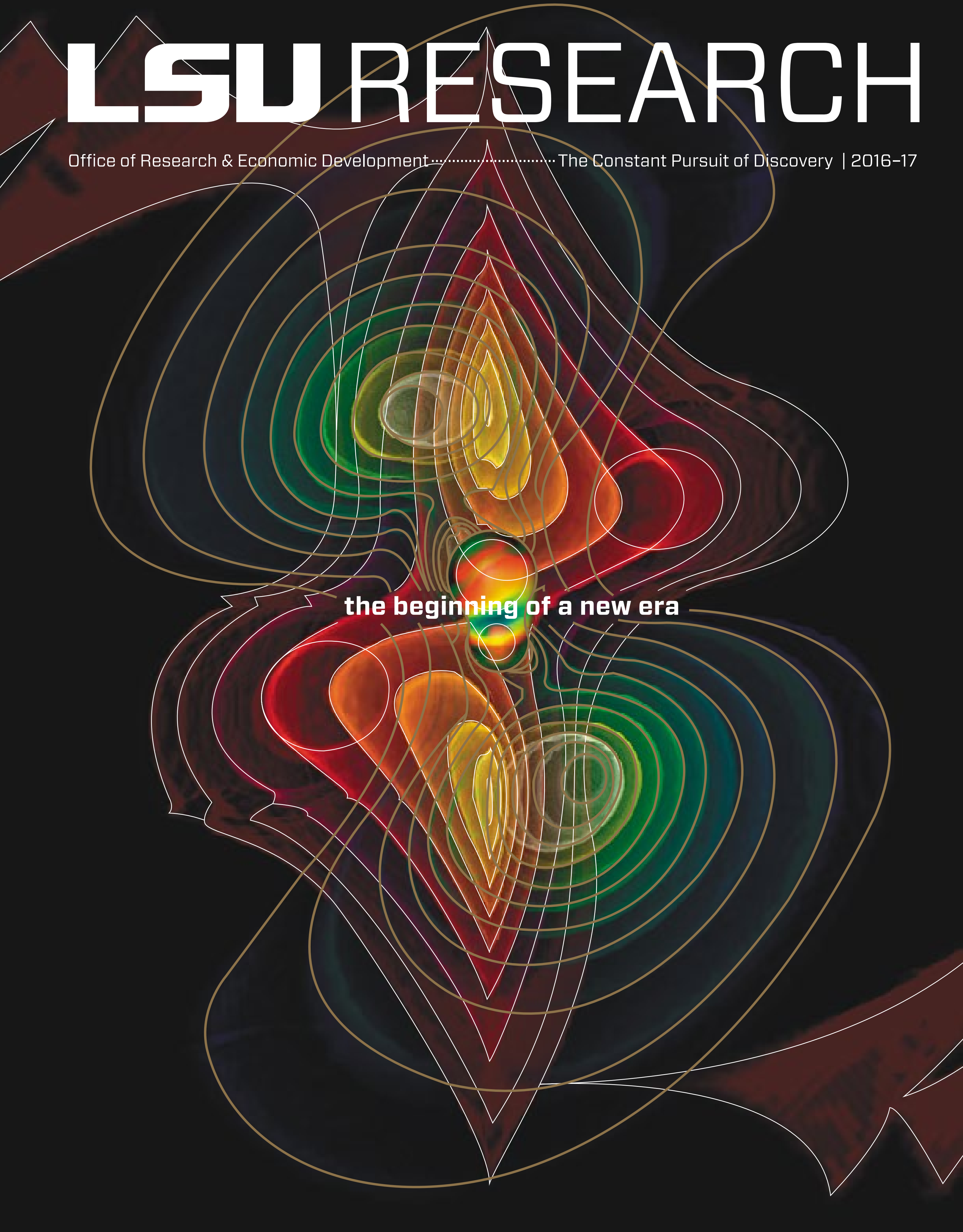
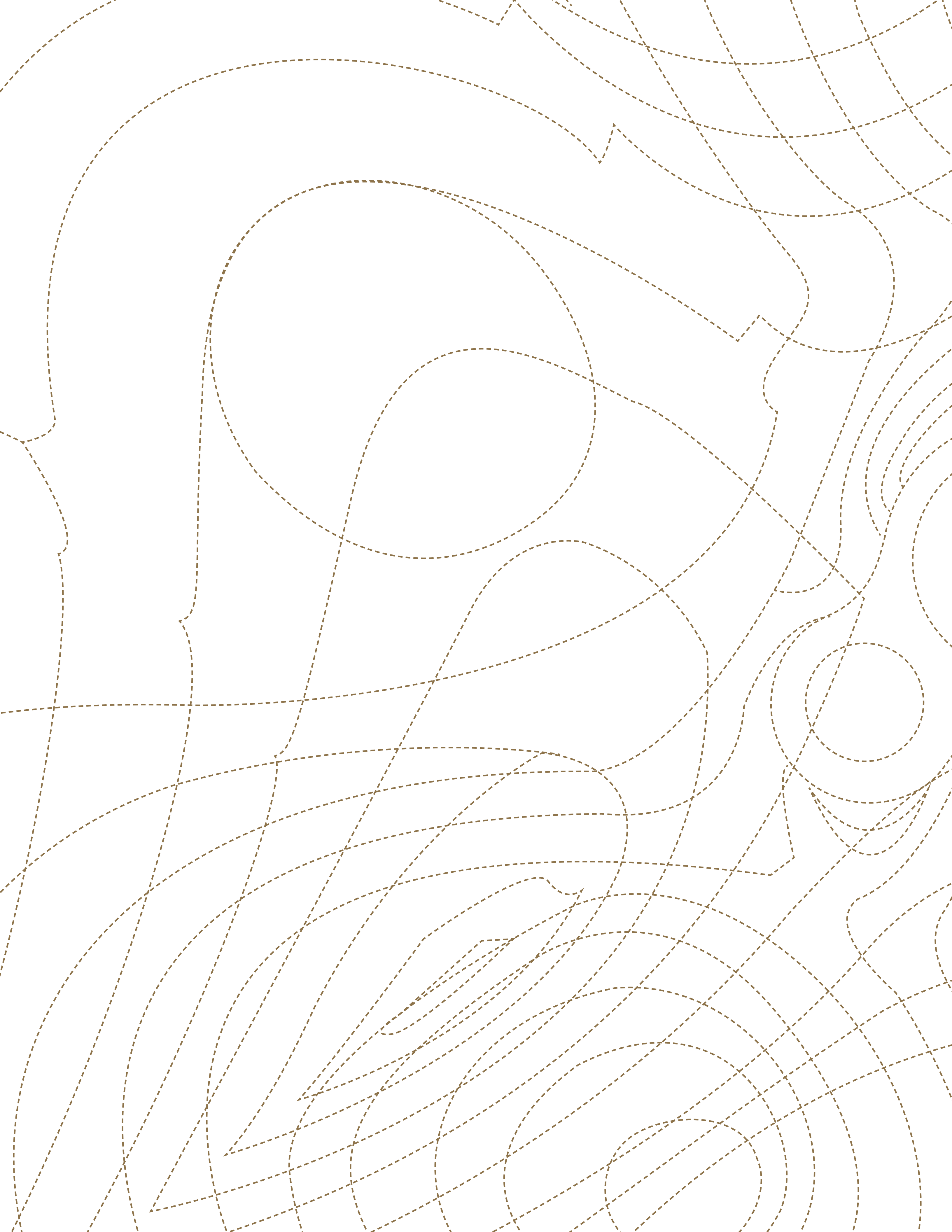
LSU RESEARCH

Office of Research & Economic Development ··· The Constant Pursuit of Discovery | 2016–17



the beginning of a new era



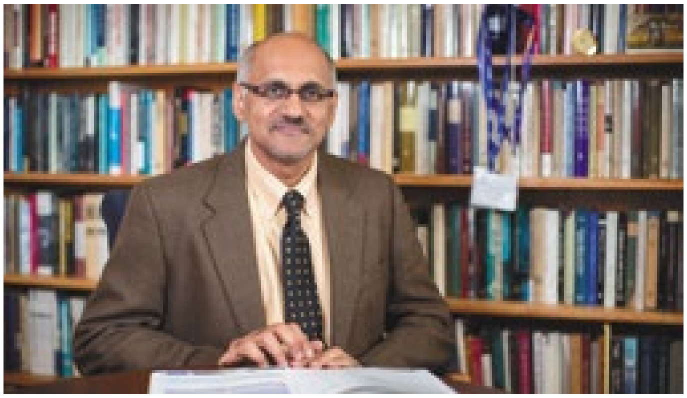
COVER FEATURE

News

Creative Sector

Science Sector

Recognition



FROM THE VICE PRESIDENT

This year has been marked by several new research discoveries. When scientists at LIGO Livingston detected the first gravitational wave created by two black holes colliding, not only did it open our eyes (and ears) to the universe, but it opened a new discipline for research. This has been the result of years of tireless work by many including LSU research faculty who pioneered previous generation gravitational wave detectors on campus. A deep commitment by the National Science Foundation, which has provided the major support for this research, along with the Max Planck Society, the Science and Technology Facilities Council in the U.K., and the Australian Research Council, have all made this possible. At LSU, we are proud to be part of this international collaboration and groundbreaking discovery.

This discovery and many others inspired us to create the Big Ideas issue of *LSU Research*. In this issue, you will find some of LSU's biggest ideas and meet the talented researchers behind them. From Mars to Antarctica and everywhere in between, we will give you a behind-the-scenes look at LSU's research enterprise.

I hope you will enjoy the stories and information about our research. For more details and multimedia content, please visit our website, **LSU.edu/research**.

Kalliat T. Valsaraj

Vice President, Research & Economic Development
Charles and Hilda Roddey Distinguished Professor of Chemical Engineering
Ike East Professor of Chemical Engineering

ABOUT THIS ISSUE

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LSU Research

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About the Cover

The cover image is a scientific visualization with linear and typographic accents. The visualization, provided by LSU researcher Werner Benger, is of two asymmetrical black holes colliding and emitting gravitational waves taken from the first-ever fully 3D numerical computation of this type of event (for more information on these visualizations, see page 60). The cover illustrates not only the revolutionary detection of gravitational waves, but LSU's commitment to discovery, collaboration, and innovation. Its beauty demonstrates that research can transcend the boundaries of art, science, and technology.

Credit: Scientific visualization by Werner Benger, LSU, Zuse-Institute Berlin, and Max Planck Institute for Gravitational Physics/Albert Einstein Institute, or AEI; numerical simulation by Ed Seidel, LSU and AEI; graphic design and illustration by Sydney Langlois, LSU.

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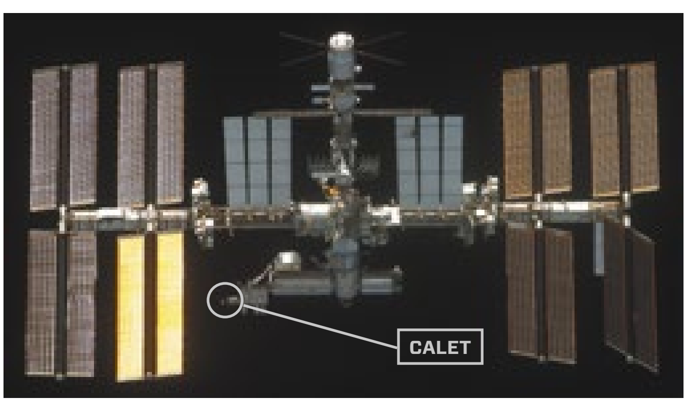
NEWS

LSU Astrophysicists Develop High Energy Telescope aboard International Space Station

By Mimi LaValle

The CALorimetric Electron Telescope, or CALET, is a Japanese–Italian–U.S. experiment on the International Space Station that is currently observing very high energy cosmic ray particles and gamma rays. Designed to search for possible nearby sources of high energy cosmic rays, such as from an undetected pulsar, and for signatures of Dark Matter, which is the poorly understood component that accounts for about 27 percent of the mass-energy of the universe, CALET is the first instrument specifically designed to identify electrons at energies above one trillion electron volts.

Launched from the Tanegashima Space Center off the southern coast of Japan on August 6, 2015, the 1,400 pound CALET will spend the next two to five years measuring very high energy cosmic ray electrons, nuclei, and gamma rays. CALET's first results on "space weather"—observations of low energy electrons in Earth's trapped radiation belts—were published in the journal *Geophysical Research Letters* and the preliminary measurement of the spectrum of high energy electrons and cosmic ray nuclei will be presented at an international meeting in Turkey. A secondary instrument, the CALET Gamma ray Burst Monitor, or CGBM, has already seen and reported over two dozen gamma ray bursts, and will be involved in the search for electromagnetic counterparts to gravitational wave events. LSU Physics and Astronomy Professor John Wefel is the U.S. spokesperson. At LSU, Wefel, professors Michael Cherry and Gregory Guzik, postdoctoral researcher Amir Javaid, doctoral student Nick Cannady, research scientists Bethany Broekhoven, Douglas Granger, Michael Stewart, and a team of undergraduates are working with collaborators at more than 30 institutions in Japan, Italy, and the U.S. to analyze the CALET data.



Credit: NASA.

Credit: Blue Origin.

Fluid Dynamics Experiment aboard Jeff Bezos' Suborbital Space Flight

By Alison Lee Satake

An experiment led by LSU Chemistry Professor John Pojman was aboard the historic flight by Blue Origin, the space tourism company established by Amazon CEO and founder Jeff Bezos. LSU was one of three universities, including Purdue University and Braunschweig University of Technology in Germany, selected to have an experiment aboard the suborbital test flight.

LSU's Pojman and his collaborators at William Jewell College in Liberty, Mo., designed and conducted an experiment that tests the physics of how fluids move between each other, a principle termed effective-interfacial-tension-induced convection, which is a type of flow at the interface between two fluids. It is well known that two separate miscible fluids, like oil and water, can experience fluid flow at their boundary when changes in temperature or gradients in their concentration are applied. However, it's not clear whether a similar process occurs at the boundary of miscible fluids that dissolve into each other.

"There's no way on Earth we could do this experiment because gravity interferes with fluid dynamics," Pojman said.

> "It's exciting to finally be able to test a theory that's over 100 years old."
>
> —John Pojman
> LSU Chemistry professor

Pojman and his collaborators built a system that applies ultraviolet light to a reactive molecule, or a monomer, called

Credit: Blue Origin.

Researchers from William Jewell College and LSU were selected to have an experiment aboard the Blue Origin suborbital space flight on June 19. Researchers from left to right: Grace Bunton, Patrick Bunton, John Pojman, and Erika Storvick.

dodecyl acrylate, which causes the monomer to convert into a viscous fluid. (The material and process is similar to how liquid dental fillings are hardened with light.) Tiny particles are dispersed throughout the monomer while a laser light illuminates them in a plane. A GoPro camera focused on the experiment records what happens over the three minutes of weightlessness. The experiment reveals how fluids with different compositions will move and interact when they come into contact with one another. The results of this experiment may reveal insights into the fluid dynamics of magma from volcanic lava flows as it moves over thousands of miles and how materials need to be processed in space.

This payload flew on-board Blue Origin's New Shepard space vehicle. The New Shepard vertical takeoff and vertical landing vehicle is capable of carrying hundreds of pounds of payloads per flight and will ultimately carry six astronauts to altitudes beyond 100 kilometers, the internationally recognized boundary of space. This payload was part of Blue Origin's Pathfinder Payloads program, demonstrating the integration and operation of scientific experiments during untended test flights of the New Shepard system to high altitudes.

"This is also exciting because this experiment combines my love of space and astronomy with chemistry," Pojman said.

Pojman's chemistry and fluid dynamics experiments have been conducted on the International Space Station.

Scientists Craft an Artificial Seawater Concoction

By Alison Lee Satake

Microbiologists have concocted an artificial seawater medium that can be used to successfully cultivate abundant marine microorganisms, many of which have not been genetically characterized before. The recipe and study led by LSU doctoral candidate Michael Henson and LSU Assistant Professor Cameron Thrash with support from LSU undergraduate researchers David Pitre from Houma, La., Celeste Lanclos from Opelousas, La., and Jessica Lee Weckhorst from Denham Springs, La., was published recently in the open access journal, *mSphere*.

"Less than 1 percent of microbes have been cultivated, and we need new cultures," Henson said.

The research team developed a suite of four artificial sea water media that vary based on salinity to make it more accessible to more people to conduct this research. The artificial seawater media consists of about 60 ingredients that include chemical elements such as calcium, sodium, magnesium plus organic and inorganic nitrogen, carbon, trace metals, and B vitamins.

> "We developed an artificial media, which means you can make it in the lab; and anyone can order these chemicals and make this media anywhere in the world."
>
> —Cameron Thrash
> LSU Biological Sciences assistant professor

Credit: Cameron Thrash, LSU.

LSU doctoral candidate Michael Henson collects seawater samples in the Gulf of Mexico.

Prior to this discovery, many of the most abundant microorganisms in the ocean that have been successfully cultured were done so with the aid of natural seawater media. The painstaking culturing process that includes filtering and sterilizing the seawater can pose many challenges. First, it requires access to large volumes of seawater, which can be logistically challenging for research labs that are not located near the coast. Secondly, the composition of natural seawater is not clearly defined or understood; therefore, it is difficult to characterize it physiologically. Thirdly, the composition of seawater at various times and places chemically changes; it's not static.

"You get what we call 'vintages' of seawater at the same location over various periods of time," Thrash said. "Bacteria that grow easily in saltwater rarely grow easily in freshwater and vice versa."

To solve some of these challenges, his lab created a complex yet defined artificial seawater media that is portable and reproducible. The researchers have made all of their data and supplemental materials publicly available online.

Study Maps Rate of New Orleans Sinking

By Alan Buis

New Orleans and surrounding areas continue to sink at highly variable rates due to a combination of natural geologic and human-induced processes, finds a new study led by NASA and researchers at universities including LSU and UCLA, using NASA airborne radar. The observed rates of sinking, otherwise known as subsidence, were generally consistent with, but somewhat higher than, previous studies conducted using different radar data.

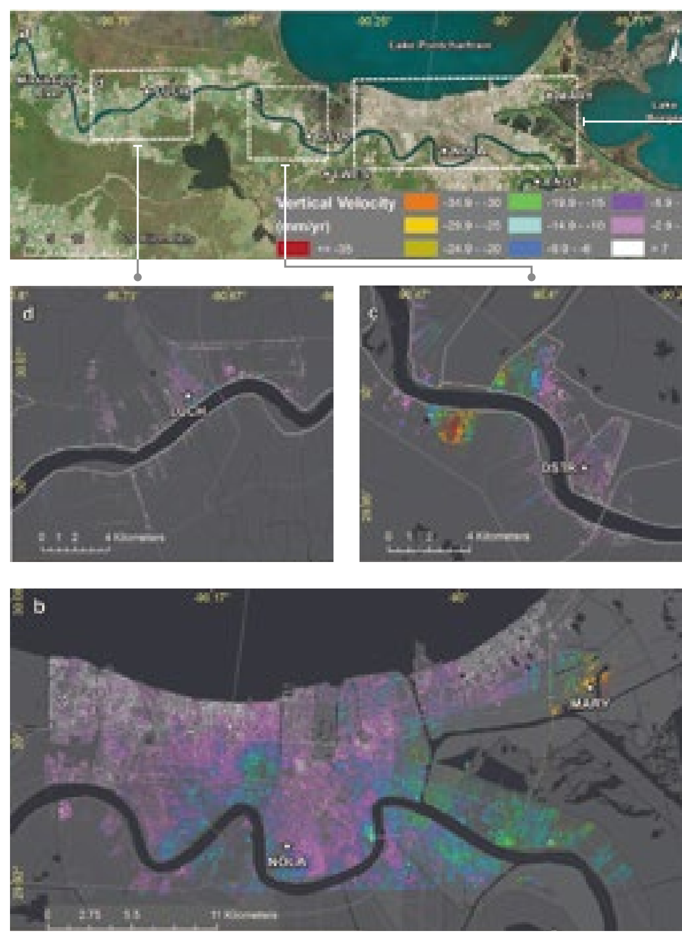
The research was the most spatially extensive, high-resolution study to date of regional subsidence in and around New Orleans, measuring its effects and examining its causes. Scientists at NASA's Jet Propulsion Laboratory, or JPL, in Pasadena, Calif.; UCLA; and the Center for GeoInformatics at LSU collaborated on the study, which covered the period from June 2009 to July 2012.

The highest rates of sinking were observed upriver along the Mississippi River around major industrial areas in Norco and in Michoud, with up to 2 inches, or 50 millimeters, a year of sinking. The team also observed notable subsidence in New Orleans' Upper and Lower 9th Ward and in Metairie, where the measured ground movement could be related to water levels in the Mississippi River. At the Bonnet Carré Spillway east of Norco—New Orleans' last line of protection against springtime river floods overtopping the levees—research showed up to 1.6 inches, or 40 millimeters, a year of sinking behind the structure and up to 1.6 inches, or 40 millimeters, a year at nearby industrial facilities.

While the study cites many contributing factors for the regional subsidence, the primary contributors were found to be groundwater pumping and dewatering, or surface water pumping to lower the water table, which prevents standing water and soggy ground.

JPL scientist and lead author Cathleen Jones said study results will be used to improve models of subsidence for the Mississippi River Delta that decision makers use to inform planning.

"Agencies can use these data to more effectively implement actions to remediate and reverse the effects of subsidence, improving the long-term coastal resiliency and sustainability of New Orleans," Jones said. "The more recent land elevation change rates from this study will be used to inform flood modeling and response strategies, improving public safety."



Credit: NASA JPL.

A map of the Mississippi River Delta study area with white boxes outlining the three areas analyzed and the findings derived from NASA airborne radar.

To fully measure and predict future subsidence in and around New Orleans, it is necessary to better understand the various natural and human-produced processes contributing to the sinking. Those include withdrawal of water, oil, and gas; compaction of shallow sediments; faulting; sinking of Earth's crust from the weight of deposited sediments; and ongoing vertical movement of land covered by glaciers during the last ice age. Jones said the comprehensive subsidence maps produced by this study, with their improved spatial resolution, help scientists to differentiate these processes.

The maps were created using data from NASA's Uninhabited Aerial Vehicle Synthetic Aperture Radar, or UAVSAR, which uses a technique known as interferometric synthetic aperture radar, or InSAR.

In addition to the UAVSAR data, researchers from the Center for GeoInformatics, or C4G, at LSU provided up-to-date GPS positioning information for industrial and urban locations within southeast Louisiana. This information helped establish the rate of ground movement at these specific points. C4G maintains the most comprehensive network of GPS reference stations in the state. The Louisiana network consists of more than 50 Continuously Operating Reference Stations, or CORS sites, which acquire the horizontal and vertical coordinates at each station every second of every day. The CORS sites are part of the National Geodetic Survey network.

CORS data pin InSAR data down to specific, local points on Earth. The LSU research team derived the positional time series using precise point positioning software developed by JPL.

"We define all the parameters to reduce the ambiguities. This enables us to distill a location down to millimeter-level precision," said Joshua Kent, Geographic Information System manager at C4G.

> "A wide range of people rely on the CORS data, from geoscientists to surveyors, engineers, and farmers."
>
> —Joshua Kent
> LSU Center for GeoInformatics
> Geographic Information System manager

The study was published in the *Journal of Geophysical Research: Solid Earth*.

Physicists Contribute to Nobel Prize-Winning Research

By Mimi LaValle

The 2015 Nobel Prize in Physics was awarded to Takaaki Kajita of the University of Tokyo and Arthur McDonald of Queens University in Canada for the discovery of neutrino oscillations, which shows that neutrinos—a type of subatomic particles—have mass. LSU Professor of Physics Thomas Kutter and his group of researchers were members of the Sudbury Neutrino Observatory, or SNO Collaboration, led by McDonald, which made the key measurements by observing neutrinos from the sun.

In the case of solar neutrinos, the SNO team solved the 30-year-old puzzle of the "missing solar neutrinos" in their underground laboratory two kilometers below the surface of the Creighton Mine in Sudbury, Ontario. The scientists discovered that neutrinos change on the way from the sun to Earth, which proves that neutrinos have mass. This modifies the long-held Standard Model of particle physics.

The discovery provides insight into fundamental processes governing neutrinos and potential new discoveries into the universe.

LSU's Kutter co-authored, while working at the University of British Columbia, two of the three papers that document the discovery of neutrino oscillations, which the Nobel committee deemed essential.

> "It has been an honor to be a member of the SNO Collaboration and to participate in this historic research, which required meticulousness in every step along the way."
>
> —Thomas Kutter
> LSU Department of Physics & Astronomy professor

Kajita was the leader of the Super-Kamiokande Collaboration, which made similar measurements by looking at neutrinos generated in the atmosphere of Earth.

The Super-Kamiokande detector is currently also being used as a distant detector by the T2K experiment, which further explores neutrino oscillations by means of a man-made neutrino beam. Kutter, Martin Tzanov, assistant professor in the LSU Department of Physics and Astronomy, and their team of LSU post-doctoral researchers and students are members of the T2K collaboration and continue to make significant contributions to the measurement of neutrino oscillations and their properties.

The awarding of the Nobel Prize for neutrino oscillations represents an important endorsement of the neutrino experiments led by the Nobel laureates, and the field of neutrino physics. This is also a great recognition for all of the contributors, which include LSU faculty. The Nobel Prize in Physics is awarded by the Royal Swedish Academy of Sciences in Stockholm, Sweden.

New Smartphone App Provides Critical Information to Commercial Fishermen

By Paula Ouder

A free smartphone application is now available to improve emergency preparedness for those who navigate Louisiana waters. Waterway Information for Vessels, or WAVE, is unique because it brings a host of useful data from numerous sources into a single mobile platform. The idea grew from Sea Grant's work on harbors of refuge, with the initial goal of helping commercial fishermen locate safe mooring for their vessels in the event of a major storm.

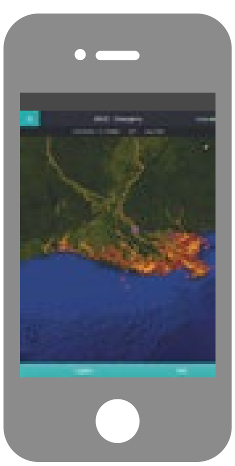
"If fishermen are away from their home port, they don't necessarily know where to go when a hurricane approaches," said Lauren Land, Louisiana Sea Grant sustainability coordinator.

WAVE users can toggle on and off the layers of information they want to view, including maps; charts; weather conditions, warnings, and forecasts; fisheries data; and historic storm information. The application also shows publicly owned waterfront areas, and an emergency preparedness section is provided for Vermilion Parish. Fisheries content is drawn from the Louisiana Department of Wildlife and Fisheries and includes public seed grounds, private oyster leases, boundaries for fresh and saltwater shrimp zones, and Louisiana Department of Health and Hospitals harvesting areas, and how they are classified.

National Oceanic and Atmospheric Administration content includes electronic navigation charts and raster navigational charts, the latter of which is similar to what a captain might print and store on the boat. The charts are built into the application and can be retrieved without access to the Internet.

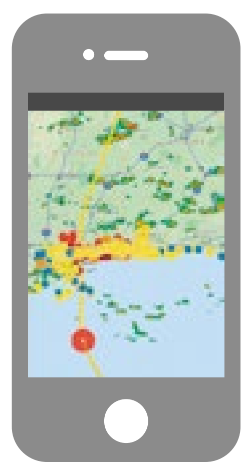
The Coastal Emergency Risks Assessment, or CERA, model data enables users to select a monitoring station and see one line for observed storm surge and another for predicted storm surge in a particular area. Boaters can also access databases of prior hurricanes to view historical high water marks, storm surge, hourly position, and intensity. Weather and tide information continuously updates with online access and will show the time of the most recent update when the smartphone does not have an active Internet connection. The design is adaptable and scalable and can be adjusted to incorporate other types of data.

WAVE was made possible with funding from the LSU Coastal Sustainability Studio's 2014–2015 Small Projects Fund. Other WAVE team members include lead application developer Danny Holmes, a Ph.D. candidate at the LSU School of Music and an employee at the LSU Center for Computation and Technology, or CCT; Carola Kaiser, an information technology consultant and GIS specialist with the Coastal Sustainability Studio; Hal Needham, program manager for NOAA's Southern Climate Impacts Planning Program at LSU; Marc Aubanel, director of Digital Media Arts and Engineering at CCT; and Alexa Andrews, project manager with the Center for Business Preparedness at the Stephenson Disaster Management Institute at LSU. WAVE was designed for iPhone and iPad and is available as a free download through the Apple App Store. ■



The WAVE app helps fishermen access:

- maps
- charts
- fisheries data
- historic storm data
- weather
- public areas
- forecasts and warnings
- emergency preparedness



Daniel Stetson

Q&A with the LSU Museum of Art's New Executive Director

By Ernie G. Ballard

Daniel Stetson has more than 30 years of executive museum and curatorial leadership experience and has worked within a variety of institutions and governance structures, including public and private universities and government-based and private not-for-profit organizations.

Before coming to Baton Rouge, he served as executive director of the Hunter Museum of American Art in Chattanooga, Tenn. Prior to that, he was the executive director of the Polk Museum of Art in Lakeland, Fla., for nearly 15 years; executive director of the Austin Museum of Art/Laguna Gloria in Austin, Texas (now Austin Contemporary); director of the Davenport Museum of Art in Davenport, Iowa (now the Figge); director and instructor at the Gallery of Art at the University of Northern Iowa in Cedar Falls, Iowa; and acting director of the Picker Art Gallery at Colgate University in Hamilton, N.Y.

Stetson holds a bachelor's degree in art history from the State University of New York at Potsdam and a Master of Fine Arts degree in museology, or museum studies, from Syracuse University. He is a 2010 graduate of the Getty Museum Leadership Institute at Claremont Graduate University in Los Angeles.

What drew you to LSU?

LSU and the LSU Museum of Art have outstanding reputations for quality and a genuine dual concern for students and community. I came because of the excellence found here, and to contribute to the university and to the growth and development of the LSU Museum of Art.

The museum is in a unique position—it serves as a bridge between the campus and the community. I think it's an exciting decision to locate a major museum of art within a redeveloped downtown as a positive catalyst for change—positive change that is truly visible in the stimulating activity of this renewed downtown space that's attracting students and individuals of all generations to our city.

The diverse and exciting culture of Louisiana also drew me in. A desire to relocate and be immersed in this richness of place and people is a challenge and an opportunity for someone who loves lived culture. Sharing this with students and the community is an imperative and a joy.

What was your impression of the LSU Museum of Art prior to arriving here?

I was already familiar with the museum to a degree. My first visit was rewarding, though. The Toulouse-Lautrec exhibition was installed at the time, and it was a marvelous and important project for the museum. The plans for the full reinstallation of the permanent collection were only visible in conceptual design drawings and in an empty 10,000-square-foot gallery space. The ambitions of the museum were visible to me in these plans and activities.

My first five months here have been filled with work and accomplishments by our team as the major reinstallation of our collection has been completed and opened, and two temporary exhibitions have been installed—one of Haitian paintings and the current one of internationally renowned Louisiana artist Hunt Slonem. Both of these projects have been installed in a way that is immersive, colorful, and experiential. It's an example of the care and energy put into our projects.

What are your plans for the LSU MoA going forward?

I began my tenure here in January, and the first order of business was getting a new curator on board to be a big part of the creative and leadership team. We were successful in that search, and now have Curator Courtney Taylor, who joined us in June.

We are a center for the study and experience of the arts of Louisiana and aspects of the world through our collection, exhibitions, and programs. My goals include strengthening the connection of the museum and the campus through our activities and through the support of our new Communications Coordinator Brandi Simmons; increasing our service to the greater Baton Rouge community; empowering the staff to advance the position of the museum within our state, region, and nation; and also assuring that the museum has a stable and growing funding base.

American painter Hunt Slonem signs Stetson's tie. LSU Museum of Art presented Slonem's Antebellum Pop! exhibit in Spring 2016.

Importantly, as a bastion of free expression and the right of assembly, I want the museum to be seen as a go-to place for socializing and fun, as well as a place for thoughtful engagement for all ages.

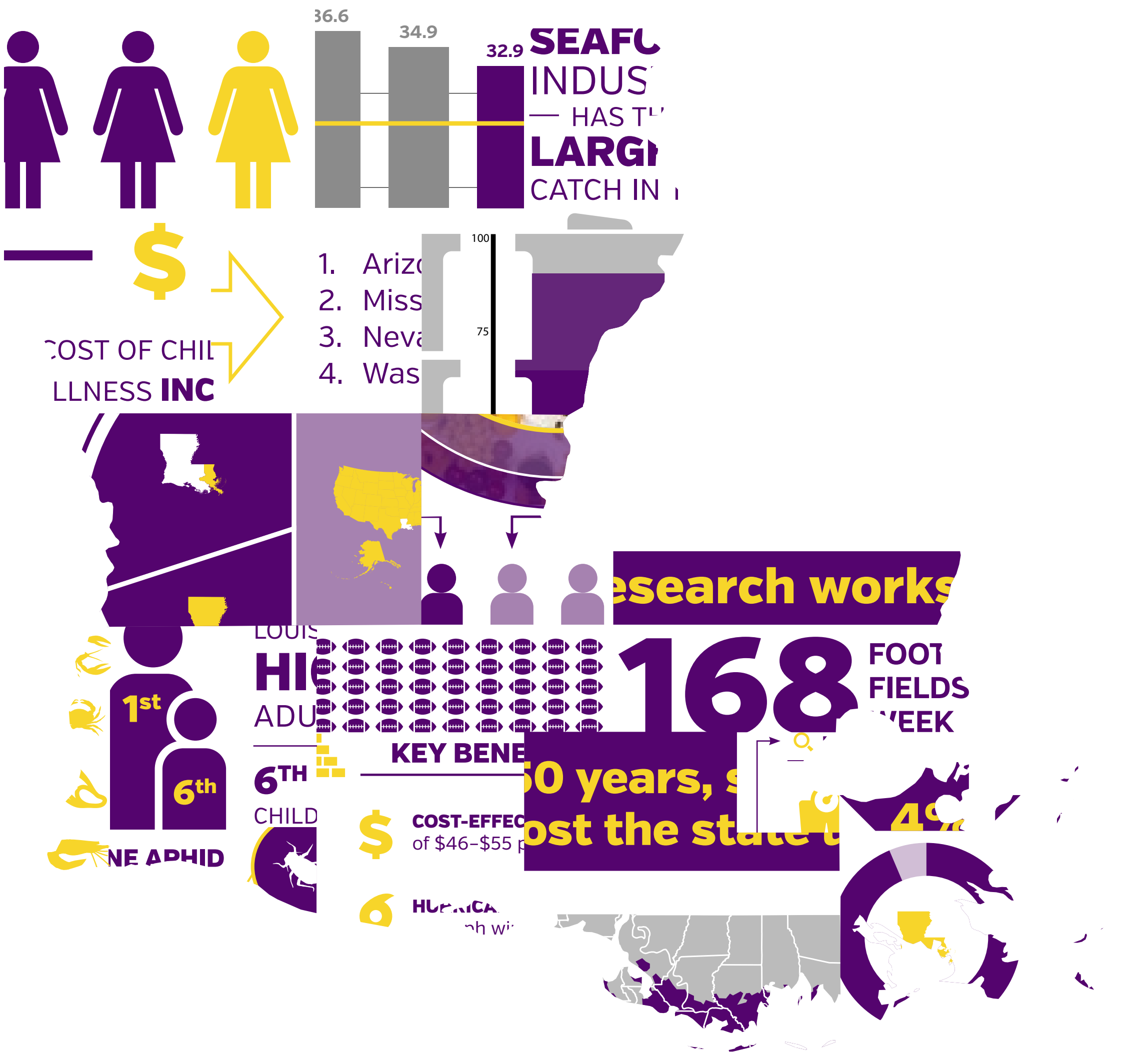
What has been the biggest surprise to you about LSU, the museum, or Baton Rouge?

The biggest surprise is the ease of access for almost anything I need—including cultural events, shopping, dining, and music. As an example, while my arrival this past December coincided with the opening of our wonderful Haitian painting exhibition, I additionally experienced the holiday parade where even Santa throws beads, had a wonderful meal at the downtown Capital City Grill, and attended a performance by BeauSoleil with Michael Doucet at the Manship Theatre. That was a great day! The number of festivals and events in Town Square on North Boulevard has been another welcome surprise. The very special campus Live Oak trees, the access to the levee, beautiful Mississippi River sunsets, and the people of Baton Rouge have all in their own way said to me, "welcome home." I know New Orleans is just down the mighty Mississippi, but there is so much here to enjoy and explore.

What do you want people to know about the LSU MoA?

Sometimes I feel like we are the best kept secret in town. Our attendance has seen a near doubling since last calendar year. So we are being discovered, but it's never enough. The Museum of Art is a place to gather, socialize, discuss, celebrate, and be a community. Our exhibitions are truly excellent and you don't have to be an "art person" to enjoy the company, the beautiful spaces, and cultural treasures we have in the Shaw Center. We're here for all ages to enjoy, and we love seeing families visit our exhibition galleries and our new Pennington Foundation Family Education Gallery. Freedom of expression and the right to gather are part of our founding principles, and the Museum of Art is a testament to those values.

I invite everyone to come for a visit for the first time or the one hundredth time. You won't be tested on the way out, so don't be afraid of the art. Come and be surprised and know that this is your museum. Civilization is something we need more of in this world, and it can be fun! ■



LSU RESEARCH WORKS FOR A BETTER LOUISIANA

By V. Todd Miller

LSU faculty conduct research that touches the lives of millions of people. As the state's flagship university, our work focuses on finding solutions to some of the largest problems we face, which span chronic disease to coastal land loss. Through science, scholarship, and discovery, our faculty and students are making a difference and improving our lives.

In the spring of 2016, LSU set out to create a means to communicate the important solutions being created and refined daily by LSU research faculty on behalf of Louisiana, the nation, and the world. In an effort to inform state legislators and their constituents of the significance of LSU research and higher education, LSU Research Works was born.

Through a series of one-page fact sheets, social media posts, web-based communications, and traditional media outlets, LSU Research Works was introduced to educate every corner of Louisiana about the need for LSU in our state. We are here and will always be here, as long as the support of Louisiana and its citizens never waivers.

LSU RESEARCH WORKS has thus far focused on:

Alzheimer's Disease

Problem: Louisiana ranks 5th nationally in deaths related to Alzheimer's Disease.

Research at Work: Members of the LSU Life Course and Aging Center are collaborating with state and community partners to provide programs like "Music and Memory" as an alternative to antipsychotic drugs.

Childhood Obesity

Problem: More than 40 percent of Louisiana children are overweight or obese.

Research at Work: The LSU College of Human Sciences and Education and the LSU AgCenter offer nationally recognized, innovative programs for nutrition and physical activities such as the Smart Bodies program, which is integrated into Louisiana elementary schools to prevent childhood obesity.

Energy

Problem: The drop in oil prices has created economic challenges throughout Louisiana, which produces 20 percent of U.S. crude oil.

Research at Work: The USDA awarded LSU AgCenter Audubon Sugar Institute researchers a $17 million grant to develop new processes in biofuels from Energy Cane (high-fiber sugarcane) and sweet sorghum, using existing Louisiana sugarcane factory infrastructure.

Mental Health

Problem: Nearly 20 percent of Louisiana citizens are currently living with mental illness.

Research at Work: The LSU AgCenter is working to identify behavioral health needs of Orleans Parish residents, share data, and develop and promote best practices for improving community behavioral health.

Hurricane Preparedness

Problem: In 50 years, storm and flood damages could cost the state up to $23.4 billion a year.

Research at Work: LSU oceanographers, engineers, and computer scientists are improving upon latest computer models to help state emergency response teams predict hurricane storm surge and potential damages more accurately.

Coastal Restoration

Problem: Louisiana loses an equivalent of a football field of coastal wetlands every hour.

Research at Work: LSU geologists conduct new research on where Mississippi River mud moves to speed up land growth and slow down erosion. LSU research informs coastal planners on current and future erosion, sediment deposits, and plant growth to mitigate land loss.

Louisiana Seafood

Problem: Louisiana's $2.4 billion seafood industry is threatened by man-made and natural factors.

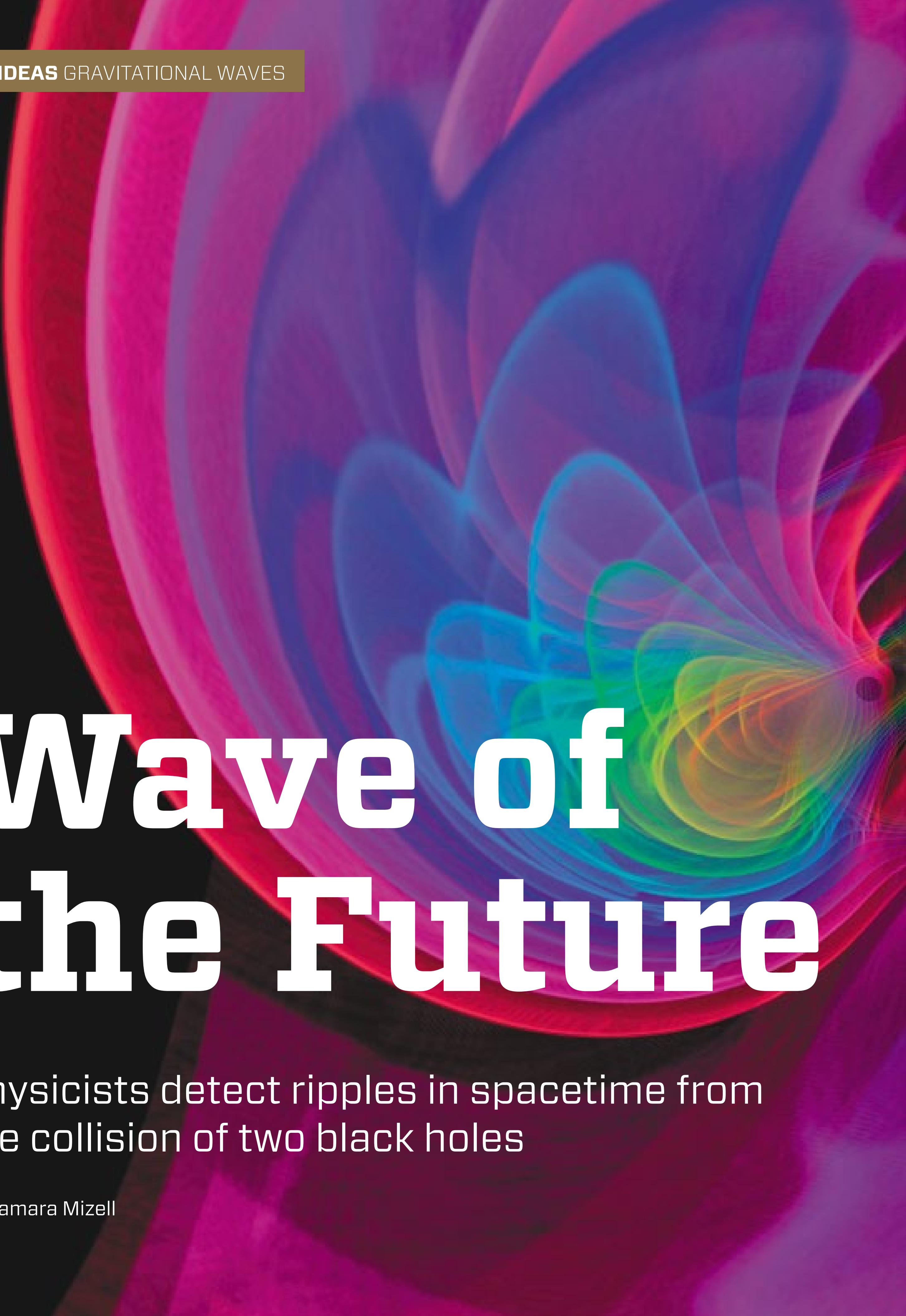
Research at Work: LSU AgCenter has led seafood safety training for 3,000 processors, packers, wholesalers, and harvesters for two decades and with Louisiana Sea Grant launched a mobile training lab to educate commercial fishermen in the field in the latest onboard seafood refrigeration to produce high-quality seafood that captures the highest market price.

Cancer

Problem: Louisiana cancer rates are higher than the national average.

Research at Work: LSU is working on various new chemotherapies and cancer-fighting drugs that prevent and attack cancer without destroying healthy cells. ■

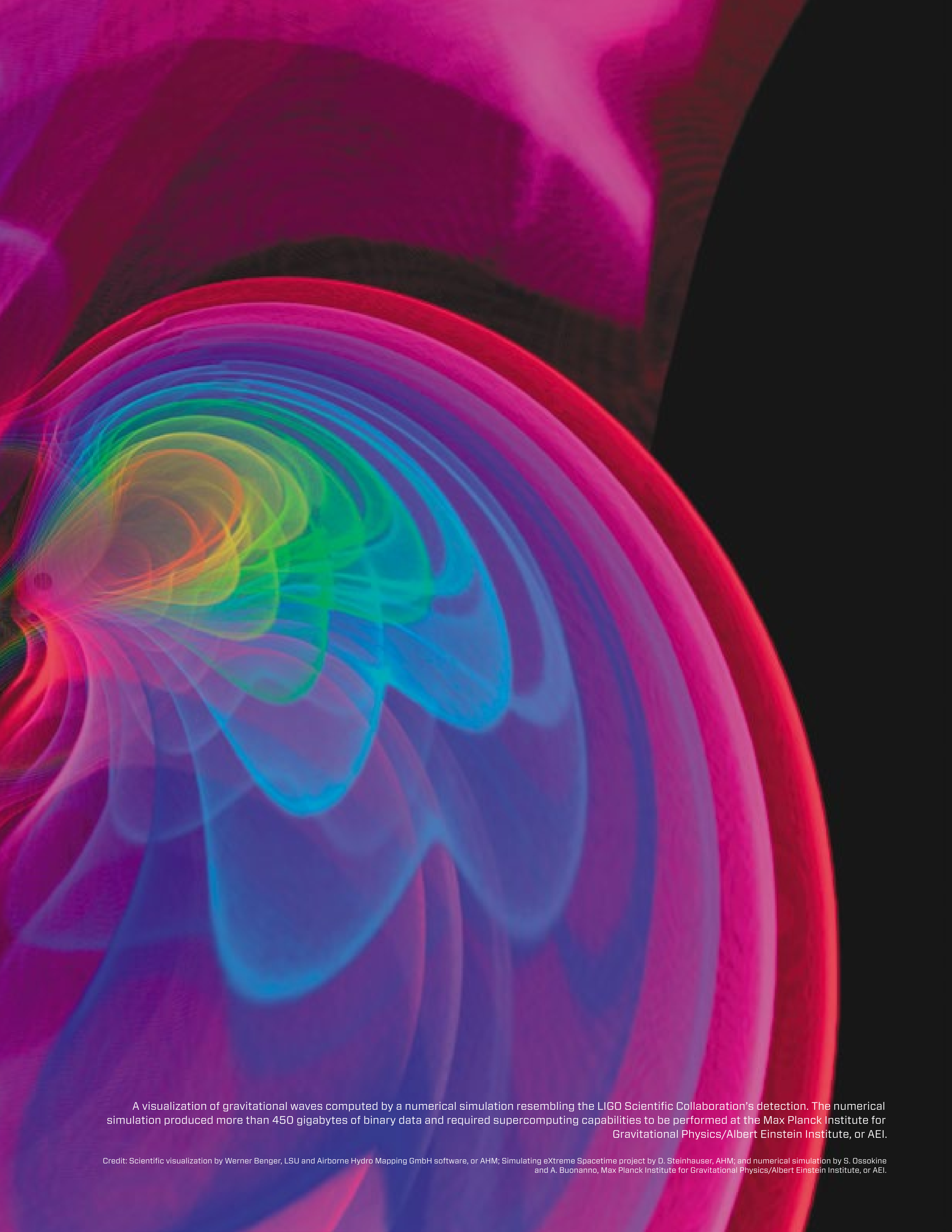
To learn more about all of the research being conducted by LSU faculty and students, visit **LSU.edu/researchworks**. **#LSUresearch**



Wave of the Future

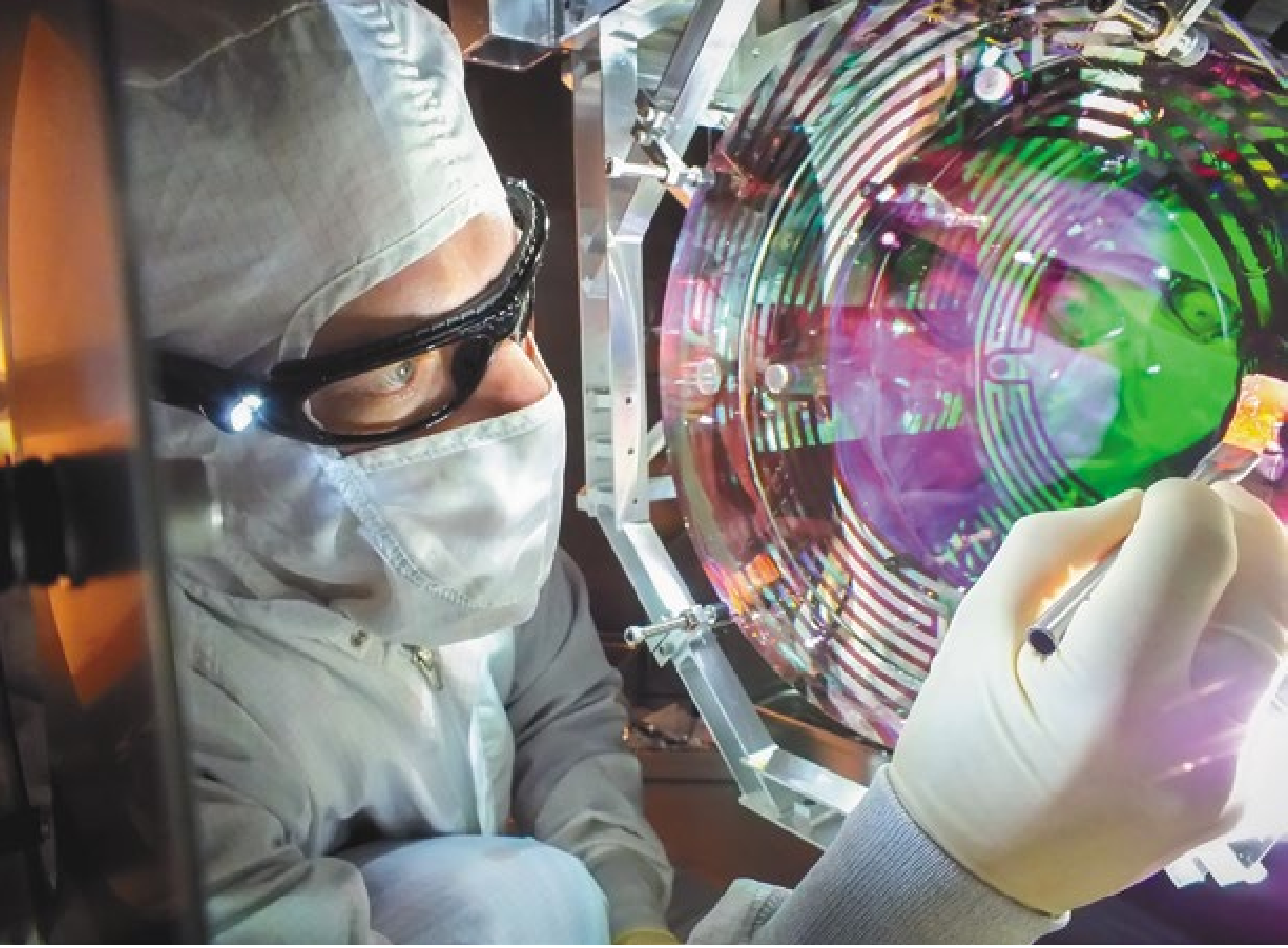
Physicists detect ripples in spacetime from the collision of two black holes

By Tamara Mizell



A visualization of gravitational waves computed by a numerical simulation resembling the LIGO Scientific Collaboration's detection. The numerical simulation produced more than 450 gigabytes of binary data and required supercomputing capabilities to be performed at the Max Planck Institute for Gravitational Physics/Albert Einstein Institute, or AEI.

Credit: Scientific visualization by Werner Benger, LSU and Airborne Hydro Mapping GmbH software, or AHM; Simulating eXtreme Spacetime project by D. Steinhauser, AHM; and numerical simulation by S. Ossokine and A. Buonanno, Max Planck Institute for Gravitational Physics/Albert Einstein Institute, or AEI.



A researcher inspects the optic reflection in the interferometer at LIGO Livingston.

Credit: Caltech/MIT/LIGO Laboratory.

Since the beginning of civilization, humans have looked to the sky for guidance, whether charting a destination by the stars, measuring time by the sun, or attempting to determine what lies beyond our planet. On February 11, 2016, the scientific community took another leap forward when researchers announced the first-ever detection of gravitational waves, predicted by Albert Einstein's 1915 general theory of relativity, ushering in a new era of cosmic observation.

Einstein hypothesized that massive objects could warp or bend spacetime. So, for example, a pair of black holes orbiting near one another would eventually collide, forming a single, more massive black hole. Their combined mass is converted to energy, following Einstein's formula, $E=mc^2$. This energy is emitted as a burst of gravitational radiation, which travels outward like ripples on a pond. These ripples, or gravitational waves, are what researchers hoped to measure—and they succeeded. In this first-ever physical detection of gravitational waves, scientists were able to conclude that the collision and subsequent merger of two black holes happened approximately 1.3 billion years ago.

Picking Up the Signal: GW150914

While the announcement came in February, the waves were actually detected on September 14, 2015, at 4:51 a.m. CT by both of the twin Laser Interferometer Gravitational-wave Observatory, or LIGO, detectors, located in Livingston, La., and Hanford, Wash. Top LIGO researchers woke up to text messages and emails from scientists who were analyzing data from an engineering run, during which systems were being tested prior to the planned observational run. But since the universe never sleeps, researchers got an early wakeup call.

"Even in the beginning, for the first few hours, I thought somebody had made a mistake and that this was a test. So it took some time—a few hours for me, a few weeks for others—to convince ourselves that this was not a test, that this was a candidate."

—Gabriela González
LSU Department of Physics & Astronomy professor
LIGO Scientific Collaboration spokesperson

Once the suspected waves were detected, teams sprang into action to execute detection procedures: first, more data had to be taken and analyzed; then it had to be reviewed for errors or inconsistencies; and a paper had to be written and submitted for review to outside referees who would further analyze the findings. While the LIGO Scientific Collaboration, or LSC, was still analyzing the data and presenting their paper for review, speculation began on social media that gravitational waves may have been detected and reluctant excitement began to build in the scientific community. Once the results were confirmed by outside referees, the LSC announced them to the world.

The LIGO Scientific Collaboration

A century after Einstein predicted the existence of gravitational waves, representatives from the National Science Foundation, or NSF, which funds LIGO, along with researchers from Caltech, MIT, and the LSC took to the podium in Washington, D.C., to announce their findings. LSC is a large, international collaboration with more than 1,000 members led by Gabriela González, who represented LSU and LSC at the National Press Club press conference.

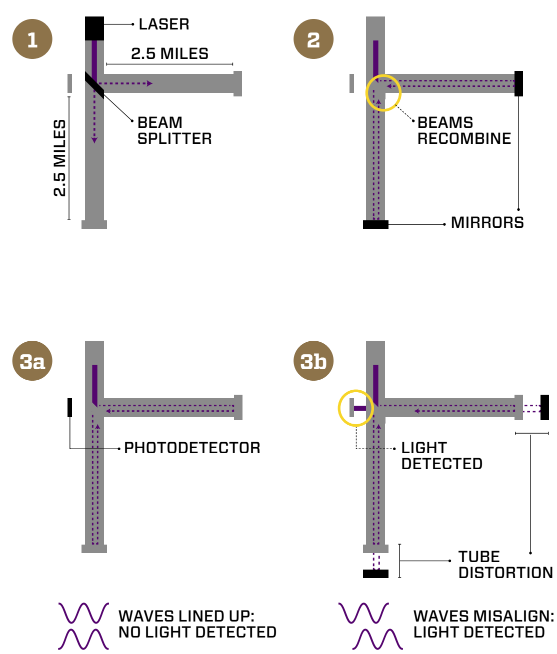
NSF has invested about $1.1 billion in this project over the past 40 years to cover research and development, student education, facilities construction, and staffing. It provides about $50 million per year for research. LIGO Livingston's annual budget is $6–9 million per year and is fully funded by NSF.

The LIGO Livingston observatory is located on LSU property, and LSU faculty, students, and research staff are major contributors to the 15-nation, international LSC. More than 1,000 scientists from universities across the U.S. and 14 other countries conduct LIGO research as members of the LSC. More than 90 universities and research institutions in the LSC develop detector technology and analyze data; about 250 students are contributing members of the collaboration.

"This first detection of gravitational waves owes its existence to the hard work over many years by hundreds of scientists,

HOW DOES THE INTERFEROMETER WORK?

Both the Livingston and Hanford observatories have L-shaped arms that are 2.5 miles, or 4 kilometers, long and 4 feet in diameter. Lasers are sent in two beams down the arms under a near-perfect vacuum. The beams of light are used to monitor the distance between mirrors precisely positioned at the end of the arms. According to Einstein's theory, the distance between the mirrors would change by an infinitesimal amount when a gravitational wave passes by the detector. A change in the lengths of the arms smaller than one-ten-thousandth the diameter of a proton can be detected. The near-simultaneous detection by the two observatories is necessary to confirm that an event is real.



KEY TERMS

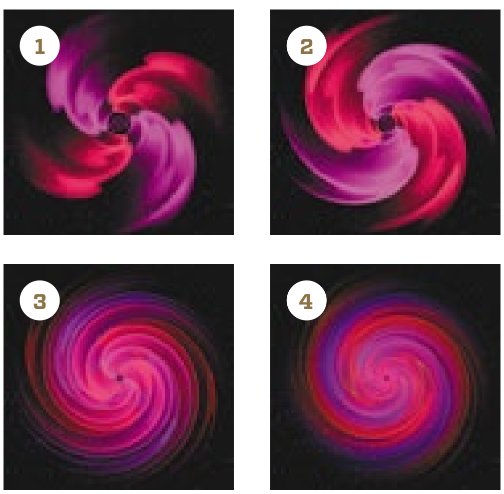
What is spacetime?

In its simplest form, spacetime is the combination of the three-dimensional world of space, which we see all around us, plus time. This gives us the four-dimensional spacetime, a warped fabric that tells how masses move.

Credit: Caltech/MIT/LIGO Laboratory.

What are gravitational waves?

Gravitational waves are ripples in the fabric of spacetime that radiate outward from a cataclysmic astronomical event.



A time sequence of the gravitational wave energy emitted by two black holes colliding. While black holes orbit each other, they radiate gravitational energy and lose angular momentum. The closer they get, the stronger the gravitational energy emitted, which results in an increase of the radiation that is felt as slight distortions in spacetime. The final result is a single rotating black hole that no longer radiates.

Credit: Scientific visualization by Werner Benger, LSU and Airborne Hydro Mapping GmbH software, or AHM; Simulating eXtreme Spacetime project by D. Steinhauser, AHM; and numerical simulation by S. Ossokine and A. Buonanno, Max Planck Institute for Gravitational Physics/Albert Einstein Institute, or AEI.

engineers, and operations staff members. The breathtaking observation of a never-before-observed system of black holes had earned LIGO its ‘O’ as a completely new kind of astronomical observatory,” said Joseph Giaime, LSU professor of physics and astronomy and the observatory head of LIGO Livingston.

LSU’s investment in gravitational wave detection spans more than four decades, and is among the institutions contributing the longest to the present discovery. LSU faculty, students, and scholars have had leading roles in the development of several generations of gravitational wave detectors, in their commissioning and operation as well as the collaborations formed. This achievement is in part an outcome of LSU’s long-term vision and commitment to high-risk, high-potential scientific research.

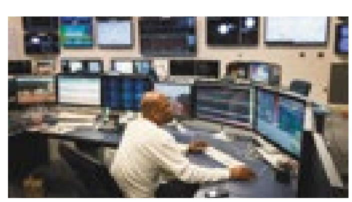
Credit: LSU.

LSU student researchers have been a part of the LIGO Scientific Collaboration work.

A New Window to the Cosmos

From this breakthrough, we will be able to learn more about gravity near a black hole, where spacetime is warped, but that’s only the beginning. LSC scientists continue to conduct research on the existing data and expect to detect more astronomical events as the LIGO detectors and technology become more sensitive, and the European gravitational wave detector, VIRGO, located in Cascina, Italy, begins to collect data this year. They anticipate detecting other events, including neutron stars in our galaxy, other black holes, and supernova explosions.

“I actually have been saying for a long time that I wasn’t looking forward to the first detection, I was looking to get past the first detection,” González said. “What’s more exciting is that the future is now here. We now know that we’ll be detecting more of these, and we really have an observatory. The goal was not to detect the first gravitational wave; it was to detect gravitational waves—plural.” ■



The two LIGO gravitational wave detectors in Hanford, Wash. and Livingston, La. caught a second signal from two black holes in their final orbits and then their coalescence into a single black hole on Dec. 26, 2015.

▲ National Science Foundation Director France Córdova and Gabriela González inside the control room at LIGO Livingston, which is completely funded by the federal agency.

◀ LIGO Scientific Collaboration spokesperson Gabriela González stands in front of one of the two arms of the Laser Interferometer Gravitational-wave Observatory in Livingston, La., that detected the gravitational waves.

Q&A WITH GABRIELA GONZÁLEZ

What role does LSU and its students have at LIGO?

LSU has had a very unique partnership with LIGO because we are so close to the Livingston Observatory. I'm a professor at LSU, but I became very important for the field because of the work that I do at LIGO Livingston. That's how I was elected spokesperson, eventually. And that's true of our students who have been named as critical pieces of this enterprise. They've been able to have that kind of contribution much better and more efficiently than students at other institutions, because they're here.

What has been the most exciting moment, for you, through this process from the first detection until now?

It was seeing the reactions of people, the questions we had, how everybody was watching and reacting to this so favorably. I was kind of expecting some more skeptical questions and people saying, "Well, we should wait and see." But everybody was so excited about this, and the general public wanted to know. And it's been like that since then; it hasn't died down. It's been a steady stream of excitement.

Average Americans may not understand what this discovery means to their everyday lives. How would you simplify this accomplishment in a way that makes it relevant and understandable?

Well, we have no idea—and, in general, scientists have no idea—which discoveries will later turn out to be essential. So we have to keep making them. But I think that there are two aspects of this that get everybody inspired: one is that this proves, not just with math equations from Einstein but from measurements, that the spacetime in which we all live is moving around. We measured this here on Earth. It's moving around; it's not static. You think that the distance between you and me, if we don't move, is set, but it's not. And that just changes the way you think about the universe. The universe is a very, very dynamic place. The other thing that I have learned that inspires everybody, more than I thought, is that we are always looking at the sky, and we want to understand what's out there. So, in this instance, you're looking at the sky and these ripples are coming to you from so, so long ago. So it's like we're beginning to hear the universe, instead of just seeing it.

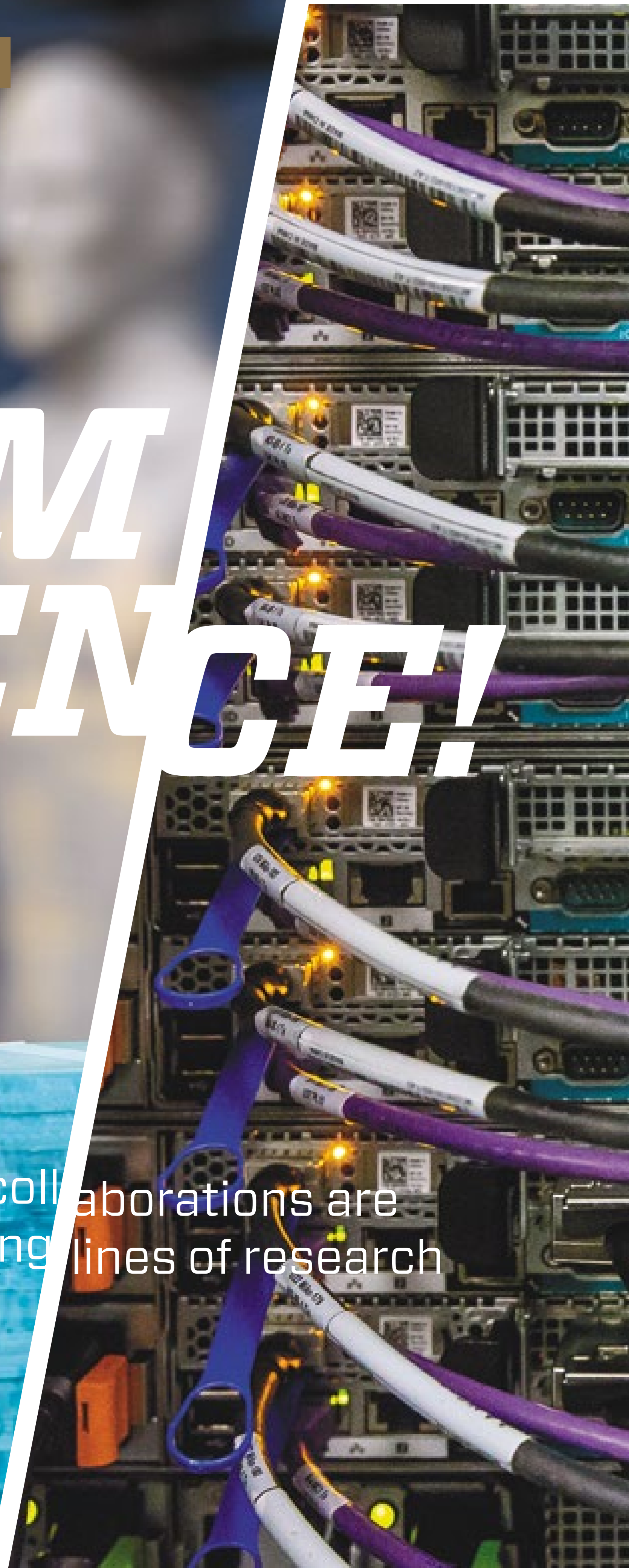
We all know that we need lasers for everything now—in medicine, in movies, and so on—but when lasers were invented, people didn't believe they had any application and said, "Oh, this is a solution looking for a problem." And even with relativity, we tend to think about this as a mathematical way of describing the universe, but it's more real than that; you have to use relativity to get GPS right. So now, relativity is essential to our lives; we all use GPS.

What do you say to people who believe this discovery indicates that time travel is now possible?

This doesn't have anything to do with time travel. It does have to do with time being part of spacetime. When we say that distances get stretched and squeezed, it's actually spacetime—so time gets stretched and squeezed too. We knew that, but now we've measured it. But that's not the same as time travel. You can go forward faster or slower in time, but not back...yet.

What advice would you give to young people, particularly to young women, who want to go into scientific fields?

Ask questions! Ask questions of everybody. And when people say they don't know—because you have to ask questions to people who know the answers, and sometimes you don't know who knows the answers—keep asking. Now, with social media, with the Internet, you can email anybody. We receive questions from school children all the time. So, ask questions; that's how you learn.



TEAM SCIENCE!

How transdisciplinary collaborations are opening new and exciting lines of research

By Alison Lee Satake

As researchers drill down into even more specific areas of expertise, collaboration has become essential. And while most researchers, especially in the sciences, have been working with colleagues in their fields for years, more and more faculty are pushing the boundaries and coming together across disciplines to tackle some of the big challenges of today.

MODELING COASTAL SUSTAINABILITY

LSU Professor and Abraham Distinguished Professor of Louisiana Environmental Studies Nina Lam and a transdisciplinary team is addressing one complex question: is coastal Louisiana sustainable? Amid coastal land loss, subsidence, sea level rise, flooding, hurricanes, and oil spills, the researchers have come together to assess where the tipping point is that would make coastal Louisiana too costly to sustain.

“It’s so emotional. It’s so political. We just want answers,” Lam said. “The real world needs some solution. We need to find the most reasonable estimates.”

To address this complex, multifaceted problem, she has assembled a team of six researchers who bring expertise in hydrology, sedimentation, ecology, impacts on the energy industry, real estate, development, and government policy. An award from the National Science Foundation’s Coupled Natural-Human Dynamics program supports them.

They are studying Louisiana’s lower Mississippi River basin where inland populations have increased while coastal populations have declined over the past 10 years since Hurricane Katrina, which exacerbated the migration trends. Compared to previous land loss studies that have focused on quantifying the vegetation, sedimentation, and soil loss, this study incorporates the human component in a quantified way. It aims to answer how humans are impacted by land loss.

Left: Medical physics researchers utilize 3D printing technology to personalize and improve cancer treatment.
Right: SuperMike-II is the supercomputing powerhouse that makes it possible for researchers at LSU to tackle today’s biggest research questions.

"Very few people are trying to model it quantitatively, because it's difficult to translate it into factors that can be modeled," Lam said.

The team meets monthly to share the parameters that are essential to each of the expert's piece of the puzzle. They also are working together to determine the data resolution and time frame so each of these environmental and human factors can mesh in the model.

scientists, engineers, government agencies, and stakeholders to "produce transdisciplinary results and provide effective tools and products that enhance coastal resiliency."

Lam and Hagen's work contribute to LSU's research strength in coastal and environmental sustainability.

trans·dis·ci·plin·ary re·search

noun \ˈtran(t)s, ˈtranz\-ˈdi-sə-plə-ˌner-ē\ \ri-ˈsərch, ˈrē-ˌ\

research efforts conducted by investigators from different disciplines working jointly to create new conceptual, theoretical, methodological, and translational innovations that integrate and move beyond discipline-specific approaches to address a common problem.*

**as defined by Harvard Transdisciplinary Research in Energetics and Cancer Center*

"It's difficult, but exciting," Lam said.

It's a fine line between community adaptability and vulnerability.

"The relationship between exposure and damage is vulnerability. The relationship between damage and recovery is adaptability," she said.

As a precursor to this study, Lam developed a model to measure human resiliency in Louisiana. She used 10 variabilities that include housing density, road density, flood zone areas, percentage of native born, median household income, percentage of female headed households, percentage of housing built after 2000, and percentage of telephone service available to assess community resiliency. The team of researchers plans to present the model thus far to resource managers and planners to get their feedback. Ultimately, the tool needs to be useful for the decision makers on the ground.

"We need to be pragmatic and credible. In my field of GIS remote sensing, you can do a lot of modeling but I have one goal here and it is: what is the outcome? How can people use these results?" Lam said.

She has lent her expertise in modeling community sustainability around the world including earthquake resilience in Sichuan, China and the Caribbean to flood resilience in the Netherlands.

"I like to try to model in such a way that's as objective as possible and from a regional perspective," she said.

The new LSU Center for Coastal Resiliency led by Louisiana Sea Grant Laborde Chair Scott Hagen is also fostering collaboration between natural and social

ADVANCING CANCER TREATMENT

The survival rate of cancer is increasing due to advances in detection and treatment. According to the National Cancer Institute, there were about 14.5 million cancer survivors in 2014, and experts project that that number will grow to about 19 million survivors by 2024.

"As a researcher, you're trying to look over the horizon and develop the things for 10, 15, 20 years from now. What's going to be the next big need?" asked Wayne Newhauser, director of the Medical Physics and Health Physics program at LSU.

Newhauser and his students and colleagues are working on ways to continue to improve radiation treatment.

"My vision is to further improve cancer survivorship by reducing the side effects of radiation therapy. As a research community, we have in the past concentrated on curing the primary cancer, and rightly so. In the future, research will discover ways to make treatments gentler on the patient's healthy tissues. About two out of every three cancer patients will receive radiotherapy, often together with surgery and chemotherapy. The advantages of radiation therapy are that it is non-invasive, unlike surgery, and it is highly focused on the tumor, unlike systemic chemotherapy. However, a disadvantage is that low levels of unwanted stray radiation reach the entire body. This can cause side effects. Our laboratory is working on reducing those side effects. This requires research on the physics of the radiation transport in the patient's whole body, which in turn requires novel approaches to imaging the whole body quickly and with no additional radiation exposure. Once this research is completed, we will be able to calculate the dose to all of the tissues and use that information to design treatments that have fewer side effects," he said.

For example, breast cancer is one of the most common forms of cancer. And due to the proximity to the lungs and heart, which are sensitive to radiation, researchers seek to further minimize exposure of those organs to the lowest level physically possible.

"If we can develop personalized treatments that both eradicate the tumor and spare the heart and lungs, then we can expect to improve survivorship by keeping women free from major complications down the road," he said.

To do so, Newhauser has turned to what may seem like unlikely collaborators: faculty in the LSU School of Architecture and the College of Art and Design. Utilizing 3D scanners and printers, this transdisciplinary team has been able to create models, or phantoms, of cancer patients to research personalized radiation treatment and better target cancer cells.

The researchers created a phantom of a patient, who had undergone surgery that removed a tumor on his nose. After surgery, radiation is often prescribed to remove any residual disease. But because the topographical area in this case was complex, the detailed phantom was helpful to locate specific areas that needed radiation.

> "I'm always on the lookout for new and interesting technologies. 3D printing is going to change how we do so many things across the human enterprise."
>
> —Wayne Newhauser
> LSU Medical Physics & Health Physics program director

In addition to the physical 3D printed models, Newhauser's team is working on a mathematical model of the whole body that can simulate radiation treatment of a primary tumor and calculate the radiation dose to the whole body. "It's a very detailed yet comprehensive way to simulate radiation therapy. One needs a lot of computing power and lots of memory," he said.

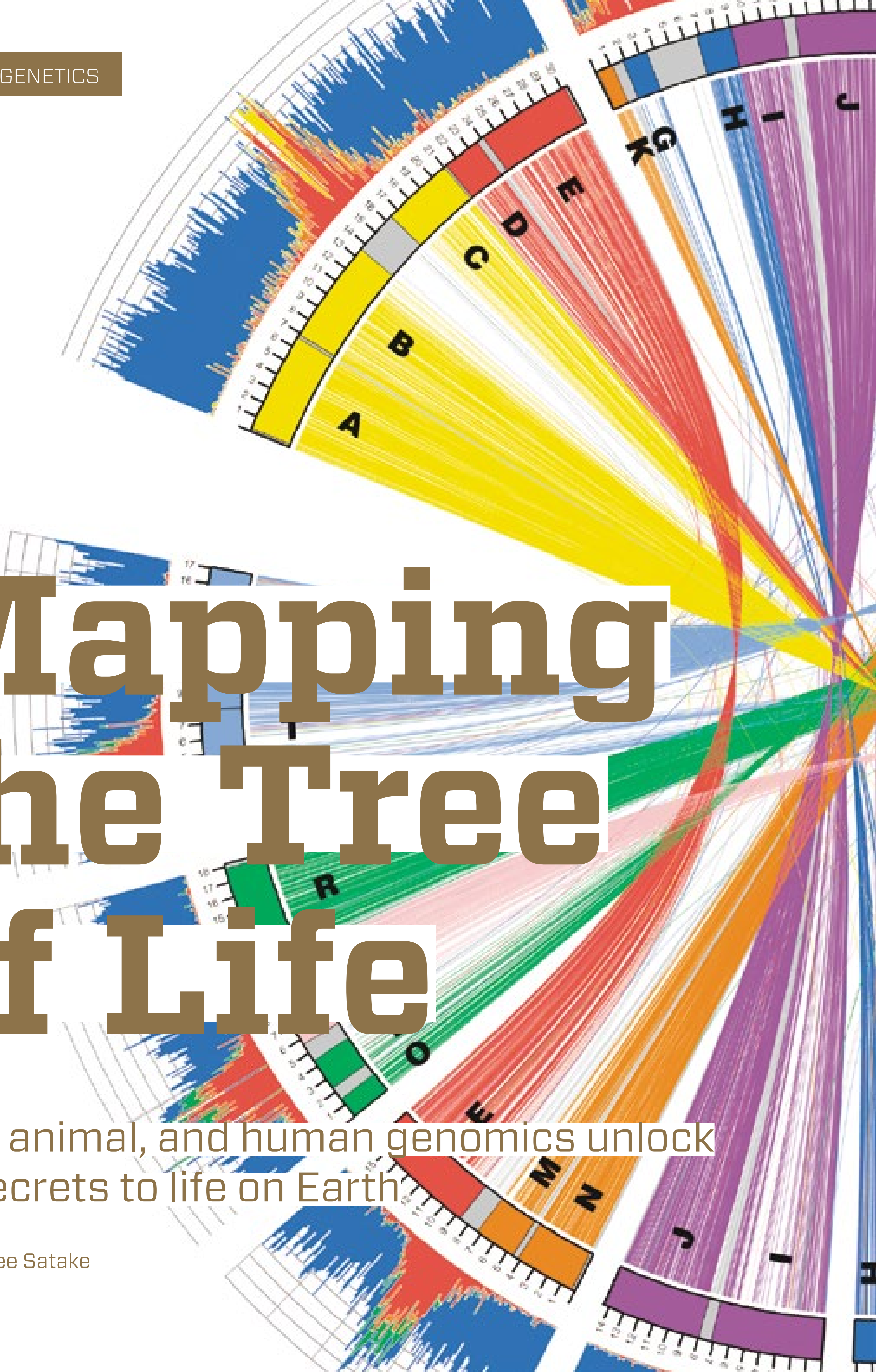
He relies on the high performance computing power at the LSU Center for Computation and Technology, or CCT, for this research. Access to the supercomputers and scientific computing staff was a major draw for him to LSU from the University of Texas MD Anderson Cancer Center. "The capacity of the high performance computing clusters like SuperMike-II are just so far beyond what's available at academic medical centers. There's no comparison," he said.

Although many universities have computational centers that foster transdisciplinary work, LSU may be the only one that jointly funds research faculty through the center. CCT has joint faculty positions with the departments of physics and astronomy, chemistry, math, biology, College of the Coast and Environment, College of Human Sciences and Education, College of Engineering, College of Science, Manship School of Mass Communication, the E. J. Ourso College of Business, and the College of Music and Dramatic Arts.

"I'm not aware of any other center in the U.S. with this many faculty supported by a computational center jointly with departments drawn from such a diverse variety of disciplines. The way we're going, I think we're going to expand even more," said J. "Ram" Ramanujam, CCT director. ■

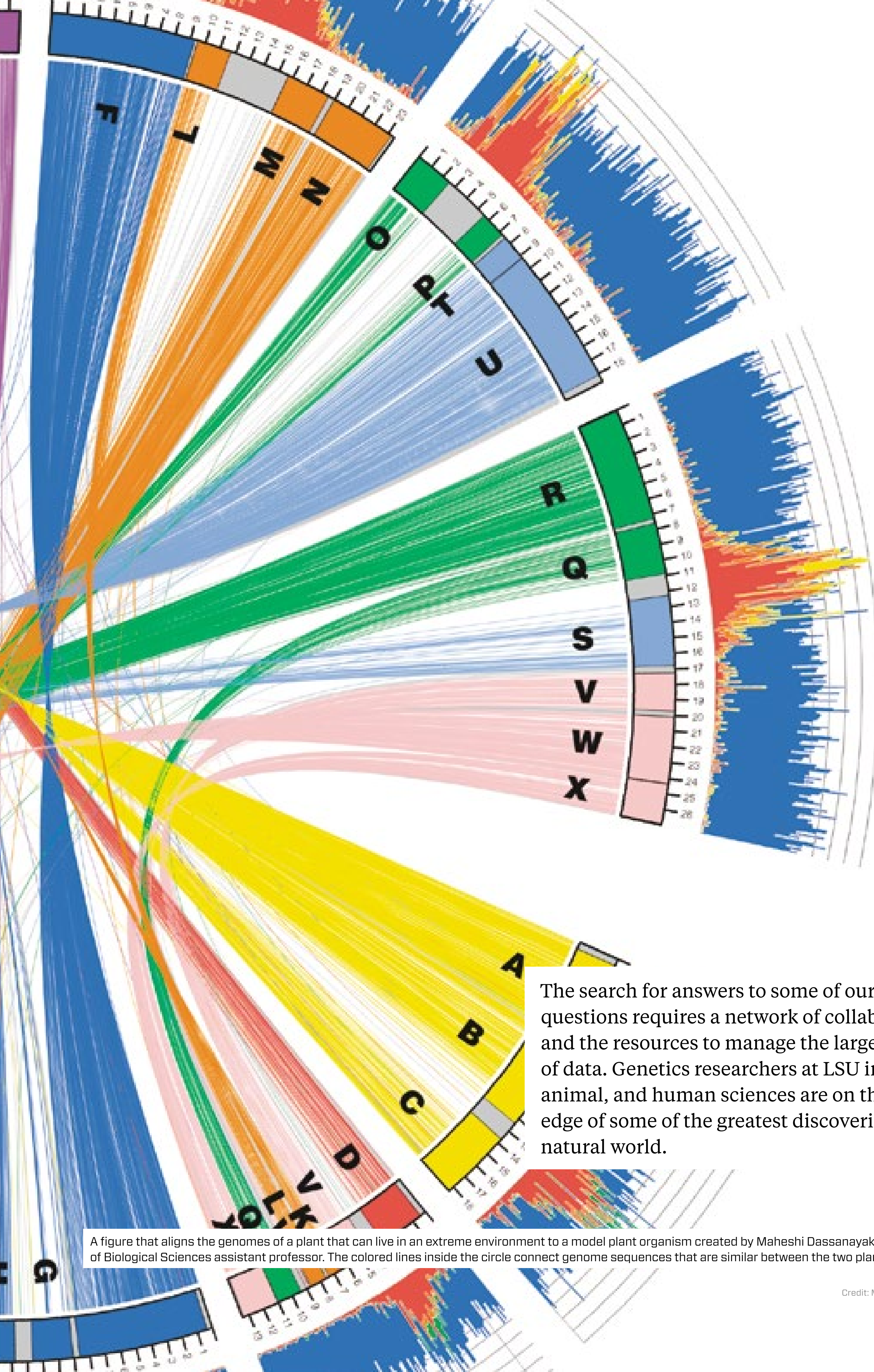
LSU Medical Physics and Health Physics Program Director Wayne Newhauser and his graduate student create 3D printed models, or phantoms, for cancer patients to personalize their radiation treatment. They collaborate with faculty in the LSU School of Architecture and the College of Art and Design to scan and create the 3D phantoms.

Mapping the Tree of Life



Plant, animal, and human genomics unlock the secrets to life on Earth

By Alison Lee Satake



The search for answers to some of our biggest questions requires a network of collaborations and the resources to manage the large volume of data. Genetics researchers at LSU in the plant, animal, and human sciences are on the leading edge of some of the greatest discoveries of the natural world.

A figure that aligns the genomes of a plant that can live in an extreme environment to a model plant organism created by Maheshi Dassanayake, LSU Department of Biological Sciences assistant professor. The colored lines inside the circle connect genome sequences that are similar between the two plants.

Credit: Maheshi Dassanayake, LSU.

Credit: Maheshi Dassanayake, LSU.

Plants are grown hydroponically in a temperature controlled chamber for all three species studied in the project investigating the genomic basis for salt adaptation.

Extreme Green

What makes some plants able to grow in deserts or cold climates or saline environments? How these plants, called extremophytes, thrive in extreme environments may unlock the secret that could help solve the challenges to feeding the world.

"With climate change, limited fresh water available for crops, less land suitable for agriculture, all of these problems require the plant science field to evolve. We need to be able to understand how these plants evolved over hundreds of millions of years to successfully master the skills to grow in difficult environments," said Maheshi Dassanayake, assistant professor in the LSU Department of Biological Sciences.

Dassanayake is looking for the secret gene-by-gene and her quest has already yielded some surprising clues.

She and her research team carefully selected two extremophytes, based on their genetic closeness to a common crop species and a model plant organism, to study.

The model plant organism, *Arabidopsis thaliana*, is like the fruit fly for plant geneticists and serves as the control. She overlays its genome with two other plants that are within the same family and have been genetically sequenced. All three are within the cabbage, kale, canola, and cauliflower family. But *Schrenkiella parvula*, which scientists in the field call parvula for short, grows on the banks of one of the world's largest salt lakes, Lake Tuz in Turkey, where the sodium concentration is six times higher than sea water. And *Eutrema salsugineum* can be found in very cold climates with salty soil around the world including coastal China, some parts of Russia, Canada's Yukon plateau, Montana, and Washington state.

Both parvula and *Eutrema* are highly adapted to salt and ultraviolet stress. However, the model plant, *Arabidopsis*, is poorly adapted to environmental stressors.

"The genomes of the three plants are almost superimposable," Dassanayake said.

This enables Dassanayake and her research team to be able to see how the extremophytes differ genetically from the model.

One difference that leapt out was a transporter gene that helps plants pump out the chemical element, boron. All three plants have this gene. In fact, all plants have this gene. But the boron transporter was expressed 500 times more in parvula than in the control.

"We were surprised by this observation," Dassanayake said.

When the researchers looked closer, they realized boron is mined in the area surrounding Lake Tuz, where parvula thrives. Therefore, it makes sense why the gene that controls its boron pump would be expressed at such a high level.

Other transporter genes that regulate ions including sodium, potassium, and lithium were expressed 10 to 20 times higher in the extremophytes than the model plant. But it's not just the gene expression that is the differing factor, sometimes the gene itself has multiple copies. This copy number variation can sometimes signal an adaptive genetic trait.

Dassanayake's team is looking specifically at the set of genes shared across all plants enabling them to metabolize, grow, and reproduce. Her research may yield valuable information for anyone studying plants from crops to oak trees.

"The idea is not to make our crops extremophytes. But we want to try to get these pieces from the extremophyte genomes to understand and manipulate the crop genomes or find cultivars that can be bred into commercially viable varieties," she said.

For example, being able to withstand sodium stress is a complex trait. Hundreds of genes work together in a plant to help it adapt to high levels of sodium in the environment. Not only does the plant need to be able to prevent salt from entering, but the system needs to capture and compartmentalize the salt once it does enter. Also the plant needs to grow quickly to outpace rising temperatures in the summer when limited available water evaporates and the environment becomes too dry. Parvula and *Eutrema* begin growing in the spring and must mature and reproduce before summer. How plants achieve this genetically is not completely known.

"Even in *Arabidopsis*, we do not know a large proportion of genes that control many of these processes. By using parvula with *Arabidopsis*, we are learning more about the plants' entire life cycle," she said.

Her work can help plant breeders including those in Louisiana.

"For example, Louisiana rice fields face a saltwater intrusion problem. But rice is grown all over the world and the environment for rice growth differs around the world. So we can customize the cultivars based on each region's challenges," she said.

Dassanayake and her team study plant genomes that have 150 million to 450 million base pairs each. It takes a significant amount of computational power to compare these large genomes. For that, they rely on the high performance computing capabilities at the LSU Center for Computation and Technology and specifically supercomputer, SuperMike-II. The gene sequencing technology has revolutionized the field.

"Ten years ago, none of this would have been possible," Dassanayake said. So much so that from her lab in the Life Sciences Annex, they can track the sequencing of whole genomes across campus on SuperMike-II.

While it took about 10 years to sequence the human genome, it took about a year to sequence the parvula genome. Trying to expose genomes is like deciphering a new language.

"I use *Arabidopsis* like the Rosetta Stone to piece together new models for plant science," she said. "Putting together this genetic jigsaw puzzle is intellectually and computationally challenging."

Animalia

An international team of scientists completed the largest whole genome study of a single class of animals. To map the tree of life for birds, the team sequenced, assembled, and compared full genomes of 48 bird species representing all major branches of modern birds including ostrich, hummingbird, crow, duck, falcon, parrot, crane, ibis, woodpecker, and eagle species. The researchers have been working on this ambitious genetic tree of life, or phylogeny, project for six years.

As part of the Avian Phylogenomics Consortium—comprised of more than 200 scientists from 80 institutions across 20 countries—LSU scientists' work was published in three research papers featured in a special issue of *Science*.

"Mapping the tree of life is one of the grand challenges in biological science. Being part of this project is like being part of the writing of evolutionary history," said Robb Brumfield, director of the LSU Museum of Natural Science and Roy Paul Daniels Professor of Biological Sciences.

"Mapping the tree of life is one of the grand challenges in biological science. Being part of this project is like being part of the writing of evolutionary history."

—Robb Brumfield
LSU Museum of Natural Science director
Roy Paul Daniels Professor of Biological Sciences

The LSU Museum of Natural Science maintains one of the world's largest frozen tissue collections of birds, reptiles, amphibians, and mammals. Since 1979, the museum's curators and researchers have collected samples from unexplored regions of the world. They carry liquid nitrogen tanks in the field to flash freeze the tissue samples, which are brought back and stored in the Museum's Collection of Genetic Resources. They provided six of the 48 avian tissue samples whose genomes were sequenced for this project.

"When we collect a specimen, we try to preserve it in a way that will maximize its future utility. The challenge is that we don't know what the future uses will be," Brumfield said. "Ornithologists collecting bird tissues in 1979 had no idea that the entire genomes of these birds could one day be sequenced and featured in a study like this. It would have been impossible to envision."

One of the flagship papers published in *Science* titled, "Whole-genome analyses resolve early branches in the tree of life of modern birds," presents a well-resolved new tree of life for birds, based on whole-genome data. Several LSU scientists are co-authors on this paper including Brumfield, Assistant Professor of Biological Sciences Brant Faircloth, Curator of Genetic Resources Frederick Sheldon, former Department of Biological Sciences Post-doctoral Researcher David Ray, and former Museum of Natural Science Post-doctoral Researchers Elizabeth Derryberry and John McCormack.

This international research project disentangled parts of the bird tree of life that have been particularly challenging to resolve. Because modern birds split into species early in time and in quick succession, the different lineages did not evolve enough distinct genetic differences at the genomic level to clearly determine their early branching order using smaller amounts of data, the researchers said. To overcome this problem and resolve the timing and relationships of modern birds, the consortium authors used whole-genome sequences to infer the bird species tree.

LSU's Brant Faircloth contributed to the reconstruction of the bird tree by running statistical analyses of genomic loci called ultraconserved elements, or UCEs, that are found throughout the genomes of many organisms. His group, in collaboration with Brumfield's students and post-doctoral researchers, developed the technique for studying UCEs. By aligning these highly conserved parts of the genome and analyzing the subtle variations across the different species, the UCE data helped piece together this new tree of life for birds. Faircloth found that the UCE data provided consistent results to infer evolutionary history whereas traditionally, scientists have used data from the protein coding parts of the genome called exons for this purpose.

"It opens up the potential in terms of the types of data people will collect and use in the future when reconstructing the tree of life," Faircloth said.

Once they inferred a tree from the data, the researchers dated the divergence of each species across millions of years based on the fossil record. The result is a genome-scale phylogeny of birds that dates the evolutionary expansion of modern birds, or Neoaves, to 66 million years ago, when a mass extinction event killed off the dinosaurs but a few bird lineages survived.

In addition to resolving the early branches of Neoaves, this research supports conclusions about some relationships that have been long-debated. For example, the findings support three independent origins of waterbirds. It also indicates that the common ancestor of land birds, including songbirds, parrots, woodpeckers, owls, eagles, and falcons, was an apex predator, which also gave rise to the giant flightless terror birds that once roamed the Americas.

The second flagship paper titled, "Comparative genomics reveals insights into avian genome evolution and adaptation," illustrates that genomic diversity across birds correlates with adaptation to different lifestyles and evolutionary traits. These findings help bridge the chasm between micro and macroevolution.

Lastly, a third paper titled, "Three crocodilian genomes reveal ancestral patterns of evolution among archosaurs," was co-authored by Faircloth, McCormack, and former LSU Post-doctoral Researcher David Ray. The authors used newly assembled genomes of the closest living relatives to birds—crocodilians—to provide context for the diversification of archosaurs, a group that includes birds, crocodilians, and dinosaurs. Using the genomes of the American alligator, the saltwater crocodile, and the Indian gharial, the scientists showed that crocodilian genomes are among the slowest evolving vertebrates. Their collaborators also used these genomes to infer the genome sequence of the common ancestor of archosaurs and therefore all dinosaurs including those that became extinct 66 million years ago. Tissues of the individual crocodilians whose genomes were sequenced by the team will also be stored in the LSU Museum of Natural Science Collection of Genetic Resources.

Setting up the pipeline for the large-scale study of whole genomes—collecting and organizing tissue samples; extracting the DNA; analyzing its quality; sequencing, managing, and analyzing torrents of new data—has been a massive undertaking. But the scientists say their work should help inform other major efforts for the comprehensive sequencing of vertebrate classes. To encourage other researchers to dig through this big data and discover new patterns that were not seen in small-scale data before, the Avian Genome Consortium has released the full dataset to the public in GigaScience and other databases.

"The next grand challenge in our field would be to expand upon this and sequence the genomes of all birds," Brumfield said. "The Avian Genome Consortium is currently raising funds to do just that."

1000 Genomes Project 2000–2016

2000	2002	2008	2009
Human Genome Project completed	HapMap launches now ~3 million SNPs	First public data release	First INDEL calls released

Mapping Man

LSU biologists Mark Batzer, Miriam Konkel, and Jerilyn Walker are among the international team of scientists from the 1000 Genomes Project, who have created the most complete catalog of human genetic variants. The researchers created a map of the genomic differences of 2,504 people from 26 populations across Africa, East Asia, South Asia, Europe, and the Americas.

"The ability to look at entire genomes across the globe is just amazing. It provides new insight into human biology," said Batzer, who is a Boyd Professor and the Dr. Mary Lou Applewhite Distinguished Professor in the Department of Biological Sciences at LSU. LSU Assistant Professor-Research Miriam Konkel and research scientist Jerilyn Walker worked with Batzer on this study.

The 1000 Genomes Project has led to a better understanding of the genetic size, diversity, and history of the human population. It doubles the number of known variant sites to 88 million in the human genome. Batzer and his colleagues' research was published in *Nature*.

"We have a better understanding of human history and migration now," Batzer said.

In addition to elucidating what happened in the past, this data also serves as a gateway to the future of personal genomics and individualized medicine. By better understanding the random patterns of genetic variation, the medical field may be able to identify an individual's medical predispositions. This catalog provides the basis for a new understanding of how inherited differences in DNA can contribute to disease risk.

"The 1000 Genomes Project was an ambitious, historically significant effort that has produced a valuable resource about human genomic variation," said Dr. Eric Green, director of the National Institutes of Health's National Human Genome Research Institute, or NHGRI, which helped fund the project. "The latest data and insights add to a growing understanding of the patterns of variation in individuals' genomes, and provide a foundation for gaining greater insights into the genomics of human disease."

2011	2013	2015	2016
Final Phase 1 low coverage alignments are released	Final alignment release for Phase 3	GRCh38 mappings released for low coverage	New data portal, new populations, and re-analysis of functional datasets

Credit: 1000 Genomes Project

The 26 populations studied include groups such as the Esan in Nigeria; Colombians in Medellin, Colombia; Iberian populations in Spain; Han Chinese in Beijing; and Sri Lankan Tamil in the United Kingdom. All of the individuals studied for the project consented to broad release of their data, and the data can be used by researchers around the world.

Due to the highly coordinated and consistent nature of the methodology and the investigators working on this project, the results have been a uniform dataset of human genetic variation that provides a baseline from which other lines of future research can stem.

For example, it has confirmed previously debated topics such as the geographic origin of mankind. In this study, the African populations exhibited the greatest genetic diversity. The other populations had some of the genetic variants found in the African populations, which supports the theory that Africa's population is the oldest and from which other populations dispersed around the world.

Batzer's research expertise includes structural variation. Specifically, he studies the segments of DNA that move and insert themselves elsewhere in the genome, which are called transposable elements, or transposons. Transposons create new insertions when they move or transpose and also generate other chromosomal alterations through genetic exchanges. These "jumping genes" are linked to many inherited human disorders and forms of cancer.

Diseases such as hemophilia, breast cancer, and neurofibromatosis in which tumors form on nerve tissue, have been linked to transposable elements. One-half of one percent of all human genetic disorders come from changes in the structure of the genome involving new transposable element insertions. The researchers mapped eight classes of structural variants that potentially contribute to disease. They found nearly 69,000 differences or genetic structural variants in the study.

"This is some of the most exciting science out there and it brings together the best investigators in the world to work on one project," Batzer said. ■

Life on the Red Planet

By Christine Wendling

Researchers and scientists from various disciplines are lured by the mystery of the Red Planet. Mars is not only the fourth planet from the sun in our solar system, but it offers the possibility of being the next frontier where the imaginations of all who wish to pierce the veil of its mysteries, including researchers at LSU, can run wild.

LSU Department of Geology and Geophysics Assistant Professor Suniti Karunatillake is the lead investigator of the Planetary Science Lab, or PSL, where he and his students study the physical landscape of Mars, while also creating software to analyze images of soil. They believe their research may be key to the building blocks of life on Mars—human life, that is. The knowledge they gain about the constraints on the planet's habitability from evidence, such as the absence of a global ocean, or more recently, sulfates contributing to how Martian soil stores water, could support human missions to Mars within our lifetime, or at least provide some of the information and tools necessary for future colonization of planets beyond Earth.

Mars visualization by Robert Kooima, LSU School of Electrical Engineering and Computer Science assistant professor.

Credit: Nicki Button, LSU.

LSU doctoral student Nicki Button studies the volcanic environment at Inferno Chasm near King's Bowl in the Craters of the Moon National Monument in Idaho to better understand the geology of Mars.

Lay of the Land

The researchers are studying a gaping Martian canyon called Valles Marineris, which is located on the planet's largest plateau, Tharsis Rise, at a much higher elevation than the rest of the region. Tharsis Rise is located south of Valles Marineris and is about the size of the continental U.S. The scientists are counting the number of craters from meteors, meteorites, or other space rocks to calculate the age of the region based on the probability of how often the planet has been impacted by these flying objects. It's a painstaking process.

"We literally count all the craters by hand," said Don Hood, PSL doctoral student.

The researchers also analyze the chemical make-up of the soil to better understand how soil is produced on planets other than Earth. The more similar the geological formations are to Earth's development, the higher the potential for habitability on Mars.

In addition to dating the age of terrain with craters, they are also researching volcanic environments. When a rock, which researchers refer to as a "block," is ejected from an explosive volcanic site and impacts the ground, it creates a crater called a bomb sag. Doctoral candidate Nicki Button's research involves comparing impact craters and bomb sags. To do this, she investigated the block distribution pattern surrounding King's Bowl, Craters of the Moon National Monument in Idaho during her fieldwork in August 2015. King's Bowl is a volcanic pit that once spewed blocks. Large blocks, which are usually no more than 0.5–1 meters in diameter, were observed closest to the pit. Now, she plans to use this block distribution pattern to analyze volcanic environments on Mars as well as compare it to the block distribution pattern of impact craters.

"On Earth, if you're in Hawaii, and you see one of these, you would know that this is a volcanic environment, so it must be a bomb sag. On Mars, it's more complicated. You don't have that contextual information, because the environment currently isn't volcanic," Button said.

Earth is an active planet while Mars isn't, says microbiologist Gary King.

In order to find out what creatures could live on Mars, King studies life at some of the most extreme environments on Earth. One life form is a microbe that lives near an active volcano on the Big Island of Hawaii. King described the new species and named it *Haloferax namakaokahaiae* after the Hawaiian goddess of the sea. This extreme halophile does not need oxygen to survive and can metabolize carbon monoxide for energy.

"Carbon monoxide is one of the few substrates available on Mars," King said.

Another region on Mars, called Arabia Terra, is believed to hold the remnant features of giant super volcanoes. When active, the volcanic system in Arabia Terra was violent and explosive, like the volcanic activity that occurred during Earth's early evolution. The region also held a much younger and less violent volcano known as Elysium Mons. Elysium Mons was similar to Earth's Hawaiian volcanoes.

"It dates back to about a couple of tens-of-hundreds-of-millions of years ago, which in geological times, is essentially yesterday," said graduate student David Susko.

Elysium Mons also has unique chemical signatures that differ from the rest of the Martian crust as well as the other volcanic provinces of Mars. Its unique chemical composition may offer a clue as to what is going on deep inside the planet, not just on the surface. This is valuable because the instruments used to analyze Mars, such as the most depth-sensitive gamma ray spectrometer and neutron spectrometer in orbit, are limited to the shallow surface of only a few tens of centimeters. The chemical makeup of Elysium could provide clues into further sub-surface analyses of the planet.

"We think there could be a connection between the chemistry here and how the magmatic processes on Mars evolved over time. Maybe this volcanic province evolved compositionally in terms of its magmatic processes, like magma chamber composition, over a relatively short geological time period. So, that'd be a first confirmation on Mars of rapid igneous evolution," Karunatillake said.

This could reveal similarities between the early formation of Mars and the early formation of Earth.

> "By studying ancient Mars, we are studying ancient Earth."
>
> —David Susko
> LSU Department of Physics & Astronomy graduate student

Life at the Extreme

Volcanoes on the Big Island of Hawaii offer some of the most inhospitable environments on our planet where extreme life forms exist. Microbiologist Gary King studies these extreme halophiles in barren, cold, and salty environments in Hawaii and the Bonneville Salt Flats in the Utah desert that resemble what Mars may have once been.

"These systems are analogous to Mars," King said. This bodes well for his Haloferax, which he has freeze dried in a test tube in his lab. It's easily transportable, he says, even to—say, Mars.

EVERYDAY QUESTIONS ABOUT MARS

Answered by LSU Researchers

Why is Mars red?

Suniti Karunatillake: While Mars looked red to early observers from Earth, its surface color, as would be seen on the ground by a human explorer, is variable. Mars' redness as seen at a distance, especially from orbit, as well as the reddish earth-colored tones of its soil, are derived from a layer of fine particles. The layer is found at each of the six landing sites to-date but is typically only millimeters thick and moves easily when disturbed to reveal darker soils beneath. The "fines," informally called dust, owe their reddish hue primarily to nanophase ferric oxides, like what we know as rust, with nanocrystalline red hematite (alpha-Fe_2O_3) suggested as the volumetrically dominant mineral based on infrared spectroscopy from satellites. Iron is more common in Mars' crust than Earth's.

Why is Mars so small compared to Earth?

Gary King: This has to do with the distribution of debris in the orbit of Mars as it first formed. The distribution of molecules, dust, and small bits of comets, meteorites, etc. determines what can get swept up to form a planet.

What makes this planet so exciting for humans?

Gary King: Mars has long been part of human imagination, well before the idea of a planet existed in any scientific context. It features in mythology across many cultures. People deep in the past thought the planet, or the god it symbolized, had powers over human life.

With the advent of telescopes, some of Mars' features became visible enough that they were interpreted as engineered. This led to ideas about alien life that persist today in both scientific and non-scientific forms.

An excerpt from Everyday Questions about Mars, Answered by LSU Researchers in the LSU College of Science Blog by Paige Jarreau. For other great research stories, visit ***lsuscienceblog.squarespace.com****.*

This may be useful for future Martian colonists who will need to replicate their own supplies on the dead planet. Certain halophiles may be able to survive Martian conditions. They can even produce by-products, King says, that can be transmuted into practical resources—such as nutrients or plastics.

Origins

Karunatillake first became curious about planetary study after reading the works of science fiction writer Arthur C. Clarke and watching Carl Sagan's documentaries on the cosmos as a child growing up in Sri Lanka.

"There's something about thinking of ourselves as children of the stars that really clicked," Karunatillake said.

While working towards his Ph.D. in physics at Cornell University, Karunatillake met a professor, Steven Weldon Squyres, who would steer the Mars Exploration Rovers on one of the longest and productive missions on Mars. Squyres invited Karunatillake to join another mission named after Arthur C. Clarke's 2001: A Space Odyssey—2001: A Mars Odyssey. (Carl Sagan served on Squyres' doctoral committee at Cornell.)

Karunatillake calls this a serendipitous "completion of the circle" that led to his research on the red planet.

So what about life on Mars?

"I'm comfortable with not knowing much about the world. When it comes to life beyond Earth, though, I have a sense of faith that it exists, broadly speaking. I believe that there are existing civilizations in the universe. It's too massive a place and we have too much evidence in terms of other solar systems for that not to be the case," Karunatillake said.

However, he is less sure of the possibility of alien life within our solar system.

"Now, in the context of our solar system, I think life, at the level of what you see on Earth, is much less likely and perhaps even non-existent. Mars is a cool place as a stepping stone to that type of discovery," Karunatillake said.

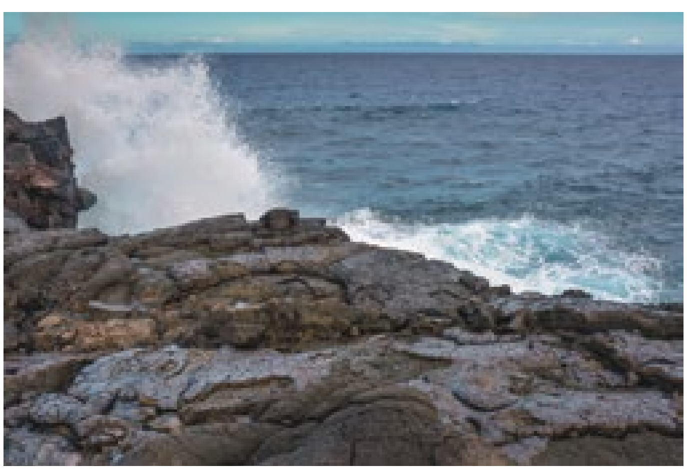
> "I believe Mars had conditions at some point in its history that would be habitable to the life forms we currently have on Earth."
>
> —Suniti Karunatillake
> Planetary Science Lab lead investigator

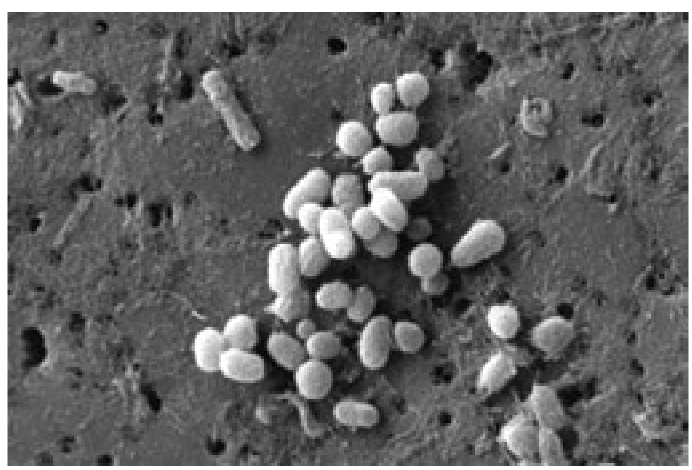
Microbiologist Gary King agrees. Images of tracks caused by runoff serve as evidence that there was water on Mars. However, in order for there to have been liquid water on Mars at zero degrees Celsius and under 200 bar pressure, there must have been brines created by salt deposits, he said. That's why he studies the microorganisms living in the hypersaline brine pools in Hawaii's Volcano National Park.

He collects samples on Earth's barren landscapes, isolates the microbes in his lab, and freeze dries them into test tubes. He surmises they could be transported to Mars if colonization were to occur.

"Extreme halophiles could provide a community of organisms on Mars. We could exploit them when establishing life there," he said.

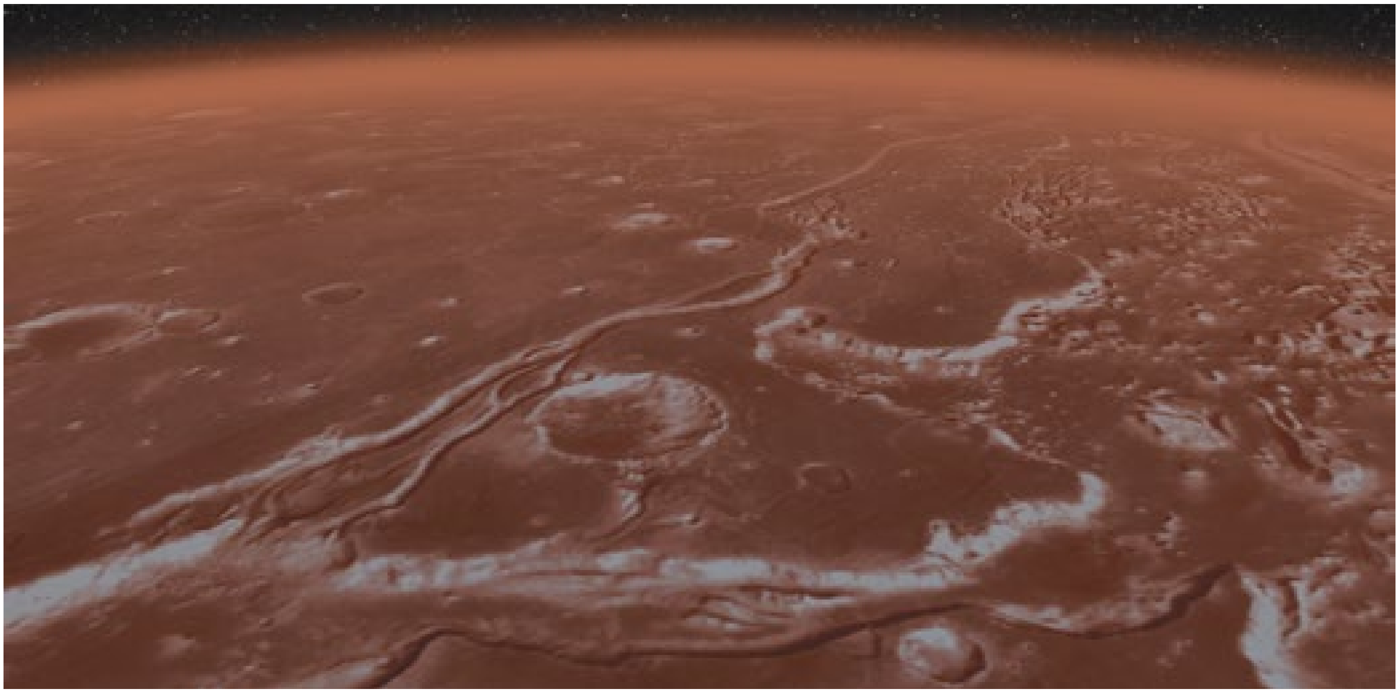
One of the microbes' by-products is a precursor to plastic, which could be used in a 3D printer to create things, he said. Another by-product is a fatty acid called butyrate that provides an important form of energy for human health.





Credit: Gary King, LSU.

An active volcano on the Big Island of Hawaii is where LSU microbiologist Gary King discovered a new microbe that could be a candidate for life on Mars. Extreme microbe, *Haloferax namakaokahaiae*, can survive without oxygen and metabolize carbon monoxide.



Credit: Robert Kooima, LSU.

Robert Kooima, LSU School of Electrical Engineering and Computer Science assistant professor, develops software to translate the massive amount of raw data collected by Mars space probes into images.

Mapping Mars

Large amounts of raw data have come back from Mars, but translating that into useful information has been a challenge. Robert Kooima, assistant professor in the LSU School of Electrical Engineering and Computer Science, is creating a 3D map of Mars from this data.

He is developing software that can compile a large amount of data and use it to create an interactive virtual environment, or virtual reality, that the user can explore. This immersion into the computer program would enable the user to engage with the data and absorb more of the information in a shorter amount of time.

However, the data sent back from Mars space probes is raw. It exists in a cumbersome form that is not straightforward or engaging. So, Kooima translates the data into a meaningful experience that is accessible to the average person.

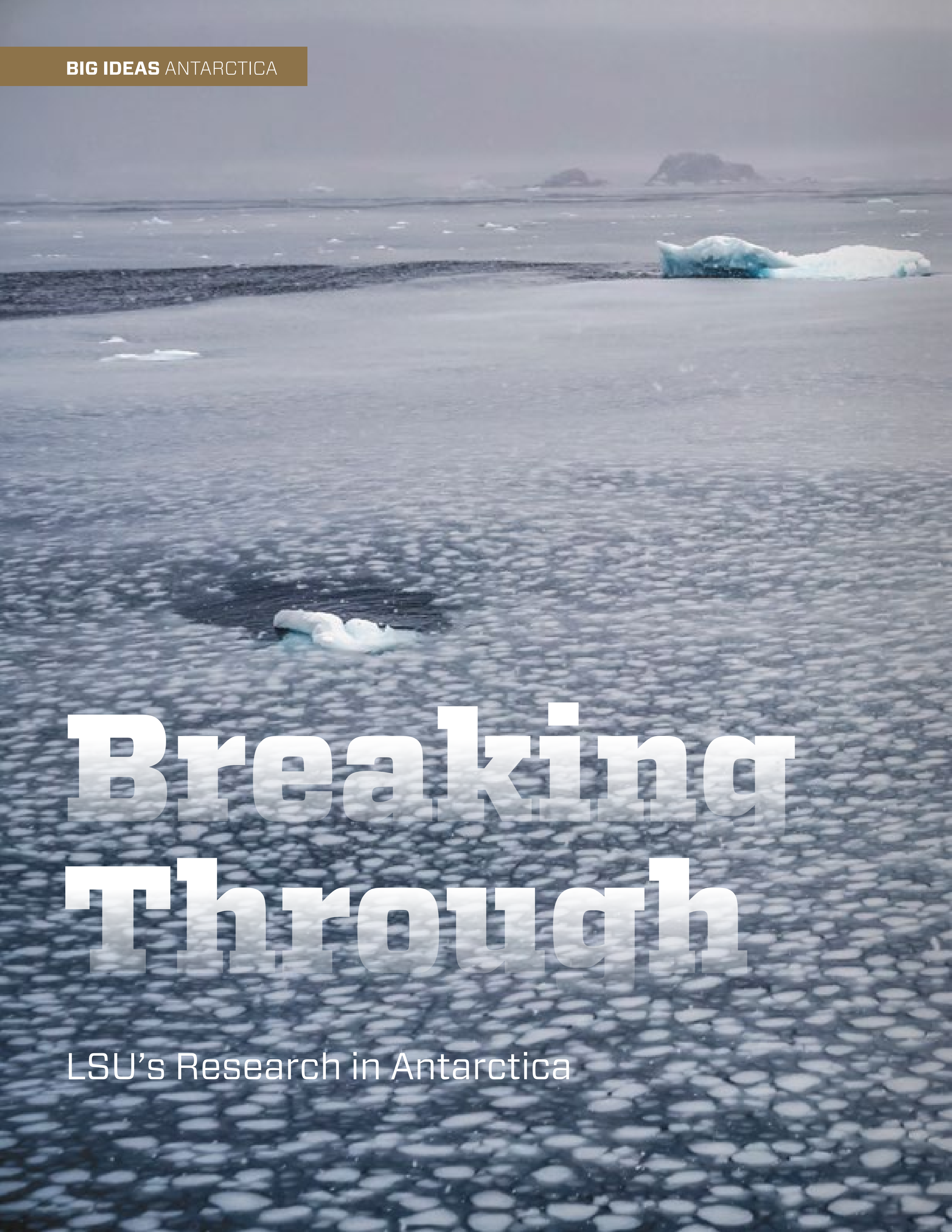
He has an immense quantity of information to work with in regard to the color of the planet, the altitude, and in which direction land forms are facing. This last piece of the puzzle is especially important as it determines how he will demonstrate the illumination on Mars, or where the shadows would fall at a given time of day. He even simulates the atmosphere of Mars, draping his virtual planet in a misty orange haze.

He has over four gigapixels—or four billion pixels—of images, equivalent to about 500 iPhone photos. But, there are still limits to that large quantity of material.

"Even if you have 40 billion pixels that still means that you have a pixel every 30 feet. And there are features of the planet that are smaller than that," Kooima said.

He also has a distortion problem. Photographic images of Mars are flat rectangles that must somehow be made 3D. A person can digitally bend a photograph into a cylinder, creating a 3D image, but there will be gaps and distortions in the image at the top and bottom of the cylinder. Instead, Kooima takes a digital representation of a map of Mars and first contorts it into a cylinder. From there, he creates a cube, and then smooths over the edges to create a spherical, 3D image of Mars. Because a cube is closer in shape and dimension to a sphere than a cylinder, it requires less manipulation and distortion on Kooima's part to create the 3D, spherical image of Mars.

So, Kooima must manipulate the images to a certain extent. He said that virtual reality is not necessarily about representing everything accurately, but about getting the user to perceive everything accurately—with minimal distortion of space or depth perception. However, he has high resolution imaging of isolated areas of Mars from HiRISE, a high resolution camera orbiting the planet. NASA, and Kooima, are interested in capturing more high resolution photos, but with a planet as large as Mars, it will take time. As Kooima obtains more details from NASA, he will continue to update the 3D map. ■



Breaking Through

LSU's Research in Antarctica

As one of the most mysterious places on Earth, due in part to its remoteness and extreme environment, Antarctica has fascinated explorers and researchers for hundreds of years. Despite the longevity of research on the continent, there is still much to be discovered and LSU researchers are making significant breakthroughs.

Search for Life Beneath the Ice

Professor Peter Doran in the Department of Geology and Geophysics has spent about 20 field seasons in Antarctica as part of a research team conducting a long-term ecological study of a cold desert region called the McMurdo Dry Valleys. He and his collaborators research the aquatic and terrestrial ecosystems of glaciers, soil, streams, and lakes in this region of East Antarctica, where the effects of climate warming are less than other parts of the continent. The McMurdo Dry Valleys Long-term Ecological Research project, or McMurdo LTER, is funded by the National Science Foundation through the year 2022.

The researchers established and maintain a network of weather stations that collect meteorological data including average, maximum, and minimum temperatures and precipitation. Sensors capture information every 30 seconds year-round. The data is downloaded from storage drives during the austral summer when the region is accessible. The McMurdo LTER Automatic Weather Network now consists of 13 permanent weather stations and provides valuable local meteorological information integral to ecological research.

The researchers also continue to collect data on the physical and chemical conditions of the ice-covered lakes in the region. The lakes are the only source of liquid water in this desert study site. They support life including single-cell plants and animals throughout the year. Therefore, the lakes contain traces of the life history of the region. Long-term data collected on the water levels, thickness of ice, and photosynthetically active radiation offer information on changes in climate and hydrology. Using sediment collected from the bottom of the lakes, Doran and colleagues are able to piece together the paleontological history of the region.

Doran is also involved in another project that aims to develop a state-of-the-art cryobot, an ice-penetrating robotic vehicle, to search for life in lakes and oceans under miles-thick ice in Antarctica. It will be the first cryobot system to carry a second stage hovering autonomous underwater vehicle, which will enable it to collect samples, uplink data, and potentially return samples to the surface.

Pancake ice in Rockpepper Bay along the northern coast of Joinville Island in the Antarctic Peninsula.

Credit: Juliette Hennequin, M/V Hans Hansson.

Credit: Peter Doran, LSU.

▲ LSU Department of Geology and Geophysics Endowed Chair Peter Doran at the Doran Glacier in the McMurdo Dry Valleys. The Advisory Committee on Antarctic Names named the glacier after Doran, who has conducted research in the region since 1993.

◀ Ice covered D'Urville Island in the Antarctic Peninsula.

Credit: Michael Polito, LSU.

Algae and Pollen Grains Provide Evidence of Remarkably Warm Period

For Sophie Warny, associate professor in the Department of Geology and Geophysics and curator at the LSU Museum of Natural Science, years of patience in analyzing Antarctic samples with low fossil recovery led to a scientific breakthrough. She and colleagues from around the world discovered proof of a sudden, remarkably warm period in Antarctica that occurred about 15.7 million years ago and lasted for a few thousand years.

When Warny studied samples sent to her from the Antarctic Geologic Drilling Program, or ANDRILL AND-2A, a multinational collaboration between the Antarctic Programs of the U.S., New Zealand, Italy, and Germany, one sample stood out as a complete anomaly.

"First I thought it was a mistake, that it was a sample from another location, not Antarctica, because of the unusual abundance in microscopic fossil cysts of marine algae called dinoflagellates. But it turned out not to be a mistake, it was just an amazingly rich layer," Warny said.

Among the 1,107 meters of sediment recovered and analyzed for microfossils, a two-meter thick layer in the core was rich in fossils. This is unusual because the Antarctic ice sheet was formed about 35 million years ago, and typically frigid temperatures there impede the presence of woody plants and blooms of dinoflagellate algae. These palynomorphs, a term used to describe dust-size organic material such as pollen, spores, and cysts of dinoflagellates and other algae, provide hard evidence that Antarctica underwent a brief but rapid period of warming about 15 million years before present.

These results will offer new insight into Antarctica's climatic past—insights that could potentially help scientists better understand current climate change.

Retracing Antarctica's Icy Past

A large part of Antarctica's seafloor has been covered by ice and inaccessible. But as the ice has retreated over millennia, it has left clues that have helped researchers piece together the puzzle of the region's geologic past.

Associate Professor Phil Bart in the Department of Geology and Geophysics recently conducted one of the largest geological surveys of the Antarctic continental shelf to-date. He and his team of undergraduate and graduate students spent 28 days at sea on the Southern Ocean. They scanned the topography of the seafloor creating a three-dimensional picture of a roughly 2,500 square kilometer area. They mapped the eastern part of the Ross Sea, which was covered by grounded ice, or ice that was connected to the seafloor, during the Last Glacial Maximum about 26,000 years ago. The grounded ice continuously flowed toward the South Pacific Ocean. Like a bulldozer, the ice plowed a path leaving behind a large trough and study site with clues for geologists like Bart to piece together the history of how and when the ice retreated.

"This is one of the big things lots of scientists around the globe are interested in: trying to reconstruct the recent ice retreat history. That's part of the information we need in order to make predictions as to how the ice sheet might respond in the future to whatever the situation may become," he said.

Multi-beam swath bathymetry and seismic instruments mounted to the hull of research vessel Nathaniel B. Palmer collected the data Bart's team uses to construct the 3D map of the seafloor. The researchers comb through the imagery in this virtual map to find where sediment was being deposited while the ice was last in contact with the seafloor. At those locations, they drill and collect sediment cores, which they analyze and look for evidence of life.

In the sediment cores, they have found fossilized shells of single-cell organisms called foraminifera. These fossils are like timestamped footprints that give the researchers an estimate of when the ice was last there through radiocarbon dating.

"We are pioneering this technique of utilizing the understanding we gain from the morphology to better core the deposits and thereby increase the possibility we're getting the right age constraints," Bart said.

The results have offered new information on Ross Sea Ice Sheet retreat in relation to global fresh meltwater pulses.

> "One thing that's surprising to us is that the story seems reverse to what many have assumed was the case."
>
> —Phil Bart
> LSU Department of Geology & Geophysics associate professor

A working hypothesis has been that a significant contraction of the Antarctic ice sheet resulted in a pulse of fresh meltwater about 14,500 years ago. However, Bart's research team found that the contribution of fresh meltwater from their study site was negligible at that time. In contrast, they found ice retreat from their study site made a rather significant contribution to a second pulse about 11,500 years ago.

Recreating the Heroic Age

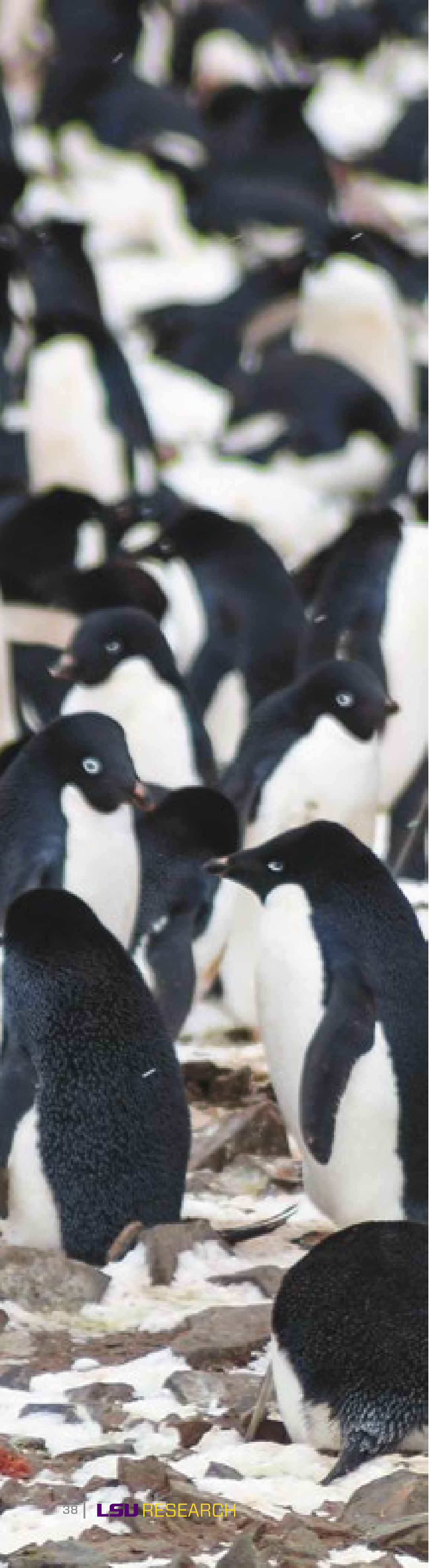
Professor Vince LiCata in the Department of Biological Sciences, and Associate Professor Trish Suchy in the Department of Communication Studies, have created a body of work called "Antarctica: Persistence of Vision," which consists of modern versions of some of the most iconic photography of Antarctic exploration captured more than 100 years ago. The project is supported by a National Science Foundation Antarctic Artists & Writers grant.

Antarctic expeditions during the "Heroic Age" almost always included a photographer to document the landscape, the people, and the discoveries made by explorers and scientists such as Robert Falcon Scott, Edward Adrian Wilson, Roald Amundsen, and Sir Ernest Shackleton. Suchy and LiCata used modern researchers and staff at the U.S. Antarctica Program's McMurdo Station to re-enact some of these iconic photos—but with a few twists. The subjects of the Suchy–LiCata photos were in their modern winter gear, working in state-of-the-art laboratories and research facilities, and the photos showcase the now internationally diverse group of people who work on this remote continent. For example, while a photo from the 1910 Terra Nova Expedition shows a dog sled and explorers in heavy wool coats, the Suchy–LiCata photos show scientists with a snowmobile in modern parkas doing research at the same location.

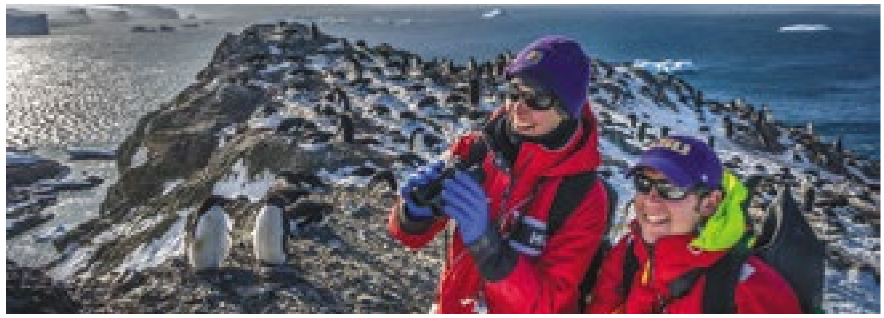
The second twist was the way the modern scientists and staff are photographed. Using artistic techniques with which artists like Bill Viola and Robert Wilson have experimented, Suchy and LiCata made high-definition "video portraits," where the image at first looks like a photograph to the viewer, but upon closer inspection is seen to be slowly moving.

"Antarctica: Persistence of Vision" was installed at the Lautaret Gardens Alpine Research Station in Col du Lautaret, France this summer. The Lautaret Gardens Alpine Research Station, owned by the University of Grenoble Alpes, is located 7,000 feet up in the French Alps above the city of Grenoble.

Suchy and LiCata have worked together on a number of different artistic and performance projects that combine art and science, and their deployment to Antarctica followed nearly three years of proposal writing, planning, and preparation for the project.



Credit: Michael Polito, LSU.



Credit: Alex Borowicz, Stony Brook University.

▲ LSU Department of Oceanography and Coastal Sciences Assistant Professor Michael Polito and graduate student Rachael Herman survey an Adélie penguin colony on Patella Island in the Antarctic Peninsula.

◀ Adélie penguin colony at Kinnes Cove on Joinville Island in the Antarctic Peninsula.

Tracking Resiliency in Penguins' Diets

Assistant Professor Michael Polito, Department of Oceanography and Coastal Sciences, has worked in the Antarctic for 16 years. He first went to Antarctica as an undergraduate student, when he studied the dietary habits of Adélie penguins spanning hundreds of years near McMurdo Station on the Ross Sea. Since then, he has worked in Antarctica on research teams with federal agencies such as the National Oceanic and Atmospheric Administration, or NOAA, and led research projects as a principal investigator for the National Science Foundation. He and his LSU research team have published the results of another Antarctic study that revealed the importance of the Gentoo penguins' dietary flexibility in adapting to climate change.

Chinstrap penguins, whose namesake describes the black stripe under their chins, are decreasing in number while Gentoo penguins, recognizable by their bright orange beaks, are increasing at summer breeding colonies in the Antarctic Peninsula. The potential for these two penguins to compete for food is highest when they are found breeding near each other on land and the need to feed their chicks daily restricts the distance they can search the ocean to find food. However, the key differences in what they eat and where they look for food likely evolved over time to reduce competition and to help Gentoo and Chinstrap penguins co-exist.

"Our data shows Gentoo penguins have a more diverse and flexible diet than Chinstrap penguins, which forage farther offshore and preferentially feed on Antarctic krill during the breeding season," Polito said.

Penguins' main prey, Antarctic krill, which are shrimp-like crustaceans, rely on sea ice. Young krill in particular use sea ice for protection from predators, and they feed on algae that grow beneath the sea ice. As temperatures warm, there is less sea ice and therefore fewer krill for penguins to eat.

This research sheds light on the different strategies these two similar species have carved out over time to reduce competition for food and how they are influenced by rapid environmental change. ■

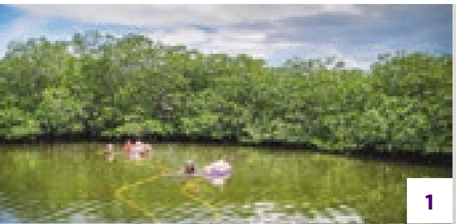
By blending the arts and sciences, researchers are creating new forms of craftsmanship that result in works such as the above installation, "Humming Mississippi," by LSU faculty Jesse Allison and Derick Ostrenko.

MOVERS AND MAKERS

By Abby Jennings

In the age of Etsy, YouTube, and Pinterest, craftsmanship, as defined as the art of making something tangible, is starting to make a new comeback. This movement began with the first publication of "Make" magazine in 2005, followed in 2006 by the first Maker's Faire. A Maker's Faire is a public event where craftsmen of all disciplines spanning engineering, science, the arts, technology, and many others come together to bring their ideas into the tangible. This new craftsmanship is a blend of familiar mediums such as wood, metal, or cloth with innovative digital technologies.

The role of a maker is to create something from these mediums that can be used, interacted with, or simply experienced in a new way. Whether it be for work or play, this new generation of tinkerers and innovators has taken the world of craftsmanship by storm. This movement even made an appearance in the White House with the inaugural White House Science Fair and the "Week of Making." This comes as the push for integrating a maker mentality into public education gains momentum. The emergence of the Maker's Faire over the past few years has brought a renaissance of craftsmanship, and LSU researchers are on the cutting edge. Researchers are using technology like 3D printers and specialized computers to bring academia off the page and into the tangible.



Credit: Heather McKillop, LSU.

1 LSU Archaeologist Heather McKillop and her graduate students research underwater Mayan artifacts in Belize.
2 The research team logs the GPS coordinates of the artifacts and scans them in the field, which enables them to leave the artifacts in their original locations.
3 The team reconstructs the artifacts using a 3D printer in McKillop's Digital Imaging and Visualization in Archeology, or DIVA Lab, at LSU.

ANCIENT TREASURES

Professor Heather McKillop and her team of archeology students have spent many summers in Belize excavating artifacts from Ancient Maya salt works, which the Maya used to harvest salt from the ocean for their massive empire. She and her team stumbled upon wooden structures built by the Maya that had been preserved in a layer of peat on the ocean floor for thousands of years. What they discovered was a perfectly carved wooden post.

"We weren't supposed to find it because wood does not preserve in the tropical landscape of Central America, just like it doesn't preserve here in Louisiana. It decays. But we had perfect preservation," McKillop said.

After their discovery, the team went back and investigated sites they had visited previously and found several more wooden structures, including the only Maya canoe paddle ever found, which has become a national treasure in Belize. This discovery brought in grants which allowed for the creation of the LSU Digital Imaging and Visualization in Archeology, or DIVA Lab. The DIVA Lab is dedicated to the preservation of Maya artifacts recovered in Belize in more ways than one.

McKillop realized that the artifacts were extremely difficult to preserve out of seawater; so she created the lab in 2008 with the idea of digitally scanning each artifact in the field so it could be studied out of the water without risking damage back at the lab. The actual artifacts are either left in GPS-marked locations in Belize or stored in Tupperware containers of salt water and the digital scans taken at the camp in Belize allow for the artifacts to be recreated on the screen and 3D printed in the U.S.

McKillop's students have scanned hundreds of Maya artifacts and have printed realistic, textured replicas that closely mimic the originals. The work of the DIVA Lab is on the cutting edge, and LSU is one of the first universities where 3D scanning and 3D printing is used in archaeological research. Now, institutions such as the Smithsonian and the British Museum have begun to adopt this technology for their own valuable collections.

HERE AND NOW

LSU School of Art Professor Derick Ostrenko uses technology to create pieces that transcend the barriers between different fields. Ostrenko, along with the Communication Across the Curriculum studio coordinator for the College of Art and Design Vincent Cellucci and experimental music Associate Professor Jesse Allison, has been using technology to create innovative experiences for audiences across the nation. The team recently completed an interactive poetry performance called "Diamonds in Dystopia," which was presented at TEDxLSU. The performance opened with a reading of a poem by Cellucci. The audience was invited to select words that resonated with them through a mobile app designed by Ostrenko. The words selected by the audience were filtered through a massive computer database of former TED talks utilizing code Ostrenko developed. The crowdsourced words form new stanzas, which Cellucci added to the unfolding composition while Allison developed a coinciding sonic soundscape. The makers and the audience created an absolutely unique poem from that collective moment.

Another interactive poetry performance called "Causeway" used the same code base as "Diamonds in Dystopia," but harnessed the power of a super computer known as High-performance Interactive Visualization and Electro-acoustics, or HIVE. This machine consists of more than 40 nodes, or individual computers, working as one. "Causeway" was the first time HIVE has been used for artistic purposes, and it gave Ostrenko the opportunity to work with code that allows for language analysis and creation to be done in an instant, on scales far greater than what a single computer alone could handle.

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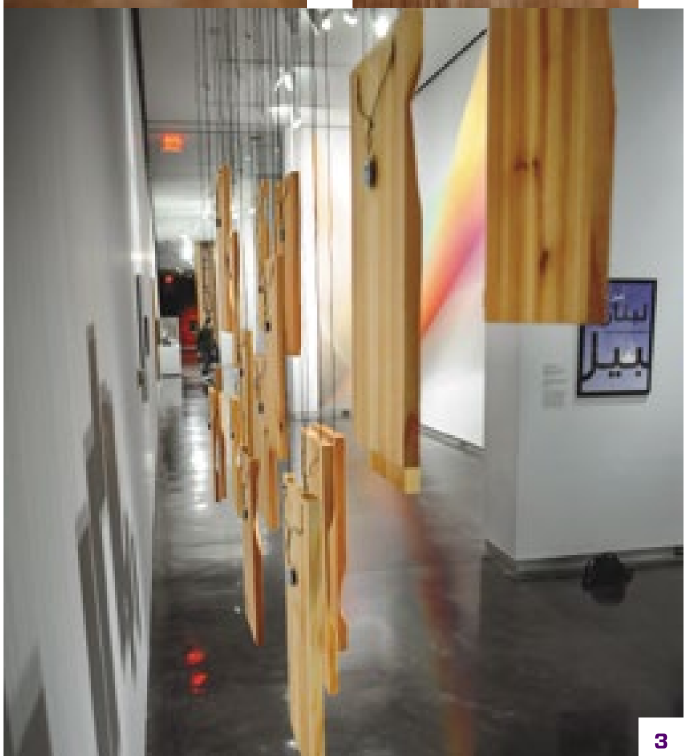

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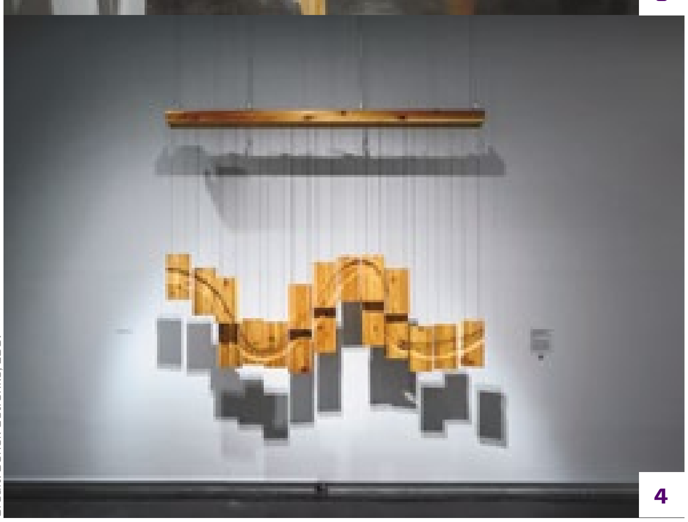

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Credit: Derick Ostrenko, LSU.

1 Craftsmen carved driftwood from the Mississippi River for the “Humming Mississippi” installation.

2 Small transducers were affixed to the back of the driftwood that were connected to real-time data collected by U.S. Geological Survey buoys along the river.

3 Unique sounds created by the vibrations from the transducers reflected what was happening on the Mississippi River in each moment.

4 “Humming Mississippi” was created by LSU Assistant Professor Derick Ostrenko and Associate Professor Jesse Allison, and was exhibited at the LSU Museum of Art.

“We’re not designing software for current systems,” Ostrenko said. “We’re trying to design software and experiences for systems that are at the cutting edge.”

“Humming Mississippi,” another collaboration between Allison and Ostrenko, brought traditional mediums into play as well. The craftsmen carved pieces of driftwood from the Mississippi River and hung them at the LSU Museum of Art. A U.S. Geological Survey buoy took real-time readings of the Mississippi River’s salinity, water level, pH, temperature, and river flow. The pieces of wood had small transducers on the back that created a unique vibration depending on the readings being taken at that exact moment, such as when a boat went by or when it was raining. Each sound coincided with a specific moment on the Mississippi River.

Ostrenko is excited for the revival of the maker’s movement and its arrival in the field of research. He believes that technology allows for unique moments in time to be captured and experienced in ways that have never been before.

“It’s an opportunity to really merge these two worlds of art and technology,” he said. “It becomes very community oriented all of sudden.” Research and development is becoming more of a democratic process.

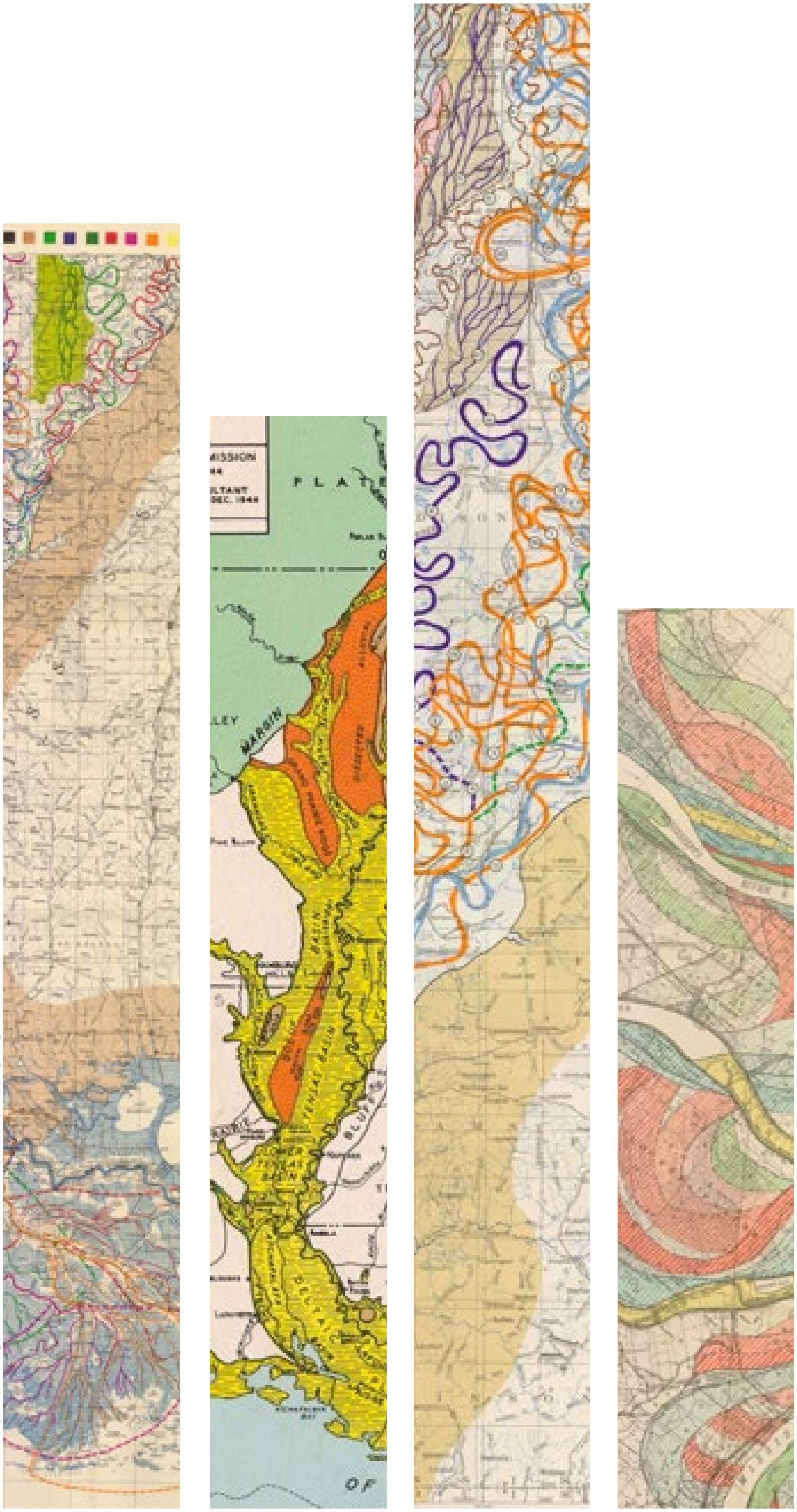
MOVING INTO THE FUTURE

Brygg Ullmer, the Effie C. and Donald M. Hardy Associate Professor in the School of Electrical Engineering and Computer Science, and his group, Tangible Visualizations, research how certain physical objects, like a knob on a machine or a doorway in a building, help increase understanding and communicate complex systems. In simpler words, the goal of his work is to make things function better with a few simple utilitarian objects. By tweaking the physical aspects of something, like a keyboard or mouse on a computer, he hopes to make an object easier to use and more accessible. He was inspired by Harvard’s Museum of Historical Scientific Instruments’ artifacts 20 years ago and decided to focus his research on bringing ideas about tangibles into the scientific domain through information visualization.

His on-going project involves “re-skinning” walls and hallways with passive printed content, LED-illuminated content, and screens. These displays present students’ work, including new papers and software development, so that this research can be seen as people walk down the hallway between their labs and offices. He hopes to take this beyond a working model in the next few years, adding all of the digital media works of current and former students to make a living database of academic works that can be easily accessed. Rather than just having flyers pasted to the wall, the use of these large screens along a hallway allows for a dynamic, memorable experience. ■

Mighty Mississippi Mud

By Alison Lee Satake



Credit: U.S. Army Corps of Engineers Lower and Middle Mississippi Valley Mapping Program.

Maps of the evolution of the Alluvial Valley of the Lower Mississippi River by LSU Associate Professor in the Department of Geology Harold Fisk for the U.S. Army Corps of Engineers, 1944.

In 1878, the country's leading river engineer James Buchanan Eads spoke about the Mississippi River to the St. Louis Merchant's Exchange.

"We…see that the Creator has, in His mysterious wisdom, endowed the grand old river with almost sentient faculties for its preservation. By these it is able to change, alter, or abandon its devious channels, elevate or lower its surface slopes, and so temper the force which impels its floods to the sea," said Eads, who developed the Mississippi River levee system for navigation.

Since this time, scientists and engineers have studied and attempted to tame the ninth largest river in the world. This natural resource plays a large role in the economic and environmental sustainability of the nation.

Credit: Sam Bentley, LSU.

Researchers dig into the mud to collect sediment samples at Four League Bay. Researchers from left to right: LSU Department of Geology and Geophysics doctoral candidate Giancarlo Restreppo, master's student Chris Magliolo, and LSU Coastal Studies Institute Director Sam Bentley.

Coastal Louisiana boasts the largest commercial fishery in the lower 48 states. It also supplies 90 percent of the country's oil and gas drilled from the outer continental shelf. Marshes and wetlands serve to protect communities from hurricanes and storm surge. Yet, this valuable natural resource is diminishing.

Ninety percent of the U.S.'s coastal wetland loss occurs in Louisiana. LSU faculty, students, and alumni are on the frontlines gathering valuable information on the processes that contribute to land loss. One part of the land loss process is understanding and predicting how sediment—sand and mud—moves down the Mississippi River to the coastal wetlands. Current numerical models can simulate the physics of sand well as it moves and is deposited. However, sand comprises only about 10 percent of the sediment that is transported down the Mississippi River. Mud makes up the other 90 percent.

Viscous and rich, mud is much more complex than individual grains of sand.

"Sand particles behave as individual entities like a bunch of ping pong balls, but mud is sticky," said LSU Coastal Studies Institute Director Sam Bentley, who is also the Billy and Ann Harrison Chair in Sedimentary Geology. "It gloms together, it breaks apart, and it forms aggregates and flocks that behave differently over time and space depending on the forces it's exposed to."

For the most part, current computer models that are used to simulate widespread land-building of the wetlands are simplified to reduce computational burden, which means much of the detail in the physics are left out.

"So there's a part of the story that is not well represented in a lot of the numerical models particularly the ones used for land-building calculations," Bentley said.

His research team is working with collaborators at The Water Institute of the Gulf to improve the computational tools so they more accurately capture the transport of mud. They hope their new tools can help the next generation of the Coastal Master Plan.

Muddy Complexity

Mud is complex. Organisms live in it. Plants help hold it together. It's ever changing. In order to accurately simulate how mud moves, its physical properties need to be described newly at every location and every time.

"If you miss that, you can't simulate the processes," he said.

Another nuance of mud is that after it is deposited on a river bank or a bay floor, a storm can kick up the particles again. However, the resuspended particles differ from the originally deposited sediment. They've changed.

This resuspended sediment may be key to naturally occurring land-building of the wetlands. Emeritus Boyd Professor Harry Roberts, professors in the LSU Department of Oceanography and Coastal Sciences Chunyan Li, John White, and colleagues initiated research on how mud moves from the river, is suspended, and then gets swept again into the wetlands far from the river mouth. Through support from the National Science Foundation, Bentley and collaborators on the Coastal Science, Engineering, and Education for Sustainability, or Coastal SEES, project are continuing this research.

They have found that mud is transported in the spring by floods from the Atchafalaya River and is deposited into Atchafalaya Bay, which is located on the ball of the foot of the Louisiana boot. Cold fronts and tropical storms create waves that churn up the sediment and transport it again. Data shows that this mud can move up to 50 kilometers away from the mouth of the river and settle in the wetlands.

Researchers are studying Four League Bay, which is adjacent to the mouth of the Atchafalaya River. The 20-kilometer long marsh on the bay changes as you move away from the river. It is firm, elevated, and has more abundant fresh water plants growing on the bank than farther from the mouth of the river. The farther you go from the river source, the less sediment you see.

Credit: Sam Bentley, LSU.

LSU Coastal Studies Institute student researchers Ryan Clarke, James Smith, and CSI field technician Charlie Sibley measure sediment cores offshore of Venice, La. on the Mississippi Delta onboard the R/V Coastal Profiler.

"This particular experimental gradient captures the end members—from marshes that are extremely resilient to marshes falling apart. This is telling us qualitatively that the radius of influence is much greater than what was previously thought," he said.

To capture the quantitative data, Bentley's research group collects sediment cores from around Four League Bay and the marsh, and analyzes them for a radioisotope called Beryllium-7. Beryllium-7 is found in higher concentration in sediment carried by rivers than sediment found in the coastal ocean. It serves as a fingerprint for recently deposited sediment from the river. The researchers can trace the origins of the sediment that are on the bay floor and the marshes.

> "The concept of sediment being transported from the river to the bay floor and from the bay floor to the wetlands has been around for a long time. However, the effort of quantifying the nurturing effects rigorously so we can plug the numbers into numerical models, is new."
>
> —Sam Bentley
> LSU Coastal Studies Institute director
> Billy and Ann Harrison Chair in Sedimentary Geology

LSU Department of Oceanography and Coastal Sciences Assistant Professor Kevin Xu is measuring the currents and waves that resuspend the mud. CSRS Distinguished Professor in Coastal Engineering Jim Chen is developing numerical models to simulate land-building processes that capture the phenomena. Louisiana Sea Grant Executive Director and Department of Oceanography and Coastal Sciences Professor Robert Twilley is quantifying the roles of plants in capturing carbon and nutrients that further help build the delta.

"We can take our field measurements and extrapolate to some extent. But we can't measure everything at every location. That's where the models come in," Bentley said. ■

Credits: Christopher Austin, Prosanta Chakrabarty, and Jacob Esselstyn, LSU.

Notes from the Field

The challenges and rewards of discovery

By Michelle Watson

As noted naturalists Henry David Thoreau and John James Audubon knew well, exploring nature is an adventure. From preparation to discovery, the process of discovering something new is not only invigorating, but helps us understand our world and life, in general, better.

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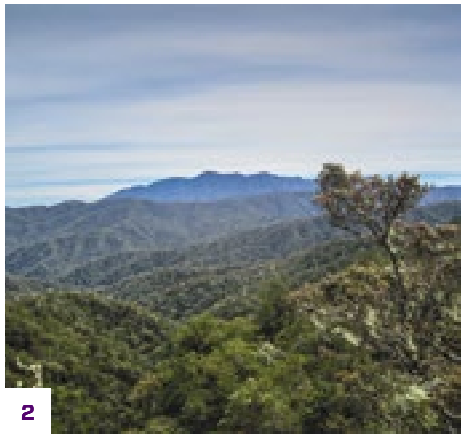

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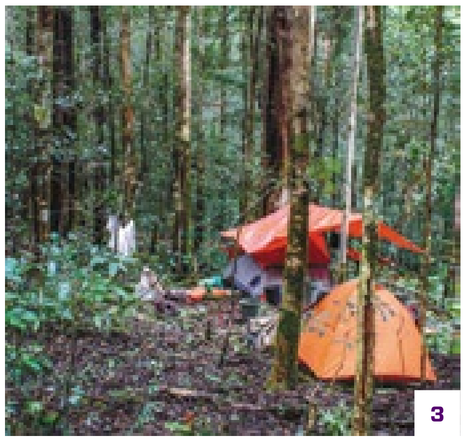

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Credits: Christopher Austin, Prosanta Chakrabarty, and Jacob Esselstyn, LSU.

For decades, LSU researchers have navigated the rugged terrain in some of the world's most remote locations for their work. Since 2006, this dynamic group of scientists have discovered more than 60 new species of birds, fish, and mammals including the hog-nosed rat in Indonesia and the green-blooded lizards of Papua New Guinea.

The work put into finding these new species is not easy, but the rewards outweigh the challenges. Most discoveries begin with a field expedition and a commitment to science.

Jacob Esselstyn, assistant professor in the Department of Biological Sciences and curator of mammals at the LSU Museum of Natural Science, had his most recent discovery of the hog-nosed rat, or *Hyorhinomys stuempkei*, featured in the *Journal of Mammalogy*. BBC and Discovery covered the announcement of the new species as well, but some of the grittier details that led to the discovery were left out of the news announcements.

In the Field

On field expeditions in the mountainous regions of Indonesia, Esselstyn wakes up every morning and puts on damp clothes. In the field, most researchers have one set of dry clothes and one set of wet clothes. Researchers try very hard to keep at least one set of clothes dry.

"Sometimes we'll dry them over the fire, but they start smelling pretty bad," Esselstyn said.

He typically eats a meal of salted fish and rice for breakfast with a cup of coffee to get his day started. Then it's off to check the traps he set to see if he caught anything during the night.

"Maybe you get something exciting or maybe you get something expected. Sometimes you just get ants, which to the right biologist might be exciting, but we're looking for mammals," he said.

If Esselstyn and his team find something in their traps, they take the specimens back to camp and start prepping them for further research. Prepping specimens involves skinning the animal, stuffing it with cotton to make it look more life-like, and removing its bones. They also freeze and preserve a small tissue sample in liquid nitrogen that will be added to the museum's vast tissue collection, which researchers around the world rely on for various analyses including DNA sequencing. The goal is to have a clean specimen so that researchers can study the morphology of the organism in the future. After a long day of prepping specimens, Esselstyn typically goes to sleep.

"If we're done and it gets dark, I usually go to bed, because there's not much else to do," he said.

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The next day, he and his team do it all over again. Esselstyn said that his favorite species that he's discovered to this day is the hog-nosed rat.

"The hog-nose is just so silly," he said. "It's so goofy-looking and it was one of those things that you just kind of look at and go 'well that is completely different. I was not expecting to see that.'"

While Esselstyn works during the day to find mammals, Christopher Austin, professor in the Department of Biological Sciences and head curator of amphibians and reptiles at the LSU Museum of Natural Science works through the night from 8 p.m. to midnight. Austin and his team are responsible for discovering the world's smallest vertebrate known to-date.

1. LSU Museum of Natural Science Curator of Herpetology Christopher Austin discovered the world's smallest vertebrate, a frog that is smaller than a dime.
2. A study region in the mountains of Indonesia where LSU Museum of Natural Science Curator of Mammals Jacob Esselstyn conducts research.
3. One of Esselstyn's field camp sites on Sulawesi island, Indonesia.
4. Esselstyn discovered the hog-nosed rat.
5. LSU Museum of Natural Science Curator of Fishes Prosanta Chakrabarty discovered the first Sleeper Goby cavefish in the Western Hemisphere.

DISCOVERING OUR NEW EARLY HUMAN ANCESTOR

By Juliet Brophy

I study teeth—fossil teeth to be precise. In fact, I've been called the "fossil dentist" by colleagues because I'd get so excited when we'd find a new tooth while sifting through the largest collection of early human fossils found at one site called the Dinaledi Chamber in South Africa. My research interests involve using morphometric analyses to examine taxonomic differences among early human, or hominin, teeth and to better understand early human evolutionary relationships. In 2010, my hominin dental research supported the identification of a new hominin species, *Australopithecus sediba*.

After the recovery of fossils from the Dinaledi Chamber in 2014, lead researcher Lee Berger hand selected 30 early career scientists to analyze the specimens. I was chosen for my experience in hominin teeth. To date, excavations from the Dinaledi Chamber have uncovered ~1550 skeletal specimens that include 190 whole or fragmentary teeth from at least 15 individuals. The dental team and I described and analyzed the teeth of the new fossils. My specific expertise involves documenting and comparing the occlusal, or chewing, surface outlines to other human ancestors in order to determine the biological identity and to establish phylogenetic, or evolutionary, relationships between the ancestors. This work is important to the project because dental morphology plays a pivotal role in our understanding of early humans. Ultimately, we found that the teeth are small and overlap in size with other early *Homo* species. The dentition retains a number of features that are primitive, or ancestral, for the genus *Homo* but not found in later, more modern early humans. What's different about *Homo naledi* is the outline of the surface of their teeth; specifically, their mandibular third premolar is unique.

Participating in the examination of these fossils has been one of the most exciting experiences in my paleoanthropological career thus far. I absolutely love studying fossils from southern Africa—it is why I became a paleoanthropologist! There is just something so special about being on the team that first gets to investigate new hominin fossils. Furthermore, the vast sample size of indisputably associated skeletal elements is unprecedented in paleoanthropology. We knew we were making history.

Credit: Juliet Brophy, LSU.

Juliet Brophy is an assistant professor in the Department of Geography and Anthropology at LSU. Her research includes analyzing the shape and size of early human teeth to better understand early human evolution. She is among a handful of scientists selected to research the fossils found in the Dinaledi Chamber in South Africa that led to the naming of a new human ancestor, Homo naledi.

Austin and his team listen to the mating calls of adult male frogs to identify and find new species. However, the world's smallest vertebrate sounds more like a cricket than a typical frog.

"In the tropical forest, there's really thick leaf litter on the ground and some frogs call from that leaf litter. So we heard this thing calling from some leaf litter," he said.

Next, he and his team picked up a few handfuls of leaves and put them in a clear plastic bag. They began sorting through the leaf litter to see what was making the noise.

"Eventually we picked up a leaf and a small frog hopped off it and we said 'ah, that's a juvenile frog of something else. That's not what's calling. It must be something else.' But the only thing in that bag was the frog so we thought, 'oh maybe it is the frog,'" he said.

The world's smallest vertebrate or *Paedophryne swiftorum*, was found in Papua New Guinea, where he conducts most of his research. The frog is smaller than a dime, and is less than 8 millimeters long. This frog isn't the only creature that Austin and his team have discovered thus far that's turning heads. Austin is also responsible for finding a unique group of lizards.

"There's this incredible group of lizards from New Guinea that have green blood," he said. "And I've collected a new lizard of that species and have yet to describe it. I'm excited to work on it."

> "There's nothing like being at the top of a 6,000-foot mountain, sitting around the fire at night, collecting frogs, having a cup of tea, and telling stories."
>
> —Christopher Austin
> LSU Museum of Natural Science curator of herpetology

While Esselstyn works on mammals and Austin works on reptiles and amphibians, Prosanta Chakrabarty, associate professor in the Department of Biological Sciences and curator of ichthyology, works on fish. For him, discovering a new species of cave fish in Madagascar was an experience he'll remember forever.

"The species that we discovered there was one of the few times that I held in my hand a new species and I knew it was new right away. This thing was so different. There's never been a dark species of a cave fish like that discovered," he said.

Unfortunately, during this exciting discovery, Chakrabarty and his team became sick from swimming in the bacteria-filled sink hole where they found the dark cave fish.

"I threw up all the cave water as soon as I got out," Chakrabarty said. "It wasn't gross or anything, but I did feel funny. I didn't get as sick as some of my colleagues. We probably found a new species of sickness too, but don't tell the CDC that," he said jokingly.

Sickness and physical discomfort are all things that the researchers face in the field. But there are a few other things that can be challenging. For one, many of the researchers talk about the monotony of having to eat the same food over and over again.

Austin and his team primarily eat hardtack, a type of biscuit made of salt, flour, and lard for breakfast and lunch every day.

"It's what sailors used to eat in the 1600s, 1700s, and 1800s," Austin said. "It's relatively light, relatively easy to carry, and has a fair amount of calories. But you can imagine what it's like to eat crackers 20 days straight for breakfast and lunch."

Sometimes Austin and his team will splurge and open up a can of Spam to put on top of their hardtack. But eating Spam only happens on special days—usually Sunday. Additionally, to break up the monotonous diet, Austin has gotten smart and started bringing Tabasco on his trips to add some flavor to the food they eat.

Finding a nice place to bathe, or even bathing at all, is another obstacle that researchers face in the field. Chakrabarty said it's typical to go three days without bathing. LSU ornithology researcher and wildlife artist Daniel Lane said he's gone a month without bathing because it can get cold in the mountains and it's uncomfortable to bathe.

Credit: Christopher Austin, LSU.

LSU Museum of Natural Science Curator of Herpetology Christopher Austin and former undergraduate researcher Lauren Oliver record frog calls in Papua New Guinea.

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Credits: Christopher Austin and Jacob Esselstyn, LSU.

1 Christopher Austin with a village elder and field helpers on Goodenough Island, Papua New Guinea.

2 Building a bush table for a remote field camp on Papua New Guinea.
3 Drying clothes and preparing food over a fire at a field camp in Indonesia.

Off the Grid

Researchers have to be continuously aware that they are in a remote location, usually pretty far from a major city, when doing field work. Positive interactions with local people and knowing their language can be key to a successful trip. Otherwise, miscommunication may have scary results.

"You always want to be very careful on how you interact with the locals, because it's their land and you're a visitor," Lane said.

LSU doctoral candidate Vivien Chua specializes in bird species from Malaysian Borneo. She will never forget a particularly grueling field expedition.

Chua and her group rode in a truck for six hours to a local village; then they took a longboat for another three hours to reach base of the 8,000-foot Mt. Mulu. They started climbing at 8 a.m. Chua said the climb was unforgiving.

"At that time, I remember it being one of the hardest physical and mental challenges I had ever faced," she said. "It was pushing my physical limit plus not knowing when we would reach our camp site was difficult."

By nightfall, Chua and her group were still climbing. There was no place to sit, but whenever Chua needed a break, she'd listen to the calls of the local collared owlet, a native bird to many west Asian countries. Chua and her team finished the climb after 13 continuous hours. They rewarded themselves with hot coffee and instant noodles for dinner while gazing up at the night sky.

"By the end of that leg of the expedition, I had lost both my pinky and big toenail on both feet from the climb," Chua said. "Somehow it was all worth it and I had a great and unforgettable time in the field."

Throughout all of the obstacles that researchers face in the field, they all agree that there's nothing like field work. They contend that it's the best part of their job.

"I think a lot of people go into this program because there's a part of them that enjoys the field work," she said.

For Austin, the true beauty of exploration is being alone in nature.

"The best part is exploration, discovery, and getting to the top of a mountain that no herpetologist has been to. Local people are great too," he said.

All of the researchers appreciate the absolute solitude while discovering new things. For Lane, the experience of field work offers an escape.

"My favorite part is that you're in the moment. You cannot worry about anything else in your life because you can't do anything about it. So you're very much living in the moment," Lane said.

The LSU Museum of Natural Science researchers have made significant contributions to the growing number of new species discovered throughout the world. Their love of exploration, nature, and the diversity of life teeming in these natural environments have helped make these discoveries possible. And, there is still much more to be discovered. Scientists predict that 8.7 million species inhabit our planet and less than 15 percent of these species have been cataloged. This leaves researchers with much more work to do in the field they love. ■

At the LSU Rainmakers event were, left to right: President F. King Alexander, Associate Vice President for Research & Economic Development Stephen David Beck, Associate Professor Alex Cohen, George C. Kent Professor in the Department of Biological Sciences Marcia Newcomer, Vice President of Research & Economic Development K.T. Valsaraj, Assistant Professor Catherine Deibel, Associate Professor Jesse Allison, Associate Professor and Curator of Fishes Prosanta Chakrabarty, Campus Federal Credit Union Chief Development Officer Ron Moreau, and Executive Vice President and Provost Richard Koubek.

RAINMAKERS

As a top-tier research institution, LSU's research faculty are proven leaders in their respective field, performing at truly outstanding levels each day. The LSU Office of Research & Economic Development, with the support of Campus Federal Credit Union, takes the opportunity each year to acknowledge some of our many outstanding faculty with the Rainmaker Awards for Research and Creative Activity.

Faculty members chosen as Rainmakers are those who balance their responsibilities in the classroom with securing external funding for their research and broadly disseminating their findings to not only the scholarly community but to society as a whole. Exemplary representatives of LSU, who garner both national and international recognition for their innovative research and creative scholarship, while also competing for external funding at the highest levels and attracting and mentoring exceptional graduate students.

Each of the following award-winning faculty members has met one or more of the criteria for high-quality research or creative activities and scholarship, which include but are not limited to, publication in a high-impact journal(s); highly cited work; external awards; invited presentations at national and international meetings; high journal publication productivity; critically acclaimed book publication(s), performance(s), exhibit(s) or theatrical production(s); high grant productivity; and, for more senior candidates, outstanding citation records and high-impact invited presentations at national and international meetings. Two awards are granted at each career level including the Emerging Scholar, Mid-Career Scholar, and Senior Scholar levels.

All Rainmaker recipients receive a one-time stipend of $1,000 and a plaque in recognition of their achievements.

Emerging Scholar Award

Arts, Humanities, Social & Behavioral Sciences

Jesse Allison is an associate professor of Experimental Music and Digital Media with a joint appointment in the School of Music and the Center for Computation and Technology, or CCT. As an innovator in sonic art technology, thought and practice, his work centers around the idea that computer interactivity, used wisely, can produce new and engaging forms of art.

In addition, he is the coordinator of the LSU Experimental Music and Digital Media program in the School of Music, co-directs the Laptop Orchestra of Louisiana, or LOLs, heads up the Mobile [App | Art | Action] Group, or MAG, and chaired the 2015 International Conference on New Interfaces for Musical Expression, or NIME, at LSU.

Allison is a member of CCT's Cultural Computing focus area. His research develops technology that can expand what is possible in the arts. His research and invention interests focus on computer interactivity in performance, distributed music systems, mobile music, interactive sonic art installations, hybrid world experiences, and multimodal artworks, which can be experienced through a variety of means.

His recent performances, exhibits, and interventions include the International Symposium on Electronic Arts, or ISEA, Pixilerations Festival, NIME, SIGGRAPH, Techfest Mumbai, the International Computer Music Conference, or ICMC, Boston Cyberarts Festival, TEDxLSU, and the Society for Electro-Acoustic Music in the United States national conference, or SEAMUS.

Science, Technology, Engineering & Mathematics

Catherine Deibel, assistant professor in the Department of Physics and Astronomy, received her bachelor's degree from Amherst College and her doctorate in the field of experimental nuclear astrophysics from Yale University. Her doctoral research focused on the synthesis of ^{26}Al in stellar explosions known as classical nova. She then spent three years at Argonne National Laboratory as a Visiting Research Associate with the Joint Institute for Nuclear Astrophysics studying a series of nuclear reactions responsible for driving the most common stellar explosions in the galaxy: x-ray bursts.

Since joining the LSU faculty in 2011, she has continued her research on the synthesis of elements in a variety of stellar explosions, including supernovae, x-ray bursts, and classical novae. Specifically, she has developed experimental devices and techniques to measure the nuclear reactions responsible for this nucleosynthesis and employed them at accelerator laboratories around the country and abroad, including the installation of a 35-ton magnetic spectrograph at Florida State University supported by a Major Research Instrumentation Award from the National Science Foundation.

Deibel has also received a five-year Career Award from the Department of Energy as well as an LSU College of Science Research Award for her work.

Mid-Career Scholar Award

Arts, Humanities, Social & Behavioral Sciences

Alex Cohen, an associate professor in the Department of Psychology, is a licensed clinical psychologist who focuses on understanding and improving the lives of individuals with serious mental illnesses. His work focuses on adapting biological and behavioral technologies, notably automated computerized analysis of natural behavior, for a wide range of clinical issues, including psychosis, mania, depression, stress, and anxiety.

His work has been featured in top psychology and psychiatry scientific journals, and he currently has 94 scientific publications and book chapters. He has received funding at the state, federal, and international levels, and he has played a central role in more than $2 million in grants and contracts.

He will be featured in the upcoming National Geographic Channel's "Brain Games" series. He is an adjunct professor at Pennington Biomedical Research Center and LSU Health Sciences, and he maintains a team of six doctoral students and more than 15 undergraduate research assistants. His clinical team provides services at a variety of outpatient and inpatient clinics in the greater Baton Rouge area. His free time is spent with his wife, Melissa Beck, who is also a faculty member in the psychology department, his daughter, and friends enjoying the many comforts of southern Louisiana.

Science, Technology, Engineering & Mathematics

Prosanta Chakrabarty is an associate professor in biological sciences and the curator of fishes at the LSU Museum of Natural Science, a post he has held since August 2008. He is a systematist and an ichthyologist studying the evolution and biogeography of freshwater and marine fishes. His work includes studies of neotropical fishes in Central America, South America, and the Caribbean as well as Indo-West Pacific species in the Indian and western Pacific oceans.

Chakrabarty's lab has contributed to the collections at LSU by gathering specimens locally and internationally from countries including Japan, Australia, Taiwan, Honduras, Guatemala, and Kuwait. He has described over a dozen new fish species including several anglerfish and cavefish taxa that have been new to science. He oversees more than half a million fish specimens and nearly 10,000 tissue samples covering most of the major groups of fishes that are part of the LSU Museum of Natural Science fish collection.

TED, the international nonprofit organization dedicated to spreading ideas in the form of short, powerful talks, selected Chakrabarty as one of its 21 TED Fellows for 2016. He is part of the exclusive network of more than 360 scientists, artists, and entrepreneurs connected through TED. You can follow Chakrabarty on Twitter @LSU_FISH.

Senior Scholar Award

Arts, Humanities, Social & Behavioral Sciences

Fahui Wang is the James J. Parsons Professor in the Department of Geography and Anthropology. He is an internationally renowned expert in Geographic Information Systems, or GIS, applications in the social sciences and public policy, and most well-known for his groundbreaking work on spatial analysis methods and related applications in urban studies, public health, and crime analysis. His work has been supported by the National Science Foundation, National Institutes of Health, and other federal agencies including the U.S. Department of Housing and Urban Development, the Department of Energy, and the Department of Justice garnering more than $2 million in grants and contracts.

His publication record includes four books and more than 100 refereed articles that are widely cited. His popular 2SFCA method is adopted by government agencies in countries including France and Australia for designation of physician shortage areas. He has taught a wide range of courses from large-section General Education courses for undergraduates to graduate seminars. His major service roles at LSU include having served as the director of the Chinese Culture and Commerce Program from 2007–2013 and as the current Department of Geography and Anthropology chair since 2014.

Wang received his bachelor's degree in geography from Peking University in China, his master's degree in economics and doctorate in city and regional planning from The Ohio State University.

Science, Technology, Engineering & Mathematics

Marcia Newcomer is the George C. Kent Professor in the Department of Biological Sciences. Her research interest in structural biology is driven by a wish to understand how biological catalysts are able to promote the complex biochemical reactions that make life possible. Her recent work has focused on understanding the molecular basis of the inflammatory response.

She received her bachelor's degree in chemistry from the College of Charleston and a doctorate in biochemistry from Rice University. She conducted post-doctoral research at the Wallenberg Laboratory at the University of Uppsala, Sweden. After spending several years at the Universidad Autonoma de Mexico and then Washington State University, she joined the biochemistry faculty at Vanderbilt University School of Medicine. She joined the LSU Department of Biological Sciences in 2001. ■

*For more information about the Rainmakers Awards, visit **LSU.edu/research**.*
*For more information about Campus Federal, visit **campusfederal.org**.*

ACCOLADES

Distinguished Chemist Elected to American Academy of Arts and Sciences

LSU Boyd Professor Isiah Warner is among the 213 new members elected to the American Academy of Arts and Sciences. The 2016 inductees include some of the world's most accomplished scholars, scientists, writers, and artists, as well as civic, business, and philanthropic leaders.

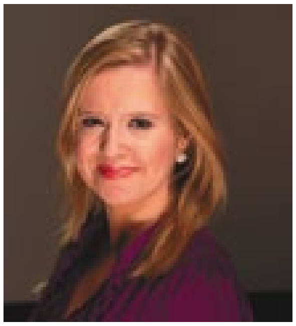
Founded in 1780, the American Academy of Arts and Sciences is one of the country's oldest learned societies and independent policy research centers, convening leaders from the academic, business, and government sectors to respond to the challenges facing—and opportunities available to—the nation and the world. Members contribute to academy publications and studies of science, engineering, and technology policy; global security and international affairs; the humanities, arts, and education; and American institutions and the public good.

"Isiah's election into the American Academy of Arts and Sciences is a testament to his ground-breaking research efforts and his commitment to making college accessible to all, including first-generation students and minorities," said Cynthia Peterson, LSU College of Science dean.

> "Today, LSU is the nation's top producer of African American Ph.D.s and women Ph.D.s in chemistry, and this is largely due to Isiah's widely successful research and mentoring programs."
>
> —Cynthia Peterson
> College of Science dean

Warner is the Phillip W. West Professor of Chemistry and Howard Hughes Medical Institute Professor at LSU. His research aims to develop and apply chemical, instrumental, and mathematical measurements to solve fundamental questions in chemistry. The Bunkie, La. native also serves as LSU's Vice President for Strategic Initiatives, which oversees the university's efforts to increase diversity among its science, technology, engineering, and mathematics programs, and he is considered to be one of the world's experts in analytical applications of fluorescence spectroscopy. He is also the 2016 recipient of the SEC Professor of the Year Award.

Alumna Part of *Washington Post*'s Pulitzer Prize-Winning Series



LSU Manship School of Mass Communication alumna Amy Brittain is part of *The Washington Post* staff recently recognized with a Pulitzer Prize for "its revelatory initiative in creating and using a national database to illustrate how often and why the police shoot to kill and who the victims are most likely to be."

Brittain's main contribution to the Pulitzer Prize-winning project was a piece titled "On Duty, Under Fire." The story follows a Wisconsin state trooper who was gunned down on his first day by a bank robber. As he was dying, he returned fire and shot and killed the suspect. The story also provides statistics about how many police officers have shot and killed individuals who have already shot someone, brandished a gun, or attacked other people.

Brittain also contributed reporting to a story titled "Different Shooting, Same Police Officer," which was about the number of police officers who shot and killed someone in 2015 who had previously been involved in a fatal shooting.

"From my first day at LSU, I've heard about Amy Brittain and her reputation for being the most dogged reporter on the *Reveille*."

—Jerry Ceppos
Manship School of Mass Communication dean

"I'm not the least bit surprised that Amy's name is forever attached to this Pulitzer," Ceppos said.

Brittain received her bachelor's degree with a concentration in print journalism from the Manship School in 2009. She worked as a reporter for *The Daily Reveille* for four years while at LSU.

Brittain began at *The Washington Post* in 2013 as an investigative reporter. While at *The Washington Post*, she has covered a range of topics, including deaths of children in unregulated daycares, the Ebola epidemic in West Africa—during a two week reporting trip to Guinea, and the circumstances of Supreme Court Justice Antonin Scalia's death.

Vice President of Research & Economic Development Elected to National Academy of Inventors

LSU Professor and Vice President of Research & Economic Development K.T. Valsaraj has been named a Fellow of the National Academy of Inventors, or NAI.

Valsaraj is now one of 582 NAI Fellows representing more than 190 prestigious research universities and governmental and nonprofit research institutions. The 2015 Fellows account for more than 5,300 issued U.S. patents, bringing the collective patents held by all NAI Fellows to more than 20,000.

The academic inventors and innovators elected to the rank of NAI Fellow are named inventors on U.S. patents and were nominated by their peers for outstanding contributions in areas such as patents and licensing, innovative discovery and technology, and support and enhancement of innovation in their field.

"This is a recognition of our progress in technology commercialization and the role that LSU plays in the overall economic development efforts within the state."

—K.T. Valsaraj
Vice President of Research & Economic Development

"I am also delighted that my own research, which has gone from the laboratory to large-scale industrial implementation, has been recognized by this award," said Valsaraj.

Being elected as an NAI Fellow is a high professional distinction accorded to academic inventors who have demonstrated a prolific spirit of innovation in creating or facilitating outstanding inventions that have made a tangible improvement on quality of life, economic development, and the welfare of society.

Several NAI Fellows are presidents or senior leaders of research universities and nonprofit research institutes, Nobel Laureates, members of the National Academies, inductees of the National Inventors Hall of Fame, and recipients of the U.S. National Medal of Technology and Innovation and U.S. National Medal of Science, among other awards and distinctions.

Credit: TED.

LSU Museum of Natural Science Curator of Fishes and Associate Professor in the Department of Biological Sciences Prosanta Chakrabarty (far right) was selected to be one of the 21 TED Fellows for 2016. More than 360 artists, scientists, and entrepreneurs comprise the international network of TED Fellows.

Museum of Natural Science Curator Selected as 2016 TED Fellow

TED, the international nonprofit organization dedicated to spreading ideas—usually in the form of short, powerful talks—has selected LSU Associate Professor and Museum of Natural Science Curator of Fishes Prosanta Chakrabarty as one of 21 TED Fellows for 2016.

"I feel honored to be recognized by TED, because conveying my science in a way that's understandable and relatable to people is such an important part of what I do."

—Prosanta Chakrabarty
LSU Museum of Natural Science curator of fishes
LSU Department of Biological Sciences associate professor

As the Curator of Fishes at the LSU Museum of Natural Science, Chakrabarty's research focuses on the evolution of both marine and freshwater fishes including cavefishes, bioluminescent species, and lineages that help explain ancient geological events. He and his students conduct fieldwork around the world including Central America, Southeast Asia, the Middle East, and Louisiana.

He received his doctorate from the University of Michigan–Ann Arbor. He was a postdoctoral fellow at the American Museum of Natural History in New York, and joined the LSU faculty in 2008.

As a TED Fellow, Chakrabarty is invited to become part of the exclusive network of more than 360 artists, scientists, and entrepreneurs. He will participate in the annual TED conference, which aims to grow each fellows' potential.

"The collaborative spirit of the program yields a powerful network where each person profoundly influences each other person, and the group as a whole functions like a supercomputer. It's a powerful thing to witness and be part of," said TED Fellows Founder and Director Tom Rielly.

Chakrabarty presented a TED talk titled, Clues to Prehistoric Times Found in Blind Cave Fish, at the TED Fellows conference in Vancouver. ■

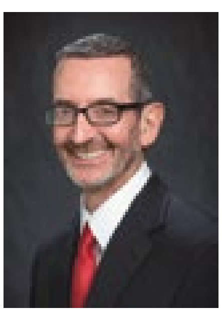
GOING THE DISTANCE

Distinguished Research Masters

Since 1972, the LSU Council on Research has presented the university-wide Distinguished Research Master award in recognition of outstanding faculty accomplishments in research and scholarship. The recipients are chosen by the council from nominees proposed by the university community. Each year, one recipient is chosen from the arts, humanities, social sciences, and behavioral sciences disciplines, and another from the science, technology, engineering, and mathematics—or STEM—disciplines.

From left to right: LSU President F. King Alexander, Phyllis M. Taylor Professor of French Studies John Protevi, Charles H. Barré Distinguished Professor in Chemistry Graça Vicente, and Vice President of Research & Economic Development K.T. Valsaraj.

Arts, Humanities, Social & Behavioral Sciences



John Protevi, French Studies
College of Humanities & Social Sciences

John Protevi is the Phyllis M. Taylor Professor of French Studies, and by secondary appointment, a professor of philosophy. He is currently chair of the Department of French Studies. The holder of bachelor of arts and master of arts degrees from Pennsylvania State University, he received a doctorate in philosophy from Loyola University of Chicago in 1990. He was the Scots Philosophical Association Centenary Fellow in 2012, a recipient of the LSU Distinguished Faculty Award in 2013, the Niebuhr Lecturer at Elmhurst College in 2014, and Distinguished Visiting Professor at the Institute for the Arts and Humanities at Pennsylvania State University in 2015.

Protevi teaches courses primarily in contemporary French philosophy including Foucault and Deleuze, and plans to offer courses in philosophy of mind and philosophy of biology. His research focuses on the intersections of dynamical systems theory, the cognitive, life and earth sciences, and contemporary French philosophy.

Science, Technology, Engineering & Mathematics

Graça Vicente, Chemistry
College of Science

Graça Vicente was born in Portugal and received her Ph.D. in chemistry from the University of California, Davis, in 1990. After three post-doctoral experiences in France, Switzerland, and Portugal, she started her academic career at the University of Aveiro, Portugal, in 1993. She moved back to the University of California, Davis, in 1998, and she came to LSU in 2001. Currently, she is the Charles H. Barré Distinguished Professor in Chemistry. She is also the program director for the Initiative for Maximizing Student Development, or IMSD, program.

Vicente's research involves the synthesis of organic materials based on the porphyrin, chlorin, phthalocyanine, and boron dipyrromethene cores, their conjugation to biomolecules and their development for applications in biology and medicine. She has mentored 27 graduate and 35 undergraduate students in her research laboratories at LSU. As a principal investigator, she has been awarded three individual research grants from the National Science Foundation, and six grants from the National Institutes of Health, since coming to LSU. Vicente is the co-author of nine book chapters, 170 peer-reviewed publications, and four patents. Her publications have been cited more than 4,700 times and her h-index is 38, according to the Web of Science. She has been honored with several awards, including a 2004 Young Investigator Award from the Society of Porphyrins and Phthalocyanines, a 2008 Tiger Athletic Foundation Undergraduate Teaching Award, a 2009 Tiger Athletic Foundation President's Award, a 2012 LSU–HHMI Distinguished Undergraduate Research Mentor Award, and the 2015 LSU Foundation Distinguished Faculty Teaching Award.

The Distinguished Research Masters award provides winners a salary stipend and the University Medal—the symbol of exceptional academic accomplishment at LSU.

Distinguished Dissertation Awards

Since 1983, the LSU Alumni Association and the Graduate School have sponsored two Distinguished Dissertation Awards. Graduates at any of the three commencements in a calendar year are eligible for nomination. A committee of the graduate faculty selects the winning dissertations.

From left to right: Vice President of Research & Economic Development K.T. Valsaraj, Aubrey Heath, LSU Graduate School Dean Michelle Massé, Katherine Willis, and LSU Department of English Professor Jesse M. Gellrich.

Arts, Humanities, Social & Behavioral Sciences

Katherine Willis, Josephine A. Roberts Alumni Association Award

Katherine Willis's dissertation, Chaucer's "Naked Text" and the Tradition of the Medieval Sublime, offers a revision to the history of literary criticism and theory. Analyzing the Latin tradition from the late classical and patristic period forward, she overturns the commonplace that the sublime had no existence in the Middle Ages by documenting its centrality to medieval rhetoric and hermeneutics.

She defines the medieval sublime as the transporting power of deceptively simple style: the text that seems unornamented or humble is uniquely equipped to move its audience out of language and into great thoughts and great emotions. Her project is of special import for Chaucer studies as she challenges standard explanations of his "plain style." Chaucer's rhetorical interests, she argues, are best explained not by literary realism but by his commitment to write sublime poetry and to explore how sublimity works.

Her department chair writes that her dissertation is "a work of groundbreaking scholarship" and a college selection committee member noted that it "will result in a major revision in how the concept of the sublime will be viewed."

Willis received her Bachelor of Arts degree in English from Grove City College and her Master of Arts degree in English from LSU. She received her doctorate in English with a minor in linguistics from LSU in 2015, directed by Jesse M. Gellrich. She is now an assistant professor of early British literature and language at the University of Central Arkansas.

Science, Technology, Engineering & Mathematics

Aubrey Heath, LSU Alumni Association Award

In this dissertation, Aqueous Atmospheric Species, a Dual Study: Phase 1. Comparison of the Effects of Temperature, Oxygen Level, Ionic Strength and pH on the Reaction of Benzene with Hydroxyl Radicals at the Air-water Interface to the Bulk Aqueous and Phase 2. Determination of Carbonyl Compounds in Fog Water Samples via Online Concentration and HPLC, Aubrey Heath performed both laboratory and field studies to further understand atmospheric processes and the fate of common environmental pollutants, such as benzene and carbonyl compounds, in fog droplets.

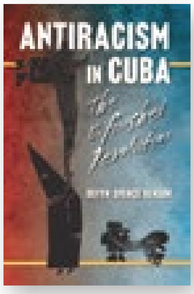
The bulk of the dissertation focused on the reaction of benzene, a common primary atmospheric pollutant, with the hydroxyl radical in both a bulk-phase reactor and a thin film flow-tube reactor. Volatile organic compounds, like benzene, can oxidize in the environment to form additional fog water pollutants, including carbonyl compounds. These compounds can form secondary organic aerosols and are precursors to photochemical smog. This study helped gain a better understanding for fog/smog processes in the natural environment. An award committee member noted that this research stood out as "impactful and impressive," and the college selection committee highlighted its outstanding technical quality.

Heath received her Bachelor of Science degree in chemical engineering with a minor in chemistry from Florida Institute of Technology in Melbourne, Florida, and her Ph.D. in chemical engineering from LSU in 2015 under the guidance of her committee chair K.T. Valsaraj. While at LSU, she received the William Brookshire Graduate Assistantship in Chemical Engineering. She has made presentations at eight conferences, received the Student Presenter Award in chemical processes at the 249th ACS National Meeting, and was first author on three publications. Heath is currently working as a process engineer at G. R. Stucker and Associates in Baton Rouge. ■

The Distinguished Dissertation awards recipients receive a monetary gift and a certificate of commendation.

MEDIA SHELF

By Christine Wendling



Antiracism in Cuba: The Unfinished Revolution

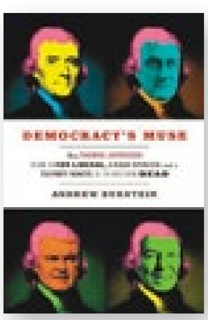
Devyn Spence Benson
Assistant Professor of History

Antiracism in Cuba analyzes problematic race relations during the Cuban Revolution in 1959. It illustrates the contrast between government programs designed to eliminate racism with how these programs actually helped to reproduce racism in Cuba. Leaders of the revolution wanted nationalism to be at the forefront of their cause, which resulted in an erasure of blackness for Afro-Cubans. Revolutionaries were expected to be Cubans first, often ignoring other identities in the name of social equality. However, the paternalistic erasure of the Afro-Cuban experience by the revolutionaries ensured the continuation of stereotyping and racism in the country through the present-day.

Bone Confetti

Muriel Leung
Creative Writing MFA alumna

Bone Confetti is a collection of poetry that centers on a post-apocalyptic theme. The characters are survivors at the end of the world. Themes of death and resurrection are played and re-played on the canvas of a crumbling city of ash. These ashes, like bone confetti, permeate the atmosphere and all that is left for the survivors is the memory of what was. Now, they must pick up the pieces and create a new sense of order out of the chaos.



Democracy's Muse: How Thomas Jefferson Became an FDR Liberal, a Reagan Republican, and a Tea Party Fanatic, All the While Being Dead

Andrew Burstein
Charles Phelps Manship
Professor of History

Democracy's Muse explores the significance of Thomas Jefferson's presidency in regard to modern day politics and how it has changed over time. In his lifetime, Thomas Jefferson supported ideals traditionally associated with both the Left and the Right. As such, both political parties have co-opted Jefferson's legacy in order to garner support for their respective causes. For example, Franklin Roosevelt, a Democrat, lauded Jefferson as a liberal humanist. Alternately, avowed Republican Ronald Regan perceived Jefferson as a small-government conservative. However, Jefferson's actual views on polarizing, modern-day, political issues are much more nuanced than these sweeping generalizations indicate. Burstein's book sets out to extract the truth from the rhetoric and reveal the facts and inconvenient truths of the man behind the politics.

Hispanic and Latino New Orleans: Immigration and Identity since the Eighteenth Century

Co-authored by Andrew Sluyter
Associate Professor of Geography

Hispanic and Latino New Orleans is a historical account of lesser-known aspects of the history and culture of New Orleans' geography. In particular, it discusses how the Hispanic and Latino communities have influenced the city throughout its history. Sluyter and his co-authors take care to illustrate the nuance between the Latino and Hispanic communities discussed here: immigrants from Mexico, Latin America, South America, and the Caribbean. The authors also explain how the separate groups' experiences differed depending on when they arrived in New Orleans. Hispanic and Latino New Orleans is the 2015 recipient of the John Brinckerhoff Jackson Prize. This prize is awarded to popular academic books about human geography in the contemporary U.S. Award winners must be scholarly works and accurate but also accessible and attractive to a wide audience.

Local Church, Global Church: Catholic Activism in Latin America from Rerum Novarum to Vatican II

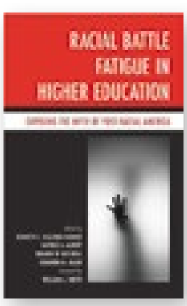
Stephen Andes
Assistant Professor of History

Local Church, Global Church uncovers the history of Catholic activism in Latin America from the 1890s to 1962. The vein of Catholicism runs deep in Latin America and all throughout Latin American history. Industrialization, political unrest, and increasing secularization during this time period urged Catholic activists to foster new ways of organizing for social and political change. Young and Andes investigate the complex politics of an assortment of grassroots organizations, including student activists, devotional societies, and missionaries. They include stories from a large swath of Latin American regions as well as transnational connections to Catholic activists in the U.S. and western Europe. These international relationships reveal how Latin American Catholic politics rose to prominence on the global stage. These stories are especially relevant to modern Catholics worshiping under the first Argentinian and first Jesuit pope: Pope Francis.

Margaret Thatcher: Shaping the New Conservatism

Meredith Veldman
Associate Professor of History

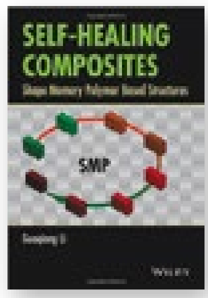
Margaret Thatcher's biography is a classic tale of one intrepid individual rising from obscurity to the highest seat of political power in her nation. Thatcher rose from humble beginnings as the second daughter of a provincial grocer into one of the central founders of New Conservatism in England. In the post-World War II economic climate, Thatcher challenged notions that a strongly state-regulated economy was the only way to economic success. She championed private business ownership and was skeptical of state activism and governmental power. She led Britain's Conservative party by 1975, and from 1979–1990, she served as prime minister of Britain. Veldman's book reveals the personal side of this trailblazing political icon and the movement she helped create.



Racial Battle Fatigue in Higher Education: Exposing the Myth of Post-Racial America

Co-edited by Roland W. Mitchell, Associate Director of Education; **Katrice Albert,** Vice Provost for Equity, Diversity & Community Outreach; **Chaunda Allen,** Director of Multicultural Affairs; and **Kenneth Fasching-Varner,** Associate Professor of Education.

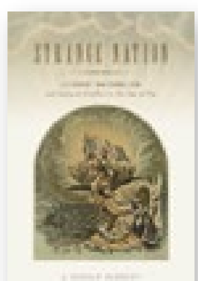
Racial Battle Fatigue discusses how "soft" racism, in the form of microaggressions, stereotyping, and other indirect means of discrimination, affect those who are subjected to it. People who are immersed in an environment of discrimination, whether at work or at school, tend to express intense physical and emotional symptoms of generalized anxiety. Members of all classes of higher education feel this anxiety, whether they be graduate students, mid-level faculty and academics, or even diversity officers. This volume illustrates their stories in detail, offering many examples of how differences of identity are used to create a climate of exclusivity and inequity in higher education.



Self-Healing Composites: Shape Memory Polymer Based Structures

Guoqiang Li
John W. Rhea Jr. Professor of Engineering

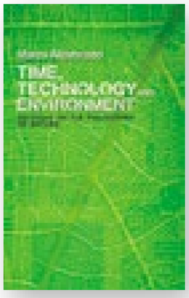
Plants and animals have biological mechanisms that promote healing. But, what if these adaptive traits can be applied to technology and synthetic materials? That is the next step in technological development. Li's book focuses on using self-healing technology, inspired by the human skin's ability to heal itself in "a two-step close-then-heal, or CTH, scheme for healing wide-opened cracks in composite structures-by constrained shape recovery first, followed by molecular healing." In this book, he explores the potential application of this emerging technology to civil engineering structures, based on physical changes of polymers.



Strange Nation: Literary Nationalism and Cultural Conflict in the Age of Poe

J. Gerald Kennedy
Boyd Professor of English

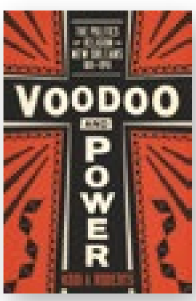
Strange Nation combines history and literature to analyze the rise of American nationalism. Prior to the War of 1812, Americans did not have a strong sense of national identity. But, war forced them to examine their sense of self and identity. The road to a national identity was messy and rife with conflict over contemporary issues such as slavery, Native American resettlement, the role of women, and the westward expansion of the nation itself. Kennedy explores conflicting concepts of national identity as they are described in literature. Several authors of that period were pitted against each other with narratives and counter-narratives on the meaning of Americanism. Edgar Allen Poe publicly criticized literary nationalism, opposing what he interpreted to be unwarranted self-congratulation. Kennedy illustrates how Poe, more than any other author, “personifies the contrary, alien perspective that discerns the weird operations at work behind the façade of American nation-building.”



Time, Technology, and Environment: An Essay on the Philosophy of Nature

Marco Altamirano
Instructor of Philosophy

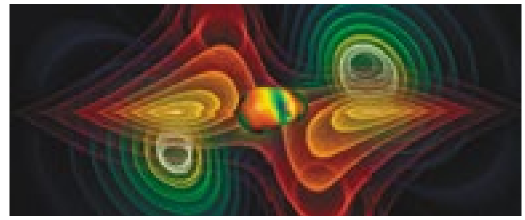
When discussing the philosophy of nature, it is often necessary to differentiate between what is considered to be natural and what is considered to be artifice. However, *Time, Technology, and Environment* criticizes the philosopher’s traditional view of the natural versus the artificial and argues for a concept of nature based on time and technology. Altamirano begins with a history of the concept of nature, philosophized by Descartes, in which a subject discovers an object in space and wonders about their mode of access to that object. He also includes philosophical theories of nature from Foucault, Bergson, Deleuze, Guattari, and Leroi-Gourhan. He then provides a counterargument to these previously held beliefs—that a time-based concept of nature is necessary to the understanding of nature.



Voodoo and Power: The Politics of Religion in New Orleans, 1881–1940

Kodi A. Roberts
Assistant Professor of History

Voodoo and Power explores power, religion, and politics in New Orleans through the lens of Voodoo and those who practiced it between 1881 and 1940. While Voodoo in America is inextricably linked to New Orleans culture, Voodoo is not a homogeneous religion. It is made up of many influences with intersections of race, class, and gender. Roberts focuses on how New Orleans Voodoo promises social mobility, power, and influence to the disenfranchised. He also discusses the economic reasons behind why practitioners formed loosely organized entities and “churches” in order to become tax exempt and legitimate in the state of Louisiana. ■



LSU SCIENTIFIC VISUALIZATION GROUP

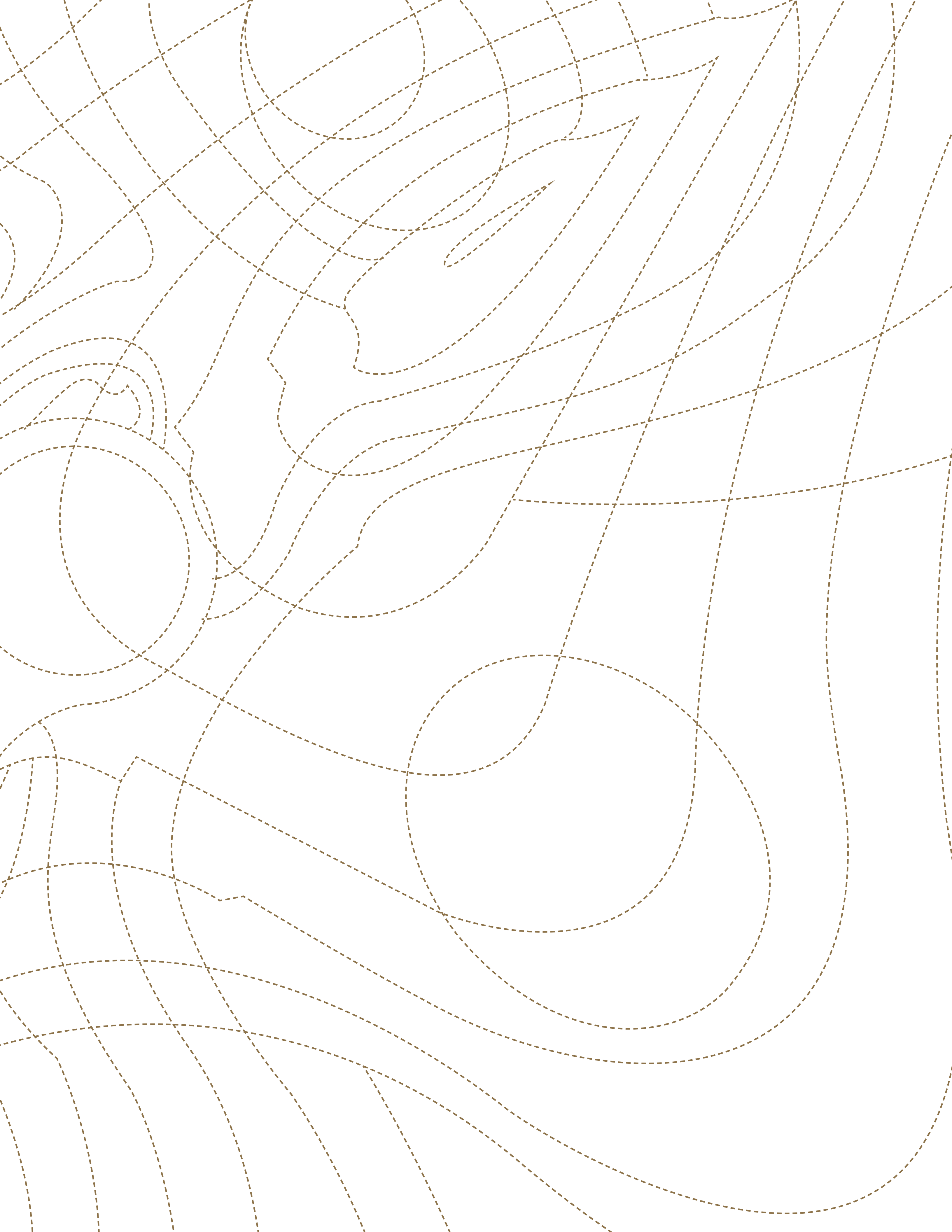
Researcher **Werner Benger** creates scientific visualizations for the Center for Computation and Technology, or CCT. His expertise is in using big data to visualize astrophysical and computational fluid dynamic processes.

Benger’s scientific visualization featured on the cover was created by a numerical simulation of two black holes colliding and emitting gravitational waves. It technically shows a component of the gravitational wave polarization emitted by the merger process with the peanut-shaped surface in the center representing the so-called “apparent horizon” at the moment two unequal-mass black holes merge.

This numerical simulation was computationally intensive and produced huge amounts of data. It was performed on a supercomputer at the National Center of Supercomputing Applications in 1999. It was an important milestone in numerical relativity. In a recent project, LSU helped improve visualization software capabilities to handle such big data by optimizing and extending a widely used data format called HDF5. This project was funded by the National Science Foundation and involved collaborations with Stony Brook University, Brandeis University, Max Planck Institute for Gravitational Physics/Albert Einstein Institute, and Airborne Hydro Mapping Software GmbH.

“General Relativity, or GR, is often dismissed as an abstract science with little relationship to daily life. However, the research activities by the Scientific Visualization, or SciViz, group at CCT have proven otherwise. GR is about geometry. And geometry is all around us everywhere,” Benger said.

Originally developed for big data visualization challenges from numerical relativity, the concepts and methods developed and advanced by the CCT SciViz group, have charted a path to a far-sighted approach to other application domains all under a common hood. As a central part of this research, methods developed for GR have been successfully applied to data from computational fluid dynamic simulations, hurricane simulations, and observations as well as the BP oil spill. Images resulting from this work have been featured on magazine covers demonstrating both the research aspect of GR’s applicability to everyday problems as well as the work of application scientists at LSU using challenging computational technology. ■



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