

stewards of science and the environment

Maunakea is a deeply revered cultural landscape that also happens to be the premier site in the world to study the cosmos. We deeply respect its cultural importance and storied past. The decisions we make today are intertwined with the future of Maunakea and its cherished summit. We appreciate that Maunakea is sacred to many people in different ways, and we are thankful and privileged to study the universe from Maunakea's summit – a unique portal to the universe.

Nonprofits for Research & Education

The Maunakea Observatories are a collaboration of nonprofit, independent institutions with telescopes located on Maunakea on the island of Hawai'i. Together, the Observatories make Maunakea the most scientifically productive site for astronomy worldwide.

- Observing time is free. Everyone with a compelling research proposal is welcome to apply.
- We are supported by numerous international partners and research institutions worldwide.
- Nonprofit in nature, the Observatories do not generate revenue, rather are principally funded through Federal research agencies, such as the National Science Foundation.
- Our astronomical research is purely scientific in nature, dedicated solely to better understanding the universe around us.

Commitment to Natural Resources

The Maunakea Observatories deeply value safety, environmental stewardship, science, cultural heritage and community.

- We support the Comprehensive Management Plan and the Office of Maunakea Management.
- We comply with strict guidelines that protect the natural environment.
- Maunakea watershed areas are replenished by rainfall below 8,000 feet. Observatories located above 14,000 feet do not impact Hawai'i Island aquifers, confirms hydrologists.
- Any chemicals used in operations are contained on-site for maintenance, properly handled by trained professionals and disposed of safely and immediately, once no longer necessary.
- Native species on the summit remain unimpacted by observatory operations.

The Maunakea Observatories

Caltech Submillimeter Observatory

Canada-France-Hawai'i Telescope

East Asian Observatory (JCMT)

Gemini North Telescope

Very Long Baseline Array

NASA Infrared Telescope Facility

Subaru Telescope (NAOJ)

Submillimeter Array

United Kingdom Infrared Telescope

University of Hawai'i 2.2 Meter

University of Hawai'i Hilo Educational Telescope

W.M. Keck Observatory (Keck I and Keck II)

The telescopes on Maunakea are operated by separate nonprofit observatories. Each has its own strengths with varying fields of view and sensitivities to light from radio to ultraviolet wavelengths. They are all important to the scientific productivity of Maunakea.

committed to Hawai'i

The Maunakea Observatories are committed to supporting the Hawai'i community, of which they are deeply a part. They provide STEM education opportunities, workforce development, environmental protection and Hawaiian cultural advancement. It is through a collaborative vision for the future of Maunakea that this remarkable blend of interests (culture, environment and science) can flourish and honor Maunakea.

Kama'āina Observatory Experience

The Kama'āina Observatory Experience, presented by Maunakea Observatories and 'Imiloa Astronomy Center, is a free monthly community event that seeks to inspire a passion for astronomy and an appreciation for the cultural and environmental future of Maunakea among Hawai'i residents. For the first time in the 50-year history of astronomy on Maunakea, the Kama'āina Observatory Experience provides local residents with an opportunity to visit the summit, see world-class telescopes and learn about the mountain in a holistic manner.



Events for the Community

The Observatories enthusiastically share their love of science and technology with the community all year, especially with schoolchildren. The Mauna Kea Astronomy Outreach Committee organizes events and programs to engage the community, including Journey through the Universe and Astro Day. The THINK Fund sponsors dozens of STEM Learning Grants each year, college scholarships and equipment for classrooms across Hawai'i Island.

JOURNEY THROUGH THE UNIVERSE

Each year, more than 70 observatory professionals and educators extend their reach to communities across Hawai'i Island to help students discover the magic of science and kindle their interest in becoming the next generation of engineers, researchers and visionaries that help guide Hawai'i's future.

SOLAR SYSTEM WALK

The annual Solar System Walk turns Waimea into a scale model of our solar system with the sun at the W.M. Keck Observatory office and Pluto/dwarf planets at the Canada-France-Hawai'i Telescope office with stations at each planet in between. Keiki learn about solar system discoveries made nearby from the summit of Maunakea.

ASTRODAY

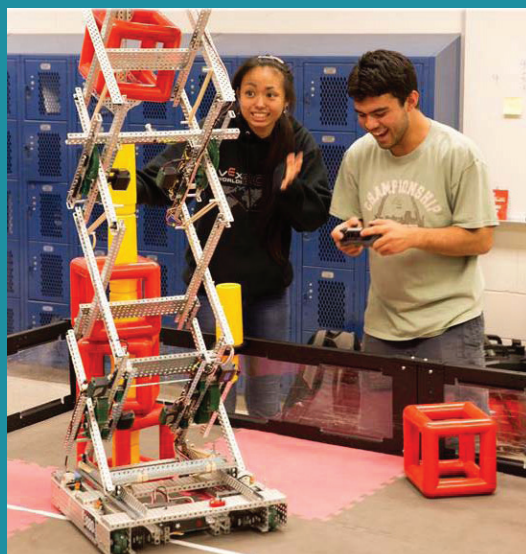
AstroDays in Hilo and Kona are the largest single outreach events organized by the Maunakea Observatories each year. Attended by thousands of community members, they provide Hawai'i Island residents with opportunities to meet observatory staff members and explore the science and technology that is unique to the Maunakea Observatories.



Maunakea Fund at Hawai'i Community Foundation



Established in 2016, the Maunakea Fund is a collaboration between the Maunakea Observatories and the broader community to support a future for Maunakea that honors the intersection of science, culture and environment. The Maunakea Fund strives to support cultural advancement and environmental conservation as a means to enable science advancement and educational opportunity for all of Hawai'i's people. To date, a total of \$250,000 has been contributed to the fund.



Beneficiaries of the Maunakea Fund have included:

Akaka Foundation for Tropical Forests - Teaching Change: Increasing youth participation in conservation related STEM fields in Hawai'i

Akamai Workforce Initiative - Akamai Internship Program

Canada-France-Hawai'i Telescope Corporation - Maunakea Scholars Expansion with Mānoa Academy

Girl Scouts of Hawai'i - Hawai'i Island and Kaua'i STEM Fests and The Girl Scout Leadership Experience

Hawai'i Academy of Arts & Science Public Charter - STEAM Learning

Hawai'i Institute of Pacific Agriculture - Farm Mentorship & Apprenticeship

Hawai'i Pacific University - Citizen Science Program Using eDNA

Hawai'i Preparatory Academy - HPA's Career-Connected STEM

Hilo Medical Center Foundation - Pre-Health Career Corps Program

Hökūpa'a - Hōkūpa'a Purpose-Driven Career Pathways

Holualoa Elementary School - Holualoa C2C Food Sustainability Project

Honoka'a Complex - Honoka'a Complex STEM Partnership: STEM Career Connected Learning Program

Kahua Pa'a Mua Inc. - KPM Ag STEM Connection

Ke Kula 'O Nāwahīokalani 'Ōpu'u - Ko Kula Kai

Kealakehe High School - Expanding Excellent STEM Access in West Hawai'i

Keaukaha One Youth Development - RISE 21st Century After School Program

Keonepoko Elementary School - KeOBots Grant Proposal

Mala'ai - The Culinary Garden of Waimea Middle - STEM Learning in the Garden

Mālama Kai Foundation - STEM to Careers via Boatbuilding and Watershed Science in North Kohala

Marine Mammal Center - Nā Kōkua o ke Kai: Advancing Middle-School Marine Science and Ocean Conservation

Parker School - Expansion of Parker School's Technology Education Plan

Prince Dance Company - Rhythm of the Universe

Kea'au Elementary School - Kea'au Robotics Inspire

*Multiple donor contributions were merged into a single pool to sponsor various programs on Hawai'i Island.

Other programs supported by the Maunakea Fund include those providing professional training for educators, after school care programs and youth computer literacy programs.

'ōlelo Hawai'i reaching beyond our shores

Adding indigenous perspectives to modern science helps audiences understand global discoveries, making sense of what it means for them, their communities and beyond. It provides a valuable connection between past and present that can inform the future.

Astronomy proudly serves as a platform where the 'ōlelo Hawai'i renormalization movement

- Helps enrich astronomical researchers' understanding of the science in cultural context
- Advances the Hawaiian language as a daily-used medium in STEM fields



SHARING TRADITIONAL KNOWLEDGE, VALUES AND PRACTICES THROUGH GENERATIONS

Hawai'i's a legacy of astronomical observation dates back over a thousand years with hundreds of Hawaiian names given to planets, stars, and constellations. The A Hua He Inoa collaboration positions Hawaiian language on the global stage, integrating science and culture and laying the foundation for the people of Hawai'i to continue connecting astronomical discoveries from Hawai'i to our cultural genealogy.

INSPIRING INDIGENOUS COMMUNITIES THROUGH RECOGNITION WITH THE IAU

Led by 'Imiloa Astronomy Center, in partnership with Ka Haka 'Ula O Ke'elikōlani and the Maunakea Observatories.

- Pilot program, launched in October 2018, convened local students, leaders in Hawaiian language education, traditional cultural practitioners and top research scientists
- A two-day experience culminated in the final selection of student-created names for recent discoveries.
- Names made official internationally by the International Astronomical Union (IAU), which governs worldwide astronomical nomenclature.

KEIKI NAME ASTRONOMICAL DISCOVERIES MADE IN HAWAII

Hawaiian immersion students participated in culturally-based celestial nomenclature project, naming the recent discoveries such as:

- 'Oumuamua means "a messenger from afar arriving first," given to an icy comet and first interstellar visitor to our solar system.
- Kamooalewa is sourced from the Kumulipo, the primordial chant describing the creation of the Hawaiian universe, and alludes to a celestial object that is oscillating, reflecting the asteroid's path in the sky when viewed from Earth.
- Ka'epaoka'awela means "the mischievous opposite-moving companion of Jupiter," evoking the image of a retrograde object of unknown origin.
- Pōwehi means "embellished dark source of unending creation," also sourced from the Kumulipo. Pō, the profound dark source of unending creation, is a concept emphasized and repeated in the Kumulipo, while wehi, or wehiwehi, honored with embellishments, is one of many descriptions of pō in the chant.

'ōlelo Hawai'i reaching beyond our shores

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A fruitful partnership led by Hawaiian language experts

"The success of the A Hua He Inoa pilot nomenclature project is a huge step forward for the fusion of indigenous culture and modern day science. By designating Hawaiian names for Hawai'i-born discoveries we enrich our connection to Hawai'i's cosmic genealogy and help people gain a spiritual sense of understanding, a greater grasp of Hawaiian culture as it relates to the universe."

Ka'iu Kimura, executive director of the 'Imiloa Astronomy Center

"A Hua He Inoa is an opportunity to provide Hawaiian names to objects discovered in Hawai'i, the place where their existence and nature were first authenticated. As we participate in reclaiming the survival of our Hawaiian language and identity, it is especially deserving that our new generation of Hawaiian language speakers, nā pua o Hawai'i, return a living Hawaiian language to the world around us, especially to the cosmos, the source our Hawaiian genealogy."

Uncle Larry Kimura, professor of the Hawaiian language and Hawaiian studies at the University of Hawaii, Hilo; founding member of A Hua He Inoa

"It was important to us to actively involve our keiki in the process and use the Hawaiian names they created. These keiki, all brilliant students proficient in 'ōlelo, were able to make history and witness how bold steps can truly change the world."

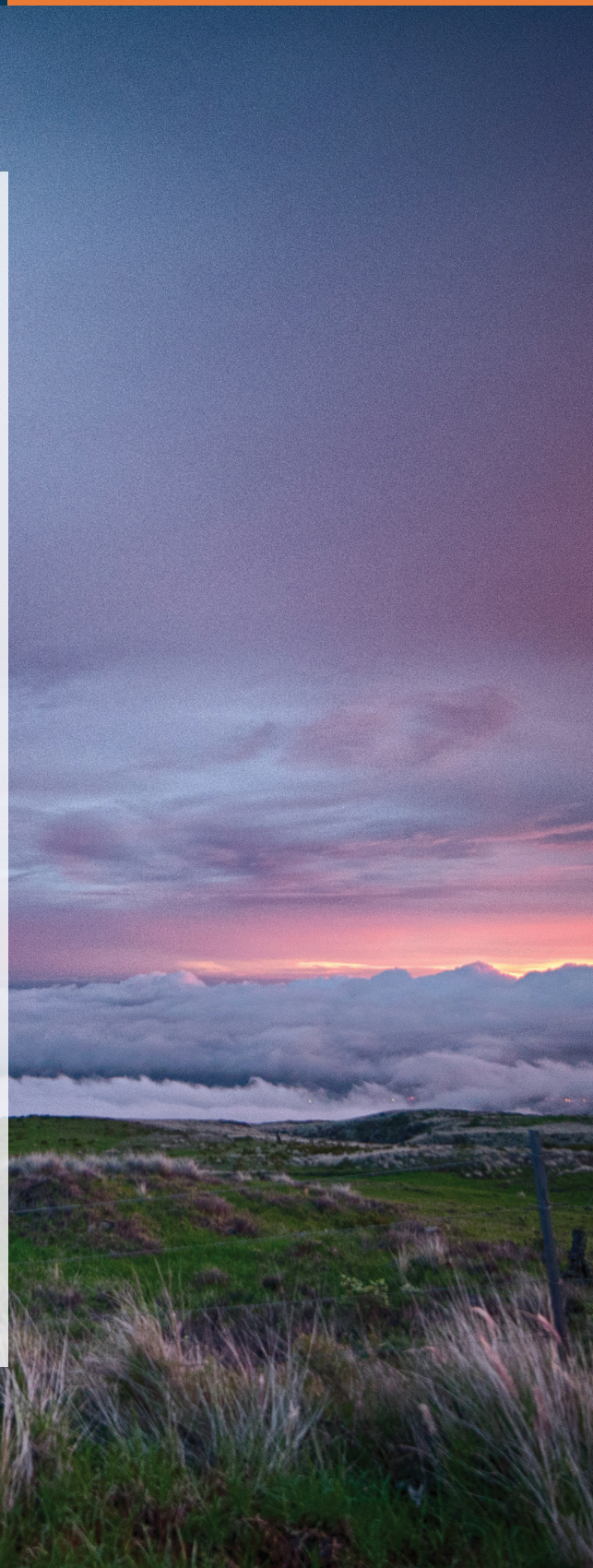
John De Fries, former director of research and development, Hawai'i County; founding member of the A Hua He Inoa volunteer working group

"Being able to be a part of, and experience, the connection between today's science and our ancestral knowledge in the A Hua He Inoa program showed me the importance of learning about our culture and applying these lessons to our future."

Ālika Kuamo'o-Wilhelm, senior at Ke Kula o Nāwahīokalani'ōpu'u

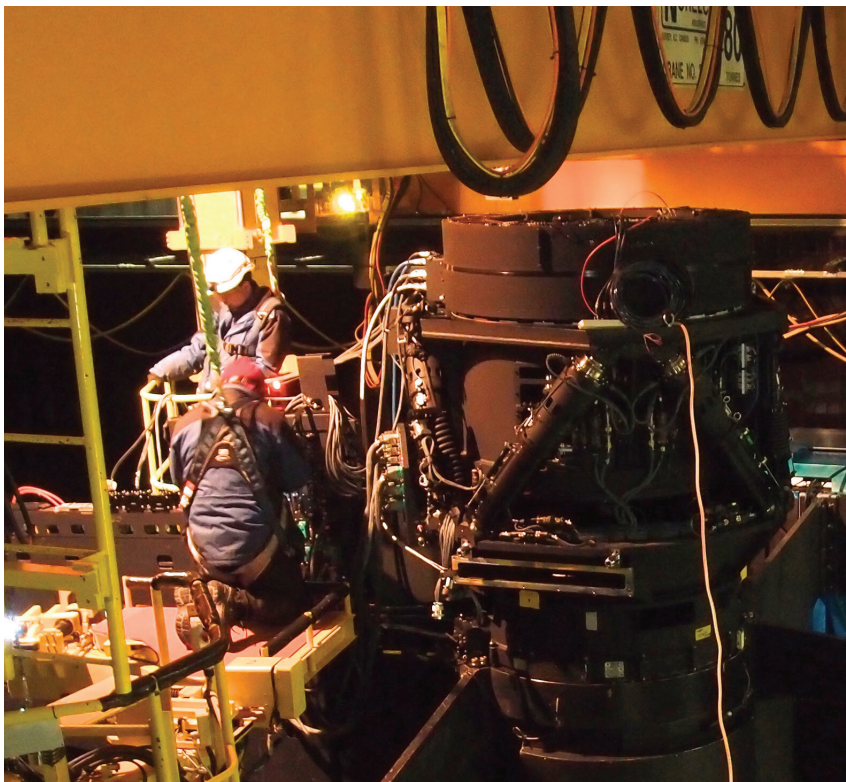
"Naming asteroids using 'Ōlelo Hawai'i and Hawaiian traditions, and having those names recognized by the IAU, demonstrates that Hawaiian language has a significant place in modern science."

Kelekolio Kuamo'o-Wilhelm, senior at Ke Kula o Nāwahīokalani'ōpu'u



working for Hawai'i

More than 500 men and women on Hawai'i Island enjoy careers at the observatories. Statewide about 1,400 jobs are sustained annually by astronomy. These are some of the most sought-after STEM jobs in the state.



Astronomy is Vital to Hawai'i and the World

- Astronomy careers provide great jobs to support roughly 1,000 local families.
- Millions of dollars drawn annually from international partners, most of which is put into Hawai'i's economy through salaries.
- Technology in modern astronomy uses advanced electronics, optics and computers, providing an array of cutting-edge tech jobs for Hawai'i residents.
- Ultrafast Internet2 fiber-optic links help educational institutions across the state.
- Since the '90s, the Hawai'i County lighting ordinance, driven by astronomy, has saved local taxpayers \$5M - \$10M each year through more energy efficient outdoor lighting.
- Research conducted on Maunakea helps fulfill a deep human need to explore the mysteries of the universe for the advancement of future generations.

Hawai'i Astronomy by the Numbers

Approximately **1,400 JOBS STATEWIDE** with economic impacts of **\$90M/YR** on Hawai'i Island and **\$170M/YR** statewide.

\$2B - \$3B INVESTED IN THE LOCAL ECONOMY over the 50+ year history of the Observatories.

Research from the Maunakea Observatories consistently has **HIGHER SCIENTIFIC IMPACT** than that from any other collection of telescopes worldwide.

OVER 10,000 PEOPLE PARTICIPATE ANNUALLY in Maunakea Observatory-sponsored and organized education, cultural, environmental and outreach events

Workforce Pipeline

To cultivate interest in astronomy and STEM careers, the Maunakea Observatories partner in programs for Hawai'i's young professionals. Examples include:

MAUNAKEA SCHOLARS Allocates observatory time on world-class telescopes to high school students. Advances student-designed projects that are scientifically promising and technically viable. Mentors students through research with professional astronomers. **More than 500 high school student participants to date.**

THE AKAMAI INTERNSHIP PROGRAM Places college students on summer projects at observatories and companies in Hawai'i. Increases participation of underrepresented groups in STEM. Enables current workforce to train the next generation with the skills and experience to be successful. **More than 85% of Akamai alumni remain in STEM.**

education for the next generation

Maunakea Scholars is the first program of its kind internationally, leveraging the most powerful collection of telescopes in the world for the direct educational advancement of Hawai'i's high school students. Designed to bring Hawai'i's aspiring young astronomers into the observatory community, Maunakea Scholars competitively allocates observing time on world-class telescopes to local students.

Future Astronomy Stars

Initiated by Canada-France-Hawai'i Telescope, in partnership with the Maunakea Observatories, Hawai'i State Department of Education, and the University of Hawai'i, Maunakea Scholars aims to bring Hawai'i's aspiring young astronomers into the observatory community with real hands on experience. Now in its fourth year, this is the first program of its kind internationally, leveraging the most powerful collection of telescopes in the world for the direct educational advancement of Hawai'i's high school students.

Total program participants to date

530

Total "winning" students:

95+

Number of summit visits

20

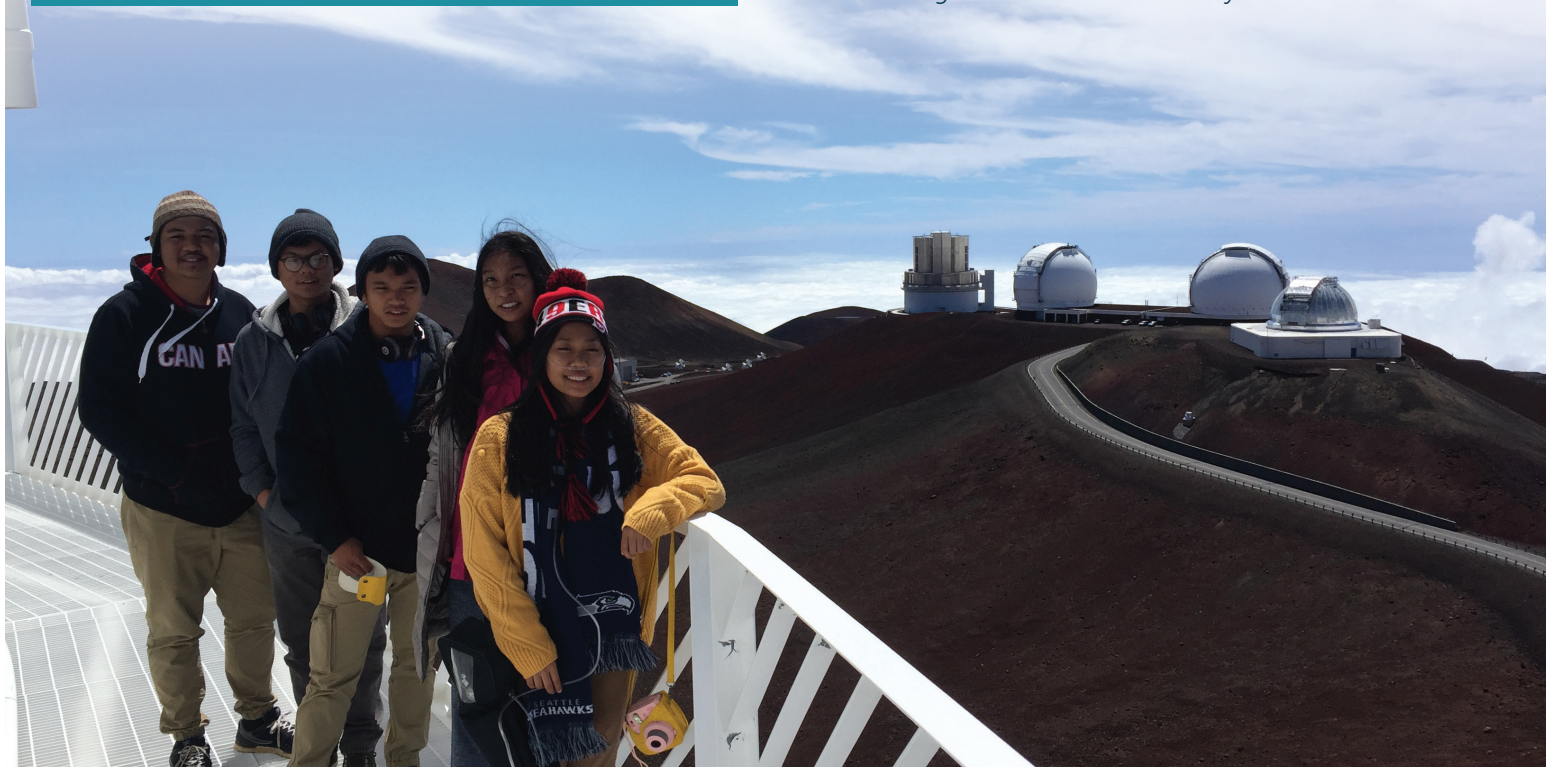
Selected Projects

77

Top Student-Led Discoveries

Just like professional astronomers, students analyze data to design a proposal that may earn them telescope time to do precedent-setting research alongside some of the best astronomers in the world. Each student is paired with a professional astronomer mentor to help them better understand the potential of their research and advanced ideas that are scientifically promising and technically viable, such as work done by –

- Spencer Young "Star Forming Regions and How they Retain their Shape"
Data used and Spencer cited by professional astronomers
- Hoku Sanchez and Keilani Steele "LDN 483"
First students to attend the state science fair from Honokaa
- Keilani Steele "The Key to Detecting Dark Matter"
First two-time winner and first Hokuala Scholarship recipient
- Laura Daclison "The Planet of Two Suns"
Second Keck time awardee
- Emily Little "The Source of Earth's Water"
Pushing the boundaries of solar system observations



education for the next generation

- **MAUNAKEA SCHOLARS IS IN CLASSROOMS ON EVERY ISLAND**, catalyzing students curiosity and inspiring them to push the boundaries of imagination. There are 12 participating schools on 6 islands across the state.
- Kaua'i - Kapa'a High School
- O'ahu - Kapolei High School, Waipahu High School, Kalani High School, Nānākuli High School
- Lāna'i - Lāna'i High and Elementary School
- Moloka'i - Moloka'i High School
- Maui - King Kekaulike High School
- Hawai'i Island - Honoka'a High School, Waiākea High School, Kealahou High School, Kohala High School

STEM EDUCATION OPENS DOORS

In addition to receiving valuable observing time at the world's most powerful telescopes to conduct their own scientific research, Maunakea Scholars participants consider careers in science, technology, engineering and math (STEM) fields right here in Hawai'i.

The success of Maunakea Scholars has motivated sponsors, partners and philanthropists to provide Hawai'i keiki with world class STEM education opportunities, including –

- A grant from the **Hawai'i Community Foundation** brings dual credit college level online astronomy classes to participating Hawai'i Island schools at no extra cost.
- A grant from **First Hawaiian Bank** covers expansion costs including inter-island airfares for students flying to visit Maunakea and mentors flying across the state.
- A grant from **Kamehameha Schools** to 'Imiloa Astronomy Center supports increased cultural education.
- The **Hokuala "Rising Star" Scholarship** awards \$10,000 annually to Maunakea Scholars interested in pursuing astronomy in college.

Keilani Steele
receives scholarship
from Mary Beth
Laychak, Outreach
Manager for
Canada-France-
Hawai'i Telescope



Selected for her extraordinary work as a junior and senior at Honoka'a High School in the Maunakea Scholars program, Keilani Steele became the first recipient of the Hokuala Scholarship in 2018. Through observations at CFHT during the 2016/17 school year, Steele and her research partner Hoku Sanchez discovered a forming star during their study of dark nebulae. During the 2017/18 school year, Steele explored dark matter at the W.M. Keck Observatory by measuring the motions of stars in the gravitational influence of dark matter. She plans to use her data as the basis for her undergraduate research efforts.



For more information about the Maunakea Scholars and astronomy opportunities for local students, please visit www.maunakeascholars.com.

"Our team is building bridges between high school, college and the futures of students across the state. Today's Maunakea Scholars will be tomorrow's leaders who not only stand out in their fields, but understand the crucial connection between culture and science and their responsibility to pass this on to future generations."

Doug Simons, executive director of the Canada-France-Hawai'i Telescope (CFHT)





EnVision Maunakea

FACT SHEET REPORT OF THE HUI HO'OLOHE

The result of two years of effort, and 15 'aha kūkā listening sessions plus written submissions involving over 100 diverse Hawai'i Island voices, the Report of the Hui Ho'olohe delivers great insight into the complexities surrounding Maunakea's past, present, and future.

EnVision Maunakea was established in 2015 in recognition of the need for civil, productive dialogue about the issues surrounding Maunakea, what the mountain means to the island community and how the various perspectives can move forward together.

WHILE THE VOICES IN THE REPORT VARY WIDELY IN OPINION, SEVERAL KEY THEMES EMERGED INCLUDING:

- Maunakea as a place of sacredness and spirituality for Native Hawaiians, locals, and visitors alike, including hunters, astronomers, ranchers, spiritual practitioners, and many others.
- Maunakea's power to teach and be an example for the world.
- Maunakea's significant place in childhood, family, and traditions.
- Need for the mountain to be cared for in a comprehensive, coordinated manner.
- Impact of the astronomy community and ways it can contribute to the Island's future.
- Need for more general education about Maunakea; sharing knowledge gained from the mountain, along with the proper behavior concerning the summit, the lower slopes, and sacred sites.
- Increasing impact of excessive traffic on Maunakea.
- Who is, and who should be, responsible for the management of the mauna.
- Visions for Maunakea's future.
- Potential solutions that may inspire movement towards a time when nature, culture and science coexist on Maunakea in a thriving, vibrant way for generations to come.

As one 'aha kūkā participant said, "I hope eventually we can all value what the people opposing and those with different points of view value. Culture, watershed, geological, flora, fauna, scientific value. If we can value all of them instead of only one, that may be the key."

Please visit the EnVision Maunakea website to download the full report: <http://www.envisionmaunakea.org>

studying the universe

The best astronomical observations in the world happen on Maunakea. It is home to some of the most scientifically productive telescopes in the world, making Hawai'i an international leader in astronomical science. We are proud of the value science brings to the state of Hawai'i — it diversifies our strengths and reminds the world that we are so much more than a visitor destination.

Global scientific discoveries led by MKO

PŌWEHI, THE FIRST-EVER IMAGE OF A BLACK HOLE: Two Maunakea telescopes played a vital role in a groundbreaking initiative linking eight telescopes from six locations across the globe to form an Earth-sized telescope powerful enough to capture light from a supermassive black hole 55 million light-years away and produce the world's very first image of a black hole. Astronomers worked with Hawaiian language luminary Dr. Larry Kimura to name the black hole Pōwehi: embellished dark source of unending creation.



DARK ENERGY AND COSMIC ACCELERATION: While studying Type Ia supernovae, astronomers revealed that the Universe's rate of expansion is accelerating. The repulsive force responsible for this acceleration is commonly known as "dark energy." This discovery earned the 2011 Nobel Prize for Physics.

SUPERMASSIVE BLACK HOLE IN THE MILKY WAY: By measuring the motions of stars in the heart of our Milky Way galaxy, researchers revealed a black hole that is 4.1 million times the mass of our Sun. It is the closest "laboratory" we have for research in extreme gravity environments, allowing us to test General Relativity, a pillar of modern science, in ways that are not otherwise possible.

EXTRASOLAR PLANETS: The first images of a planetary system orbiting another star were recorded on Maunakea.

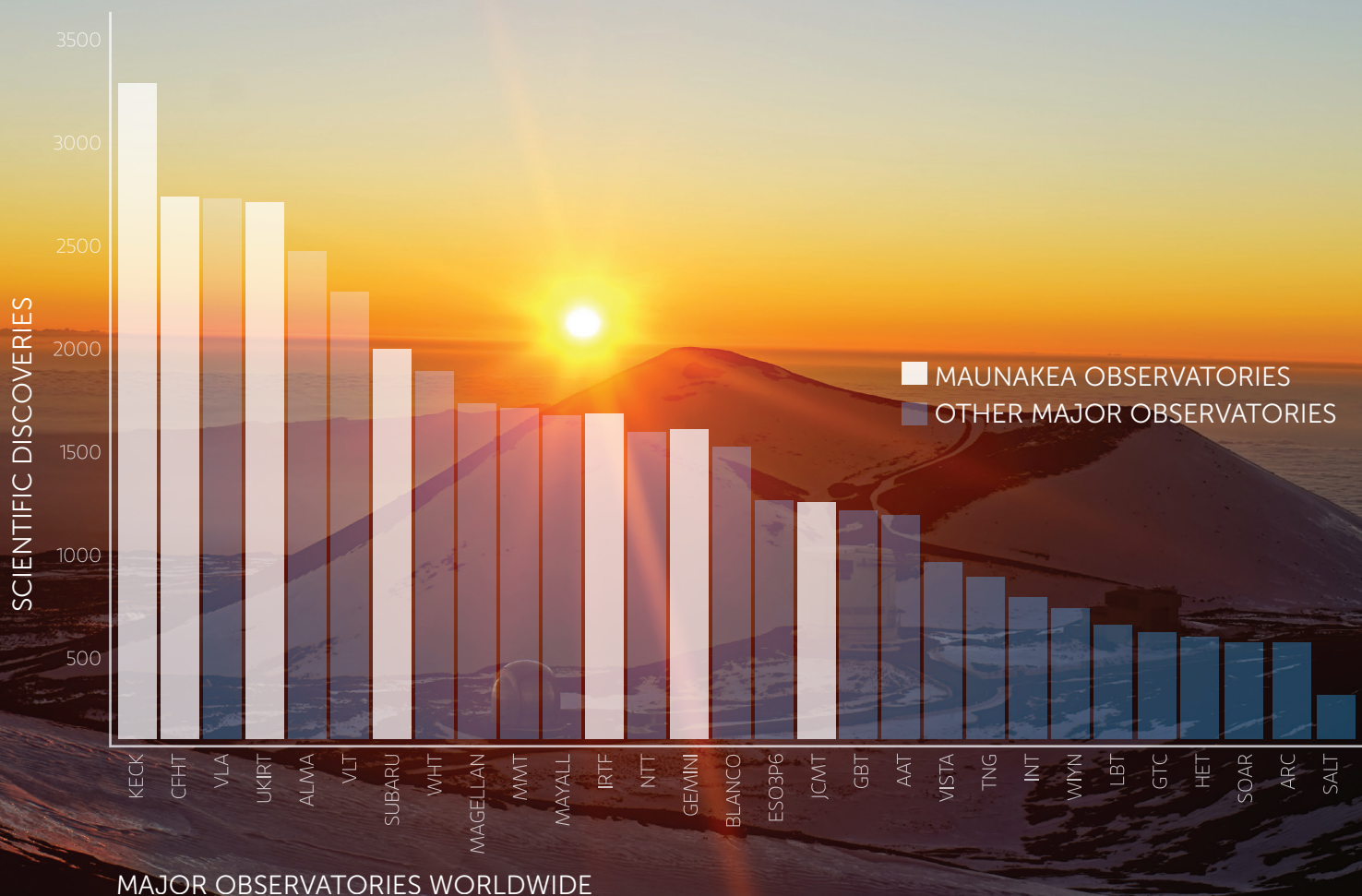
'OUMUAMUA AND KILLER ASTEROIDS: Telescopes on Maunakea and Haleakalā are the world's leaders in detecting and studying near-earth asteroids, including those that may put the earth at risk. Recently the first object from interstellar space, a comet named 'Oumuamua from a distant star system, was discovered and characterized by telescopes on Maunakea and Haleakalā.

MOST-DISTANT GALAXIES: Our cosmic frontier has been pushed to new extremes through the discovery of some of the most distant objects ever detected. Maunakea observatories helped astronomers reach back to a time when the universe was only five percent of its present age of 13.8 billion years.

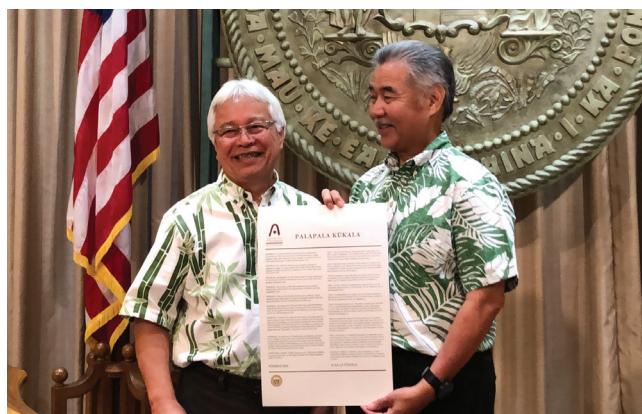


studying the universe

Fundamental scientific research conducted by the Maunakea Observatories advances the kind of scientific curiosity that has always been a part of Hawai'i's cultural heritage, from the ancient celestial navigators to today.



2017 - Courtesy D. Crabtree



"There is a connection between astronomy and the question about where we come from, about how creation happened. We look at it through the Hawaiian lens as our genealogy, and maybe scientists look at it through atoms and stardust, but it takes us into another realm. It's not from this world, it's from the world out there, and that's the first significant connection that we have."

Dr. Larry Kimura, professor of Hawaiian language and Hawaiian studies at the University of Hawai'i, Hilo