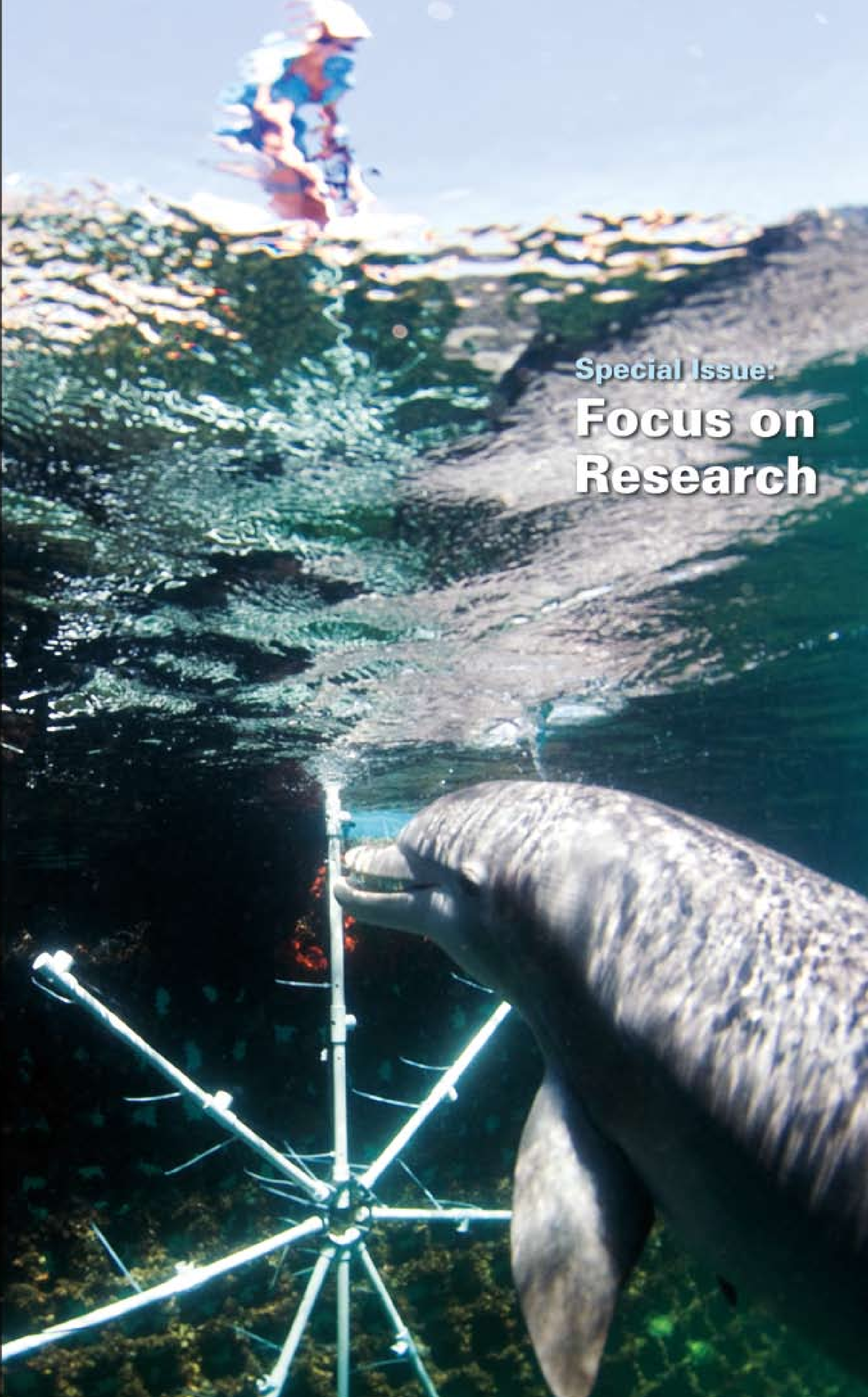
MĀLAMA

THE LIGHT OF KNOWLEDGE



Special Issue:

Focus on Research

The magazine of the University of Hawai'i

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Nature's choice: Michael Antal, center, and his team developed a flash carbonization reactor process to turn waste products into Earth-friendly charcoal for alternate fuel and soil enrichment. **See story on page 14**

Dolphins at UH Mānoa's Coconut Island, like Boris and BJ, above, and their offspring Hoʻolono, on the cover, assist Hawaiʻi Institute of Marine Biology researchers with studies on marine mammal hearing. A dolphin's round forehead is really an acoustic lens that the animal uses to focus its outgoing biosonar beam. Hoʻolono checks out an array of transducers, 16 underwater microphones that measure the echolocating animal's outgoing beam as well as what it hears of its own outgoing sonar beam and the echoes bouncing back from objects in the water.

For years, UH Mānoa psychologist Paul Nachtigall has studied sensory and perceptual processes of dolphins and small whales, most recently focusing on hearing and echolocation. He has observed, for example, that marine mammals, like humans, may suffer hearing loss as they age, and that prolonged, high sound exposures are necessary to induce the physiological and behavioral indications of sonar-induced temporary hearing loss in a bottlenose dolphin.

Nachtigall's Marine Mammal Research Program team conducts audiograms and observes both behavior and brainwaves to collect baseline data to characterize hearing within a species and compare hearing between species. Among questions he is currently exploring—

- is the limited high-frequency hearing in a young, rehabilitated pilot whale the result of antibiotic treatment or a reflection of larger mammals' tendency to produce lower frequency sounds?
- do false killer whales adjust their hearing by employing partial forward masking of a sonar pulse as a kind of automatic gain control in their auditory systems?

"The ability to reliably and accurately measure what an animal hears of its outgoing echolocation click and returning echo while it is echolocating opens an exciting new way to explore and understand a variety of auditory processes underlying the odontocete's ability to echolocate," he says.

More information at www.hawaii.edu/mmrp

MĀLAMALAMA
THE LIGHT OF KNOWLEDGE
www.hawaii.edu/malamalama

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Innovation marks UH's history...and future


UH President M.R.C. Greenwood

Few institutions can do as much to spark discoveries that change lives and improve worlds as public universities. Time and time again, ideas that start as basic inquiries into what, why and how turn into knowledge, techniques and tools that influence the human condition. The benefits run the gamut, from alleviating suffering to predicting natural phenomena to launching industries. Faculty and graduate students at the University of Hawai'i have been major players in this process for years.

Two 2010 Nobel prizes have UH ties. Isolation of palytoxin naturally occurring in organisms inhabiting a Maui tide pool by a UH chemist in 1971 and subsequent analysis and synthesis of the chemical here were cited by the chemistry prize winners as an essential technique in their award-winning work to create organic compounds used in medicine, agriculture and electronics. An in vitro fertilization technique perfected in the School of Medicine provided the groundwork for human in vitro fertilization garnering the medicine prize. Likewise, UH physicists spotted a 1973 paper by two Japanese colleagues predicting broken symmetry in subatomic particles that might have gone unnoticed had they not tested the theory experimentally and shared their findings. The Japanese researchers won the 2008 Nobel Prize in Physics.

This special edition of *Mālamalama* explores more recent work taking place at UH—projects that create new technologies, develop innovative approaches and explore natural answers. Hawai'i has unique and acknowledged advantages in its natural and human environments that support discovery, and our ties East and West promote collaboration. Still, these kinds of discoveries do not happen by accident. That is why I appointed a President's Advisory Council on Hawai'i Innovation and Technology Advancement last April. This blue ribbon group of experts from academia and industry, both locally and nationally, were charged with advising us on the steps the university should take to foster innovation and technology transfer that will support a multi-billion dollar industry for Hawai'i in research, spin-offs and related services. The advisory council will share its recommendations at a meeting of the National Academy of Sciences' Board on Science, Technology and Economic Policy that I am hosting in Honolulu Jan. 13–14 and on the symposium website, www.hawaii.edu/innovation. I invite you to join me in my pledge to support a 21st-century institution and insure that the University of Hawai'i is a university *for* Hawai'i.

Recent awards and appointments

Hired

Former Max-Planck Institute astrophysicist and *Fate of the Universe* author **Günther Hasinger** as director of the Institute for Astronomy beginning Jan. 2.


Günther Hasinger

Ranked

UH Mānoa's Department of Physics and Astronomy among the nation's top 12 graduate programs by the National Research Council based on the proportion of faculty with research grants, scientific publishing productivity and citations per publication.

Honored

UH Mānoa Postdoctoral Fellow **Yu Kosaka** with the Meteorological Society of Japan's Yamamoto-Shyono Medal for her work on factors affecting the summertime Asian jet stream.


Yu Kosaka

UH Mānoa geologist **Charles "Chip" Fletcher** with a U.S. Environmental Protection Agency 2010 Environmental Award for climate change science.

UH Cancer Center nutritionist **Suzanne Murphy**, elected to the prestigious Institute of Medicine for her achievements and commitment to service.


Suzanne Murphy

UH Hilo physics and astronomy faculty members **John Hamilton** and **Christian Andersen** with NASA's Group Achievement Award for work related to the Pacific International Space Center for Exploration Systems.

UH Mānoa astronomer and NASA Infrared Telescope Facility Director **Alan Tokunaga** with the American Astronomical Society's 2010 Harold Masursk Award for contributions to planetary science.


Alan Tokunaga

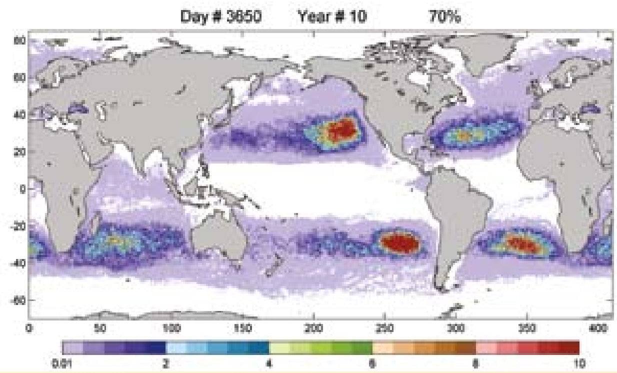
UH Mānoa Professor and Water Resources Research Center Interim Director **Chittranjan Ray**, elected to fellowship in the American Society of Civil Engineers.

Recent UH discoveries

Among recently published papers by UH faculty is news that—


illustration by Lynette Cook

- With surface temperatures similar to Earth, planet Gliese 581g, which orbits a star in the Libra constellation, may have liquid water, making it a prospect in the search for extraterrestrial life. (Institute for Astronomy Associate Astronomer Nader Haghighipour, *Astrophysical Journal*, October 15, 2010)
- Toward the end of the last ice age, a major reorganization took place in the current system of the North Pacific with far-reaching implications for climate. (International Pacific Research Center Professor Axel Timmermann and Postdoctoral Fellow Laurie Menviel, *Science*, July 9, 2010)
- The hypoxia inducible factor 1 gene helps maintain constant levels of an enzyme critical to keeping stem cells healthy. (John A. Burns School of Medicine Assistant Professor Richard Allsopp, *Proceedings of the National Academy of Sciences*, July 2010)



- A computer model developed to track long-living objects that float on the ocean surface successfully predicted the location of a giant, floating garbage patch created by converging currents in the western North Atlantic. (International Pacific Research Center Senior Researcher Nikolai Maximenko, *Science*, Sept. 3, 2010)

Cloud cover's impact on climate change predictions, recent coral research developments and progress on a new solar observatory are described in Research Briefs posted at *Mālamalama* Online, www.hawaii.edu/malamalama.

photo by Jennifer Crites

Mehrdad Ghasemi Nejhad at the furnace where carbon nanotubes are made

Stronger materials and better fuel cells are a nanotube away

by Cheryl Ernst

Since the Hawai‘i Nanotechnology Laboratory was established in the University of Hawai‘i at Mānoa’s College of Engineering in 2003, the group has made the *Guinness Book of World Records* for producing the world’s smallest brush, developed new nano and dramatically improved composite materials and launched a start-up company to develop proprietary materials in Hawai‘i.

At the heart of each development is carbon nanotubes, microscopic marvels that hold the potential to improve the performance of products from wind turbines to fuel cells.

A nanometer is one-millionth of a millimeter—about 50,000 times finer than the average human hair—so manipulation is a tricky business, says lab director Mehrdad Ghasemi Nejhad, professor and chair of mechanical engineering. Japanese physicist Sumio Iijima made the first nanotube in 1991. Carbon nanotubes form on a silicon-oxide coated silicon wafer when a source of carbon, such as xylene, is combined with a liquid containing a catalyst, such as iron, cobalt or nickel, on a silicon wafer and baked at very high temperature. The iron particles precipitate as the liquid evaporates, creating islands on the wafer. The carbon atoms settle on the iron particles, building up in hollow cylindrical structures held together covalently in nature’s strongest chemical bond.

“The key for achieving desired properties for a host material or structure is finding the right form, amount and integration technique for the nanomaterial,” Nejhad says. Nanotubes form the bristles of the group’s record-book brush, which could be used to clean micro-electromechanical systems as well as micro-capillaries, separate harmful ions from industrial waste waters or paint surfaces with molecule-thin coats. Get the carbon nanotubes to grow in the form of forests, and you have the potential to “turn fiber cloths super strong,” he continues. Composite materials, such as fiberglass polyester and carbon epoxy, combine a fiber system with a polymer system for increased strength and performance. But cracks can form and propagate between the layers, causing the composite to delaminate.

Postdoctoral researchers work with Nejhad to improve composite material performance in two ways. Vamshi Gudapati is tackling the carbon nanotube forests that strengthen the fiber materials. Richard Russ is perfecting the polymers that hold composite layers together. Picture Velcro reinforced with Super Glue. Or, rather, imagine it. You’ll need a high-resolution electron microscope to see it, and some secret steps in the process to ensure uniform and bubble-free dispersal. The payoff, Nejhad says, is that carbon fibers are almost the same strength as steel, but just a third of the weight, and carbon nanotubes are 50–100 times stronger than steel. When integrated into polymers or onto the fibers, they result in nanocomposites with 100- to 400-percent property improvements over their traditional counterparts, such as carbon epoxy. “Hence, we can use them anywhere composites are used, from boats to automobiles to spacecraft, with much better performances and durability,” he says. Reduced weight translates into decreased costs.

Consider the wind turbine. The energy it produces is proportional to the length of its blades, which are essentially ribbed, skin-covered structures like airplane wings. Longer blades are subject to higher stresses as they turn, which can cause them to fail. Glass epoxies allowed engineers to increase blade length to 150 feet, and graphite epoxies, to about 300 feet. Nanocomposite blades could potentially double that, Nejhad says.

Nanotechnology also has applications in fuel and solar cells. For example, Nejhad envisions someday painting the roof of homes with a nanomaterial-based thin film to capture solar energy without the need for more costly silicon-based photovoltaic cells.

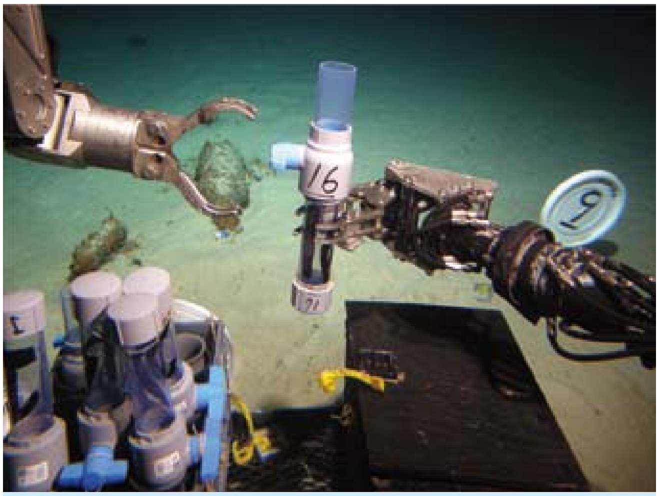
Improving hydrogen fuel cell performance and durability is key to making hydrogen a more feasible alternate fuel. A proton exchange membrane fuel cell requires a hydrated membrane, two electrodes and two catalyst layers, usually carbon paper coated with platinum, to split hydrogen gas into proton and electron. Completing the circuit produces electric energy, with water as the by-product. Using hydrophobic carbon nanotubes as the electrodes and catalyst layer bed increases surface area, electrical conductivity and hydrophobicity for the catalytic reactions. This reduces the need for auxiliary humidification equipment, in turn reducing size, weight and costs for the fuel cells.

Postdoctoral researcher Atul Tiwari has been working on the production of graphene nanosheet, a flat version of the cylindrical carbon nanotube but with much higher surface areas. High surface-to-volume ratio and super properties could improve the durability, performance and efficiency of batteries and supercapacitors while reducing their weight, size and costs. Four undergraduate and four graduate students round out the lab staff.

An American Society for Mechanical Engineers Fellow and associate editor of the *Journal of Thermoplastic Composite Materials*, Nejhad holds several patents. He has received support from the U.S. Congress and Office of Naval Research and serves as co-principal investigator with Chair of Electrical Engineering Tony Kuh on a renewable energy initiative involving 20 faculty members that is primarily funded by the U.S. Department of Energy and Mānoa Office of the Vice Chancellor for Research and Graduate Education. In addition to his university research, Nejhad is the founder and chief technology advisor of Honolulu-based Adama Materials, Inc. The company received a $4.75 million venture investment from Artiman Ventures and Startup Capital Ventures in September 2010.

"Adama represents the ideal model of cross-disciplinary development of technology, business and law at UH and demonstrates how UH discoveries can be successfully transferred to industry," says Jonathan Roberts of the UH Office of Technology Transfer and Economic Development. Ⓜ

Cheryl Ernst is creative services director in External Affairs and University Relations and editor of *Mālamalama*



Sidescan sonar helps in underwater munitions hunt

Using high-resolution sidescan sonar developed at UH Mānoa and remotely operated underwater vehicles in the UH fleet, a School of Ocean and Earth Science and Technology team demonstrated a systematic approach for locating and characterizing munitions disposal sites in water as deep as 1,500 feet.

Thousands of military munitions and bombs containing chemical mustard agent were disposed at sea approximately five miles south of Pearl Harbor. Working with the Army and Environet, Inc., the UH team identified more than 2,000 munitions on the seafloor in the study area and collected water, sediment and biological samples within a few feet of several munitions. Based on analysis at UH Mānoa and independent laboratories, team leader Margo Edwards reported that even the best-preserved casings are deteriorating, but no adverse affects on the ecological health of the study area were observed, and the health risk from consuming fish and shrimp collected near the area is within Environmental Protection Agency acceptable levels.

"By providing demonstrated, proven procedures for characterizing and assessing a munitions disposal site, SOEST has made a significant contribution to the Department of Defense's understanding of the potential effects of historic sea disposal sites on the ocean environment and those who use it," Deputy Assistant Secretary of the Army Tad Davis announced in July 2010. Ⓜ

Read the complete report at www.hummaproject.com; an account of the research effort appears at www.hawaii.edu/malamalama/2010/04/underwater-ordnance.

–Cheryl Ernst

Imaging tool could boost national security, local economy

by Alex Salkever

With cost effective components and some mathematical magic, a University of Hawai'i researcher and Honolulu start-up company are developing a hyperspectral sensor system with detection capabilities useful in commercial, research, military and national security applications.

A professor in UH Mānoa's Hawai'i Institute of Geophysics and Planetology and 2005 recipient of the Regents' Medal for Excellence in Research, Paul Lucey is a pioneer in remote sensing technology. He has won more than $14 million in competitive grants over the past two decades, studying the composition of the moon's crust, developing a space-based camera to map distribution of coral reefs and building sensors for on-site compositional analysis of rocks on Mars.

Hyperspectral imaging uses information from infrared to ultraviolet light to identify unique chemical or biological fingerprints known as spectral signatures. It is used in many disciplines, including agriculture, astronomy, geology and oceanography. Lucey's hyperspectral sensor system can recognize spectral signatures known to be associated with dangerous substances and convert the signatures into a visual format that humans can easily look at and understand.

The new technology grew out of successful field tests of Lucey's Airborne Hyperspectral Imager, a helicopter-mounted sensor system for detecting buried landmines that was funded by the Defense Advanced Research Projects Agency, the research and development arm of the U.S. Department of Defense. Pursuing a longer-range system that would be cheap and compact enough to deploy widely, he began experimenting with a system that combined a Sagnac Interferometer and new types of high-powered, low-cost infrared detection systems.

Hyperspectral imagers remotely gather data from across the electromagnetic spectrum to identify chemical signatures of things, such as weapons in the landscape, the human eye doesn't detect

Previous systems were based on detectors that cost close to $1 million each and used spectrometers with the size and heft of a refrigerator. The Sagnac interferometer costs $50,000 or less. "The real advantage was we put together this spatial interferometry and coupled it with these new infrared detectors," says Lucey. He has received one patent on this technology and has a second pending.

"I recognized that Paul's technology had real potential," says Edward Knobbe, former vice president at ICx Nomadics, a Stillwater, Okla., company specializing in advanced sensor technologies for homeland security, force protection and commercial applications. In 2008, he licensed the technology and formed Honolulu-based start-up firm Spectrum Photonics with Lucey as his chief of research. The company has hired nine technical employees—including five UH graduates—and secured nearly $6 million in federal research grants. In a recent round of field tests at the Army's Dugway Proving Ground in Utah, their system was able to accurately detect surrogate chemical weapon signatures from a distance of three kilometers.

Lucey and Knobbe have reduced the size of the units, which could now fit in a large shoebox. That's small enough to mount on the multi-technology Cerberus sensor platform manufactured by ICx, which has a long track record with both the U.S. Department of Defense and the Department of Homeland Security. The goal is to have a commercially viable, made-in-Hawai'i prototype ready for testing within the next two to three years. Ⓜ

Alex Salkever is the editor of the UH research magazine *Kaunānā*

An innovative telescope stands sentinel

On Sept. 16, 2010, just four months into its science mission, Pan-STARRS 1 produced images identifying a 150-foot-diameter asteroid some 20 million miles distant that was on a trajectory to pass within 4 million miles of Earth. With more pride than relief, University of Hawai‘i scientists agreed that their revolutionary prototype telescope was doing its job—“sucking down the whole sky,” as one scientist puts it, in search of lurking but unidentified threats.

Pan-STARRS employs the world’s largest digital camera (1.4-billion pixels per snapshot—the data equivalent of a feature-length film on DVD in each image) and sophisticated software to handle the enormous data stream (as much as 2.5 GB every 30–40 seconds). Both were developed at the University of Hawai‘i at Mānoa’s Institute for Astronomy to enable PS1 to scan the entire sky several times a month and catalog objects under a mile in diameter. The data is processed and stored at the Maui High Performance Computing Center, which is also managed by the University of Hawai‘i.

Asteroid 2010 ST3 may have missed Earth, but astronomers calculate that there is a 1 in 1,000 chance that another potentially hazardous object could strike the planet within 100 years. (In fact, there is a very slight possibility that ST3 will hit Earth in 2098.) While objects the size of 2010 ST3 usually break up in the atmosphere, the resulting blast wave on the surface can devastate an area covering hundreds of square miles, says Robert Jedicke, a UH member of the PS1 Science Consortium.

Tens of thousands of such objects exist; an estimated 90 percent have yet to be identified. Pan-STARRS is the newest, widest-looking tool in an arsenal of asteroid mapping projects tackling a congressional mandate to identify by 2020 objects large enough to pose a threat.

Advance warning could allow time for evacuation at the target site of smaller objects, or employment of countermeasures against larger asteroids, Jedicke adds. (Former astronaut and UH postdoc Ed Lu proposes a gravitational tractor, a spacecraft positioned to create a tiny force in gravity that, given sufficient leadtime, could tug the asteroid into an alternate orbit.)

Located on Haleakalā on the island of Maui, PS1 is a prototype. Its bigger brother, PS4, is proposed to replace UH’s 2.2 meter telescope on Mauna Kea. Designed to be less obtrusive and occupy less space than the current observatory, it will employ four mirrors and is expected to discover a million or more asteroids in total, as well as more distant targets such as variable stars, supernovas and mysterious bursts from galaxies across more than half the universe.

The Air Force Research Laboratory provided funding for construction and NASA’s Near-Earth Object Observation program supports the asteroid hunt. Besides UH and NASA, the PS1 Science Consortium includes 10 institutions from four countries—Germany’s Max-Planck Society and astronomy and extraterrestrial physics institutes, Johns Hopkins University, Harvard-Smithsonian Center for Astrophysics, Las Cumbres Observatory Global Telescope Network, Durham University, University of Edinburgh, Queen’s University Belfast and the National Central University of Taiwan. Ⓜ

Learn more about Pan-STARRS at http://pan-starrs.ifa.hawaii.edu

New telescope to open astronomical vistas

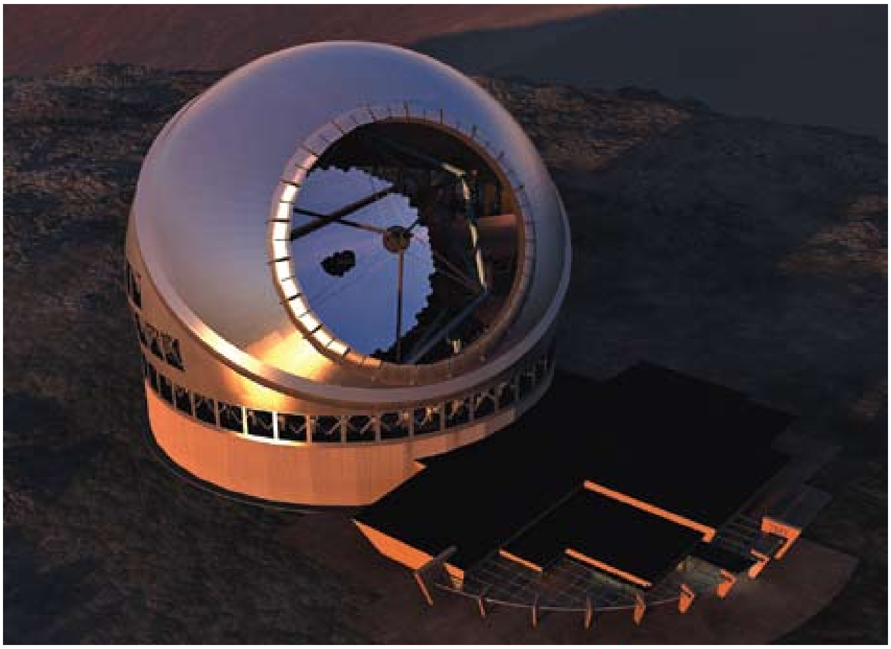
The world's most powerful optical telescope is coming to the world's premiere astronomical site—Hawai'i's Mauna Kea summit. Construction is expected to begin on the Northern Plateau in 2011 pending receipt of a Conservation District Use Permit.

The Thirty Meter Telescope takes its name from the 492 mirror segments that collectively make up a 30-meter primary mirror. TMT will have nine times the light collecting area of today's largest optical telescopes.

Coupled with adaptive optics technologies, the telescope will obtain extremely sharp images—three times sharper than existing capabilities—and detect faint objects, "extending our vision farther into space and understanding further back in time," says Sandra Dawson, Hawai'i site representative for the TMT Observatory Corporation. Expected to begin operation in 2018, the telescope will detect planets in other solar systems, she says. It will shed light on the dark energy that appears to be accelerating the expansion of the universe and black holes, which are objects with such strong gravity that not even light can escape their grasp.

"It is a telescope that will change the science of astronomy in a fundamental way," says former University of Hawai'i Institute for Astronomy Director Rolf Kudritzki. TMT, like the Keck telescopes at Mauna Kea, will generate unanticipated discoveries, he predicts. "That's the beauty of science and beauty of astronomy—you detect the unexpected things.

One thing is certain: bringing this next generation telescope to Hawai'i with guaranteed observing time for University of Hawai'i scientists will ensure that the state and the University of Hawai'i remain in the forefront of astronomy for the next 50 years, he adds.



Pan-STARRS observatory, left, begins a nightly search for nearby threats; TMT, in artist's rendering above, will see sharper and farther than existing telescopes

TMT is breaking the mold in another, less scientific but equally important way. It is the first project to undergo the Mauna Kea Science Reserve Master Plan's complete project review process, which provides for public input and Mauna Kea Management Board review on project design and placement. To be a good partner, TMT will provide $1 million per year for the life of the telescope for educational programs to be selected and managed locally and $2.5 million annually to assist in the management of Mauna Kea and ongoing UH Hilo education programs.

The project is both an international and a public-private partnership. The $77-million design development phase was funded primarily by the Gordon and Betty Moore Foundation and Association of Canadian Universities for Research in Astronomy. The Moore foundation has pledged an additional $200 million for construction. California Institute of Technology and the University of California have agreed to raise $50 million each, and the Canadian partners will supply the enclosure, telescope structure and first light adaptive optics. The National Astronomical Observatory of Japan joined TMT as a collaborating institution in 2008, and the National Astronomical Observatories of the Chinese Academy of Sciences and India have joined as observers, the first step toward partnership.

The project is expected to create 140 jobs and annually contribute more than $25 million to the state and local economy. Ⓜ

Learn more about the TMT at the web-site, www.tmt.org.

The sky isn't the limit for UH space

The idea is as simple as the goal is audacious: become the only university in the world with dedicated rocket-launch capability. The University of Hawai‘i at Mānoa's Hawai‘i Space Flight Laboratory is well on its way to turning concept into reality.

"No other university will have the capability to fabricate satellites, make instruments, launch the satellites and have students operate the satellites in space," says Luke Flynn, a Hawai‘i Institute of Geophysics and Planetology specialist who serves as director of the spaceflight laboratory. "We coordinate the whole project."

A multidisciplinary program supported by a congressional appropriation through the Low-Earth Orbit Nanosatellite Integrated Defense Autonomous System, Hawai‘i Space Flight Laboratory aims to promote research for space missions; validate small spacecraft technologies; train workers to support unmanned space missions; and promote collaboration between government, academia and industry.

Flynn represents UH as prime contractor for the Operationally Responsive Space Office, a Department of Defense initiative focusing on smaller satellites and launch vehicles. UH will partner with NASA on small spacecraft design. UH scientists will develop instrumentation, partnering with local businesses and NASA centers when possible. The Navy's Pacific Missile Range Facility on Kaua‘i and on-site contractor, Sandia National Laboratories' Kaua‘i Test Facility will provide the launch vehicle and support. Staff and students at three UH campuses will participate in ground station and mission operation functions.

The first of two planned demonstration launches is a year and a half away. It will test SPARK (for space-borne payload assist rocket–Kaua‘i) and its newly designed launch rail system. The payload will be *Kumu A‘o* (Hawaiian for "source of learning"), a satellite being built by Hawai‘i students of Lloyd French, an HIGP associate specialist and spaceflight mission manager formerly with NASA's Jet Propulsion Laboratory.

The second launch, slated for 2013, will deploy *Hawai‘iSat-1*. "It will fly a lot of UH-developed technology," says Flynn. The UH designed satellite will carry instrumentation designed by HIGP's Paul Lucey (see page 5) and Robert Wright, who has experience with satellite-based monitoring of volcanoes in HIGP and ship tracking as part of the tri-university Center for Island, Maritime and Extreme Environment Security.

Students in UH Mānoa's College of Engineering and School of Ocean and Earth Science and Technology will be involved every step of the way. Hawai‘i Space Flight Laboratory builds on a decade of experience in small satellite design. Engineering students have been designing and fabricating their version in the UH CubeSat Laboratory. CubeSat is a catchphrase for a miniature satellite—think Rubrik's Cube, a container about 10 centimeters on a side that fits in the palm of your hand. Working with Professor of Electrical Engineering Wayne Shiroma, students address all aspects of satellite design and function—structure, power, attitude control, command and data handling and telecommunication.

One of the keys to building a better satellite is to do more on-board processing in space, transmitting relevant answers instead of large data streams, Flynn says. "A lot

flight lab

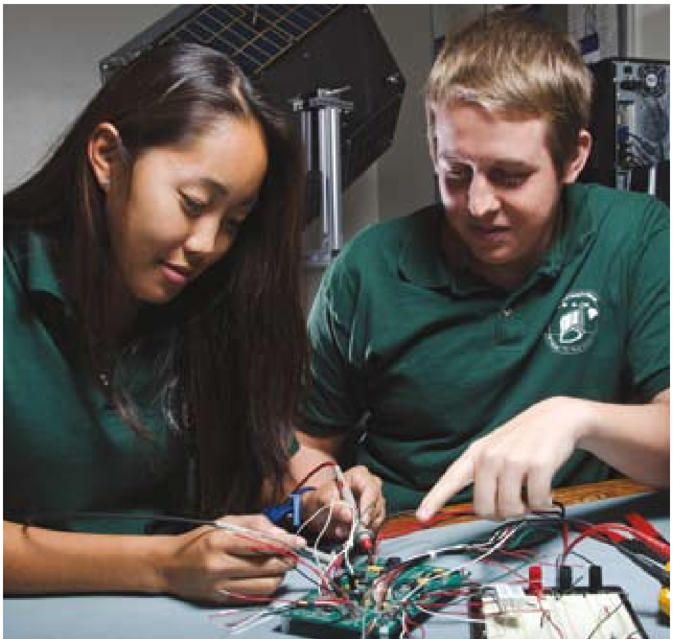
by Cheryl Ernst

of satellites in orbit now have less capacity than your cell phone." Another advantage of going small is agility in meeting the need for rapid deployment of instrumentation for crisis management or disaster mitigation, Shiroma adds. In 2009 he and a team developed a rocket payload for launch from New Mexico in a mere 45 days.

That year, UH was one of only 11 universities nationwide to receive a $110,000 award from the Air Force Office of Scientific Research's University Nanosat Program. About 20 electrical and mechanical engineering students are designing and fabricating a radar calibration CubeSat. Under a $400,000 Office of Naval Research grant, students are developing novel antennas for a CubeSat.

The UH experience is reflected in *Emergence of Pico- and Nanosatellites for Atmospheric Research and Technology Testing,* an American Institute of Aeronautics and Astronautics book co-edited by Shiroma. Chapters on microthruster propulsion, mobile ground station design, retrodirective antenna systems and starting a university small satellite program have UH authors. Four of the nine student authors have since graduated to positions at Northrop Grumman Aerospace Systems. Tyler Tamashiro, a UH Regents Scholar and the 2008 Hawai'i Student Engineer of the Year, works on launch systems. Monte Watanabe, named one of the nation's top five electrical engineering students in 2007, is designing satellite components.

Other graduates are working with Hawai'i Space Flight Laboratory. Lance Yoneshige is the small satellite structure and mechanisms engineer. Jeremy Chan, Zachary Lee-Ho, Reid Yamura and Michael Menendez are all on the *Hawai'iSat-1* engineering team. Miguel Nunes is designing mission operations with Trevor Sorensen, who was mission manager for the Clementine mission to the Moon.



Students build satellites. Far left: Mission coordinator Jeremy Chan, left, and electrical power systems engineer Reid Yamura with a model of the *Hawai'iSat-1* they are readying for launch. Above: Zachary Lee-Ho tests the attitude control system. Below: Monica Umeda and Nick Fisher develop electrical systems for a CubeSat miniature satellite.

One of the goals of Hawai'i Space Flight Laboratory is to prepare students for careers in aerospace industry, says Flynn. As director of UH's NASA-supported Hawai'i Space Grant Consortium, he fosters opportunities across the UH System, such as a planned telemetry project with Kaua'i Community College to involve students in data collection. "The Pacific Missile Range Facility has numerous job openings for telemetry engineers and technicians," he observes. He is also working with Kaua'i Professor Francis Takahashi on a campus lab that will track satellites and Windward Community College Professor Joe Ciotti on outreach activities.

The collaboration also dovetails nicely with the university's EPSCoR (Experimental Program to Stimulate Competitive Research) effort to boost educational activities that will make the United States more competitive in science, technology, engineering and mathematics. Together, Space Grant and EPSCoR bring about $1 million a year to UH. Hawai'i Space Flight Laboratory adds another $4 to $5 million a year.

It's an expensive business. The Hawai'i Space Flight Laboratory orbiters will cost $2–$3 million each and the launch itself about $10 million. Still, that's big savings over the bulky satellites and launch vehicles currently used by government and commercial operations. And the waiting list for a ride on those launches is long. Proving Hawai'i's capability to do small satellite research and development and launch payloads could create a new state industry.

"We're looking for opportunities for companies to come in and build components," Flynn says. "We hope to be self-sustaining," sharing the cost of future launches with research institutions and innovative companies who want to run experiments or test products in space. Ⓜ

Cheryl Ernst is *Mālamalama* editor and creative services director in External Affairs and University Relations

RMATRIX leaders, from left, Bruce Shiramizu, Tammy Ho, Jerris Hedges, Todd Seto, Pamela Bullard, Louise Fujisue

Grant creates matrix for meaningful health research

by Helen Altonn

University of Hawai'i researchers are teaming up with community groups, clinics and hospitals under a $12.6-million effort dubbed RMATRIX that supports interdisciplinary and translational research on health disparities among isle residents. The goal is to improve the health of people who suffer from disproportionately higher rates of (and worse outcomes from) serious illness. In Hawai'i, that includes heart disease, diabetes, asthma, cancer and dementia.

UH Mānoa is one of five U.S. academic institutions funded through the National Institutes of Health's Research Centers in Minority Institutions. That's the "R." MATRIX stands for Multidisciplinary and Translational Research Infrastructure Expansion. Translational research rapidly transfers study findings to treatment settings to benefit patients. UH investigators will use the resources to build on years of experience identifying and addressing health disparities in Native Hawaiian, Pacific Islander and other populations in multicultural and multiethnic Hawai'i, says lead investigator Jerris Hedges, dean of the John A. Burns School of Medicine.

The goal is to improve the health of people who suffer from disproportionately higher rates of serious illness

Professor of Pediatrics Bruce Shiramizu and Associate Professor of Medicine Todd Seto, a cardiologist at The Queen's Medical Center, are directing the effort, which focuses on six health disparities—cardiovascular health; respiratory health; nutritional and metabolic health; cancer prevention, epidemiology, treatment and drug discovery; perinatal, growth and developmental health; aging and neurocognitive health.

"Understanding and addressing these health outcome disparities in our multicultural setting will help our nation as a whole answer why some diseases are more prevalent in minority populations and what can be done to reduce the burden of these diseases," says Shiramizu. The grant will provide infrastructure to bolster research collaborations and investigations, such as assistance in putting grants together and navigating regulatory requirements, to "make scientific studies more doable," he explains.

At the university, faculty in nursing, engineering, geosciences, law and other programs throughout UH's Mānoa and Hilo campuses are encouraged to collaborate with medical school investigators. A single administrative infrastructure will consolidate and enhance existing resources, drawing from similar NIH-funded sites with overlapping research needs and interests, and will support investigators through education, training and career development.

In the community, Native Hawaiians and others will help identify major health issues. Successful programs in Hawai'i hospitals, neighborhood health clinics and Hawaiian civic groups (the longest-standing community organizations representing Native Hawaiians) will be integrated, and resources will support clinical and translational projects.

On the Big Island, for example, Professor of Medicine Elizabeth Tam, who leads the RMATRIX respiratory health initiative, will build on her partnership with the Ka'ū Rural Health Community Association. Environmental health is an overriding issue on the Big Island because of the vog created by gases from the ongoing eruption of Kīlauea volcano.

Queen's Health System will help identify ways to enhance collaborative activities, recruit investigators, encourage community involvement and streamline approval of studies based at the hospital, pledges CEO Arthur Ushijima, a member of the RMATRIX Council.

The university and community are very different cultures, and it can be a challenge to work together, notes David Derauf, executive director of the Kōkua Kalihi Valley Health Center. "This grant gives us an opportunity to narrow that gap considerably," building on projects begun over the past decade, such as an innovative gardening project suggested by a group of patients that promotes a healthier lifestyle.

"We want capacity in the community where ideas are self-generated and people can go to the university and ask, 'How about this? How about trying this out? Here are some obstacles. How can we get funding?'" RMATRIX can move the university and communities in that direction with shared goals and resources. Ⓜ

Helen Altonn is a veteran journalist and Honolulu-based science writer

C-MORE plumbs the depths of the microbial ocean

by Maureen O'Connell

Oceanographer David Karl, above, at C-MORE Hale, where paving detail, inset, honors an ancient marine organism

The naked eye sees a scoop of seawater as translucent and vacant, unable to glimpse the lively and vast ecological complexity in each drop. Yet life abounds at the microscopic level. The weight of all *visible* marine life—anemone to zebra turkeyfish as well as whales and coral reefs—is less than the total weight for all largely *invisible* marine microbes.

"We know now that microbes dominate the biomass of the ocean," says David Karl, director of the Center for Microbial Oceanography: Research and Education (C-MORE), headquartered at the University of Hawai'i at Mānoa. "Every other breath you take contains oxygen produced in the sea by microorganisms." And the food you eat? "Most of it derives from solar-energy capture—about half on this planet from microorganisms that live in the sea." Microbes also clean up after us, breaking down everything from fossil fuel pollutants to pesticides, Karl says.

Established in 2006, C-MORE is one of 17 National Science Foundation–sponsored Science and Technology Centers and the first to focus on microbes. The intensely competitive federal program—C-MORE was one of five new sites selected from 255 proposals—supports partnerships that produce top-notch research. C-MORE will draw $4 million a year in NSF funding through 2016. UH provides $1.2 million a year in matching funds. Private sector organizations are also pitching in—the Gordon and Betty Moore Foundation, dedicated to environmental conservation and scientific research, has contributed about $40 million so far, and the Agouron Institute, which issues grants for biology and chemistry related endeavors, is funding student education and teacher outreach efforts.

C-MORE's interdisciplinary team—scientists, engineers and educators at six institutions spread across as many time zones—describes its primary mission as linking genomes to biomes. "We are looking through the microscope at the book of life to see what organisms are capable of doing, and then we're looking through the telescope at the habitat that they're living in," the global ocean, Karl explains.

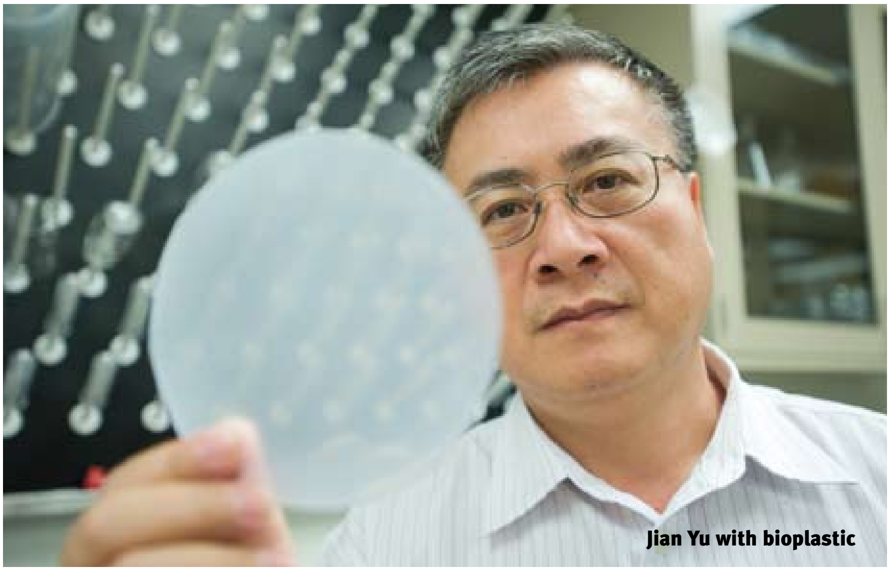
This month, he and colleagues move into C-MORE Hale, a new $22.5 million facility at the UH Mānoa campus. Occupants won't spend long stretches behind the closed doors of individual offices and laboratories. "C-MORE Hale is totally open, and people will, we hope, interact more," Karl says. That should help advance the fledgling discipline of microbial oceanography, which combines oceanography, microbiology, molecular biology, ecology and recent advances in computer-related technology and computation.

"I got into this field of microbial oceanography before it had a name," says Karl, who earned a PhD in oceanography in 1978 at Scripps Institution of Oceanography. Oceanography became a science in the mid-1800s, but virtually ignored marine life invisible to the naked eye for the next century. Technologies and methods used to investigate microorganisms have improved, but studies lag far behind those on dry land. For example, some 600 ground-based weather stations continuously sample atmospheric conditions, but only two—UH's Station Aloha, about 60 miles north of O'ahu, and a site in Bermuda—take underwater measurements on a routine basis.

Seawater data has been key to some important discoveries, such as ocean acidification, says Karl. He hopes weather stations will pervade the deep sea 50–100 years from now, allowing scientists to "take the pulse of the planet in a much more reasonable and exact way."

Research at C-MORE is organized into four intertwined themes, says Research Coordinator Ed DeLong, a professor of biological engineer-

Continued on page 15



Jian Yu with bioplastic

Byproducts become biodegradable plastic

A University of Hawai'i at Mānoa research team is turning agricultural byproducts into a new generation of biodegradable plastics that could be made in the state. "We hope the plastics we are developing will significantly improve the global environment at costs that are competitive with or less than traditional petrochemical plastics," says Jian Yu, a Hawai'i Natural Energy Institute associate researcher who heads the bioplastics research team.

Yu has filed for two patents based on the processes he developed. The technology is being used in a pilot plant in Europe, and the company that operates it plans to invest $2 million to establish a biomaterial testing laboratory in Hawai'i.

As an island state, Hawai'i has a vested interest. The archipelago receives a barrage of plastic waste that escapes the vast ocean gyre known as the Great Pacific Garbage Patch. Debris that doesn't kill birds, fish, seals and turtles outright breaks down into smaller pieces, introducing toxic petrochemicals into the global food chain.

The concept of biodegradable plastics dates to the 1970s. Producers used chemical synthesis to blend conventional plastics with a natural product, like starch. "Unfortunately, the starches only enhanced fragmentation, making it easier for these petro-plastics to enter the food chain," says Yu. Later attempts used PLA (polylactide) polymers derived from corn and other plant sugars to make rigid transparent containers. The polymers break down at the relatively high temperature in municipal landfills, but not in the natural environment.

Yu's PHA (polyhydroxyalkanoate) plastics are formed by biological activities in microbial cells without chemical synthesis. Common bacteria easily break down the resulting product into carbon dioxide and methane gas in the presence of water. "You could literally dump this plastic into the ocean and it would break down into benign components over the course of about six months," Yu says. The process generates fewer greenhouse gas emissions than petrochemical plastic production, and the byproducts recycle into new biomass from which new bioplastics can be made.

Our goal is to make biopastics in Hawai'i

–Jian Yu

The HNEI scientists use waste products that have little value yet are rich in sugars—remnant bagasse from sugarcane, low-grade molasses from sugar production or waste water from corn-based ethanol production. They are testing banagrass, a high-yield, fast-growing plant common to Hawai'i. The feedstock is scrubbed and treated in a proprietary process to make it suitable to microbial use, and then fed into a bioreactor stocked with specially bred bacteria and operated at an economical 86 degrees Fahrenheit (30 degrees Celsius). The bacteria produce and store PHA polymers, reaching density levels of nearly 80 percent of their total body mass.

A patented process separates and purifies the polymers. Yu has achieved 98 percent purities in laboratory settings and roughly 96 percent purities in larger pilot reactors. The HNEI product can be easily fine-tuned to satisfy client demand for specific properties, such as pliable or rigid plastics, without using chemical additives.

Yu says his bioplastics cost 20–30 percent more to produce per kilogram than petroleum-based plastics. But that differential could disappear quickly if oil prices continue to bump above $100 per barrel and co-location of plastic production facilities at feedstock sources reduce transportation costs.

"For places like Hawai'i, this could be a model for improving the local economy by using local means of production," he says. Ⓜ

Adapted from the University of Hawai'i research magazine *Kaunānā*

Scientists turn to the ocean to counter cancer

A milliliter of sea water can contain a million microorganisms. A deep sea sediment sample can harbor up to a billion organisms. Some may hold clues to preventing cancer, yet few are cataloged. So John Pezzuto and a small research team screen thousands of samples per year in a state-of-the-art laboratory at the University of Hawaiʻi at Hilo College of Pharmacy.

Chemoprevention is a concept both old and new. Scientists have long known that certain natural substances seem to prevent or delay certain types of cancer in large populations, yet most medical treatment to date has limited success in improving survival rates or longevity. Pezzuto would like to see cancer care catch up with the dramatic strides made in strategies for heart attacks, stroke and other leading killers over the past 30 years.

Pezzuto is dean of the pharmacy school and principal investigator on a $6.8-million grant from the National Cancer Institute that involves researchers at Purdue University, Scripps Institution of Oceanography, University of Illinois at Chicago and University of Alabama at Birmingham. Team members divide the tasks—from sample collection to basic screening and isolation of bioactive compounds to testing against various cancer types for chemopreventive characteristics. Collectively, they represent the largest chemopreventive program in the world.

Half of FDA-approved anti-cancer agents came from nature

The multi-step screening process utilizes in vitro tests—many developed by team members—to detect cancer prevention compounds. Researchers closely monitor a continuous purification process designed to isolate the most active agents. They then uses mass spectrometry, x-ray crystallography and other molecular imaging techniques to study the structure of molecules in the compound, looking for those that are likely to be chemopreventive.

Compounds that show strong anti-cancer activity in these assays may induce the synthesis of enzymes in the human body that could prevent the oxidative attack on normal cells and transformation of normal cells into cancer cells. Drawing on a decade of research and an 1880 logic tool called a Venn diagram, Pezzuto and his colleagues can ascertain the likelihood that an anti-cancer agent will be effective in animal models.

John Pezzuto and his team look for chemopreventive activity in marine compounds

Turning to Mother Nature for anti-cancer drugs is not novel. Of the 140 anti-cancer agents awarded U.S. Food and Drug Administration approval from 1940 through 2002, more than half were derived or made directly from natural sources. Taxol, perhaps the most successful modern anti-cancer agent, is derived from the bark of the Pacific yew tree. Epidemiological research has also identified a number of likely chemopreventive compounds found in common foods. Those include sulforaphane and phenethyl isothiocyanate (cruciferous vegetables), epigallocatechin-3-gallate (green tea) and curcumin (turmeric).

Pezzuto's team was the first to identify the anti-cancer potential of reservatrol, a compound found in red wine and other foods; a number of biotech startups are developing related products. Several years ago, the team turned its focus to the marine environment, where greater biodiversity provides a much larger pool of potential drug compounds.

The research fills a gap where traditional pharmaceutical research fails to tread. "It's risky for drug companies to predict ultimate success and approval. So they are increasingly averse to this type of research," says Pezzuto, who is listed as co-inventor on several patents. "Our greatest hope is, working through the National Cancer Institute, some of our findings will be picked up by other labs or drug companies, and they will carry our discoveries into the FDA approval process and then onto the shelves and into the hospitals."

The intellectual property potential isn't limited to molecular structures found in nature; compounds that show initial promise can be tweaked for more powerful bioreactivity. "The joy of natural product research is you can never predict from the beginning the chemical that comes out in the end," Even the assays developed by the team to gauge compounds' potential can become licensed technologies. Ⓜ

This article adapted from the UH research magazine *Kaunānā*

photo by Peter Tully Owen

Other UH efforts explore natural products

The effort to identify beneficial compounds from nature isn't limited to UH Hilo.

Three of the five organic chemists on UH Mānoa's 11-member Department of Chemistry faculty focus on bioorganic and natural products chemistry, with emphasis on the isolation and identification of antitumor compounds that originate in algae, sponges and other marine organisms. They are department Chair Thomas Hemscheidt, who specializes in biosynthesis and isolation of natural products from plants and fungi; organic group leader Marcus Tius, who works to improve organic synthesis methodologies; and Assistant Professor Philip Williams, who identifies and evaluates chemical compounds from marine sources as potential drug leads for the treatment of cancers and Alzheimer's Disease.

Tius also leads the Natural Products and Cancer Biology Program at the UH Cancer Center. Formally organized in 1990, it brings together 25 faculty members from the Mānoa and Hilo campuses in a multidisciplinary research/drug discovery group that works on acquisition of new, untested source material for screening; development and implementation of innovative mechanism-based, cancer-relevant in vitro and cell-based assays; isolation and identification of active compounds; and detailed pharmacological investigation, definitive in vivo evaluation and elucidation of relevant molecular mechanisms. Researchers partner with private industry to translate laboratory research results into clinical trials. (An article on the work of group member André Bachmann appears in the April 2010 issue of *Mālamalama*.

Even Windward Community College has gotten into the natural products act. Ethnobotanist Inge White established the Bioprocessing Medicinal Garden Complex in June 2007 to train students for biotech jobs and prime them for advanced scientific study. Her students learn how to analyze plants for medicinal properties and create products to deliver the benefits. Their work on honohono grass is described in the July 2010 *Mālamalama* Online. Ⓜ

Reactor turns green waste into charcoal in a flash

Michael Antal wants to make nature happy while creating a cleaner future. The Coral Industries Professor of Renewable Energy Resources developed Flash Carbonization at the University of Hawaiʻi at Mānoa's Hawaiʻi Natural Energy Institute to turn biomass into biocarbon, a.k.a. charcoal. The process involves lighting a flash fire at elevated pressure inside a reactor to produce charcoal in about 20 to 30 minutes. Other processes take anywhere from eight hours to several days.

Charcoal is traditionally made from wood; Antal's lab has used green waste and agricultural byproducts such as corncobs, even automobile tires and sewage sludge. "Nature doesn't want biomass—woody materials, sewage sludge, corn cobs—to be gasoline," he says. "Nature wants to see biomass be carbon, charcoal. This becomes clear when one does thermochemical equilibrium calculations." Using elevated pressure in a partial combustion process satisfies the ther-

C-MORE continued from page 11

mochemical equilibrium, making nature happy…and producing near theoretical yields of carbon from biomass in his commercial scale carbonizer on campus.

It is impossible to escape coal's grasp on society. It is used to produce the activated carbon that purifies water and in the production of the silicon found in metals and photovoltaic cells. It fuels electrical power plants. Substituting charcoal for coal can reduce both our dependence on coal, a non-renewable fossil fuel, and the release of carbon dioxide when it is burned.

"Increasingly, environmentalists point to coal combustion as the real challenge to climate change," says Antal. Charcoal doesn't increase CO_2 in the atmosphere, because a plant takes CO_2 out of the atmosphere as it grows. Flash Carbonization turns the plant into carbon. Burning the carbon returns the CO_2 stored by the plant to the atmosphere. "It's just part of nature's great carbon cycle in the case of charcoal. That's not true for coal," he says.

Charcoal can also be used to enrich soils. And using green waste reduces stress on landfills. Antal estimates that production of "black gold" from Hawai'i's green wastes could become a $50 million per year business. Four companies, including Kingsford Products, have licensed the technology since 2003. It has attracted the attention of Dow Corning, and Antal anticipates additional interest this year once he installs an after burner that will clean up reactor emissions, ensuring that the total package will meet environmental standards. Ⓜ

–by Stanley Lee

ing at Massachusetts Institute of Technology. The basic questions are—

Who's out there? Using laboratory-based cultivation techniques and high tech cell sorting methods to pinpoint microbial diversity.

What are they doing? Using genome libraries and biogeochemistry expertise to examine microbial metabolism, looking at how the flow of carbon, nitrogen and phosphorus is fueled by microbial activities.

How do we study microbes? Engineering tools for remote and continuous sensing of microbes, such as an autonomous sea glider that can swim, dive and surface untethered while collecting data at depths of up to 1,000 meters.

How do we put it all together? Using computerized ecosystem models that predict ocean changes.

Among C-MORE accomplishments to date is principal investigator Jonathan Zehr's discovery of a new group of nitrogen-fixing organisms. These bacteria convert gaseous nitrogen into nitrate and ammonia, which serves as food for other organisms. Without them, the planet's nitrogen supply would be lost. Zehr, from UC Santa Cruz, has discovered a group, which may not be a complete organism, but may live as an obligate parasite with other organisms.

DeLong led a group that discovered a process by which sea cells absorb sunlight without releasing oxygen. Instead of chlorophyll, they contain rhodopsin, a purplish-red light-sensitive pigment that's also present in the retinas of humans and other animals. "They're taking energy from sunlight and making a more efficient metabolism for themselves so that they don't have to use as much food," Karl explains. He likens it to putting a solar panel on your house to absorb the sun's energy so you don't have to use so much fossil-fuel based electricity.

"These are nature's hybrids," resulting from more than 4 billion years of evolution, he continues. "It looks like almost every organism in a lighted zone of the ocean has this mechanism. And we still don't know how important it is."

C-MORE fieldwork includes a series of annual cruises devoted to probing environmental concerns—global climate change, ocean acidification and plastic patches such as the mass of floating trash in the North Pacific Gyre. Cruises typically span three weeks and include team members from UH, MIT, Monterey Bay Aquarium Research Institute, Oregon State University, UC Santa Cruz and Woods Hole Oceanographic Institution. C-MORE hopes to send out a ship for half the year in 2013 so researchers can more extensively observe interactions in underwater habitats and development of life forms, as well as investigate related matters such as the subtle roles sunlight and cloud cover play in whether a marine community thrives.

"The ocean can't be sampled at our convenience. It has to be sampled on the scale that matters to the microorganisms," Karl says. Because microbes were the first life form on Earth, most of the diversity on our planet is found within their realm. "Kings and queens" of evolutionary specialization, marine microbes can teach us fundamental things about the planet, he adds—how it operates, sustains itself, how fragile it is when confronted by man-made environmental problems. Ultimately, we may be able to correct or improve our general understanding of what might be called the "ecology of the planet," he says. Ⓜ

Maureen O'Connell is a Honolulu-based freelance journalist

In science:
Genius Kelly Benoit-Bird

Profession: Associate professor of biological oceanography, Oregon State University

UH degrees: PhD in zoology, Mānoa

Roots: Francis T. Maloney High School, Meriden, Conn.

Personal: First member of her family to attend college

Following her fourth-grade passion for the ocean, Kelly Benoit-Bird demonstrated the exceptional creativity, accomplished track record and future potential needed to earn the fellowship commonly dubbed a "genius grant." One of 23 John D. and Catherine T. MacArthur Foundation honorees for 2010, Benoit-Bird was seven months pregnant when she received word of the fellowship and accompanying $500,000 prize. The foundation noted her use of sophisticated technology to explore how ocean creatures find their food while trying to avoid becoming someone else's dinner. Most of her work is done using acoustics to study where the animals are, what they are doing, how they are moving and how that is affected by their habitat. She is trying to unravel the behavioral components of the food web in the ocean—the different interconnections of predator and prey—and how aggregations of food affect their survival.

The new mom is grateful for "great relationships" with UH colleagues, mentors and peers who, she says, constantly challenged her and pushed her research. University scholarships and grants allowed her to become an independent researcher at an early age. She stays in touch with UH cohorts and collaborates on projects with her graduate advisor, Whitlow Au of the Marine Mammal Research Program and Mānoa oceanographer Margaret McManus. The MacArthur grant provides five years of unrestricted support to pursue the kinds of projects that some funding agencies might consider too risky, but that often produce the most interesting results. She remains bemused that somebody pays her to do her a job she loves. "We researchers get to do everything, from coming up with an idea, to building and designing equipment, to collecting information out in the field, to figuring out what it means, and then telling the story about it at the end."

–by Kymber-Lee Char, an External Affairs and University Relations public information officer

Photo courtesy of the John D. and Catherine T. MacArthur Foundation

In industry:
Hands-on David Kim

Profession: Engineer/project manager, HNU Energy

UH degrees: AS in electronic and computer engineering technology, UH Maui College; BS in electrical engineering, Mānoa

Roots: Makawao, Maui; King Kekaulike High School

Hobbies: Rebuilding vehicles for racing; woodworking

With callused hands more typical of an electrician than an electrical engineer, David Kim clearly bridges the gap between theory and application. "I understand a little bit of everything. It helps if you have a mechanical background, but I've rebuilt engines; I've been a power guy," he says. He did a motor swap, making his second car street legal for transportation, but fast for competition at the Maui Drag Strip. That background is well suited to the needs of HNU Energy, a Maui research and development company focused on high efficiency lighting technology and photovoltaic systems. "This company is not terribly large. Everybody has got multiple jobs," he says. "We use every resource we have to solve the problem of the day. You've got to be versed in all aspects of engineering, you've got to be versed in photonics, you've got to be versed in customer service."

Kim graduated from high school with the minimum credits in algebra and science and a passion for auto mechanics. He took community college electronics classes after joining the Air National Guard. Maui Assistant Professor Mark Hoffman took one look at Kim's transcripts and advised the young man to proceed to UH Mānoa. "You learn basic concepts in school. When you're looking at an analog circuit in a classroom, it's imaginary, but you never put it together and make it work," Kim says. HNU gives him that opportunity, be it photonics, medical devices, photovoltaics or energy systems. "I feel I am well rounded" with Guard experience and formal education, he says. "In a lot of places, an engineer will design something and somebody else will implement. Here I get to do both. I'm the guy who is designing your system, installing it and making sure it works."

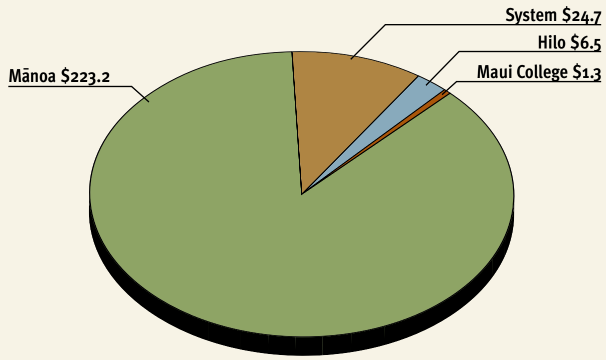
–by Ed Tanji (BA '73 Mānoa) is a former *Honolulu Advertiser* writer on Maui

Photo courtesy of HNU Photonics

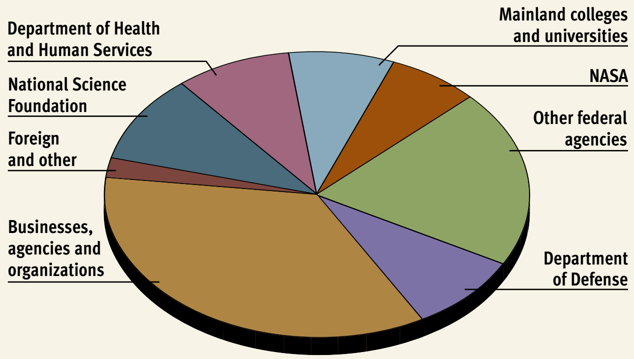
Research by the Numbers

The University of Hawai'i received more than $452 million in extramural grants and awards during the fiscal year ending June 30, 2010. The research enterprise generated more than half of that—1,161 awards worth $256 million.

Distribution by Campus (in millions)



Award Distribution by Sponsor



Top 15 Units by Research Dollars

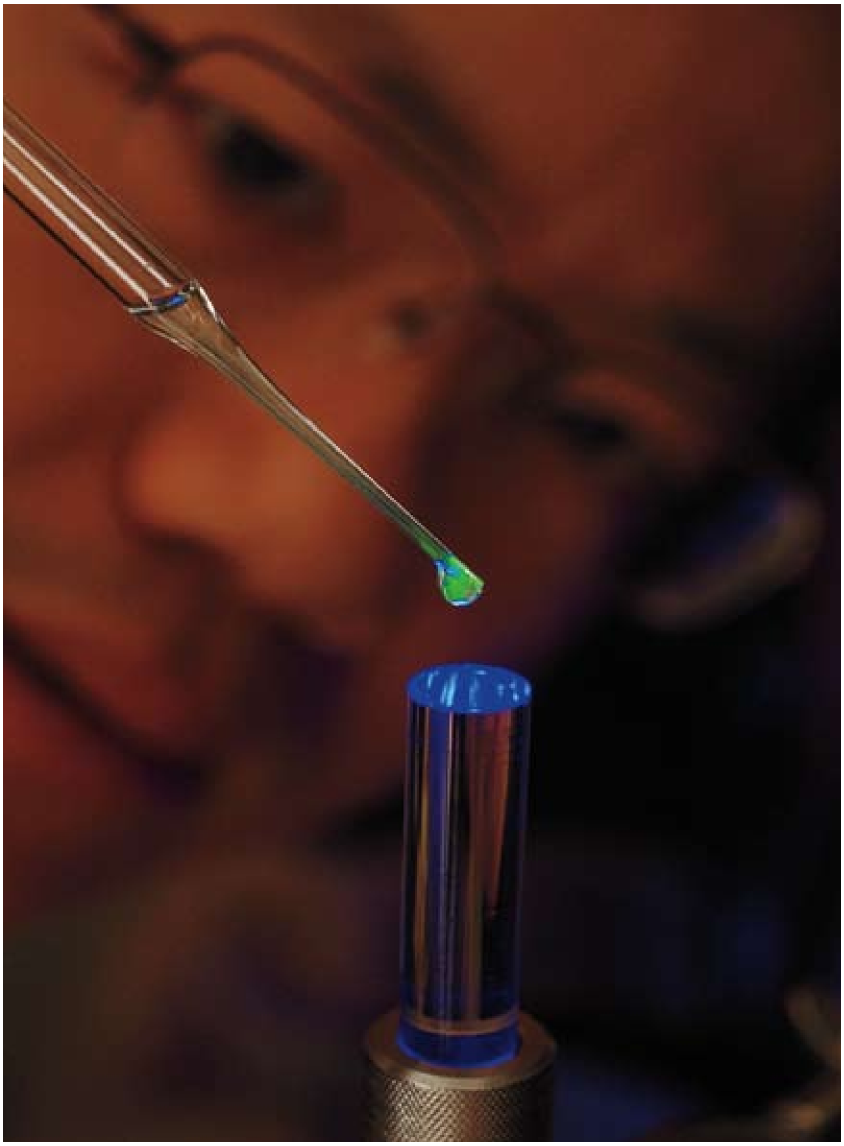
College, School or Research Unit	Number of Awards	Total Dollars (in millions)
School of Ocean and Earth Sciences and Technology (UH Mānoa)	330	$94.4
John A. Burns School of Medicine (UH Mānoa)	148	$37.6
University of Hawai'i Cancer Center (UH Mānoa)	67	$26.7
College of Natural Sciences (UH Mānoa)	162	$17.8
Institute for Astronomy (UH Mānoa)	90	$15.9
Information Technology Services (UH System)	38	$15.4
College of Tropical Agriculture and Human Services (UH Mānoa)	89	$9.7
Office of the Vice President for Research (UH System)	8	$9.3
College of Engineering (UH Mānoa)	49	$5.3
College of Arts and Sciences (UH Hilo)	22	$3.3
Pacific Biosciences Research Center (UH Mānoa)	26	$2.9
College of Agriculture, Forestry and Natural Resource Management (UH Hilo)	33	$2.2
UH Maui College	1	$1.3
College of Pharmacy (UH Hilo)	7	$ .9
Water Resources Research Center (UH Mānoa)	7	$ .9

Data from Office of Research Services; reports available at www.ors.hawaii.edu

E lawe i ke aʻo a mālama, a e ʻoi mau ka naʻauao

He who takes his teachings and applies them increases his knowledge.

–Hawaiian proverb from ʻŌlelo Noʻeau



Fast *and* Accurate: A patented biological nanosensor technology developed by College of Tropical Agriculture and Human Resources Professor Wei-Wen Winston Su can detect specific compounds in vitro or inside living cells in a simple, single-step process. Produced in bacteria, the sensor protein changes its fluorescent property in the presence of the target compound. Applications range from medicine (diagnosis and drug screening) and research (protein-protein interaction) to industrial technology (protein production) and security (toxic biological agent detection). The work has been supported by Honolulu biotechnology firm BioXene, Inc., the Victoria S. and Bradley L. Geist Foundation and a UH Accelerated Research Commercialization grant.