawaii Science and Technology Museum, the event aimed to engage and inspire young women to pursue space and related STEM careers. Though the talks were open for everyone to attend, young women were given priority during Q&A sessions. Questions poured at the conclusion of each talk, and the younger audiences showed interest and engagement regarding the work and personal journey of each presenter featured (listed above).

In light of the program's success, PISCES plans to continue the WiSE Talks series to provide greater access to valuable learning opportunities and career resources for students as the COVID-19 pandemic rages on.

For those who missed the talks or wish to review them, recordings for the full series are available to view at bit.ly/wisetalks. Educators or nonprofits interested in utilizing the recordings for educational purposes should visit the contact page on the PISCES website.

UH Focuses on Developing Next-Gen Aerospace Engineers

***Left:** (L-R) UH Mānoa engineering students Adam James Macalalag, Eric Takahashi, Efren Enriquez and Matthew Nakamura hold a rocket they built and launched as part of the Spaceport America Cup competition in 2019. Credit: UH*

By: Brennon Morioka - Dean, University of Hawai'i at Mānoa College of Engineering

The University of Hawai'i at Mānoa's College of Engineering is renewing its focus to develop next-generation leaders in the field of aerospace engineering. The College has long held expertise in this arena, but up until recently it has largely served a supplemental role to the various concentrations within the Mechanical Engineering (ME) Department. In response to the potential growth of an aerospace industry focused around small sat/cubesat initiatives, the College embarked on establishing a Bachelor of Science in Engineering Science degree program with a concentration in Aerospace Engineering, which launched in fall of 2019.

This fall, the College launched an Aerospace Engineering Seminar Series, which has proved popular with our students and faculty alike, bringing in world-renowned experts with diverse backgrounds to educate and inspire our community on a variety of topics. Recent speakers have included former NASA astronaut Richard Hieb, who addressed leadership development and career opportunities in the field, and PISCES Chairperson—and UH alumnus—Henk Rogers, who thrilled us with the possibilities of human colonization on the Moon.

Today, with a resurgent interest in space exploration, growing research collaborations, and the potential for a Space Force presence in Hawai'i, faculty from the ME Department, the Hawai'i Space Flight Laboratory (HSFL) and the Hawai'i Institute of Geophysics and Planetology (HIGP) have built momentum in furthering the University's position in aerospace engineering education and research. Through these collaborative efforts, we have established a new goal of building the aerospace engineering program from an engineering science degree concentration into a

> *Continued on* **Page 6**

Continued: *UH Focuses on Developing Aerospace Engineers ...*

Above: *A rocket built by UH Mānoa engineering students launches skyward at Las Cruces, New Mexico in June 2019. Credit: UH*

stand-alone aerospace engineering degree within the ME department. This will take greater advantage of the cross-disciplinary expertise that already exists within the University and between related units, namely Engineering and the School of Ocean and Earth Science and Technology (SOEST).

To accomplish this objective, SOEST Dean Brian Taylor and I have tasked ME Department Co-chairs Lloyd Hihara and Weilin Qu, HIGP Professor Peter Englert and HSFL Director Luke Flynn to lead the effort in developing curriculum proposals and focus areas for cross-disciplinary research efforts for the proposed Bachelor of Science in Aerospace Engineering degree program. While there is still much to do in order to realize this goal, we are tremendously optimistic about what these partnerships will bring; not only to the University, but to the State of Hawai'i, renewing interest in aerospace engineering and space exploration in the decades to come.

As the newest board representative for PISCES, I am honored to be a part of this dialogue and have a seat at the table. We at the College are excited about what the future holds for the field of aerospace engineering here in the islands, and we look forward to continuing collaborations between PISCES and our faculty and students.

Cont: Letter from the Director

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Dr. Casey Honniball, who is the lead author of the study, published the results as part of her graduate thesis work at the University of Hawai'i at Mānoa—another badge of honor for UH!

In early October we hosted our first Women in Space Exploration (WiSE) Talks series, featuring seven amazing women scientists, engineers and entrepreneurs who discussed the latest discoveries and cutting-edge research in aerospace and space exploration. The presentations were fantastic and we had a lot of engagement during the Q&A sessions. This event would not have been possible with the generous support of Microsoft and the Hawai'i Science and Technology Museum, partners who we anticipate working with on future events and programs.

Lastly, I want to welcome two new members to our board of directors this year: Brennon Morioka, dean of the College of Engineering at UH Mānoa as a designated representative for the president of UH; and Bonnie Irwin, chancellor at the University of Hawai'i at Hilo. Welcome to the board and I look forward to working closely with you in the near future.

Stay safe and hui hou!

R. Romo

Rodrigo Romo
Program Director