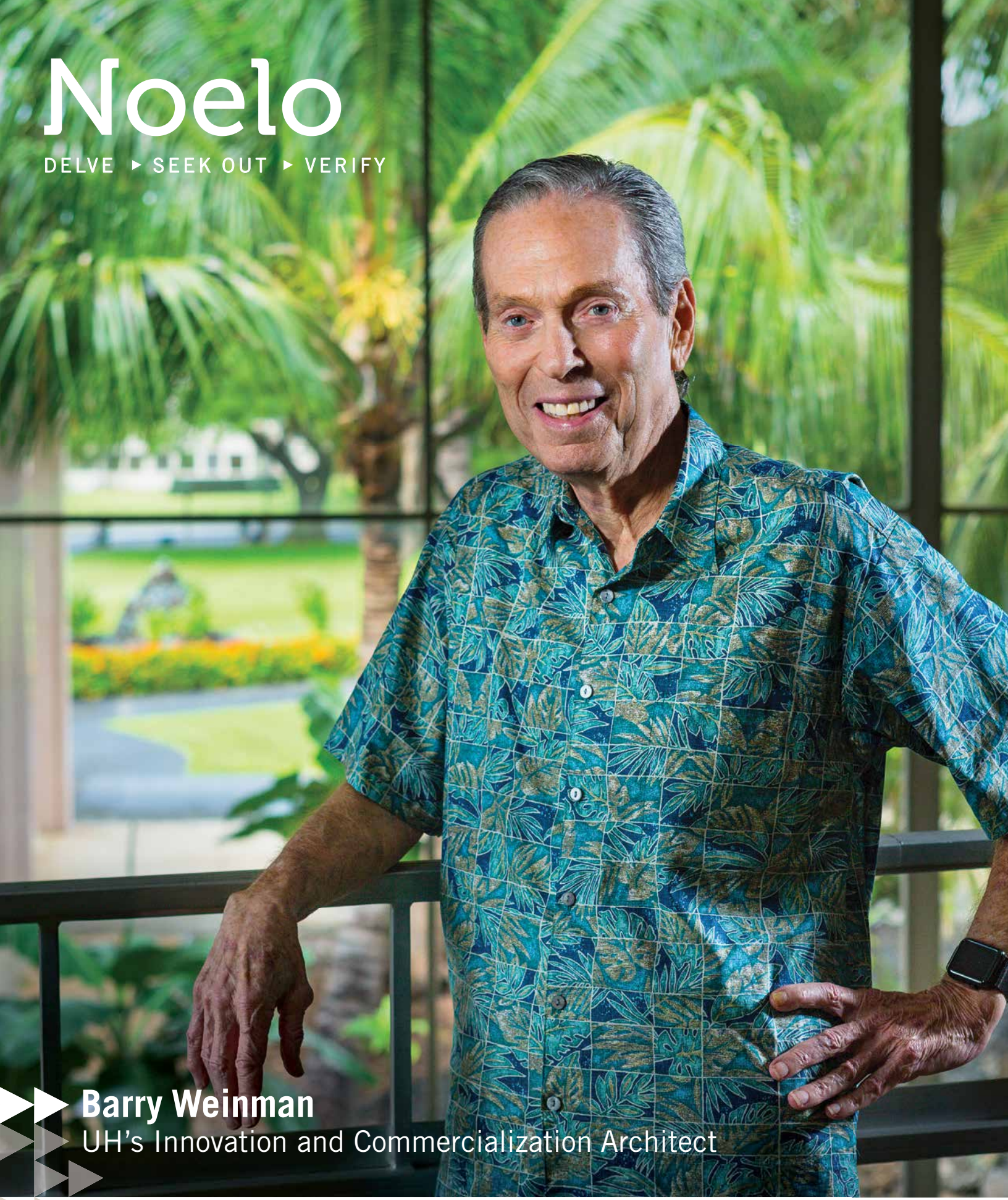
Noelo

DELVE ▸ SEEK OUT ▸ VERIFY



Barry Weinman

UH's Innovation and Commercialization Architect

RESEARCH AND INNOVATION AT THE UNIVERSITY OF HAWAIʻI - 2018

UNIVERSITY of HAWAIʻI® SYSTEM

University of Hawai‘i System

David Lassner, PhD
President

Vassilis L. Syrmos, PhD
Vice President for Research and Innovation

***NOELO,* WHICH MEANS "TO DELVE, SEEK OUT OR VERIFY" IN HAWAIIAN, IS THE RESEARCH MAGAZINE OF THE UNIVERSITY OF HAWAI‘I SYSTEM PUBLISHED ANNUALLY BY THE OFFICE OF THE VICE PRESIDENT FOR RESEARCH AND INNOVATION.**

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A Message from the Vice President

When the University of Hawai'i (UH) took on the challenge of spearheading the Hawai'i Innovation Initiative, a bold effort to diversify the state's economy through the aggressive commercialization of UH-based research—the road ahead remained full of internal and external challenges.

While internal policies, structures and personnel were recalibrated, created or added to foster a more nimble entrepreneurial ecosystem at UH, restrictive state statues remained as a roadblock to tech transfer and commercialization efforts. After three years of collaborative effort between UH and the local business community, the Hawai'i State Legislature finally passed two measures to eliminate these restrictions. Known as Act 38 and Act 39, both bills were signed into law on June 19, 2017. This created a new window of opportunity for UH.

Much of the credit for this effort and for laying out the initial roadmap for the Hawai'i Innovation Initiative must go to the Hawaii Business Roundtable, American Savings Bank President and CEO Rich Wacker and venture capitalist Barry Weinman. Known primarily for his philanthropic generosity to UH, Weinman was also a staunch, but lesser-known supporter of UH research for over a decade. In addition to managing a small seed fund for UH research at one time, Weinman provided the critical nudge to create a UH accelerator and was to first to recognize that the existing statues would stand in the way of the initiative's progress.

Thanks in part to Weinman and the efforts of others, UH's world-class faculty and student researchers in the areas of astronomy and space exploration, ocean and climate sciences, health and wellness, digital economy and civil infrastructure security, and sustainable ecosystems and energy—now have a level playing field to market their passion and life's work into successful business ventures that could potentially benefit the state, the nation and the world.

Please take a look at our work represented in the following pages and see what makes the University of Hawai'i—like no place else on Earth.

Vassilis L. Syrmos, PhD
Vice President for Research and Innovation
University of Hawai'i System

ASTRONOMY AND SPACE EXPLORATION

The Pan-STARRS 1 Observatory opens at sunset to begin mapping the sky.
CREDIT: ROB RATKOWSKI

Guardians of the Night

HUNTING FOR KILLER ASTEROIDS AND SURVEYING THE SKY WITH UH'S PAN-STARRS

While the threat has always existed, disaster movies like *Deep Impact and Armageddon* in the late 1990s created a greater public interest in the sky above and the potential of near-earth object (NEO) impacts — primarily asteroids, with the Earth. Rather than leave it to a chance observation, NASA has been actively studying NEOs since the 1970s and later began tracking asteroids and comets through a coordinated network of ground- and space-based telescopes in its Near-Earth Objects Observations Program.

A key player in this network is duo of unique telescopes developed by the Institute for Astronomy (IfA) at the University of Hawai'i at Mānoa (UH Mānoa) called the Panoramic Survey Telescope & Rapid Response System (Pan-STARRS). Located near the summit of Haleakalā on the island of Maui, The Pan-STARRS1 Telescope (PS1) began full operations in 2010 and the adjoining Pan-STARRS2 Telescope (PS2) is expected to become operational later this year.

"While Pan-STARRS1 is comparatively smaller than the 4-meter mirror on the neighboring Daniel K. Inouye Solar Telescope or the 10-meter telescope at the Keck Observatory on Mauna Kea, its 1.8-meter telescope makes up for it with the field of view and camera," said Dr. Ken Chambers, director of the Pan-STARRS Observatories. "Our telescope is equipped with special optics that provide a very wide view — three degrees across, the equivalent of an angular view of six full moons aligned in a row. Pan-STARRS1 is also equipped with a 1.4-gigapixel digital camera — currently the world's largest operationally."

Pan-STARRS1 has identified more moving objects than the rest of the worlds telescopes combined — over 4,000 Near Earth Objects, hundreds of new comets and hundreds of Trans-Neptunian or Kuiper Belt Objects.

LEFT: Artist's impression of the first detected interstellar asteroid 'Oumuamua discovered on October 19, 2017 by the Pan-STARRS 1 Observatory.
CREDIT: ESO/M. KORNMESSER

In a single night, Pan-STARRS1 will take over 500 photos of the night sky in different wavelength bands and transfer about a terabyte of astronomical data to the Pan-STARRS cluster in the Information Technology Center, the largest dedicated civilian computing system in Hawai'i, located on the UH Mānoa campus. Here the processing and analysis of the data begins with the Image Processing Pipeline (IPP), a highly parallelized and specialized computing system developed by the Pan-STARRS team, to "clean" the raw images of unwanted instrumental signatures and optical distortions. From there, the new images are photometrically calibrated against "historical" images found in the Pan-STARRS catalog. By comparing images of the same section of sky taken on multiple dates, astronomers can look for subtle changes or "difference images," that would indicate a moving, variable or new transient object.

Utilizing this method, Pan-STARRS1 has identified more moving objects than the rest of the worlds telescopes combined—over 4,000 Near Earth Objects, hundreds of new comets and hundreds of Trans-Neptunian or Kuiper Belt Objects. It has also identified over 7000 transient objects, including a surprising zoo of new kinds of supernovae and even Tidal Disruption Events—the dying flare from a star ripped apart by tidal forces as it spirals into a black hole.

Discovery of the First Interstellar Object

On October 19, 2017, Pan-STARRS1 was the first to detect an unusual visitor whose motion and speed were not consistent with a normal solar system object or comet orbit.

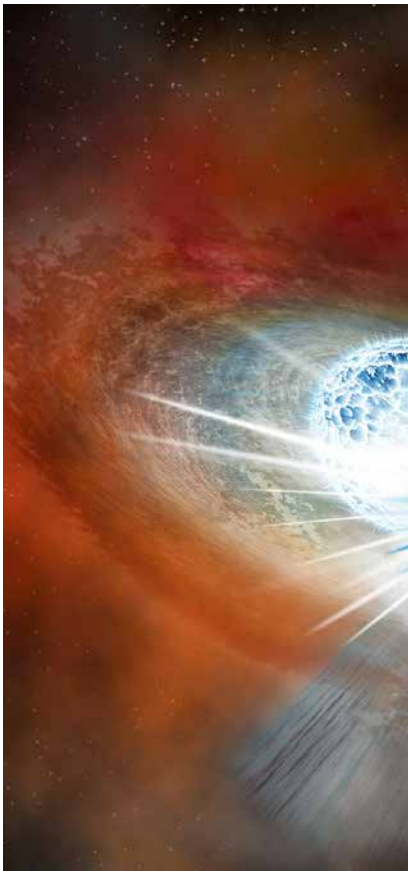
Later named, 'Oumuamua or "messenger from afar, arriving first" in Hawaiian, the asteroid or comet was the first interstellar object ever detected passing through the Solar System.

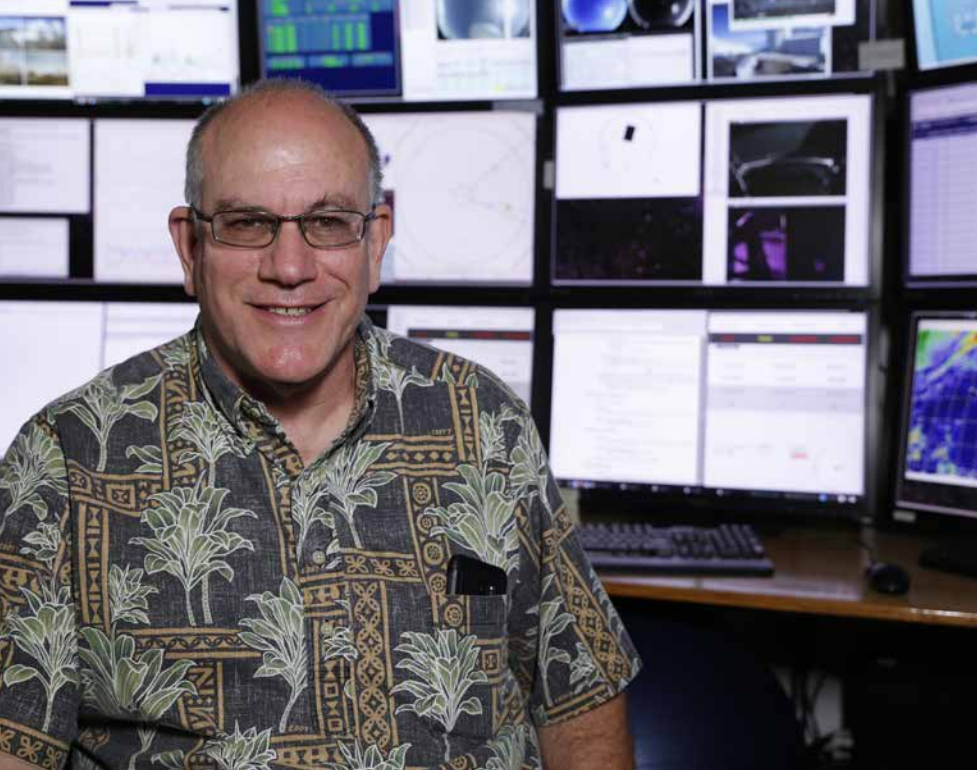
From data it obtained from Pan-STARRS1 and other observatories around the world, NASA's Center for Near-Earth Object Studies plotted that 'Oumuamua came from the direction of the constellation Lyra at speed of 15.8 miles per second. It approached the Solar System from almost directly above the ecliptic orbits of the planets, made a close approach to the Sun diving under the ecliptic plane and finally was pulled up by the Sun's gravity passing below the Earth's orbit at a distance of about 15 million miles at a new speed of 27 miles per second on its way toward the constellation Pegasus.

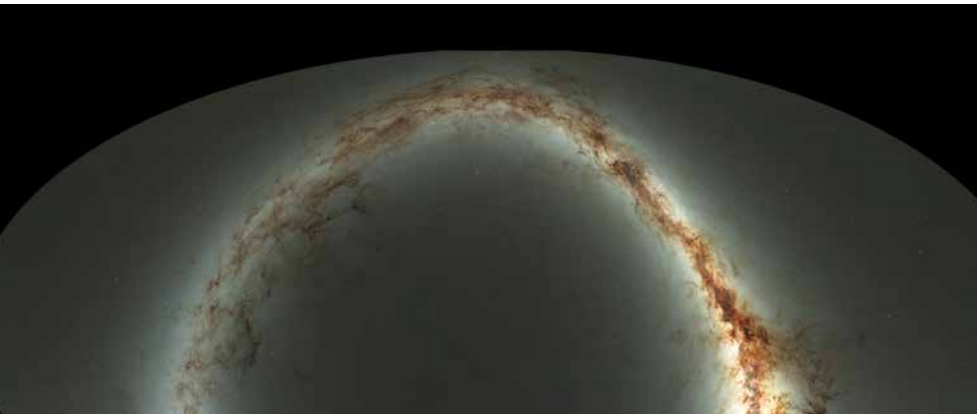
"We have long suspected that these objects should exist, because during the process of planet formation a lot of material should be ejected from planetary systems," said Dr. Karen Meech, an astronomer at IfA specializing in small bodies and their connection to solar system formation. "What's most surprising is that we've never seen interstellar objects pass through before."

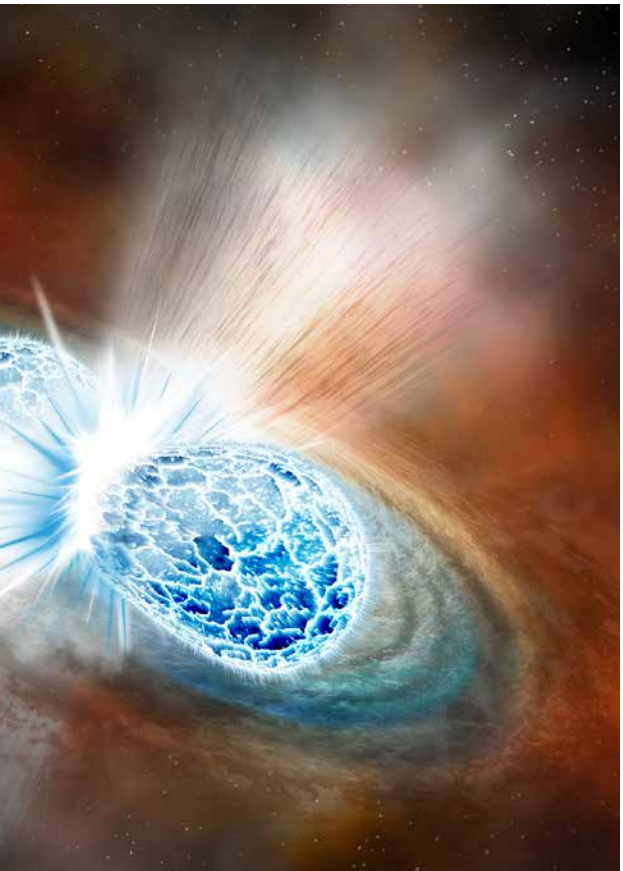
Confirmation of a Kilonova

On August 11, 2017, Pan-STARRS1 was called upon again to scan a location in the sky where astronomers in the U.S. and Chile had earlier detected strange bursts of energy being emitted. Through a comparison of new images and previous images of the source taken by Pan-STARRS1, it was confirmed that the initial brightness of the area was dimming rapidly.









TOP: Dr. Ken Chambers in the Pan-STARRS control room at the Advanced Technology Research Center in Pukalani, Maui.

TOP: Compressed view of the entire sky visible from Hawai'i taken by the Pan-STARRS 1 Observatory.

CREDIT: DANNY FARROW, PAN-STARRS 1 SCIENCE CONSORTIUM AND MAX PLANCK INSTITUTE FOR EXTRATERRESTRIAL PHYSICS

BOTTOM: Artist's conception of a neutron star merger. Pan-STARRS 1 was the first to capture its unique signature on August 11, 2017.

CREDIT: ILLUSTRATION BY ROBIN DIENEL COURTESY OF THE CARNEGIE INSTITUTION FOR SPACE

"A new astronomical object fading this fast was unheard of," said Chambers. "This was the signature of a kilonova and the Pan-STARRS Team with their precision photometry alerted the world to its unique signature."

A kilonova occurs when two collapsed neutron stars, devoid of any energy, circle toward each other in a "death spiral" and collide in spectacular fashion sending cosmic debris hurtling into space. In this first witnessed event, the object changed from a blue, to red and finally into a spectrum that was never seen before — indicating the presence of heavy elements.

"It was long believed that these heavy elements came from single massive stars exploding in a supernova long before our solar system was formed," said Chambers. "As a result of this event, astronomers believe that it will change our understanding of how each family of isotopes are created and the emergence of the periodic table of the elements over cosmic history."

World's Largest Digital Sky Survey

From 2010 to 2014, Pan-STARRS1 collected data on three billion separate sources, including stars, galaxies, asteroids, quasars, white dwarfs, brown dwarfs and various other objects. Known as the Pan-STARRS1 Surveys, the collection contains two petabytes of data, equivalent to 100 times the total content of Wikipedia, and can be used in a wide range of applications to assist the astronomical community. In 2016, Pan-STARRS/IfA and the Space Telescope Science Institute released "Static Sky," which is the average of each of those individual epochs (a date in time used as a reference point to predict the movements of a celestial body). Later this year, the second data set providing a catalog that gives the information and images for each individual epoch will be released in the largest astronomical data release in history. Ongoing releases will continue with new data and more detailed maps in the years ahead.

"The Pan-STARRS1 Surveys allow anyone to access millions of images and use the database and catalogs containing precision measurements of billions of stars and galaxies," said Chambers. "The rest of the world now uses Pan-STARRS to calibrate their data, as it has become the standard by which other systems are compared to."

Having spent years of effort developing, refining and expanding the Pan-STARRS System, Chambers and his team are now poised to reap the benefits with new, and as yet, unknown discoveries — while continuing to map the universe and quietly serving as guardians of the Earth.

A Connection with the Sun

Since the earliest times, the Sun seems to have played a central role not only in everyday life, but also in religion, art, culture and science. More than 1000 years ago, the Chinese noticed that the Sun varied slowly as tiny dark spots moved across its visible disk. Although meticulous records of these events were primarily kept for astrological or political purposes, these pre-telescope astronomers could be considered as one of the earliest solar scientists. Six hundred years later, Galileo Galilei trained the lenses of his new telescope toward the Sun and officially discovered sunspots. But it wasn't until 1908, that the true power of the Sun was uncovered by George Hale's discovery of strong magnetic fields.

Today, most people are not as concerned with the Sun's changes or the resulting solar weather patterns — taking an obviously greater interest in the weather on Earth. However, the Sun warms the seas, stirs the atmosphere, generates weather patterns and provides the energy that allows plant growth — fueling all life on Earth.

For Dr. Jeffrey Kuhn, an astronomer at the University of Hawai'i at Mānoa's Institute for Astronomy (IfA), the Sun fuels his passion to uncover the scientific mysteries that surround this yellow dwarf star at the center of the Solar System, 92.96 million miles from Earth. According to Kuhn, fluctuating solar weather has influenced the price of wheat, the rise of the sea and the disappearance of civilizations throughout history. More recently, a solar flare in 2003 darkened Sweden's power grid, disabled Japanese satellites and caused disorientation to pilots flying over the North Pole.

"Even scientists whose research is not devoted to the Sun, need to understand it," said Kuhn. "Because of the role it plays as a Rosetta stone for deciphering the planetary solar system environment and the mysteries of more distant parts of the universe."

Kuhn's affinity for solar science began after he received his doctorate in physics from Princeton University in 1981, while working to solve problems related to Einstein's theory of gravity and the Sun. During this time his research turned toward helioseismology, or the study of the Sun's interior structure and dynamics through oscillations on the surface. This new research tool opened another window into seeing the Sun's interior and the related gravitational physics.

Through his work and through other helioseismologists, humans have come to understand much about the solar interior. Kuhn's recent attention has been on the secrets of another enigma — the corona or solar exterior of the Sun. In what has become the new holy grail of solar physics, scientists are trying determine why the temperature of the Sun's corona is millions of kelvins higher than found on the surface.

"Think of heat flowing backward from a cold room back onto a heater," said Kuhn. "According to the second law of thermodynamics, energy cannot be transferred in this manner by conventional heat transfer — so another factor is in play involving the heating of the corona."

Unlike anywhere else, the Sun's corona stores enormous amounts of energy in the form of magnetic fields that are a bit stronger than the magnetism at the Earth's surface. These fields are like those that can align terrestrial compass needles. Unfortunately, the physics in the corona that controls how this energy is accumulated and released has been almost invisible to direct observations.

Kuhn's dedication to his craft eventually led him to Hawai'i and to the Institute for Astronomy 20 years ago — where he could construct a telescope at one of the few places on Earth where daytime dark-sky conditions allow the possibility of directly measuring coronal magnetism. A few years later on Haleakalā, his unusual off-axis telescope, called SOLARC, successfully isolated the faint coronal signal from the million-times-brighter light that originated from the Sun's disk. For the first time, by routinely sensing the infrared coronal emissions and the orientation of the IR electromagnetic waves called polarization, Kuhn and his colleagues directly measured the Sun's weak coronal magnetism with an accuracy comparable to the strength of magnetic fields on the Earth.

Scientists now know that magnetic fields create solar variability, ranging from the 11-year Sunspot cycle to the short bursts of flare and coronal mass ejections of x-rays and particles. Each of these energy forms can affect the Earth, either because

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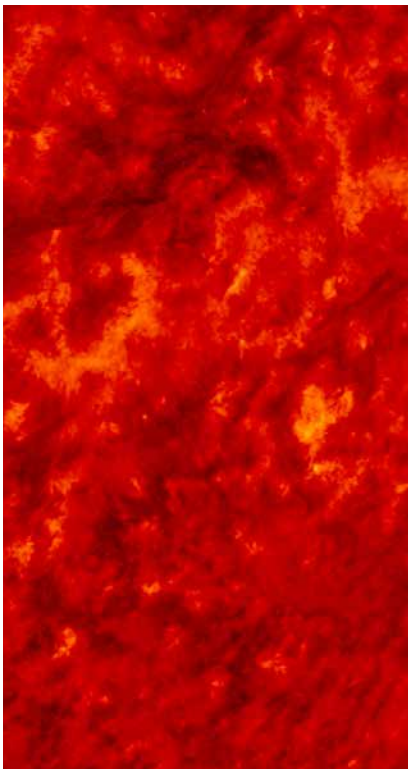
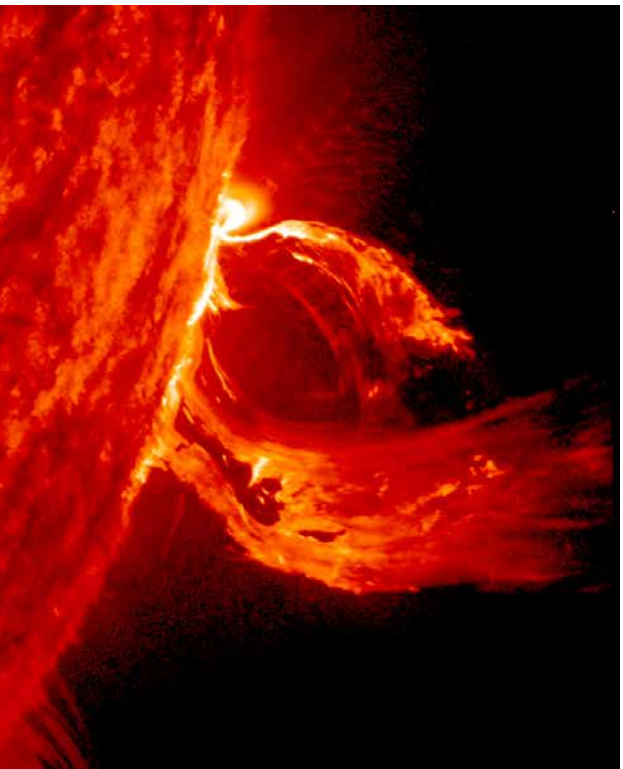




ABOVE: Dr. Jeffrey Kuhn

RIGHT: (TOP) Kuhn's SOLARC telescope was the first to measure coronal magnetism and served as the basis for the (BOTTOM) new Daniel K. Inouye Solar Telescope on Haleakalā

LEFT: A coronal mass ejection on June 17-18, 2015 taken by NASA's Solar Dynamics Observatory.
CREDIT: NASA/SDO

of their interaction with the Earth's own magnetism and upper atmosphere or even through tiny changes in the Sun's radiant brightness due to the sunspot magnetic cycle. This variability makes the Sun an even more important part of the terrestrial climate change puzzle. Measuring that magnetism is the key to understanding and predicting how, why, and when the Sun will change brightness or beam particles or x-rays toward the Earth.

When the Daniel K. Inouye Solar Telescope (DKIST) commences operations in 2020, it will accelerate humankind's understanding of the corona and solar variability in a way helioseismology fundamentally changed humanity's knowledge of the solar interior. Similar to SOLARC, DKIST will use an unusual optical telescope to separate the corona's light from the bright solar disk, but it will be nearly 100 times more powerful because of its much larger 4.2 m diameter primary mirror. At first light, it will include a sensitive detector that was especially designed for measuring this coronal magnetism. Kuhn and his colleagues at the IfA Maui are putting the finishing touches on the Cryogenic Near-Infrared Spectropolarimeter or Cryo-NIRSP—that will give DKIST the power to see the magnetic "dark energy" of the coronal magnetism that controls its evolution and outbursts. With DKIST and this powerful instrument, everyone may soon find it more difficult to take the Sun for granted.

Maunakea Scholars

NURTURING HAWAIʻI'S FUTURE ASTRONOMERS

At 13,803 feet, the summit of Maunakea on Hawai'i Island provides one of the best locations in the world for ground-based astronomy due to its high elevation and clean, relatively turbulent-free air. Each night, giant dome doors on the observatories open to allow powerful telescopes to capture distant images from the far reaches of space. Supernovas, quasars, nebulae, and other astronomical wonders all come into sharp focus for the observer.

While these observers are often national and international astronomers a select group of Hawai'i high school students, known as the Maunakea Scholars, are also getting "telescope time" for their research projects. They work alongside skilled astronomy mentors, predominately University of Hawai'i at Mānoa Institute for Astronomy graduate students to create and execute sophisticated observing proposals.

"The Maunakea Scholars program is an innovative approach to bring Hawai'i's aspiring young astronomers into the observatory community, competitively allocating observing time on world-class telescopes to local high school students," said Mary Beth Laychak, outreach manager for the Canada-France-Hawai'i Telescope (CFHT). "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."

According to Laychak, future plans for this program include —

- Expanding its scope to include all public high schools in the state
- Advancing partnerships with the Hawai'i State Department of Education, the University of Hawai'i and other education leaders
- Offering new cultural curricula within the program
- Establishing a lasting educational opportunity for Hawai'i's students that reflects unique dimensions of Hawai'i in the 21st century

The program was first developed through discussions between CFHT, Gemini Observatory and teachers in East Hawai'i Island in 2014 and was officially rolled out the following year. The Maunakea Scholars program now includes 10 high schools across four islands, including: Nanakuli, Kapolei, Waipahu and Kalani on O'ahu, King Kekaulike on Maui, Moloka'i High School on Moloka'i and Kohala, Honokaa, Kealakehe and Waiakea on Hawai'i Island.

"It was seen as a means of inverting the paradigm—to bring the observatories to students, instead of students trying to find their way to mentors and opportunities within the observatories," said CFHT Director Doug Simons. "We knew there was interest from high school students in the observatories and designed a program that we thought would spark that interest further—by giving them access to the same telescopes professional astronomers have been using for years."

Access to observing time is crucial to the program and to launch the program during its pilot year CFHT provided a night of observing time that was shared by the inaugural Maunakea Scholars cohort. The program's first year success eventually led to all of the Maunakea Observatories providing in-kind observing time to the program this year — with additional access to the Las Cumbres Observatory on Haleakalā, Maui and Kitt Peak in Arizona.

Under the program, student proposals are reviewed by a team of astronomers and scored based upon scientific merit, creativity and technical feasibility. Proposals awarded observing time are matched to telescopes and instruments ideally suited to each research project. Students selected to receive observing time are recognized during an awards ceremony at each participating school, which is often attended by teachers, parents, principals and complex area superintendents. All students who participate in the program get an opportunity to visit the summit of Maunakea and see one or more telescopes. Students receiving CFHT observing time often visit CFHT's Waimea headquarters for a night of

"It was seen as a means of inverting the paradigm — to bring the observatories to students, instead of students trying to find their way to mentors and opportunities within the observatories," said CFHT Director Doug Simons.

TOP: Maunakea Scholars (MKS) Students from Kalani High School atop Maunakea

MIDDLE: Kapolei High School MKS students conduct an observing run at the Subaru Telescope

BOTTOM: An up close and personal look at the Subaru Telescope by MKS students from Kapolei High School

PHOTOGRAPHY: CFHT

MAUNAKEA SCHOLARS

Samples of Proposals Awarded Observing Time

ECLIPSING X-RAY BINARY SYSTEM;
Amber Nakata,
Nanakuli High School

COMPARING ELEMENTS IN DIFFERENT SUPERNOVA REMNANTS;
Ashlyn Takamiya and
Justin Fernando,
Kapolei High School

STAR FORMING REGIONS AND HOW THEY RETAIN THEIR SHAPES;
Spencer Young,
Kalani High School

DARK NEBULA AND THEIR CONNECTION TO STAR FORMATION;
Hoku Sanchez and Keilani Steele,
Honokaa High School

QUASARS AND WHAT THEY ARE MADE OF;
Jamie Valdez and David Zerba,
Kapolei High School

remote observing in the telescope control room, watching their data steam live from the summit.

In May 2017, leaders from the University of Hawai'i, Hawai'i State Department of Education, and Maunakea Observatories declared their commitment to this program by creating an educational partnership to commit resources to the program and to develop a working group to further develop and advance the program. The Institute for Astronomy provides most of the program's mentors, the Department of Education provides links to teachers, schools and curricula statewide, and the Maunakea Observatories provide observing time, summit access/tours, infrastructure, funding and overall coordination of the program.

"The observatories on Maunakea are the best in the world," said University of Hawai'i President David Lassner. "The Maunakea Scholars program provides some of our best high school students with an unprecedented opportunity to conduct real research—and lays the groundwork for us to grow the next generation of world-class astronomers here at home."

OCEAN AND CLIMATE SCIENCES

National Disaster Preparedness Training Center

PUTTING SCIENCE INTO ACTION

To many individuals around the world, 2017 may have seemed like the apocalypse or at least something close to it in terms of damage from natural disasters. The 2017 U.S. hurricane season has been the most expensive ever. In late August, Hurricane Harvey hit Texas, setting rainfall records with extensive flooding in Houston. In early September, Hurricane Irma struck the U.S. Virgin Islands, devastated the Florida Keys and threatened Tampa and its surrounding areas. Just as Irma dissipated, Hurricane Maria hit Puerto Rico causing major damage to power, water, communications and other infrastructure. Many homes and businesses were destroyed with significant with economic losses exceeding $90 billion. In 2017 wildfires burned more than 9.8 million acres, with costs approaching $18 billion.

The National Disaster Preparedness Training Center (NDPTC), a research and training center in the Department of Urban and Regional Planning at the University of Hawai'i at Mānoa's College of Social Sciences, is responding to this global need for natural disaster research, education and training. Funded by the U.S. Department of Homeland Security (DHS) and the Federal Emergency Management Agency (FEMA), NDPTC uses a "whole community" approach to disaster risk reduction and works to help communities prepare for, respond to and recover from disasters.

"Disasters are teachable moments," said Karl Kim, professor of Urban and Regional Planning and the NDPTC executive director. "They magnify what works and what doesn't work in a society or a community."

Kim and his team of disaster management experts at NDPTC develop and deliver training courses for first responders, emergency managers and the community. This includes the development of FEMA's first social media class which focuses on both pushing vital information out to communities from emergency management agencies and using various social media tools for detecting and "crowdsourcing" vital information from communities.

The NDPTC team has also developed and delivered courses on hazards such as volcanoes, hurricanes, coastal flooding, and severe weather, including FEMA's first certified course on tsunamis with the National Oceanic and Atmospheric Administration and the International Tsunami Information Center. The NDPTC has also partnered with local engineering, planning and design firms to develop courses on drones, geospatial analysis, disaster communications and rapid damage assessment.

Since 2009, NDPTC has received approximately $5 million annually, totaling more than $45 million, to continue development and delivery of courses that support real-time evaluation of vulnerabilities and risks, rapid damage assessment, as well as urban planning and environmental management to address the most serious threats facing Hawai'i as well as other coastal communities. The NDPTC is one of seven members of the National Domestic Preparedness Consortium, a professional alliance sponsored DHS and the FEMA National Preparedness Directorate. In addition to the University of Hawai'i, the consortium includes three other universities (Louisiana State University, Texas A&M, and New Mexico Tech), as well as the Center for Domestic Preparedness, the Nevada Test Site, and the Transportation Technology Center, Inc.

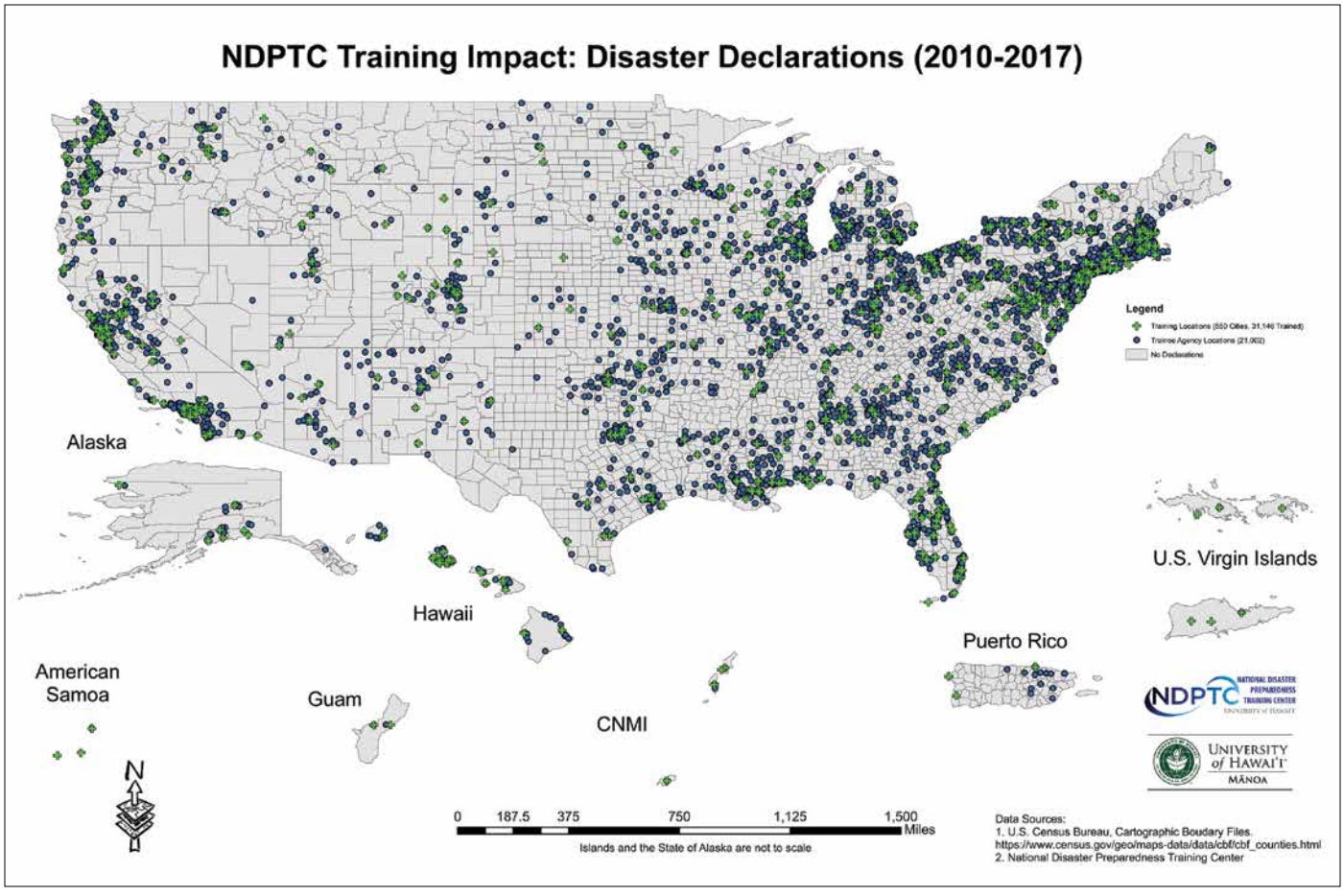
To-date, NDPTC has trained more than 35,000 first responders and emergency managers and others involved in disaster response and recovery in more than 300 cities, villages and rural communities across the United States, and in its flag and trust territories. The ultimate goal of the NDPTC is to build stronger communities.

"By looking at the impacts of disasters on communities and households, how we respond to it, how we recover from it and how we rebuild communities affected by these disasters, we can reduce the number of people that are killed or injured, lose their homes or have their lives disrupted," said Kim. "I'm confident that though the integration of scientific knowledge, risk management and effective policies and plans — we as a university can play a vital role to help increase community safety and security."

To-date, NDPTC has trained more than 35,000 first responders and emergency managers and others involved in disaster response and recovery in more than 300 cities, villages and rural communities across the United States, and in its flag and trust territories.

Dr. Karl Kim, NDPTC Executive Director

LEFT AND TOP RIGHT: Damage from Hurricane Maria in Puerto Rico, 2017


NDPTC Training Impact: Disaster Declarations (2010-2017)
Legend
Training Locations (550 Cities, 31,146 Trained)
Trainee Agency Locations (21,002)
No Declarations
Alaska
Hawaii
American Samoa
Guam
CNMI
Puerto Rico
U.S. Virgin Islands
N
0 187.5 375 750 1,125 1,500 Miles
Islands and the State of Alaska are not to scale
Data Sources:
1. U.S. Census Bureau, Cartographic Boudary Files.
https://www.census.gov/geo/maps-data/data/cbf/cbf_counties.html
2. National Disaster Preparedness Training Center
NDPTC
NATIONAL DISASTER PREPAREDNESS TRAINING CENTER
UNIVERSITY of HAWAI'I MĀNOA

Keeping an Eye on Sea Level Rise

UH'S USE OF IMPACT MODELING HELPS TO SHAPE MORE RESILIENT ISLAND COMMUNITIES

Dr. Chip Fletcher

Dr. Tiffany Anderson

Shellie Hable

ACROSS, TOP: Wave erosion will increase as sea level rises. SOURCE: DOLAN EVERSOLE, SEA GRANT

ACROSS, MIDDLE: Model result of summer wave inundation under 98 cm of SLR on the 'Ewa Beach, O'ahu coastline.

For coastal communities around the world, sea level rise (SLR) is one of the more threatening aspects of climate change. Islands, by definition consisting of limited land and water resources, are especially at risk because SLR causes erosion and flooding of the land, salt intrusion of low-lying aquifers, groundwater inundation that forms new wetlands, high wave damage and seawater blockage of drainage infrastructure, and more. In the School of Ocean and Earth Science and Technology's (SOEST) Department of Geology and Geophysics at the University of Hawai'i at Mānoa (UH Mānoa), the Coastal Geology Group (CGG) models the future of these problems in Hawai'i and the Marshall Islands.

Dr. Tiffany Anderson, who received her BA in mathematics from the University of Hawai'i at Hilo, and her PhD in geophysics at UH Mānoa, works with a small corps of graduate students, technicians and undergraduates on these problems. "The goal of our research is to provide federal, state, and county agencies with actionable model projections of the future impacts of these hazards. Specifically, we modeled SLR impacts for the Hawai'i Climate Change Mitigation & Adaptation Commission," said Anderson. The Commission published the model results in the Sea Level Rise Vulnerability & Adaptation Report which was released in December of 2017.

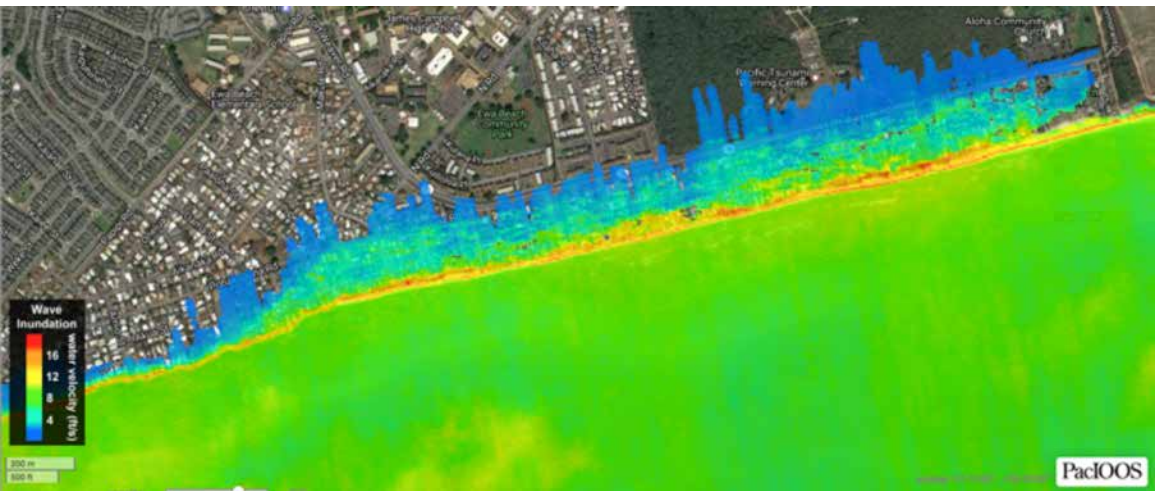
Anderson's work has focused on developing probabilistic projections of future coastal erosion hazard zones, and modeling seasonal wave run-up on all shores of the islands. Because of the diverse wave climate and reef shapes around Hawai'i, each beach behaves differently. Anderson prioritizes capturing these local characteristics in the models, to provide meaningful hazard projections on a local scale; impacts which vary greatly from place to place. To obtain the large computing power needed to run the wave model on these small scales, she used the University of Hawai'i's High Performance Computing Cluster located on the UH Mānoa campus. Erosion and flood hazards are modeled for the islands of Maui, Kaua'i, and O'ahu under 16, 32, 60, and 98 centimeters of sea level rise. Groundwater inundation and hydrostatic flooding are modeled for all of the main islands. These levels of SLR, according to scientific consensus, are expected to occur within a decade or so and continue throughout the century.

Modeling results indicate that coastal erosion rates, on average, will likely double within roughly the next 30 to 50 years. As shorelines retreat, the beach gets squeezed between the ocean and existing homes and roads. Construction of seawalls to protect upland development causes massive beach loss, a problem that will accelerate in coming years if coastal hardening continues as the management option of choice.

Results of seasonal wave modeling indicate that higher sea levels will cause annual flooding over large land areas. This also means that areas impacted by present-day infrequent wave flooding will experience floods more frequently as water levels rise over Hawai'i's reefs.

"Currently, many reefs act as buffers to incoming wave energy," said Anderson. "As sea levels increase over the reefs, more wave energy has access to the shore causing erosion and flooding, especially during high tides."

Shellie Habel, a PhD candidate in the Department of Geology and Geophysics, is working on identifying the physical characteristics and timing of groundwater inundation that will be driven by SLR. Groundwater inundation occurs when the water table is lifted by SLR and breaks the ground surface creating a wetland. She has developed a three-dimensional model that combines ground elevation, groundwater location, monitoring data, estimates of tidal influence, and numerical groundwater-flow



modeling to simulate future flood scenarios due to SLR in the urban core between Diamond Head and Pearl Harbor on O'ahu.

"This flooding will threaten over $5 billion of taxable real estate; flood nearly 30 miles of roadway; and impact pedestrians, commercial and recreation activities, tourism, transportation and infrastructure," says Habel. "The flooding will occur regardless of seawall construction, and thus will require innovative planning and intensive engineering efforts to accommodate standing water in the streets."

Habel has found that the water table is close to the ground surface — within two feet at high tide — in many places. This narrow unsaturated space means that groundwater inundation will become a serious concern well before the end of the century. When it rains and infiltration fills this space, it is a problem already.

Anderson and Habel work closely with Matt Barbee, geospatial analyst with the CGG, and with students Kristian MacDonald, Kammie Tavares and Haunani Kane.

"We strive to train local students on the issues associated with SLR so that they can graduate and take their place among the scientific, planning and resource management community in Hawai'i. These young researchers are keen to serve the people of Hawai'i and assist with the development of adaptation plans to manage these problems as they worsen in the future, said Dr. Chip Fletcher, associate dean of SOEST, professor of geology and geophysics, and supervisor to members of the CGG. "Sea level rise is a very serious issue for Hawai'i. It threatens the very existence of our low-lying communities. But I am optimistic that with focused, scientifically informed decision-making, our communities can become vibrant models of resilience for future generations."

"This flooding will threaten over $5 billion of taxable real estate; flood nearly 30 miles of roadway; and impact pedestrians, commercial and recreation activities, tourism, transportation and infrastructure," says Habel.

Fighting to Stop Cancer in its Tracks

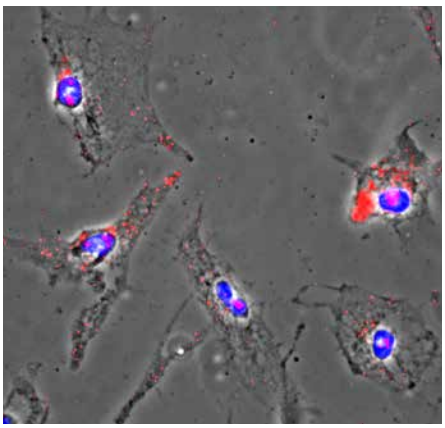
ABOVE: The Ramos Cancer Research Team: Dr. Joe W. Ramos, Vera Schwärzler, Brien Haun, Dr. Won Seok Yang

One of the most stark and sobering cancer statistics is that more than 90 percent of deaths from the disease are the result of metastasis, a process by which the cancer cells spread from the original tumor to migrate through the body to colonize and destroy other organs. While this morbid statistic is all too familiar to cancer researchers, the process of how tumor cells invade and metastasize to other locations in the body remains poorly understood.

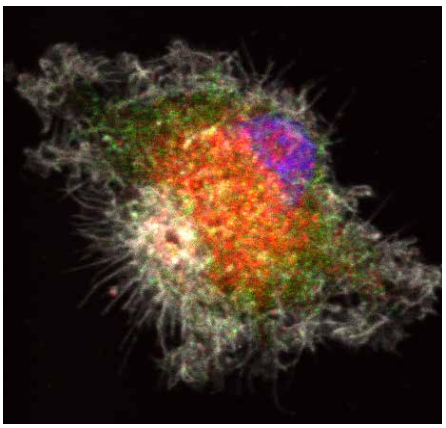
In an effort to unlock this deadly mystery and to help increase cancer survival rates, Dr. Joe W. Ramos and his colleagues at the University of Hawai'i Cancer Center (UH Cancer Center) have committed themselves to illuminating the molecular mechanisms that drive this process.

"If we can identify exactly how cancer cells move throughout the body we could better develop ways to target these specific mechanisms," said Ramos, deputy director of the UH Cancer Center. "That could lead to new therapies that block the spread and recurrence of deadly tumors and greatly reduce the number of cancer deaths."

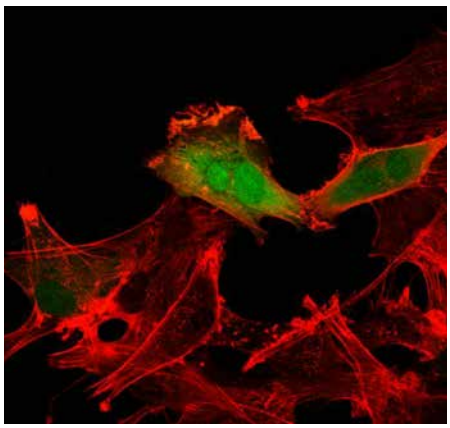
The spread of cancer by metastasis is driven by a set of mutant proteins called oncogenes, which cause cancer cells to multiply uncontrollably and promotes their ability to move. How oncogene activity specifically directs the increased movement and metastasis is highly complex and remains largely unknown. Ramos and his team have been investigating how these oncogenes and related signals trigger the impairment of normal regulatory processes within the cell and activate the highly mobile and invasive cancer cell behavior. Their work has recently centered on one protein that is turned on



RSK signaling hub in cancer cells



Brain cancer cell (glioblastoma)



Glioblastoma cells on the move

by these oncogenes called RSK2 and how this protein drives the aggressive spread of brain cancers throughout the brain.

Brain cancers were specifically targeted by Ramos' team because it is one of the most aggressive and deadly forms of cancer and can affect any age group. "Brain cancer patients with the most aggressive form, known as glioblastoma multiforme, have only a 15-month median survival time," said Ramos. "It is therefore imperative to identify new approaches to specifically attack brain cancer cell survival and motility."

Ramos and his team have found that the RSK2 protein is highly expressed and active in many patients with brain cancer. The protein propels brain tumor cells into surrounding healthy brain tissue. The invasion of these cells throughout the brain makes it difficult to remove the tumor by surgery, which contributes to a high probability of recurrence and poor survival rates in patients. Additionally, the invading glioblastoma cells are less sensitive to current standard therapies. The research team found that blocking RSK2 stops the invasion of the tumor cells and enhances the effectiveness of standard chemotherapy in tumor cells obtained from patients.

For these tumor cells to move, they must reach forward and grab onto other cells or proteins in the brain and pull. They must also let go at the rear to move forward. Over the course of several years, the team discovered that one of RSK2's major roles is to orchestrate these movements. In particular, RSK2 instructs proteins at the rear of the cell (integrins) to let go and tells another group of proteins (Rho) to pull up the tail. This is all very carefully coordinated by RSK2 through its ability to alter the charge on the surface of other proteins through a process called phosphorylation. Ramos found that RSK2 phosphorylates the protein filamin A to turn off the integrin adhesion proteins. At the same time, RSK2 phosphorylates a protein called LARG to tell the Rho proteins to contract the cell skeleton to lift up the "tail" of the tumor cells. As a result, the RSK2 protein forms a signaling hub and the oncogenes turn on this signaling hub to activate an invasion and metastasis program. The RSK2 signaling hub has also been found to be active in other cancer types such as skin and breast cancers.

"These results significantly advance our understanding of how cancer cells are made to move during metastasis and suggest more precise targets for drugs to stop cancer metastasis in patients where there are specific oncogenic mutations," added Ramos. "I'd like to acknowledge Michelle Matter of the UH Cancer Center, Santosh Kesari at the John Wayne Cancer Institute and Dirk Geerts of Erasmus University Medical Center in the Netherlands for contributing to the success of this impactful study."

Cancer invasion and drug resistance are frequently connected processes and anti-invasion drugs show promise as co-therapeutics with chemotherapy in treatment of brain cancer to prevent recurrence. This work paves the way for the development of new brain cancer therapies focused on blocking the RSK2 function. Currently, Ramos and his team have set their sights on developing new compounds to target this signaling hub. The next steps include identifying better compounds to target the RSK2 protein and testing them in pre-clinical models.

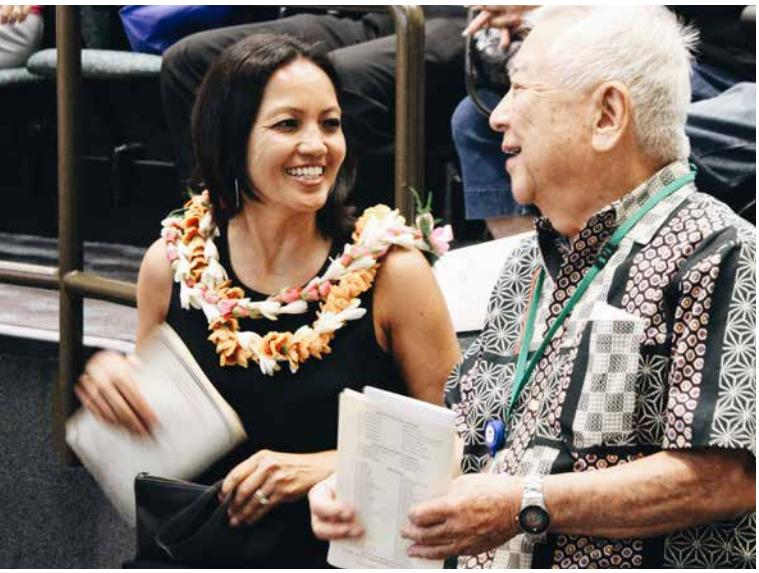
"This research can potentially lead to a new class of drugs to treat not only brain cancers, but other invasive cancers as well," said UH Cancer Center Director Randall Holcombe. "With about 60 new cases of brain cancer diagnosed every year in Hawai'i, and about 40 deaths, an effective treatment can help many patients in our state."

One of the most stark and sobering cancer statistics is that more than 90 percent of deaths from the disease are the result of metastasis, a process by which the cancer cells spread from the original tumor to migrate through the body to colonize and destroy other organs.

Native Hawaiian Center of Excellence

CREATING PATHWAYS FOR FUTURE NATIVE HAWAIIAN PHYSICIANS

Currently, Native Hawaiian and Other Pacific Islanders (NHOPI) comprise approximately 25 percent of Hawai'i's population, but make up only 3.7 percent of the state's total physician workforce.



Despite Hawai'i being ranked as one of the healthiest states in the nation, significant disparities exist for Native Hawaiians who struggle with poor health outcomes related to diabetes, cancer, obesity and other chronic health conditions. Native Hawaiians are also more likely to be homeless, incarcerated and uninsured while suffering from higher mortality rates and shorter lifespans when compared to the general population.

Native Hawaiians trace their origins to skilled Polynesian voyagers and scientists who navigated across the vast Pacific Ocean approximately 1,500 years ago to Hawai'i using only the stars. Prior to Captain James Cook's arrival in 1778, the native population was a robust 500,000 strong. However, isolation and lack of immunity left Native Hawaiians vulnerable to diseases such as measles and influenza — and by 1893, the population had decreased by 90 percent. The overthrow of the Hawaiian monarchy and subsequent annexation by the United States brought the Hawaiian people, culture and language to the verge of extinction. This history of cultural trauma and rapid social change is believed to be a significant contributor to the current health and socioeconomic disparities experienced by Native Hawaiians.

To address these disparities, the Native Hawaiian Center of Excellence (NHCOE) was established more than 25 years ago and remains a key diversity program of the John A. Burns School of Medicine (JABSOM) at the University of Hawai'i at Mānoa (UH Mānoa). With the charge of improving the health of Native Hawaiians through education, research, and community partnerships, NHCOE is located in a unique clinical department dedicated to the health of an indigenous people — the Department of Native Hawaiian Health (DNHH).

In 2017, NHCOE secured a five-year, $3.5 million dollar renewal grant from the U.S. Department of Health and Human Services, Health Resources and Services Administration, Bureau of Health Professions. The funding is used to increase the number of Native Hawaiians in medicine and allows expansion of recruitment, educational opportunities, and retention initiatives and exposure to health careers and physician role models for K-12 and college-level students. Additionally, NHCOE remains the lead unit for cultural competency training of all JABSOM medical students and faculty development initiatives under DNHH.

"Native Hawaiians are highly underrepresented in the health professions, particularly in medicine," says Dr. Winona Mesiona Lee, principal investigator of NHCOE. "We must grow our own healers by improving recruitment and retention of local students who are committed to serving their home communities."

Currently, Native Hawaiian and Other Pacific Islanders (NHOPI) comprise approximately 25 percent of Hawai'i's population, but make up only 3.7 percent of the state's total physician workforce. With pioneering efforts of former NHCOE directors, Drs. Benjamin Young and Nanette Judd, as well as critical partnerships that include 'Ahahui O Nā Kauka — Association of Native Hawaiian Physicians, Kīpuka-Native Hawaiian Student Center at the University of Hawai'i Hilo, Office of Student Equity, Excellence, and Diversity at the UH Mānoa, Nā Pua No'eau — Center for Gifted and Talented Native Hawaiian Children, Papa Ola Lokahi — Native Hawaiian Serving Organization and Scholarship Program, and the Myron B. Thompson School of Social Work at the UH Mānoa, NHCOE has created sustainable pipeline programs for Native Hawaiian students who demonstrate a desire to become physicians.

The NHCOE Native Hawaiian Student Pathway to Medicine (NHSPM) program has mentored over 100 students and 60 percent of those who have applied have been accepted to JABSOM and other medical schools across the nation. Students receive guidance on preparing medical school applications, mock interview practice and financial assistance to support preparation for the Medical College

FACING PAGE: Dr. Winona Mesiona Lee, NHCOE principal investigator with Dr. Satoru Izutsu, longtime diversity advocate and former vice dean of JABSOM

TOP: Dr. Alyssa Honda, JABSOM Class of 2017 being cloaked by Native Hawaiian physicians Drs. Kelli-Ann Voloch and Malia Lee during the annual kīhei ceremony

BOTTOM: Former Native Hawaiian Student Pathway to Medicine student Dr. Courtney Gaddis, JABSOM Class of 2017, examines her patient during a routine health exam

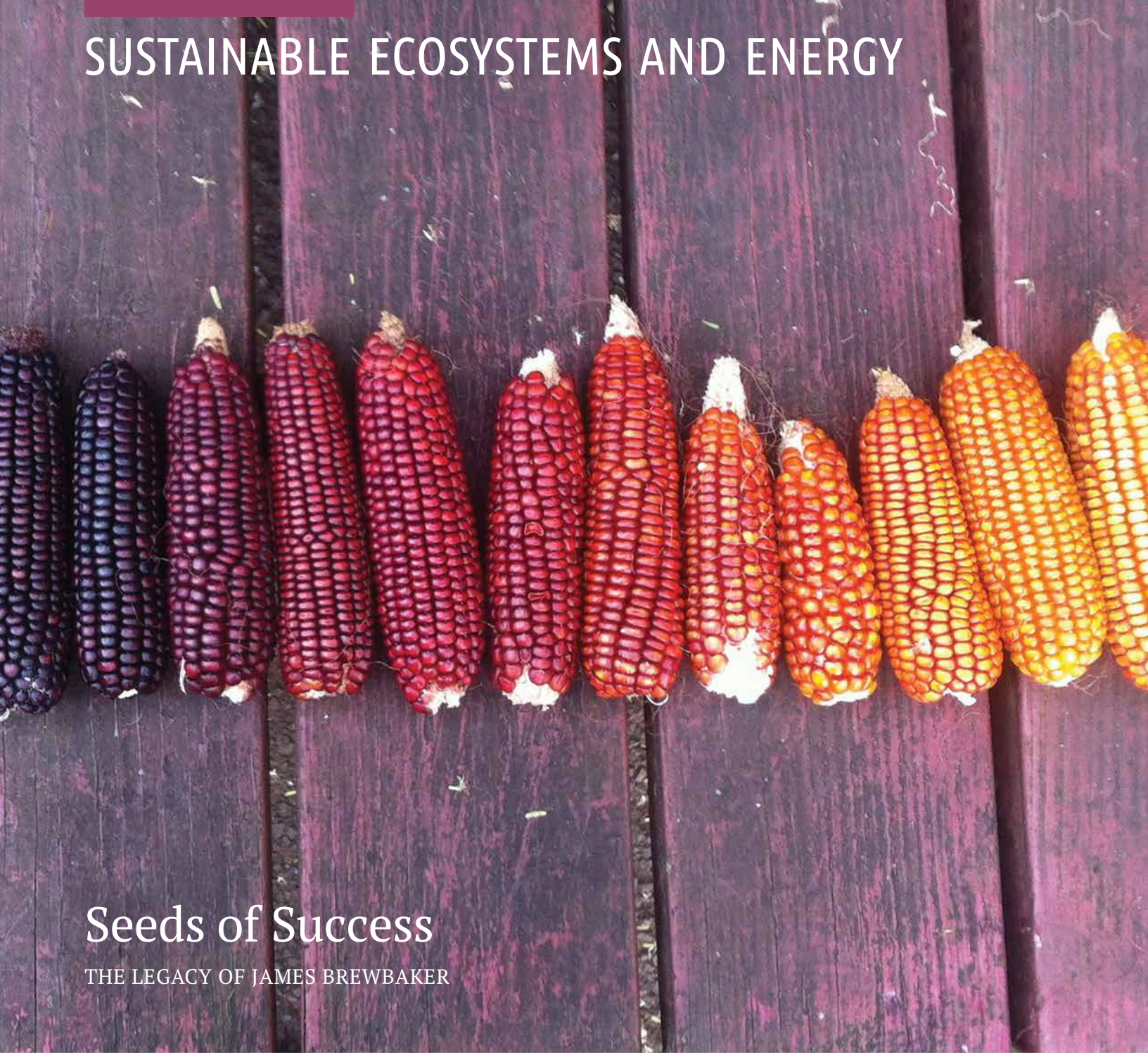
Admission Test (MCAT). While in the program, NHSPM students develop a supportive network with other pre-med students during a traditionally competitive and often overwhelming experience for most students. While participating in NHCOE's Native Hawaiian Interdisciplinary Health program, students team up with Native Hawaiian social work students to deepen their understanding of cultural empowerment within an interprofessional setting and learn how culture influences patients' perspectives on health and disease.

NHCOE has extended its reach annually to over 2,500 students spanning the K-12, undergraduate and post-baccalaureate populations with faculty and staff visits to rural areas of O'ahu and the neighbor islands to meet with prospective students who have displayed potential, but have lacked the necessary opportunities and resources. One such example is the successful Nānākuli Pathways to Health program now in its fourth year. Under the program, JABSOM students (supervised by NHCOE faculty) provide health presentations and mentor 7-12th graders who are interested in science and/or health careers. This innovative and collaborative partnership between NHCOE, Nānākuli High and Intermediate School, Kamehameha Schools, and the James and Abigail Campbell Family Foundation helps to further strengthen NHCOE's efforts to inspire students to pursue higher education and health careers.

Additionally, NHCOE has also established a research training pipeline focused on native health disparities for six undergraduate Native Hawaiian students, 28 JABSOM medical students and four Native Hawaiian research fellows. Faculty from NHCOE have published numerous peer review articles and the center has co-sponsored three national conferences including the National Association of Medical Minority Educators. Through the Summer Research Internship program at the DNHH, undergraduate students receive a stipend from NHCOE during a 7-week experience that pairs students with a research mentor and provides them first-hand experiences in health disparities research.

"The continuing success of our Native Hawaiian Center of Excellence and other related programs are vital to empowering our underrepresented groups to pursue careers in medicine. The NHCOE also serves as a vehicle to motivate these individuals to return to their communities as a physician to address the existing health disparities," said Jerris Hedges, dean of JABSOM. "Given personal and family ties to rural and neighbor island communities, these physicians are helping us tackle the existing physician shortage in those communities where physicians are most critically needed."

The Native Hawaiian Center of Excellence is supported by funds from the Bureau of Health Professions (BHPr), Health Resources and Services Administration (HRSA), Department of Health and Human Services (DHHS) under grant number D34HP16044. This information or content and conclusions should not be construed as the official position or policy of, nor should any endorsements be inferred by the BHPr, HRSA, DHHS or the U.S. Government.



Seeds of Success

THE LEGACY OF JAMES BREWBAKER

In today's world of bistros and gastropubs, the biggest decision a diner might face is what tapas to order next. However, in other parts of the world the decision is unfortunately much simpler—food or no food. This option never sat well for horticulturalist and crop geneticist Dr. James Brewbaker, who retired in 2015 from the College of Tropical Agriculture and Human Resources (CTAHR) at the University of Hawai'i at Mānoa (UH Mānoa) after a stellar 63-year career — 54 of them at UH.

"As a typical plant breeder, I'm always optimistic about the future but pragmatic about what has been achieved," said Brewbaker, emeritus professor in CTAHR's Department of Tropical Plant and Soil Sciences. "It's never quite enough in a world of seven billion where two billion are hungry."

It was at an early age that Brewbaker recognized the potential for feeding the large and undernourished populations of the world with corn from his father Dr. Harvey Brewbaker, a noted sugar beet breeder and seedsman, who had a deep interest in early American civilizations and their dependence on corn as the most important food source. Later, Brewbaker would continue his father's interest with his own significant publication in 1979 that detailed the role of corn diseases in the collapses of the Maya, Anasazi and Teotihuacan civilizations a millennium ago.

Over the years, Brewbaker's growing interest and passion in crop development brought him to the University of Colorado for his BS, to Cornell University for his PhD, and later to the California Institute of Technology, where he worked in the team under Nobel

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LEFT: The many different varieties of corn developed by Dr. Brewbaker and his team

RIGHT: Dr. James Brewbaker at UH's Waimanalo Research Station

laureate geneticist George Beadle. Later he conducted postdoctoral studies in Sweden and then at the University of the Philippines in Los Baños, where he joined a team proved that corn could be grown at least three times a year in single tropical fields — as opposed to the single crop in temperate climates. He also became familiar with tropical legume trees like Hawai'i's koa and koa haole that could provide valuable fixed nitrogen for hungry crops like corn.

In 1961, Brewbaker packed up his family of four and left for Hawai'i to join UH Mānoa's Department of Horticulture (as it was known prior to CTAHR), who sought out his expertise to aid local corn farmers seeking a solution to a maize mosaic disease that had wiped out O'ahu's sweet corn production. Operating largely out of the university's Waimanalo Research Station, a place that became his favorite working office for the next 54 years, Brewbaker's team developed disease resistant and commercially viable varieties. Among these, "Hawaiian Supersweet #9," went worldwide and now undergirds vegetable corn industries in countries such as Thailand — the world's largest producer of canned corn. Today, many of Brewbaker's hybrids can be found across Hawai'i and internationally, including the well-known "Kahuku Sweet Corn," all of them noted for resistance to often-unique tropical diseases and insects. His Waimanalo fields were maintained for more than 50 years without pesticides other than for weed control.

While away from his Waimanalo research field, Brewbaker managed to find time to create Hawai'i Foundation Seeds in 1977, a UH-sponsored organization which manages collections of parent seed stocks for research and commercial use, as well as providing seed samples and education to the community. He was also instrumental in founding the Hawai'i Crop Improvement Association in 1970 to assist the seed industry that accounts for one-third of the state's agricultural industry.

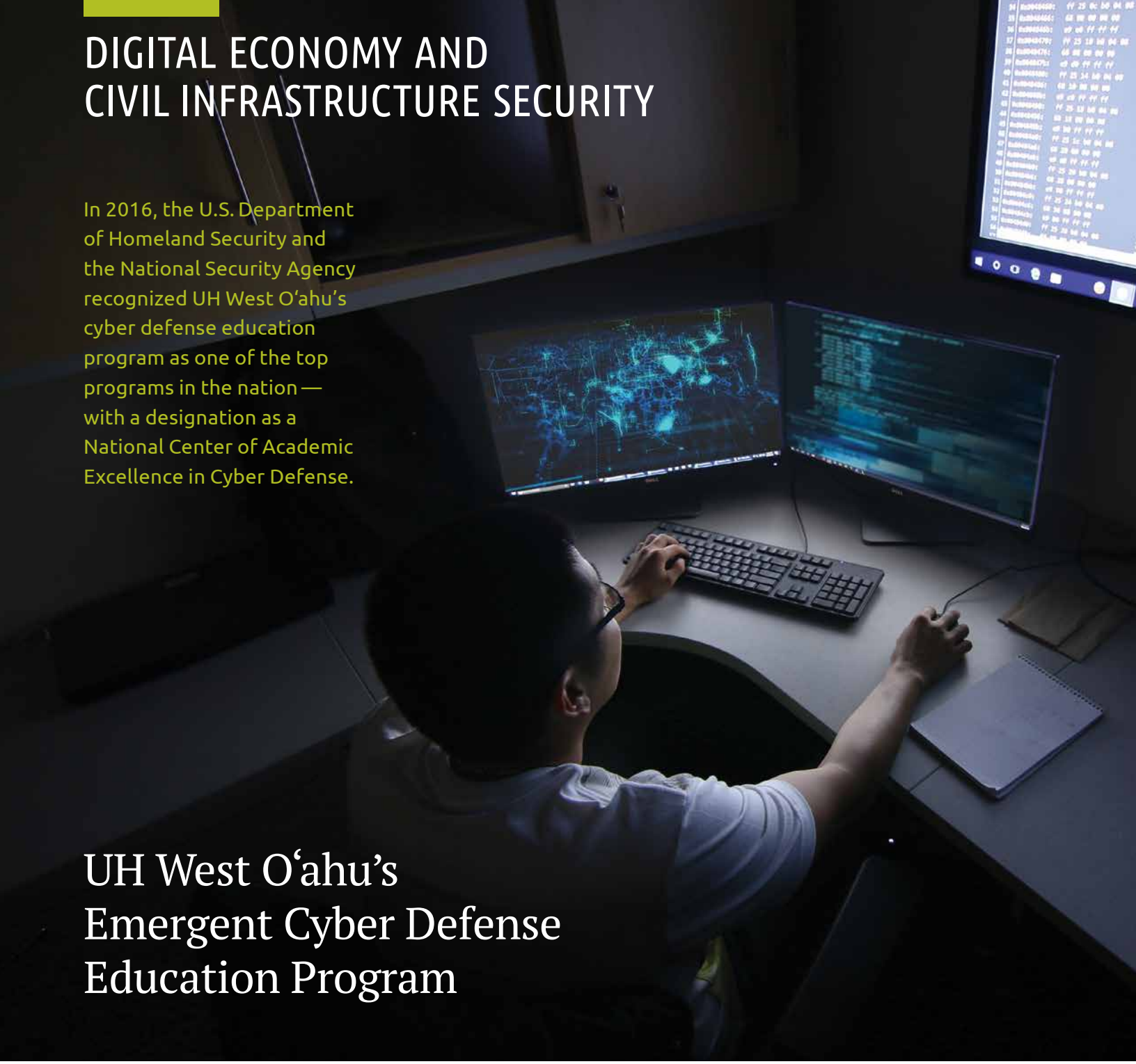
Brewbaker has received numerous awards and accolades from major plant breeding organizations, including the 2013 Crop Science Society of America Presidential Award that recognized his outstanding contributions to crop science through education, national and international service, and research. A prolific writer, he has authored more than 280 publications, including Agricultural Genetics, which was translated into seven languages. Many of these reflect the research of his 52 "wonderful" grad students, half of them having completed PhDs in corn or tree breeding. "Plant breeding is a wonderfully optimistic science because you do sometimes make these contributions," added Brewbaker.

As if his many contributions were not enough, Brewbaker donated $1 million in the same year, to establish The James L. Brewbaker Endowed Fellowship to assist full-time graduate students studying plant breeding at CTAHR to continue his remarkable legacy.

"Jim is known as the "King of Corn" in the Asia/Pacific region where his research has advanced science and touched the lives of millions of people," said Dr. Sylvia Yuen, executive director of RCUH, who served as interim dean of CTAHR. "By supporting graduate students, his endowment to CTAHR leaves a living legacy which ensures his important work continues into the future."

DIGITAL ECONOMY AND CIVIL INFRASTRUCTURE SECURITY

In 2016, the U.S. Department of Homeland Security and the National Security Agency recognized UH West O‘ahu’s cyber defense education program as one of the top programs in the nation — with a designation as a National Center of Academic Excellence in Cyber Defense.

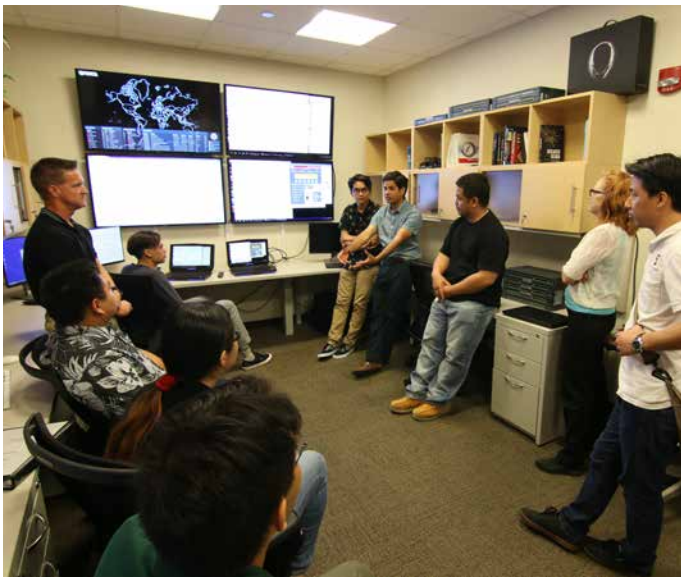


UH West O‘ahu’s Emergent Cyber Defense Education Program

According to the U.S. Department of Homeland Security, nearly one in five Americans have been a victim of a cybercrime — resulting in more than $15.4 million in annual losses for the average U.S. firm. As a result of this troubling trend, the U.S. Department of Labor estimates that the number of information security analysts and computer network architects will grow by 18 percent and nine percent respectively from 2014 to 2024 — ranking well above the national average of seven percent for all other jobs.

In response to this growing threat and to make sure that undergraduates in Hawai‘i have an opportunity and the necessary skills to compete in the rapidly expanding area of cyberspace operations, the University of Hawai‘i at West O‘ahu (UH West O‘ahu) developed its Bachelor of Applied Science degree with a concentration in Information Security and Assurance (BAS-ISA).

The BAS-ISA, a first-of-its-kind program at a public institution in Hawai‘i, offers courses in digital forensics, secure software programming and information security management, among others, in partnership with the UH Community Colleges. The concentration on ISA offers both a four-year program at UH West O‘ahu and transfer pathways for University of Hawai‘i Community College students who have completed articulated Associate of Science (AS) or Associate of Applied Science (AAS) degrees. Enrollment in the program has grown steadily from 13 students in 2014 to 108 students in the 2018 academic year under the guidance of Dr. Matthew Chapman,



LEFT: Students discuss emerging cyber threats in the Cyber Security Coordination Center at UH West O'ahu

RIGHT: Dr. Matthew Chapman

associate professor of Information Technology and Cybersecurity.

Chapman, an experienced computer scientist, served for more than 24 years as an officer in the U.S. Army in a number of varied positions nationally and internationally, including combat and operational deployments in Europe, the Middle East and Asia. Prior to joining UH West O'ahu, Chapman served as the chief of cyberspace operations at the U.S. Pacific Command and the branch chief for command, control, communications, and cyberspace strategy and architecture.

One of the key elements of Chapman's program revolves around the UH West O'ahu's Cyber Security Coordination Center (CSCC), established though the support of the Office of Naval Research, to further promote cyber workforce development.

"The purpose of the UH West O'ahu Cyber Security Coordination Center is to provide students with an opportunity to work in a cyber operations center and coordinate cyber defense information with local and regional partners," said Chapman, who also serves as the faculty lead and director of the center. "This center provides students with experience and education as network defense subject matter experts in order to prepare them for future employment in industry or the Department of Defense."

The CSCC also supports information security needs in the community and region by acting as a resource to learn about modern cyber conflicts, emerging threats and the latest development in information security. Student internship positions include: global cyber analyst, vulnerabilities researcher, best practices analyst, digital forensics analyst, and industrial control systems cybersecurity analyst. Actual reports compiled by the student analysts are available to the public at www.uhwo.hawaii.edu/cyber. Chapman added that the reports offer a way of keeping current on cyberattacks around the world and learning the best practices on avoiding or coping with the dangers.

In 2016, the U.S. Department of Homeland Security and the National Security Agency recognized UH West O'ahu's cyber defense education program as one of the top programs in the nation — with a designation as a National Center of Academic Excellence in Cyber Defense.

To qualify, two- and four-year accredited colleges must submit cyber defense curriculum and demonstrate achievement in areas including, program outreach and collaboration, student development and research initiatives. The program was established by the NSA to formally recognize schools deemed to have high-quality cybersecurity academics in response to a need for more professionals to protect public and private sector networks. Earlier, the University of Hawai'i at Mānoa earned national designation for its research in cyber defense, while Honolulu Community College received its designation for its educational program as a two-year campus. The designations are valid for five years.

"All of our campuses participate in cyber defense education," said Chapman. "We try not to duplicate capabilities among the UH System campuses — so cyber defense education is primarily centered around what we do at UH West O'ahu."

The success of the UH West O'ahu program has been demonstrated by both employment opportunities for students and graduates, including: American Savings Bank, Aulani — A Disney Resort & Spa, BAE Systems, Booz Allen Hamilton, Elemental Excelerator, Four Seasons Ko Olina, Hawaii USA Federal Credit Union, Hawaiian Airlines, Hawaiian Telcom, Hilton Worldwide, Lockheed Martin, National Security Agency, Pacxa, Protiviti, Referentia Systems Inc., Spectrum, TEKsystems, Unisys, U.S. Department of Homeland Security (DHS) Cybersecurity and ZR Systems.

Chapman's program has also garnered national attention by top performances in national cyber competitions, specifically the National Cyber League (NCL) — taking home the national championship in 2016 and a runner up finish the following year.

"The BAS-ISA program has become one of our signature programs," said UH West O'ahu Chancellor Maenette Benham. "Our program not only fulfills an urgent workforce need in the cybersecurity arena, but it also provides all of our students, including Native Hawaiian and other underserved groups in our West O'ahu community, with an opportunity for a rewarding and meaningful career in a growing and exciting field."

"Barry is a true visionary and was onboard early to support the establishment of an innovation-based ecosystem in Hawai'i driven by UH intellectual property and technology," said UH President David Lassner. "For over a decade now, he remains the biggest proponent of our faculty researchers and their IP."

Barry Weinman

UH'S INNOVATION AND COMMERCIALIZATION ARCHITECT

Since the decline of agriculture in Hawai'i, the economy has become increasingly dependent on the tourism sector and on military spending. However, this dependency has left Hawai'i vulnerable to uncertain fluctuations in world events and at the mercy of equally uncertain military policy and budget decisions emerging from Washington, D.C.— mirroring a similar situation San Diego faced in the 1960s. However, by bringing together the private sector, government and academia, and by leveraging UC San Diego research in the 1980s, the city was able to create a thriving tech-based economy that has produced a gross domestic product that currently hovers around $221 billion — of which about 25 percent is attributed to its research and technology industries. Comparatively, Hawai'i's related industries account for only about three percent of the economy.

So when the University of Hawai'i (UH) began to engage in efforts to bring about a similar change to the islands, venture capitalist Barry Weinman was one of a number of distinguished experts assembled to craft an innovation roadmap — with a goal to help diversify the state's economy by building a thriving

$1 billion innovation, research, education and training enterprise by 2025. The effort became known as the Hawai'i Innovation Initiative.

For those familiar with UH, Barry Weinman's name is mostly synonymous with philanthropy and an unmatched generosity of giving his time to help the university to reach its full potential. Over the years, Weinman and his wife Virginia have donated millions of dollars to UH through various fellowships, endowed chairs and funds to benefit UH Mānoa programs at the John A. Burns School of Medicine, UH Cancer Center, Shidler College of Business and UH athletics.

However, his greatest legacy to UH may have gone relatively unnoticed except to the most astute university supporter or those closely associated with UH research — for his role as an early champion of using UH intellectual property and technology to spur innovation to benefit Hawai'i by advancing the quality of life, healthcare, economic prosperity and other significant areas.

Weinman knew a thing or two about the subject since he had been making venture capital investments in the Silicon Valley area since the 1980s and was a co-founder and managing director of Allegis Capital, a $700 million venture capital firm specializing in incubation, growth capital and early stage startup investment. As a part-time Hawai'i resident, Weinman also shared the same concerns about the state's current economy.

"Barry is a true visionary and was onboard early to support the establishment of an innovation-based ecosystem in Hawai'i driven by UH intellectual property and technology," said UH President David Lassner. "For over a decade now, he remains the biggest proponent of our faculty researchers and their IP."

Much of Weinman's suggestions became the blueprint for the initiative. Under the leadership of UH Vice President for Research and Innovation Vassilis L. Syrmos, the university has been steadily implementing the necessary changes, including the hiring of researchers with an acumen for innovation and entrepreneurship, revising and updating of outdated patent, copyright and IP policies, redefining the mission of the university's commercialization offices and the completion of an office reorganization to better support faculty inventors and streamline commercialization efforts throughout UH's ten campus system.

Through his Silicon Valley investing experience and as managing director of the UH Foundation's Upside Fund I and II, a small seed venture capital fund that invests in UH research with commercial potential, Weinman also encouraged UH to create an accelerator, an entity that provides advice and resources to aspiring businesses, specifically designed for its faculty, student and alumni to bring their innovative research successfully to market.

Heeding to his advice, in September 2015, UH launched XLR8UH, a four-month startup program that works with UH-affiliated entrepreneurial teams to offer office hours, weekly workshops, presentations and lectures conducted by noted business, technology and startup experts, with up to a $175,000 investment from UH for eligible teams. Since that time, XLR8UH with Weinman as board member, has mentored, educated, and inspired more than 40 startup ventures with 24 matriculating out of the program — generating, in total more than $5 million in revenue, and raising more than $30 million in funding.

"As a strong proponent of UH research, Barry was familiar with the university's existing strengths in astronomy, healthcare, ocean science and energy," said XLR8UH Managing Director Omar Sultan. "He was confident that UH could take advantage of these distinctive strengths to create innovative solutions that could yield significant commercial value in the marketplace."

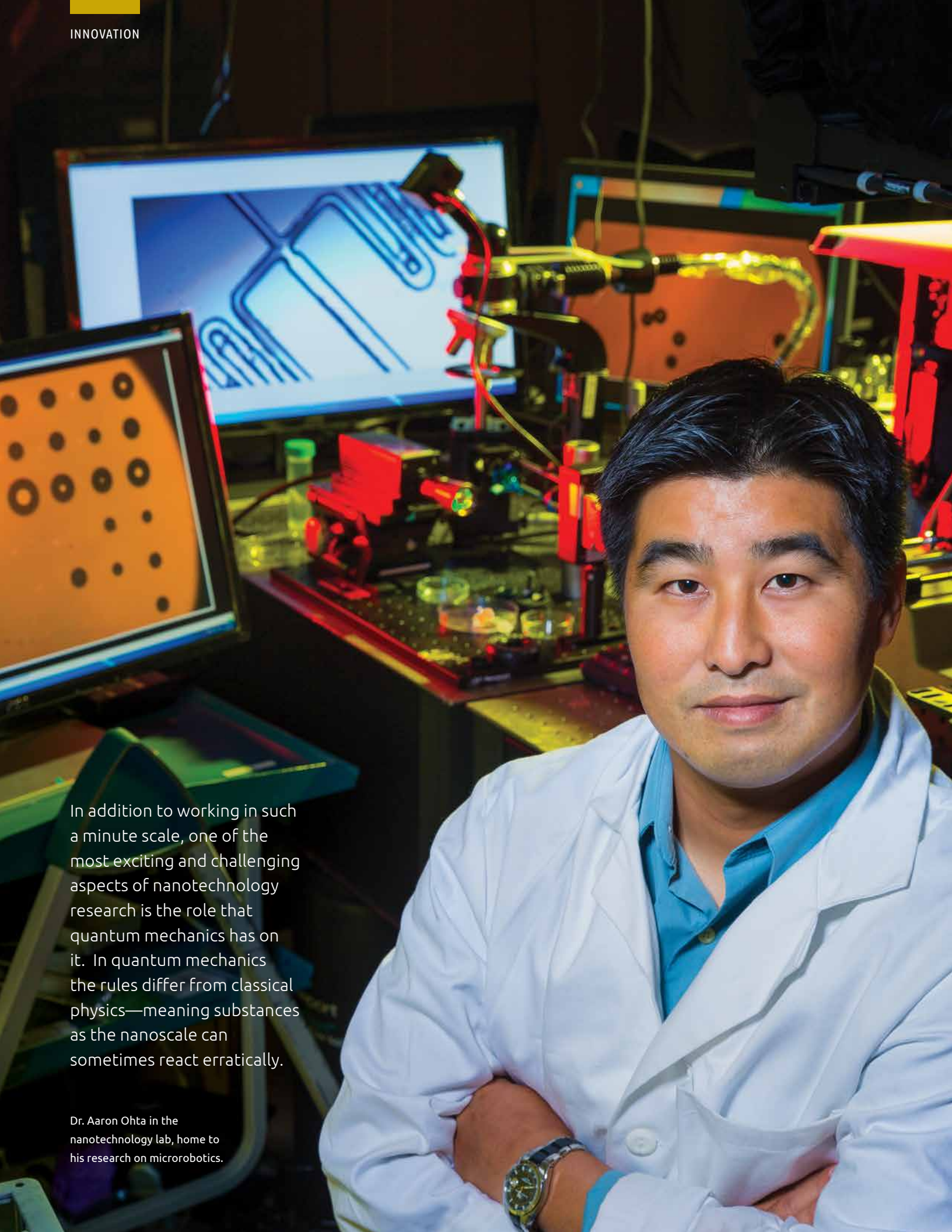
One of XLR8UH's most successful graduates is KenetiCor and its MRI motion correction technology developed by Professor Thomas Ernst formerly of UH Mānoa's John A. Burns School of Medicine and his colleagues from other research institutions. So impressed by KinetiCor game-changing potential in the medical field, Weinman now serves as the company's chairman.

In what might be considered his most valuable contribution to UH innovation, Weinman was the first to recognize that existing statutes covering UH's tech transfer and commercialization activities needed to be removed before the Hawai'i Innovation Initiative could truly be successful. After three years of determined effort by UH and the Hawai'i business and innovation community, the Hawai'i State Legislature finally passed two legislative measures to eliminate these restrictions, which was signed into law by Governor David Ige on June 19, 2017.

"In more ways than one, these two innovation bills could be considered as Barry Weinman's bills," said Syrmos. "We are fortunate to have been a benefactor of his sage advice and we can attribute much of the current and future success of the commercialization of UH research and the Hawai'i Innovation Initiative to him."

TOP: Barry Weinman and UH Vice President for Research and Innovation Vassilis L. Syrmos

BOTTOM: Weinman, shaking hands with UH President David Lassner, is honored at the 2017 UH Foundation Celebration of Philanthropy event at the Culinary Institute of the Pacific. UH Foundation Board Member Mike May, left, and JABSOM Dean Jerris Hedges proudly look on.



In addition to working in such a minute scale, one of the most exciting and challenging aspects of nanotechnology research is the role that quantum mechanics has on it. In quantum mechanics the rules differ from classical physics—meaning substances as the nanoscale can sometimes react erratically.

Dr. Aaron Ohta in the nanotechnology lab, home to his research on microrobotics.

Small Wonders… Huge Possibilities

NANOTECHNOLOGY RESEARCH IN ELECTRICAL ENGINEERING

For most people, their understanding of microtechnology and nanotechnology have come mostly from television commercials using these terms as catchy buzzwords or phrases to market products, such as "…featuring microbead technology…" or "…now with nanoparticles!" While it definitely sells products, what exactly is nanotechnology?

"Nanotechnology is the science, technology and engineering study of substances at the nanoscale—in which one nanometer is equivalent to one-billionth of a meter," said Electrical Engineering Professor Aaron Ohta of the University of Hawai'i at Mānoa (UH Mānoa) College of Engineering. "It involves the ability to see and control individual atoms and molecules in the range of one to 100 nanometers."

Even with Ohta's description, it still may be difficult to imagine the minute scale involved is this research, so here a few examples:

- A strand of human DNA = 2.5 nanometers in diameter
- A strand of human hair = 80,000 – 100,000 nanometers in diameter
- An inch = 25,400,000 nanometers

In addition to working in such a minute scale, one of the most exciting and challenging aspects of nanotechnology research is the role that quantum mechanics has on it. In quantum mechanics the rules differ from classical physics — meaning substances as the nanoscale can sometimes react erratically. Melting points can change, substances that act as insulators could become semiconductors and electrons can pass through as solid wall.

As a result, scientists are experimenting with substances at the nanoscale to learn more about their properties and how to take advantage of them. Ohta and his electrical engineering colleagues at the UH Mānoa College of Engineering are exploring new types of micro- and nanotechnology that can be used to improve the quality of life in the state and across the world.

Microrobotics

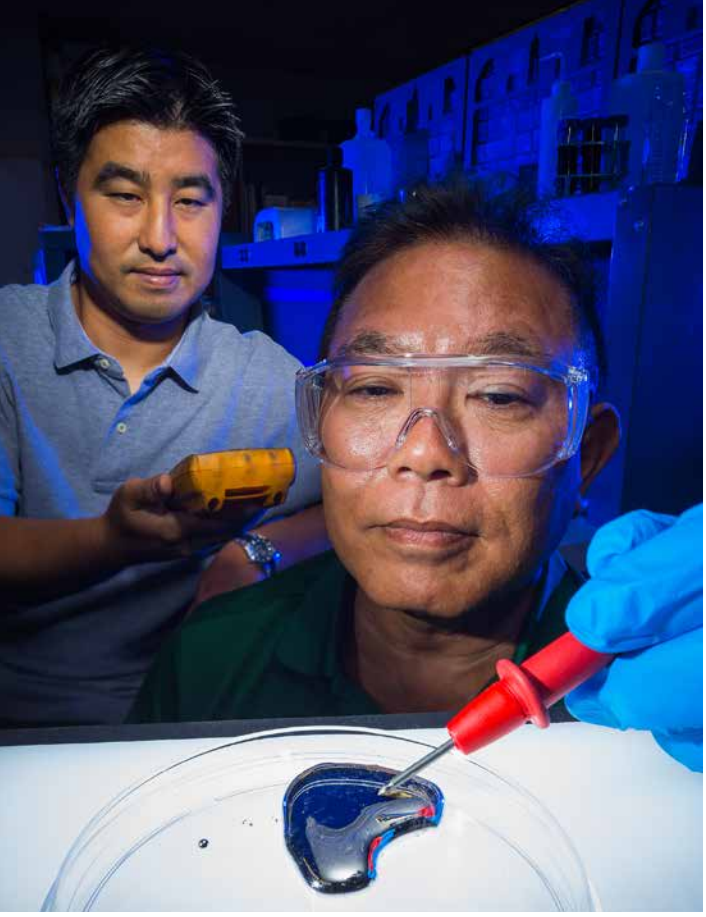
In the 1966 science fiction movie *Fantastic Voyage,* a medical team aboard a miniaturized submarine was injected into a patient to seek out and destroy a deadly blood clot. While it appeared on the silver screen a bit before this time, it seems Aaron Ohta could have written the movie's script.

That's because one research area he leads uses lasers to control microscopic bubbles in a tiny amount of liquid. In this system, these bubbles can act like tiny robots and are able to move around microscopic objects, such as living cells. Ohta's research, sponsored by the National Institutes of Health, provides a useful tool for biomedical research. It can also potentially lead to the creation of tissues and organs in the lab, assembled by these micro-sized bubble robots.

"This can help fundamental research on cell behavior, which could lead to improved disease diagnoses and therapies, said Ohta. "The capabilities of this micro-robot system could also be used to help improve the expensive, time-consuming process of discovering and testing new drugs."

Liquid metals

Professor Wayne Shiroma and Ohta are conducting collaborative micro- and nanotechnology research on liquid metals to create advanced reconfigurable electronic circuits, which can change their physical shape to adapt to a specific application. These reconfigurable circuits are being used to enable advanced communication systems that promise faster, more reliable and more secure wireless communications. This is important for many applications, including increased deployment of broadband Internet access, especially to remote or rural areas. Adaptability is another important feature, as it can adjust to congestion during peak usage times, and more importantly — help a system damaged by natural disasters or cyberattacks to remain usable.



Liquid metals can be used to make the reconfigurable circuits needed to realize these adaptable communication systems. Instead of toxic mercury, the liquid metal that most people are familiar with, they are using a more environmentally friendly liquid metal alloy, developed as a non-toxic replacement for mercury in thermometers.

"The liquid metal can be used in the circuit equivalent to the "liquid-metal" Terminator from the movie *Terminator 2,* which could change its shape for different situations." said Shiroma. "No killer robots will be created, but these adaptable circuits could allow future wireless electronics to communicate faster and more efficiently."

Nanofluidic Membranes for Drug Delivery

In today's modern warfare, guided munitions — better known as "smart weapons," have been developed to improve accuracy and lessen the impact of civilian collateral damage. Similarly, in the fight against disease and illness, researchers are looking for ways to deliver drug therapies "on target" to only the affected areas of the body, while maintaining the necessary dosage level and limiting unnecessary exposure of the drug to the rest of the body.

Associate Professor Jeffrey Weldon is working to create an ultra-low power, electrically controlled smart drug delivery device that could be used for a wide variety of drug-delivery applications using nanoporous materials.

At the nanometer size scale, fluid flow behaves differently than conventional fluidic channels. The drug molecules interact much more closely with the nanofluidic channel walls, opening the possibility to control the flow by modifying the channel wall. Chemical modification has been proposed as a means of controlling flow, but this offers no external control.

"In our work, we have designed unique nanochannels that enable control the electric potential in the channel," said Weldon. "This effect, combined with the fact that vast majority of drug molecules are charged, allows for regulation of the fluidic flow with an external voltage."

To do so, Weldon and his team fabricated a customized nanofluidic membrane that comprises of large number of nanofluidic channels acting in parallel. The use of a membrane structure allows for high overall flow with external electrical control, well suited for smart drug-delivery applications.

In the near future, a nanoparticle could encapsulate or otherwise help to deliver medication directly to cancer cells and minimize the risk of damage to healthy tissue — an application that has potential to change the way doctors treat cancer and dramatically reduce the toxic effects of chemotherapy.

LEFT: Dr. Wayne Shiroma reconfigures a sample of liquid metal, as Dr. Aaron Ohta assists.

RIGHT: Dr. Jeffrey Weldon views his research on nanofluidic membranes using the FEI Helios 660 FIB-SEM in the Advanced Electron Microscopy Center at UH www.soest.hawaii.edu/AEMC/

UH Innovation Efforts Receive a Boost

The Hawai'i Innovation Initiative, one of four priorities set forth in the *University of Hawai'i Strategic Directions, 2015-2021,* is a collaborative effort between University of Hawai'i and the Hawai'i business community to build a thriving innovation, research, education and training enterprise-based on UH research, to help grow a third major economic sector to create high-quality, living wage-jobs in the state.

Despite making strides in creating the necessary infrastructure at UH and conducting successful educational outreach efforts to constituents in the Hawai'i business and innovation community, the initiative remained hampered by existing state statues that limited UH's ability to participate in technology transfer and commercialization activities.

As a direct result of efforts led by UH and the Hawaii Business Roundtable (HBR) to familiarize and educate the Hawai'i State Legislature on the subject, these restrictions were finally lifted on June 19, 2017—as Hawai'i Governor David Ige signed into law two legislative measures to facilitate the transformation of discoveries and inventions generated by UH research into commercially viable enterprises to help broaden workforce opportunities and diversify the state's economy.

"These new laws bring the University of Hawai'i a step closer to realizing its full potential to contribute to the state and the public," said UH Vice President for Research and Innovation Vassilis L. Syrmos. "Additionally, it allows us to keep pace with peer research institutions and to maintain our competitiveness in attracting research sponsors and research talent."

The first measure, Act 38 (now HRS 304A-121), exempts technology transfer activities conducted by the University of Hawai'i from the scope of certain sections of the State Ethics Code, and confers the regulatory and oversight responsibilities for such technology transfer activities to UH. Previously, the State Ethics Commission determined whether public-private technology transfer arrangements were permissible or prohibited under general ethic principles.

The second measure, Act 39 (now HRS 304A-1959), provides broad statutory authority to the University of Hawai'i to engage in activities to support UH-based startup companies. These activities include participating financially directly or indirectly in start-ups, providing strategic marketing and networking resources, and offering hands on instruction and mentoring to the new entrepreneurs. Under its provisions, UH is also given more express authority for certain programs that are currently underway, such as the XLR8UH accelerator, and is patterned after a similar law for the State of Hawai'i Department of Business, Economic Development and Tourism.

"The Hawai'i business community believes that the commercialization of intellectual property created by basic and applied research conducted at UH yields great promise in job creation and economic growth in the islands," said HBR Executive Director Gary Kai. "Hawai'i is now one step closer to developing a successful innovation ecosystem based on UH research — a path similar to what UC San Diego research did to dynamically transform their economy."

ABOVE, L-R: UH Regent Brandon Marc Higa, HBR Exec. Director Gary Kai, UH Regent Chair Jan Sullivan, Rep. Jarrett Keohokalole, UH VP for Research and Innovation Vassilis Syrmos, Gov. David Ige, XLR8UH Managing Partner Omar Sultan, UH President David Lassner, XLR8UH Prog. Assoc. Kate Poljakova, XLR8UH Managing Partner Tarik Sultan, HVCA President Meli James, UH Corp. Counsel Presley Pang

Star Trek Technology Becomes a Medical Reality at UH

Imagine a human heart or skull being examined in a virtual 3D environment in a doctor's office or hospital room. While one might expect to see Dr. Leonard McCoy carrying out this analysis in the sickbay aboard the U.S.S. Enterprise in *Star Trek,* this augmented or virtual reality (AR/VR) technology is actually available today from Radial3D, Inc., a University of Hawai'i-based spinoff company. The company, with deep roots at the John A. Burns School of Medicine (JABSOM), is building a website for doctors to diagnose diseases using magnetic resonance imaging (MRI) or computed tomography (CT) scans in a 3D mixed AR/VR environment to give doctors, patients and researchers a new and exciting way to view medical images in "eye popping" detail and clarity on a computer or mobile device.

Radial3D was initiated by Dr. Scott Lozanoff in JABSOM's Department of Anatomy, Biochemistry & Physiology. Existing 3D medical imaging software is not very user-friendly and Lozanoff and his team set out to create an agile web-based system for disease diagnosis and treatment, as well as patient education, using medical images and AR/VR visualization.

"Our vision is to engender a paradigm shift in radiology through the use of a web-based, collaborative, zero-footprint VR/AR visualization system with relevant tools for remote consultation through personal electronic devices," said Lozanoff. "The mission of Radial3D is to use this new technology to increase the accuracy and speed of disease diagnosis."

The Radial3D team comprises of a talented group of young and aggressive entrepreneurs with expertise in anatomy, radiology, computer programming and graphics, hardware configurations and business development — powered by funding and business mentorship from the University of Hawai'i's accelerator program, XLR8UH, and the Pacific Asian Center for Entrepreneurship at the Shidler College of Business.

The team leader is CEO Jesse Thompson, JABSOM's technical director of anatomical imaging, who is tasked with implementing AR/VR learning in medical education as a means to improve student engagement, increase conceptualization of complex anatomical spatial relationships, and to decrease formal classroom time requirements. Evan Young, who serves as the CFO, is a serial entrepreneur who recently returned from Silicon Valley to join Radial3D after pitching for another VR startup. Co-founder McKay Davis was a computer programmer and graphics developer of Seg3D — initiated at the NIH Center for Integrative Biomedical Computing at the University of Utah. Rounding out the members of the Radial3D team are JABSOM's Dr. Ahmed Abdelkarim and Michele Tom, as well as newest member of the team — Leland Lopez, a local front-end developer, who is responsible for creating many of the web service components.

"These personal connections were facilitated through local technology and outreach organizations like the High Technology Development Corporation and HICapacity — that serve as a primary entrepreneurial networking facilitators in Hawai'i," added Lozanoff.

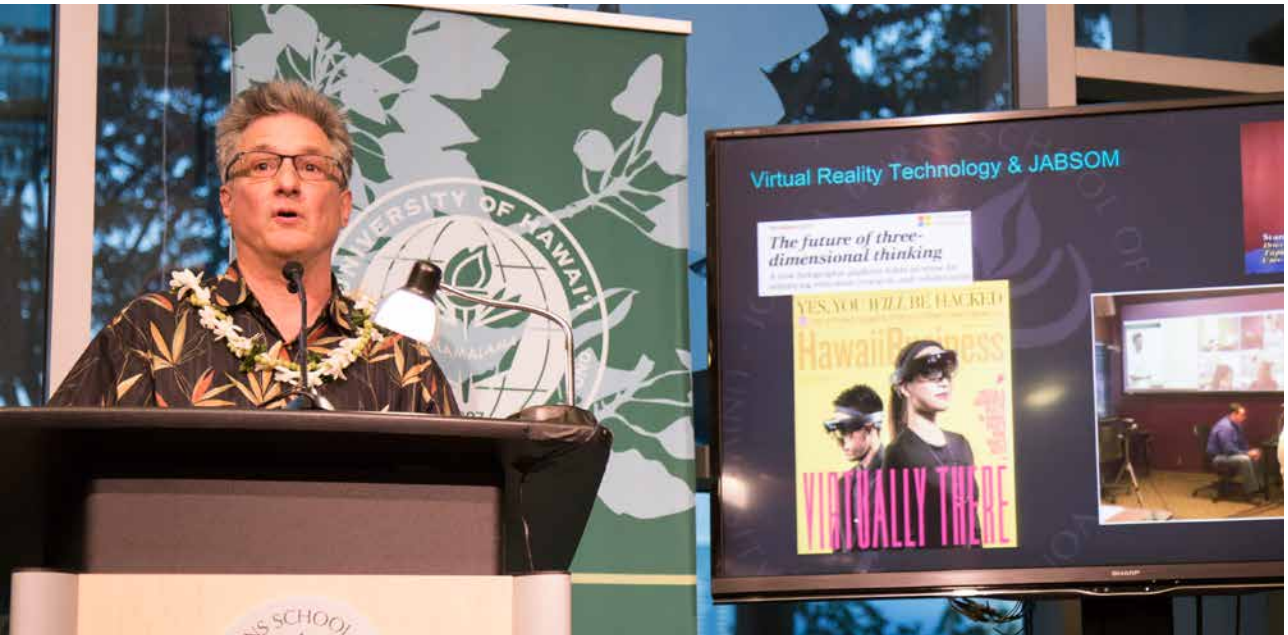
Radial3D is building support for common web devices including mobile phones, laptops and tablets and recently launched a closed-beta pilot program in collaboration with several medical and dental schools such as the University of Heidelberg, Case Western Reserve University and Bern University. Medical students at the University of Hawai'i and medical professionals can apply for closed-beta testing by enrolling in Radial3D's program at www.radial3d.com.

"Given the current and anticipated physician shortage in Hawai'i, as well as other under-served areas, Radial3D is well positioned to improve patient health care by enhancing diagnostic approaches and consultations at a distance, thereby facilitating patient access to medical expertise in remote regions throughout the world," said Jerris Hedges, dean of JABSOM.

As further testament to the confidence experts in both the medical and innovation arenas have in Radial3D, the company recently secured funding from Quake Capital, a Los Angeles-based venture capital firm that will be providing office space, mentorship and further startup support. Team members Young, Davis and Lopez will be temporarily relocating to Los Angeles to participate in the 12-week program that will put them in touch with Quake's extensive network of investors and potential acquirers in the city's sprawling tech hub.

"We are extremely pleased with our team's well-rounded effort in the prototyping, business and technical aspects that put us on the radar with Quake Capital," said Young. "This is the next step in our journey and as we continue our work to make Radial3D a successful venture — we are proud to be representing JABSOM and the University of Hawai'i at Mānoa."

"Our vision is to engender a paradigm shift in radiology through the use of a web-based, collaborative, zero-footprint VR/AR visualization system with relevant tools for remote consultation through personal electronic devices," said Lozanoff. "The mission of Radial3D is to use this new technology to increase the accuracy and speed of disease diagnosis."



LEFT: Dr. Scott Lozanoff talks about the use of virtual reality technology in medicine.
CREDIT: JABSOM

International Expert Leads New UH Innovation/ Commercialization Office into the Future

"Hawai'i has a long and proud history of diversity, which is the most important ingredient of innovation — to observe the world from a unique angle. I look forward to this unique and exciting challenge."

Buoyed by the University of Hawai'i's recent success with lawmakers to set aside restrictive statues that will now allow current and future innovation and commercialization efforts under the Hawai'i Innovation Initiative to move forward, C. David Ai's arrival to UH this March could not have come at better time. That's because Ai, director of the Office of Innovation and Commercialization, as well as chief innovation officer of the University of Hawai'i System, can truly set his sights on the management of intellectual property (IP) and UH-developed technology assets through his oversight of three inter-related entities under the aegis of the UH Office of the Vice President for Research and Innovation.

Ai heads the Office of Technology Transfer (formerly known as Office of Technology Transfer and Economic Development or OTTED), that develops, implements and manages UH's IP and technology licensing functions, including the active solicitation of invention disclosures from researchers. Ai also leads UH Ventures, a new entity that is responsible for intellectual property and technology licensing, education and the development of commercial partnerships to help drive and stimulate opportunities for economic growth. He will also work closely with the Strategic Grants Development Office, a newly created office to assist and mentor UH faculty, students and post-docs, alumni to navigate the complex development and application process associated with private research funding, including large multi-investigator grants.

"I am thrilled to join the University of Hawai'i System, and to help drive the innovation agenda with all the colleagues on 10 campuses and in research institutes under one umbrella," Ai said. "Hawai'i has a long and proud history of diversity, which is the most important ingredient of innovation — to observe the world from a unique angle. I look forward to this unique and exciting challenge."

Ai came to the University of Hawai'i from the City University of Hong Kong, where he served as director of knowledge transfer, leading the university's IP commercialization operations for the past three and a half years — concurrently leading an intense push into China's vast business and industrial world, while developing the innovation and entrepreneurship ecosystem on campus.

From 2008 to 2014, Ai served as senior IP licensing associate and licensed patent attorney for the Office of Technology Licensing at Stanford University, where he shaped the university's China strategy and spearheaded their technology transfer efforts into the country. While at Stanford, Ai also negotiated and drafted IP licenses, managed patent prosecution, marketed more than 300 inventions and served as liaison to the Stanford Linear Accelerator Center.

Additionally, he has more than 20 years of experience in various management and administrative positions within large corporations and venture companies such as vice president at NYSE-listed Varian Medical Systems and CEO at several startups, as well as chief advisor at Hitachi Corporate VC in the Silicon Valley.

Ai received his bachelor of science degree in psychology from National Taiwan University, master of science degree in computer science from Indiana University, master of business administration degree from Stanford University, and juris doctor degree from Santa Clara University. He is also a licensed patent attorney in California.

"We are very pleased and fortunate to have a person with his impressive credentials, knowledge and experience to lead the University of Hawai'i's tech transfer and commercialization efforts into the future," said UH Vice President for Research and Innovation Vassilis L. Syrmos. "In our push to become a leader of technology commercialization in the Asia-Pacific region, his stewardship of the Office of Innovation and Commercialization will be absolutely vital to that effort and to the success of the Hawai'i Innovation Initiative."

University of Hawai‘i

PHOTO CREDIT: CTAHR

UH RESEARCH

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