

Special Features

CALET on the ISS
Nobel & Breakthrough Prizes
Extreme Light from Frozen Argon
Upgrade to Auger Observatory
Improving Prostate Cancer Screening

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Or contact Mimi LaValle

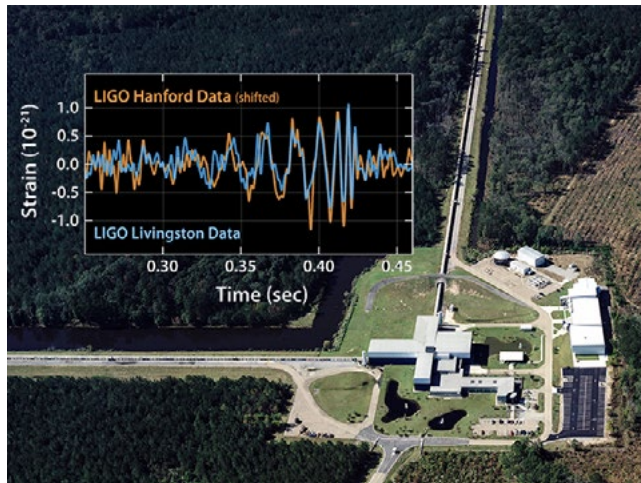
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Gravitational Waves Detected 100 Years After Einstein's Prediction

LIGO OPENS NEW WINDOW ON THE UNIVERSE WITH OBSERVATION OF GRAVITATIONAL WAVES FROM COLLIDING BLACK HOLES



On Sept. 14, 2015 at 9:50:45 UTC, the two detectors of the Laser Interferometer Gravitational-wave Observatory (LIGO) observed a transient gravitational wave signal due to the inspiral and merger of a pair of black holes with masses 36 and 29 M_{\odot} at a distance of approximately 410 Mpc. The detection confirmed a major prediction of Albert Einstein's 1915 General Theory of Relativity and at the same time provided

evidence for a new class of astronomical objects – binary black hole systems.

At 4:51 a.m. CDT, the LIGO instrument in Livingston, LA, followed 7 milliseconds later by the twin instrument in Hanford, WA, detected a gravitational wave signal from colliding black holes. The near simultaneous detection was necessary to confirm that the event was real and indicated, based on the relative time of arrival of the signals traveling at the speed of light, that the source was located in the southern hemisphere sky.

According to General Relativity, a pair of black holes orbiting around each other gradually lose energy through the emission of gravitational waves, causing them to slowly approach each other over billions of years, and then much more quickly in the final minutes. The waveform of the event detected by LIGO corresponded to model calculations for a merger of two massive black holes colliding at nearly one-half the speed of light to form a single more massive black hole, converting a portion of the combined black holes' mass to energy emitted as a final strong burst of gravitational radiation. In the event, which took place 1.3 billion years ago, about three times the mass of the sun was converted into gravitational waves in a fraction of a second—with a peak power output about 50 times that of the whole visible universe.

The LIGO Livingston observatory is located on LSU property, and LSU faculty, students and research staff are major contributors to the 15-nation international LIGO Science Collaboration.

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This will be the last Chair's Corner I write. I stepped down as chair of the Department at the end of June, and I am happy to report that John DiTusa has moved into the chair's office. John has been a leader of the Condensed Matter/Materials group in the Department, director of the Louisiana Consortium for Neutron Scattering (LaCNS), and longtime and active participant in the activities of the Department and the University.

The Department continues to move forward. We currently have 102 graduate students and 73 undergraduate majors. 12 students received Bachelors degrees in Physics in 2014-15 and 22 in Fall 2015 – Summer 2016. 9 students received PhDs and 11 received MS degrees during 2014-15, and 18 and 8 respectively in 2015-16. The Department hired two new tenure-track assistant professors

(Rui Zhang in Medical Physics and Scott Marley in Experimental Nuclear Physics) and an instructor (Nayeli Zuniga-Hansen) in 2015. Kristina Launey (theoretical nuclear physics), Emmanouil (Manos) Chatzopoulos (theoretical astrophysics), and Tabetha Boyajian (observational astronomy) will join us in August. We were sorry to lose instructor Bobby Beard, who left us last summer to take a position at Rice, and will likewise miss Aaron Grocholski, who will leave us this summer to take a position at Swarthmore. Sponsored research expenditures from state, federal, and private sources amounted to \$8.4M in 2014-15, up from \$5.8M seven years ago.

The students' and faculty's exciting research, awards, and other achievements are described elsewhere in this Newsletter. You will see news of some of our alumni in this Newsletter as well. Please stop by to visit if you are here in Baton Rouge, and let us know what you are doing. We will have our second annual Alumni Tailgate on the Saturday of the Ole Miss football game, Oct. 22, so please make plans to come see us if you can.

LIGO Continued from page 1

More than 1,000 scientists from universities around the US and 14 other countries conduct LIGO research as members of the LSC. More than 90 universities and research institutes in the LSC develop detector technology and analyze data; about 250 students are strong contributing members of the collaboration. The LSC detector network includes the LIGO interferometers and the GEO600 and Virgo detectors in Europe. Gabriela González, LSU professor of Physics & Astronomy, is the elected LSC spokesperson. Joseph Giaime, also LSU professor of Physics & Astronomy, is the observatory head of LIGO Livingston.

Together with other leaders and founders of the LIGO effort, González made the official statements and took questions at the press conference announcing the results on Thursday, Feb. 11, at the National Press Club in Washington, D.C., before gathered national science press. The announcement was also live streamed online. "This detection is the beginning of a new era. The field of gravitational wave astronomy is now a reality," González said. "This first detection of gravitational waves owes its existence to the hard work over many

years by hundreds of scientists, 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," Giaime said.

LSU's investment in gravitational-wave detection spans more than four decades, and is among the longest of the institutions contributing 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. The September detection was in part an outcome of LSU's long-term vision and commitment to high-risk, high-potential gain scientific research.

The discovery paper was published in Phys. Rev. Letters. Links to the initial paper, supporting papers, and a large number of other articles can be found on the department website <http://www.phys.lsu.edu>. A paper on a second black hole merger event, detected by LIGO on December 26, has also been published in PRL, read <http://bit.ly/29CGiHJ>.

Crawfish Boil

The annual department crawfish boil, held on the Friday of finals week, featured 500 pounds of crawfish, 50 pounds of potatoes and 250 pieces of corn. More than 160 people socialized outside of Nicholson Hall for the event. To view a photo gallery of the event, visit www.phys.lsu.edu and click on the photo gallery link.

(l-to-r) Sue Lim, Dr. Hwang Lee's wife, with her sister Jenny Lim enjoy crawfish.



Awards and Graduates

2015-16 Graduates

Fall 2015 Graduates

B.S.: Jamie Dismukes, Jordan Frick, Hunter McDaniel, and Thu Phan

M.S.: Andy Halloran, Ishita Maity (Posthumous)

Ph.D.: Anton Joe (Posthumous), Xiaoyao Ma, Ryky Nelson, Garrett Pitcher, and Drew Rebar

Spring 2016 Graduates

B.S.: Austin Baldwin, Jordan Ball, Zachary Baum, Matthew Thomas Curtis, Jay David Dias, Mark DiTusa, Colin Edward Fulham, Andrew Hastings, Jessica Hebert, Jeffrey Konner Kite, Sarah Morvant, Todd Moulder, Andrew Olivier, Nigel Payne, Rene Travieso, and Blaine Ziegel

Ph.D.: Liudmyla Afanasieva, Ashkan Balouchi, Chen Chen, Sheng Feng, Bryan Tomas Gard, Fangyang Liu, and Yan Wu

Summer 2016 Graduates

B.S.: Annelise Bergeron

M.S.: Erin Chambers, Zachary Edwards, Desmond Fernandez, David Heins, Mojammel Khan, and Edward McClain

Ph.D.: Lina Chen, Manish Gupta, Christopher Johnson, Kevin Macon, Ed Montiel, and Jonny Olson

LSU College of Science Choppin Honors Convocation

Mark DiTusa Outstanding College Senior Award

Simon Lorenzo Outstanding College Junior Award

Austin Baldwin Keen-Morris Award

Andrew Olivier Keen-Morris Award

Christopher Abadie - American Legion - A. R. Choppin Scholarship

Margarite Laborde - Willie Belle Shockley Scholarship

Derek Walker Annie and Willie Austin Scholarship

Mark Wilde College of Science Non-Tenured Faculty Research Award

Department of Physics & Astronomy Awards

Undergraduate Research Award
Zachary Baum, Jessica Hebert, & Kadi Runnels

Tiger Athletic Foundation Academic Scholarship
Rory Bentley, Harvey Shows, & John-Paul Marceaux

Outstanding Teaching Assistant
Zach Edwards

Callaway Memorial Fellowship Award
Narayan Bhusal, Terra Hardwick, & Kelsie Krafton

Undergraduate Majors Teaching Award
Kenneth Schafer



Andrew Olivier, Margarite Laborde, Austin Baldwin, Mark DiTusa, and Simon Lorenzo

Physics Block Party

ANNUAL KICK-OFF WELCOME EVENT FOR STUDENTS AND FACULTY

This year's Physics & Astronomy Block Party featured chess, Othello and ping pong tournaments, minimum-acceleration duels, Jacob's Ladder, pizza, and LN₂ ice cream.

The Physics Grads vs. Profs Challenge proved to be an intense contest of intellect between the eight contestants. The professor group of Jonathan Dowling, Juhan Frank, Jim Matthews, and Ravi Rau were victorious by a score of 40 to 38. Sample questions included:

What is the only element in the Periodic Table that is pronounced as six syllables?

Praseodymium (59) pray-zee-a-DIM-ee-um

Which signer of the US Declaration of Independence was known in Europe primarily as a physicist? Benjamin Franklin.



(l-to-r) Samuel Kellar, David Kekejian Steven Dorsher, & Nicholas Cannady

For a list of additional questions/answers, competition results and winners, visit:

www.phys.lsu.edu and click on graduate programs.



Grad students Erin Good, Ashley Disbrow & Laality Uppalapati at the 2015 Block Party.



(l-to-r) Ravi Rau, Juhan Frank, Jim Matthews, & Jonathan Dowling

Distinguished Speakers Visit LSU

HEARNE EMINENT LECTURE

BLACK HOLES IN GENERAL RELATIVITY

Dr. Robert Wald, The University of Chicago



Dr. Wald's research has been concerned with a broad range of topics in classical general relativity, cosmology, and quantum phenomena related to gravity. A great deal of his research has focused on

the theory of black holes - regions of spacetime where gravity is so strong that nothing can escape - and the remarkable (mathematical and physical) analogy between the laws of black hole physics and the ordinary laws of thermodynamics. In particular, the fact that black holes radiate as perfect black bodies as a consequence of quantum particle creation effects has led to many deep insights into the nature of quantum gravity. His interests also span mathematical investigations of classical general relativity and applications of general relativity to cosmology and astrophysics.

QUANTUM LIFE - How biological systems use quantum mechanics

Dr. Seth Lloyd, MIT



Recent experimental evidence suggests that living organisms are using quantum mechanics in a sophisticated fashion to enhance the efficiency of photosynthesis. Bacteria are

essentially performing a quantum computation to extract energy from light. Dr. Lloyd demonstrated how plants and bacteria perform quantum information processing, and discussed how living creatures engage in all sorts of quantum activities in their efforts to survive and reproduce. His research interests include quantum information, quantum computation and quantum communications, quantum control and measurement, quantum limits to control and sensing, and characterizing and controlling complex systems.

MAX GOODRICH DISTINGUISHED LECTURE

TAKING THE KING'S SHILLING: FROM STUDYING NUCLEAR TERRORISM AT LSU TO BRIEFING THE QUEEN OF ENGLAND

Dr. Peter Zimmerman, Kings College London

While teaching at LSU Zimmerman was fascinated by the notion that it was just possible for a well-heeled terrorist group to build its own atomic bomb. That ultimately led to a complete change in his career pattern including extensive government



service and a stint as Professor of Science and Security in London.

The intersection of physics with national security policy is a fascinating field, not easier than pure physics, but with very different questions on the table, totally different constraints on your research and publications; and the fact that real lives can be lost if you give a wrong answer. His new career led him to a job working with then-Senator Joseph Biden and later to London for several years where he got to study the details of the Bush Administration's intelligence on nuclear weapons in Iraq. Along the way he had to become an expert at missile defense, export control, deterring and detecting proliferation, strategic arms control, and, after the Senate was attacked, the spread and treatment of anthrax along with many other problems he had never known existed.

Observation of Gravitational Waves

Dr. Joseph Giaime & Dr. Gabriela Gonzalez, LIGO Scientific Collaboration

On February 11th, the world watched as LSU Physics Professor Gabriela González, together with other leaders and founders of the LIGO Scientific Collaboration, announced the detection of gravitational waves. In celebration of this historic moment, the College of Science and the Department of Physics & Astronomy, hosted "Observation of Gravitational Waves," a presentation by Dr. González and Dr. Joseph Giaime, LSU physics professor and observatory head of LIGO Livingston. The Laser Interferometer Gravitational-wave Observatory (LIGO) detectors in Livingston, Louisiana and Hanford, Washington, have observed gravitational waves from the inspiral and coalescence of a binary pair of black holes hundreds of millions of parsecs from the Earth. The signal carries with it information about this highly relativistic and dynamic astrophysical system. Their observation was made about a century after the publication of Albert Einstein's theory of general relativity and his prediction of such waves; and after half a century of work by several generations of experimentalists to measure the minuscule effects from the waves. At LSU, the effort has spanned 45 years. After reviewing the basic properties of gravitational waves, they presented an overview of the detector design, gave an overview of the various scientific results from the detection, and spoke about the field's future.

LSU Society of Physics Students by Amy LeBleu, LSU SPS President

What an amazing year this has been! From trips near and far, social events involving undergraduate and graduate students, and professors, to service and outreach events, SPS has kept busy.

SPS started 2015 by hosting a welcome event for the incoming REU students. As many of the officers were present on campus, we wanted to do something to introduce them to their new home. The dinner party turned out to be a hit, and we also held a Karaoke night, a favorite social event for the club.

Our fall term saw a new round of freshmen, and mentor/mentee activities. Incoming freshmen that wanted advice and an upperclassmen friend were assigned small groups, consisting of 4 to 5 freshmen and three upperclassmen. All upperclassmen were encouraged to take their group out to dinner or do an activity. Sarah Morvant, LSU SPS VP, did an amazing job matching groups based on interest and coordinating several activities, such as a capture the flag night and a joint karaoke night with our events director, Margarite Laborde.

The fall semester also saw many social events. We bonded on a fall camping trip, and also hosted a trip to the challenge course at the LSU UREC, where members went through teambuilding exercises on high and low ropes. Socials for the semester included the aforementioned karaoke night, a Halloween party, a 2001 A Space Odyssey movie night, and our Yuletide party at Area 51, a trampoline parlor.

SPS also grew as an organization, with many operational reforms. On our new Constitution day, Nov 4th, we ratified the constitution in the eyes of LSU, and made several amendments, including raising the officer's GPA requirements and formally adding several new officer positions, including web master, events director, and public relations and recruitment officer. The OSA club, the optics subset in physics, also colonized a chapter on LSU, and now operates as an independent club within SPS's greater purview. We also formed a

working relationship with the officers of the Aerospace Engineering club, and informed each other's clubs of the interesting events we had ongoing. For the first time, SPS helped welcome back our alumni, by making liquid nitrogen ice cream at the Department's first homecoming tailgate.

And, of course, what would SPS be without our service? Both alone and with MARS Truck, we went to five service activities this semester. The highlight was our trip with MARS truck to Michoud, for Space Day. There, SPS did our normal routine of demos, including the Van de Graaff, telescopes, angular momentum demonstrations, and spectrographs, and got a tour of the facilities along with an introduction to an Astronaut, Dr. Jeanette J. Epps, who has a bachelors in physics.

Spring semester began with elections for the next academic year's officers. Our new President elect, Simon Lorenzo, reintroduced the tradition of having a professor or student talk about their research at the meeting, and talks were given by Dr. Warren Johnson on LIGO, Dr. Catherine Deibel on stellar nucleosynthesis, Dr. Kip Matthews on effects of radiation on DNA, and by Simon on his summer research and the LSU hyper loop team.

Continuing with our theme of outreach, Sarah instituted the "Ask a Physics Student" booth in free speech ally, where passersby could ask a physics question or get a bit of physics trivia. We also attended seven service events this semester. Several officers attended the opening of Spring Orientation to answer questions from undecided freshmen. I also advised incoming declared physics majors scheduling their classes and answered questions about life in physics on the last day of SPIN. Two of our incoming officers helped with Tiger Calls, a program where LSU students call potential freshmen in their major and answer any questions about life as a physics & astronomy major.

A special highlight was the departmental capture the flag event, where we broke

into teams, grabbed nerf guns and swords, and attempted to use our knowledge of Nicholson Hall's layout to plan the perfect heist of the other team's flag. A enormous success, this event drew a large group of students together on a Friday night for a bit of competitive fun.

For spring break, SPS toured Huntsville Alabama's Marshall rocket base museum and Oak Ridge National Laboratory museum. Highlights included seeing a decommissioned Saturn V rocket, competing to see who had the best control over their brain at a brain wave exhibit, the Titan Supercomputer, the largest "functional" supercomputer, and a history of Oak Ridge. On our free time, we had a picnic in the park in Huntsville, AL, fed some ducks, played Dungeons and Dragons, went to a four-star restaurant in Oak Ridge, and finished our trip with a hike through the chimney-tops trail in the Great Smoky Mountains National Park under the guide of Eagle Scout and SPS treasurer Andrew Olivier.

Our events for the year concluded with the Sigma Pi Sigma banquet, the physics honor society for upperclassmen with a 3.0 or above. We inducted ten new members, and awarded graduation stoles to five members. The ceremony was performed by Dr. Michael Cherry, Dr. Dana Browne, and Dr. Greg Stacy. After the conclusion, the dancing began, at the first ever Physics Prom! Our resident DJ, Mark DiTusa, serenaded us with prom tunes from yesteryear, and our new officers brought the prom forward with some Beyonce.

It was and continues to be an honor to have been chosen as president of this organization for the year. I would like to personally thank my officers for their leadership and innovation, my club for their commitment and originality, and our adviser, Dr. Stacy, for his oversight. A special thank you to anyone who participated in any outreach events, or who helped an officer with an event. I look forward to seeing the cabinet-elect and club do even more amazing things in the upcoming year!

-Amy LeBleu, SPS President 2015-16



LSU SPS tours NASA Marshall Space Flight Center



Mike Cherry with 2016 Sigma Pi Sigma Honors graduates

MARS Truck Visits NASA Michoud

The Mobile Astronomy Resource System (MARS) truck, operated by the Louisiana Space Grant Consortium (LaSPACE) in partnership with the LSU Cain Center, the Highland Road Park Observatory (HRPO), and the LSU Department of Physics & Astronomy, returned to road-readiness and has been utilized for multiple outreach events. Staffed by LSU faculty, LaSPACE staff, and LSU students, the MARS vehicle supports public outreach events, and traveled to Scotlandville Middle Magnet School, a family expo day at NASA Michoud Assembly Facility in New Orleans, Louisiana



Earth Day at the Old Governor's Mansion and International Astronomy Day at HRPO in Baton Rouge.

Visitors to the MARS truck enjoy solar telescopes, a digital planetarium show, scientific near-space ballooning experiments conducted by students, and demonstrations by the SPS students, including a Geiger Counter Demo, Van de Graaff Generator, Angular Momentum / Rotational Inertia Chair Demo, Spectrograph, Faraday's Law of Induction Demo, and a Tube Race Demo.

Educational organizations and institutions interested in having a MARS Truck team support an event, should visit the newly launched MARS Truck website:
<http://laspace.lsu.edu/marstruck>.



LANDOLT ASTRONOMICAL OBSERVATORY

Once a month, on the Saturday (or sometimes Sunday) nearest the First Quarter Moon, with a "rain date" on the next day (Sunday), the general public is invited to observe the sky. Admission is free.

Built in the late 1930s, the Landolt Observatory featured many spectacular viewings this past year, including:

- Saturn, the Double-Double, and the Quarter Moon
- Total Lunar Eclipse (the Moon turning to

Blood)

- Saturn-with-its-Rings and the Moon
- Quarter Moon and long shadows on Pluto
- Half Moon and Orion Nebula
- Aldebaran Occultation (see the Moon cover the Eye of the Bull)
- Orion Nebula, sextuple star, and Moon
- Jupiter and moons, Sirius, Orion Nebula
- Jupiter near gibbous Moon

For more info visit: www.phys.lsu.edu and click on LAO Public Observing Night.

What I Did with My Physics Degree

Christopher Welch, 2005 BS in physics and 2008 MS in medical physics alumnus, was joined by Lawrence McCune, 2010 petroleum engineering alumnus on the LSU campus to share their career experiences.

These Shell Oil Company petrophysicists shared their progression in the oil and gas industry and explained how their background in physics provided an easy transition into their new roles.

As an undergraduate at LSU, Welch worked in the high energy physics lab under Mike Cherry. In 2009, he moved to Houston, providing physics support to the St. Luke's Episcopal Hospital radiation therapy department.

In 2012, Shell Oil Co. approached Welch to make a career change. He is currently a petrophysicist supporting the company's Onshore Unconventional Assets in Latin America. It is a role which he finds to be deeply fulfilling due to the unique challenges, technology, and opportunities.



Alumnus Christopher Welch talks with aspiring physics student.

For more information or to participate in the series, please contact Mimi LaValle:
mimi@phys.lsu.edu

Saturday Science

Among the topics covered at the monthly Saturday Science events:

“Adventures in Undergraduate Research: From Fire Ants to Foxes” *Linda Hooper-Bui, School of Environmental Sciences*

“Energy, Econ & Environment” *Gregory Upton, Center for Energy Studies*

“What is toxicology & why should I care?” *Chris Green, School of Renewable Natural Resources*

“Vibrations & Resonance in Network Graphs” *Stephen Shipman, Department of Math*

“The Nature of Earth’s Surface Environments 3.5 Billion Years Ago” *Gary Byerly, Department of Geology and Geophysics*

“Magnetic Materials and Solid State Cooling” *Shane Stadler, Department of Physics & Astronomy*

“Harnessing Chemistry to Combat Bacterial Resistance” *Carol Taylor, Department of Chemistry*

“Using Space Robots to do Science in Antarctica” *Peter Doran, Department of Geology and Geophysics*

Come visit campus on the third Saturday of the month to share in the wonder of science. Visit www.phys.lsu.edu for a schedule of Saturday Science events.

Highland Road Park Observatory

The Highland Road Park Observatory has remained a popular public destination on Friday and Saturday nights in Baton Rouge. Several LSU professors operate the telescope on public nights. Public lectures from LSU Physics & Astronomy faculty, postdocs, and students covered a diverse array of topics including: “NASA’s Chandra X-ray Observatory” (Rob Hynes), “The Sinking of the Royal Oak”, “Lunar Eclipses: History” and “Lunar Eclipses: Science” (Brad Schaefer), “LIGO: The Fantastic Search” and “LIGO: The Search for Gravitational Waves” (Amber Stuver), “Mysteries of Cosmic Dust” (Geoff Clayton, “The Lives and Deaths of Stars” (Juhan Frank), “Star Clusters” (Rory Bentley) together with annual favorites “The Star of Bethlehem” and “Dating the Crucifixion” (Brad Schaefer). The MARS truck and Society of Physics students also participate in outreach events, such as Astronomy Day, to engage the public to discover the world of physics and astronomy.



Rory Bentley stargazing at Highland Road Park Observatory

NanoDays and LASM Engineering

Nanoscale structures, such as a single strand of DNA, have been central to numerous discoveries including advanced applications in energy, information storage and medicine. Because of its promising future, organizations across the country celebrate NanoDays, a nationwide festival of programs about nanoscale science and engineering.

For the **seventh** consecutive year, LSU hosted NanoDays at the Highland Road Park Observatory. The family-friendly event featured several hands-on activities for guests of all ages.

NanoDays activities included:

- How a Scanning Probe Microscope helps scientists explore the nanoworld
- Nanomaterials to make stain-free clothes
- Playing with liquid crystals and magnets
- Making an Oobleck, a liquid with both liquid and solid properties

“This year, about 100 people visited the exhibits,” said Juana Moreno, associate professor of both the Center for Computation & Technology and the Department of Physics & Astronomy. Graduate students were on hand to share science and discovery with the children and their families.”

LASM Engineering Day

In addition, the LSU Medical Physics program joined with the Physics and CCT nanoscience group at Engineering Day at the Louisiana Art & Science Museum.

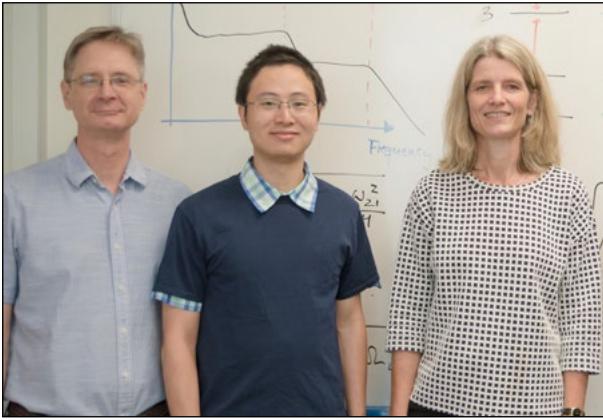
- Nanotechnology promises advanced information processing and storage, new medical treatments and much more
- LSU Medical Physics and Health Physics and the Mary Bird Perkins Cancer Center provided a cloud chamber to display radioactive particles with a radioactive source placed in the chamber to observe



the particles decaying from the source and a radiation survey meter to detect household items that happen to have some amount of radioactivity

- Physics demonstrations by the LSU Society of Physics Students, including: Van de Graaff Generator that generates “lightning,” a ring launcher that uses electromagnetic fields to launch rings into the air and induce current through a light bulb, and a rotational momentum stool which provides a practical and engaging demonstration of the effects of angular momentum.

\$12.5M MURI Grant from Department of Defense



(l-to-r): Kenneth Schafer, Mengxi Wu (Postdoc), and Mette Gaarde

A consortium of six universities, including LSU Physics & Astronomy, has been awarded a Department of Defense (DoD) 5-year \$12.5M Multidisciplinary University Research Initiative (MURI) grant to study the interaction of matter with intense, ultrafast mid-infrared lasers between 1.5 and 5 microns. LSU Physics Professors Mette Gaarde and Kenneth Schafer lead the LSU team. Present day laser technology has restricted the majority of strong field studies to a narrow window around visible and near infrared wavelengths (~0.8 microns). Using longer wavelengths means that the lasers can apply much greater acceleration to the electrons in matter, yielding gains in non-linear effects such as x-ray production and particle acceleration. The LSU team will collaborate with researchers at Ecole Polytechnique in France and Imperial College, London on theoretical studies of ionization and filamentation in strong, mid-infrared laser fields, and with Ohio State, UT-Austin, Arizona, and Central Florida. This MURI marks the first DoD collaborative effort between the US and UK.

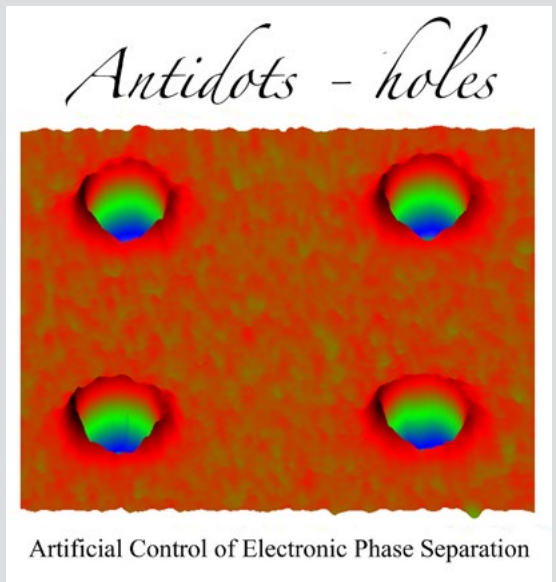
Louisiana Advanced Manufacturing Consortium

NSF has awarded a \$20M 5-year grant for the Louisiana Advanced Manufacturing Consortium to advance applications in 3-D metal printing and multi-scale metal forming. Co-lead PI Phil Sprunger, Mark Jarrell and Juana Moreno will work with five state universities, the National Center for Advanced Manufacturing (NCAM), and the Louisiana Alliance for Simulation-Guided Materials Applications (LA-

SiGMA) to produce new research, develop and diversify the Louisiana workforce, and host K-12 educational outreach. "The synergy between engineering development and scientific understanding will allow us to address key scientific barriers, accelerate technology development and reduce the time from conceptualization to large-scale production," said Sprunger. For more information, visit <http://bit.ly/29GjPJe>

Ferromagnetic Metallic Edge States in Antidots in Manganites

Hard, complex materials with many components are used to fabricate some of today's most advanced technology tools. However, little is still known about how the properties of these materials change under specific temperatures, magnetic fields and pressures. Ward Plummer and colleagues from Fudan Univ., Univ. of Florida and the Collaborative Innovation Center of Advanced Microstructures in Nanjing, China, conducted research on materials that separate into different regions through electronic phase separation. In a paper in Proc. Natl. Acad. Sci. (<http://www.pnas.org/content/112/31/9558.full>), Plummer and his collaborators created holes, or antidots, in thin films of manganite, a material used in magnetic hard discs. It was discovered that the edges of the antidots were magnetic, and the magnetic phase state at the edges of the antidots raised the metal-to-insulator phase transition temperature of the manganite film. "The discovery of the magnetic edge states on the antidots made this work possible. Nobody had ever seen this before," said Plummer. "What you really would like to do is get this temperature above room temperature, so you can switch the material by using a magnetic field", Plummer said. For more information, visit <http://bit.ly/29O9OIU>



Additional news and publications can be found on the department web page at phys.lsu.edu

Extreme Light from Frozen Argon

How does a strong laser field drive quasi-free electrons in a periodic structure? A team of researchers at SLAC National Accelerator Laboratory and Stanford University in collaboration with colleagues at Louisiana State University have directly compared the ultrafast, extreme ultraviolet radiation emitted by argon atoms when they are in their gas phase or in their weakly bound solid phase and found significant differences between them, as reported in *Nature* (<http://www.nature.com/nature/journal/vaop/ncurrent/full/nature17660.html>).

The results yield new clues about how energetic electrons in a solid behave, and may yield new compact sources of short wavelength radiation.

Commercial laser systems provide table-top sources of ultrafast, high-brightness pulses of light, all the way down to the femtosecond limit set by their wavelength, which is in the infrared. But at shorter wavelengths, in the ultraviolet and extreme ultraviolet (EUV) spectral regime, things are much more difficult. For fundamental reasons first elucidated by Einstein, it is much harder to make lasers at these shorter wavelengths, which are useful for resolving matter at nanometer length scales and sub-femtosecond time durations. Over the past two decades scientists have, nonetheless, learned how to convert intense pulses of infrared laser light into short pulses of coherent EUV light. Using a process known

as high harmonic generation (HHG) they produce laser-like short wavelength radiation by driving rapid oscillations of the electron cloud around each atom in a low-density gas. The highest frequencies emitted are limited only by the amount of energy that can be transferred from the strong laser field to the electrons. The HHG process in gases is well understood and widely used but suffers from low conversion efficiency.

Read more at <http://bit.ly/2bzOBEj>

Company Licenses LSU Physicists' Magnetocaloric Material

Shane Stadler and colleagues have discovered a material that may lead to more efficient and environmentally friendly refrigeration and air conditioning systems by eliminating the use of fluorocarbons and potentially reducing energy usage by 20-50%. The material's temperature is increased magnetocalorically, i.e. through application of a magnetic field. The excess heat is then removed via a thermal medium such as water or air, which brings the material back to ambient temperature. For cooling, the magnetic field is removed, and the temperature drops below ambient temperature. Throughout the process, the

material remains in a solid state, producing significant energy efficiency compared to conventional compressed gas systems.

The work has been supported by DOE and the LSU Leverage Innovation for Technology Transfer (LIFT2) fund developed by the LSU Board of Supervisors to help LSU faculty commercialize their research. "We could not have proceeded with the necessary testing without the seed funding from LIFT2," Stadler said. "This new development at LSU could have a positive impact not only on the energy industry but also for economic development in Louisiana."

dramatically reducing energy consumption," said Herbert Presley, managing partner of Magnetic Cool. "Magnetic Cool has followed Dr. Stadler's research for the last two years and has officially licensed the technology and is looking to generate interest from industry partners to help bring this to market."

"The world refrigeration market is expected to increase by about \$7 billion by 2018, to approximately \$47 billion annually," Stadler said. "We've studied these systems for a long time, and were fortunate to discover a system in which a magnetic transition coincided in temperature with a structural transition. That this magnetostructural transition occurs near room temperature is what makes it a strong candidate for magnetocaloric cooling devices of the future." For more information, see <https://www.businessreport.com/business/baton-rouge-patents-magnetic-cool>.

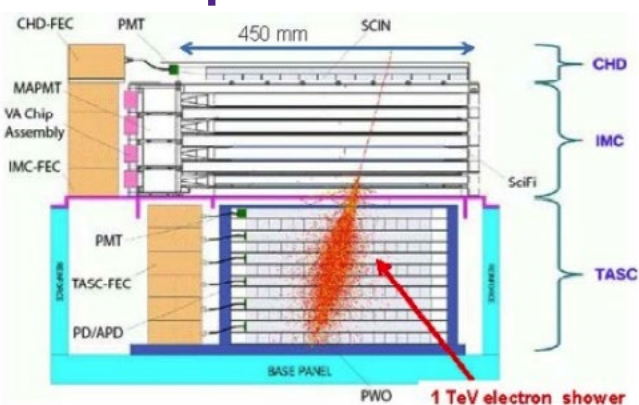


(From l-to-r) Daniel Lepkowski (Undergrad), Tapas Samanta (Postdoc), and Professor Shane Stadler

A Louisiana company, Magnetic Cool LLC, has licensed the material and is developing a prototype. "Magnetic Cool was formed to commercialize a breakthrough in solid state refrigeration that has the potential to solve a worldwide problem with harmful fluorocarbon gases used in conventional systems while

CALET High Energy Astrophysics Telescope on the International Space Station

The CALorimetric Electron Telescope (CALET) has accumulated its first 10^8 cosmic ray events above 10 GeV. CALET, a Japanese-Italian-US experiment on the International Space Station designed to search for possible nearby sources of high energy cosmic rays (e.g. from an undetected pulsar) and for signatures of Dark Matter (the poorly understood component that accounts for about 27% of the mass-energy of the Universe), is the first instrument specifically designed to identify electrons at energies above 10^{12} electron volts. Launched from the Tanegashima Space Center off the southern coast of Japan on August 6, 2015, the 1400 lb CALET experiment will spend the next 2-5 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 May 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 later this year. A secondary instrument, the CALET Gamma ray Burst Monitor (CGBM) has already seen and reported over two dozen



Schematic of high energy shower in the CALET calorimeter (<http://calet.phys.lsu.edu>).

gamma ray bursts, and will be involved in the search for electromagnetic counterparts to gravitational wave events. LSU Physics & Astronomy Professor John Wefel is the US spokesperson. At LSU, Wefel, professors Michael Cherry and Gregory Guzik, postdoc Amir Javid, PhD student Nick Cannady, research scientists Bethany Broekhoven, Douglas Granger, and Michael Stewart, and a team of undergraduates are working with collaborators at over 30 institutions in Japan, Italy, and the US to analyze the CALET data. A CERN Courier article describing CALET can be found at <http://cerncourier.com/cws/article/cern/64666>.

Auger Observatory to be Upgraded

The Pierre Auger Observatory, spread out over 3000 km² in the high plains of Argentina, has demonstrated the suppression of the cosmic ray spectrum due to interactions with the cosmic microwave background at energies above 5×10^{19} eV, searched for extragalactic point sources and anisotropy of the highest energy cosmic rays, produced surprising results about the composition of the high energy cosmic rays, and measured interaction cross sections at energies 7 orders of magnitude above what can be achieved at the LHC at CERN. An upgrade, AugerPrime, is now planned to explore the energy spectrum and mass composition results at higher energy. The idea will be to improve the surface measurements of electrons and photons vs muons and to measure the shower cores more precisely.

"We're trying to solve a 100-year old mystery: Where do these energetic particles come from?" said Jim Matthews, senior member and former co-spokesperson for the collaboration of 83 institutions from 17 countries. "How do they get so energetic? We're trying to understand Nature. Our work, like all scientific research, communicates physics concepts to and trains the next generation of scientists and engineers. LSU has played a key role in this worldwide endeavor. It's a lot of fun, too."

"At Auger, we observe high in the sky trying to reconstruct the path of the universe's most energetic cosmic rays," said 2012 LSU PhD alumnus Guofeng Yuan, Seismic Imager at Compagnie Generale de Geophysique.

"At CGG, we search deep down in the earth looking for the locations of the most needed energy resources. The methods and techniques are

quite similar. Being part of the Auger Collaboration at LSU definitely prepared me for my career and still helps me every day."

"My interest in

particle astrophysics made me choose LSU for my graduate studies," said 2013 LSU PhD alumnus Azadeh Keivani, now a postdoc at Penn State. "As a member of the Auger collaboration, I was also considered a member of the larger particle astrophysics community with many great observatories across all high-energy astronomical messengers. I am currently a postdoctoral scholar working on the Astrophysical Multimessenger Observatory Network (AMON) at Penn State; a project to link all the high-energy multimessengers and follow-up observatories. This all started for me from Prof. Matthews' Auger Lab in the Department of Physics and Astronomy at LSU."

The new international agreement for continued operation of Auger until 2025 will provide the basis for doubling the present statistics with the upgraded Observatory, and for (hopefully) solving the long-standing puzzle of the origin of the most energetic particles in the Universe. For more information, see <http://cerncourier.com/cws/article/cern/65035>.



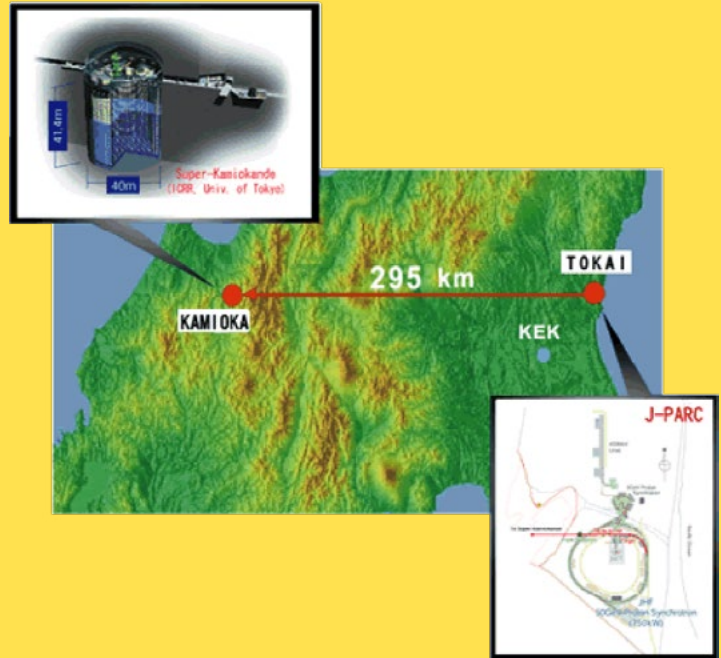
Jim Matthews and former postdoc Rishi Meyhandan at the Auger site in Argentina

Nobel and Breakthrough Prizes

For the third time in recent years, LSU physicists are members of the teams honored by this year's Nobel and Breakthrough Prizes. In 2011, Brad Schaefer was a member of the Supernova Cosmology project that won the Nobel for the startling and unexpected discovery that the expansion of the Universe was speeding up. The expansion of the Universe has been known for decades and is one of the prime pieces of evidence supporting the notion of a Big Bang. It was not expected, though, that the expansion is speeding up. Apparently there is a mysterious component of the Universe dubbed "dark energy" which is responsible. Physicists and astronomers do not understand its nature, but they know that it makes up roughly 70% of the energy of the Universe. In 2014, the team was further honored with a portion of the \$3M Breakthrough Prize in Fundamental Physics (<http://bit.ly/2bQaS0S>).

In 2015, the Nobel Prize in Physics was awarded to the leaders of the SuperKamioKande and Sudbury Neutrino Observatory (SNO) teams for the discovery of neutrino oscillations (<http://bit.ly/2c9mD0u>). Thomas Kutter and his group of researchers were members of the SNO Collaboration which made the key measurements by observing the flux and flavor composition of solar neutrinos. Kutter, Bill Metcalf, and Martin Tzanov were part of the SNO and T2K teams that then won the

2016 Breakthrough Prize also for their work in neutrino oscillations (<http://bit.ly/2bzLVqc>). Bob Svoboda, previously at LSU, was also a member of the SuperK and Kamland teams that shared in the Breakthrough Prize. The experiment at the SNO Lab, located 2 km underground in Vale INCO's Creighton mine near Sudbury, Ontario, demonstrated that neutrinos change their type - or flavor - on their way from the Sun to Earth, a discovery that requires neutrinos to have a mass greater than zero. The results also confirmed the theories of energy generation in the Sun. T2K further explored neutrino oscillations using a man-made neutrino beam produced at the KEK accelerator near Tokyo in Japan and measured 295 km away in the deep underground SuperK detector. The LSU team designed and constructed central parts of the T2K Near Detector, which maps out the neutrino beam at the accelerator before it begins its trip to SuperK. Physicists



T2K neutrino beam from Tokai to SuperK

at LSU continue to operate the experiment to collect data and make contributions to the data analysis to extract results on neutrino oscillations and other neutrino properties.

Finally, a Special Breakthrough prize was awarded in 2016 to the LIGO team for its observation of gravitational waves, described on p. 1 of this newsletter (<http://bit.ly/2ccGIWQ>).

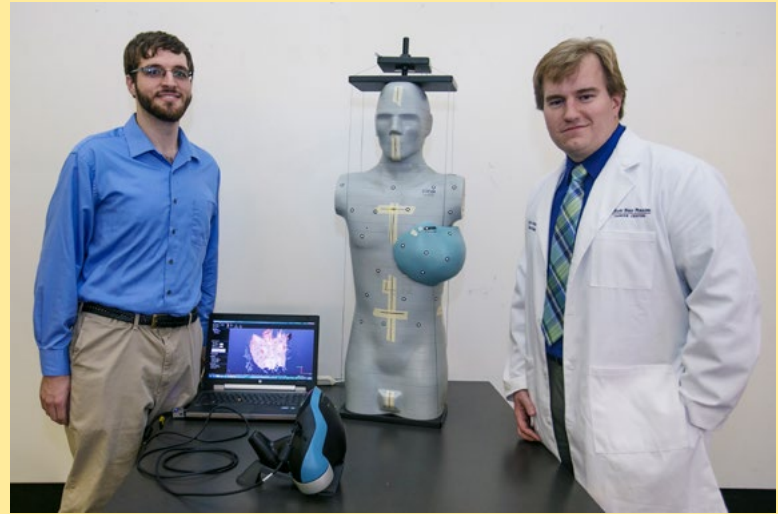
Small Entropy Changes Allow Quantum Measurements to be Nearly Reversed

Mark Wilde has improved a fundamental theorem of quantum information theory that describes the change in entropy during a quantum measurement. The new results allow for understanding how quantum information that has been lost during a measurement can be nearly recovered, which has potential implications for a variety of quantum technologies. "If the decrease in quantum relative entropy between two quantum states after a quantum physical evolution is relatively small," Wilde says, "then it is possible to perform a recovery operation, such that one can perfectly recover one state

while approximately recovering the other. This can be interpreted as quantifying how well one can reverse a quantum physical evolution." So the smaller the relative entropy decrease, the better the reversal process. As described in an article in *phys.org* (<http://phys.org/news/2015-09-small-entropy-quantum-reversed.html>), the ability to recover quantum information could prove useful for quantum error correction, which aims to protect quantum information from damaging external effects. Wilde plans to address this application more in the future with his colleagues.

Applying 3-D Scanning and Printing Technologies to Cancer Treatment

Wayne Newhauser and a team of graduate students are looking at the application of 3-D scanning and printing technologies to improve cancer treatments. The goal is to use 3-D technology to scan patients, create a virtual model of their bodies, and print a dimensionally and density-accurate phantom, making it possible to take into account each patient's unique anatomy for a personalized approach to treatment. "Radiotherapy is used for many breast cancer patients. The effectiveness of controlling the primary tumor is already pretty good, with about 80% of patients surviving long-term. But drugs, radiation and surgery each damage surrounding tissue. We'd like to minimize that damage as much as we can," Newhauser shared. More information can be found at <http://www.lsufoundation.org/s/1585/social.aspx?sid=1585&gid=1&pgid=1660> and <https://www.businessreport.com/article/3-d-printers-new-weapon-cancer-fight-mary-bird-perkins>.



Medical Physics graduate students William Donahue and Chris Schneider

Improving Prostate Cancer Screening

Current prostate cancer screening methods, including the prostate-specific antigen test and the digital rectal exam, have a wide margin of error. PSAs can be released for a variety of prostate diseases, not only cancer, and DREs may not detect small or obscurely located tumors, Physics professor Guang Jia says. Jia and PhD candidate Joseph Steiner have combined an intraoral sensor and an inner rectal coil to produce higher image resolution when used in conjunction with a CT scan. The intraoral sensor is used in dental radiography and inner rectal coils are traditionally used in MRIs. The goal is to produce more

accurate CT scans of the prostate and improve diagnoses.

Traditional prostate CT scans use a surface coil, which has difficulty producing a detailed image of the prostate because of the organ's small size and central location. An internal sensor localizes the CT radiation and produces a clearer image of the prostate, Jia said. The digital detector has 100 times smaller pixels than a CT scan, producing scans with 10 times higher resolution, Jia said.

The device is first being tested using an imaging phantom and a kumquat (an object made of biological tissue and similar in size and shape to a human prostate) at Mary Bird Perkins Cancer Center. After the kumquat tests, a series of tests will be done using canine prostates from the LSU Vet School, and a 3-D printer will be used to produce a model of either the canine or human lower body for further testing. It will likely be two years before testing is complete and the device moves on to human trials, Steiner said. A patent application for the device has been submitted.

Excerpted from Katie Gagliano's article in the LSU Reveille http://www.lsunow.com/daily/professor-doctoral-candidate-develop-device-to-improve-prostate-cancer-screening/article_3e9840aa-ca05-11e5-87ab-9fefed6b8ed9.html



12 Guang Jia with Medical Physics graduate student Joseph Steiner

Selected Publications

A recent paper by **Geoff Clayton** et al. is featured in Research Highlights from the journals of the *AAS NOVA* (<http://aasnova.org/2015/12/14/featured-image-reddened-stars-reveal-andromedas-dust>). With new, high-signal-to-noise spectra for four stars in the Andromeda Galaxy (the nearest galaxy similar to the Milky Way) using the Hubble Space Telescope's Imaging Spectrograph, Clayton and his team study how the absorption of ultraviolet light changes at different wavelengths, providing clues to what the interstellar dust in Andromeda is made out of, and its size and shape. The results are similar to those found in the Milky Way and Large Magellanic Cloud but with significantly higher metallicity.

Two papers from LSU were selected among the annual highlights for the 2014-2015 year by the journal *Classical and Quantum Gravity* published by The Institute of Physics of the United Kingdom: "Hawking radiation from a spherical loop quantum gravity black hole" by **Rodolfo Gambini** and **Jorge Pullin** and "Implementation of an f -statistic all-sky search for continuous gravitational waves in Virgo VSR1 data", by Profs. **Corbitt, Giaime, Gonzalez, Johnson**, postdocs **Kasprzack, Kokeyama, Macleod, Mullavey**, and grad students **Abbott, DeRosa, Effler, Singh, Walker** et al. A paper from LSU has made the highlights list every year since 2001!

Rob Hynes et al. have presented observations of sub-second optical flux variability during an outburst of the microquasar V404 Cyg. They interpret this as synchrotron emission from a compact jet. "Furiously Fast and Red: Sub-second Optical Flaring in V404 Cyg during the 2015 Outburst Peak," *MNRAS* 2016 : stw571v1-stw571.

Ed Zganjar has described the evolution of instruments and techniques in conversion electron spectroscopy focused on nuclear shape coexistence and electric monopole (E0) transitions in "Conversion electron spectroscopy and its role in identifying shape coexisting structures in nuclei via E0 transitions" in *Journal of Physics G.: Nucl. Part. Phys.* 43, 024013 (2016).

M. Saghayezhian, L. Chen, G. Wang, H. Guo, E. W. Plummer, and J. Zhang have

investigated the annealing effect on the surface of SrTiO₃ (111), showing an optimal temperature window for epitaxial film growth. *Phys. Rev. B* 93, 125408.2016. <http://arxiv.org/ftp/arxiv/papers/1603/1603.01680.pdf>

Jonathan Dowling's "Quantum Hall effect with small numbers of vortices in Bose-Einstein condensates" has been published in *Phys. Rev. A*: <http://link.aps.org/doi/10.1103/PhysRevA.92.023629>

"KIC8462852 Faded at an Average Rate of 0.165 ± 0.013 Magnitudes per Century from 1890 to 1989". "This star's dimming is unique and inexplicable," **Brad Schaefer** told *CNN* (<http://www.cnn.com/2016/01/16/us/space-anomaly-remains-mystery/index.html>). According to *Centauri Dreams*, "Schaefer takes a hard look at this F3 main sequence star in the original Kepler field not only via the Kepler data but by using a collection of roughly 500,000 sky photographs in the archives of Harvard College Observatory, covering the period from 1890 to 1989."

Wayne Newhauser, Rui Zhang, and Oleg Vassiliev have published a paper titled "Reducing the Cost of Proton Radiation Therapy: The Feasibility of a Streamlined Treatment Technique for Prostate Cancer" that explores ways to reduce the cost of proton radiotherapy for cancer patients while increasing convenience for patients, especially those being treated far from home. http://www.phys.lsu.edu/newwebsite/downloads/Newhauser_Cancers.pdf

A review article, "Approximate symmetries in atomic nuclei from a large-scale shell-model perspective", by **Kristina Launey, Jerry Draayer, Tomas Dytrych, S.-H. Dong** et al. focuses on new insights into nuclear structure modeling that are unveiled with the help of group-theoretical methods, together with an overview of the significant studies that have led to these findings throughout the last five decades. The paper discusses novel approximate symmetries in nuclei, chaotic behavior of nuclear dynamics based on quantum information theory, as well as unprecedented no-core shell-model descriptions of the challenging Hoyle state and intermediate-mass nuclei. <http://www.worldscientific.com/doi/abs/10.1142/>

S0218301315300052

Dan Sheehy's paper "Fulde-Ferrell-Larkin-Ovchinnikov state of two-dimensional imbalanced Fermi gases" <http://journals.aps.org/pr/abstract/10.1103/PhysRevA.92.053631> investigates an exotic superfluid state predicted to exist for a gas of atoms cooled near absolute zero. Superfluids are correlated quantum states of matter that can flow without any viscosity. By studying such atomic gases, he hopes to shed light on the related phenomenon of superconductivity in electronic materials.

Wayne Newhauser and Rui Zhang received a Physics in Medicine and Biology accolade for "most read" paper in 2015. Downloaded almost 7500 times. "The physics of proton therapy" discusses underlying processes as well as selected practical experimental and theoretical methods. It concludes by briefly speculating on possible future areas of research of relevance to the physics of proton therapy. http://iopscience.iop.org/journal/0031-9155/page/Highlights_of_2015

Chemical compounds may have properties that cannot be obtained by studying the properties of their component parts or their relations, a behavior known in philosophy of science circles as "emergence". Interpretations based on the recently introduced Montevideo interpretation of quantum mechanics by **Gambini and Pullin** provide a natural framework to explain emergence, as described in "The ADM papers and part of their modern legacy: loop quantum gravity" by Jorge Pullin. <http://arxiv.org/abs/1505.02089>

Rob Hynes, Brad Schaefer, undergrad Zach Baum, Ching-Cheng Hsu, Mike Cherry et al. present a multi-wavelength study of the low-mass X-ray binary Sco X-1 in "Kepler K2 Observations of Sco X-1: Orbital Modulations and Correlations with Fermi GBM and MAXI" in *Monthly Notices of the Royal Astronomical Society*. <http://mnras.oxfordjournals.org/content/459/4/3596>.

Additional publications can be found at the department website <http://phys.lsu.edu>

Arlo Landolt was presented the Astronomical League's 2015 Leslie C. Peltier Award "for his development of photometric stellar standards for use by professional and non-professionals alike, and his overall support for the astronomical community," at the Astronomical League Convention in Las Cruces, New Mexico.

Mette Gaarde was elected to the American Physical Society Division for Atomic, Molecular, and Optical executive committee.

Mark Wilde was selected as an associate editor of Quantum Information Theory for IEEE Transactions on Info Theory

Amber Stuver has been named to the APS Forum on Outreach and Engaging the Public (FOEP) executive committee. The purpose of FOEP is to promote scientific outreach by APS members through education.

Jorge Pullin was elected Fellow of the International Society for General Relativity and Gravitation. Read more at <http://bit.ly/2bQj2Xa>

ISGRG Award to Agullo

The International Society on General Relativity and Gravitation of the International Union of Pure and Applied Physics (IUPAP) has awarded Ivan Agullo the International Society Young Scientist Prize. The IUPAP General Relativity and Gravitation Young Scientist award is considered among the highest international recognitions in the field of general relativity and gravitation for young researchers, recognizing outstanding achievements of scientists at early stages of their career. Agullo was acknowledged "for his outstanding contributions to the physics of the early universe and possible observational consequences of quantum gravity."

Deibel receives LSU Rainmaker Award



LSU experimental nuclear physicist and Assistant Professor Catherine Deibel was named an LSU Emerging Scholar Rainmaker in the category of Science, Technology, Engineering and Math. Deibel works in the experimental nuclear physics group, conducting research in some of the forefront areas of nuclear physics relating especially to nuclear astrophysics.

LSU recognizes outstanding faculty who are leaders in their fields each year with the Rainmaker Awards. Rainmakers are faculty members who balance their teaching and research responsibilities while extending the impact of their work to the world beyond academia.

Since joining the Physics & Astronomy faculty at LSU in 2011, Deibel has focused on the synthesis of elements in a variety of stellar explosions, including supernovae, x-ray bursts and classical novae. 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. Her experimental program is primarily housed at Argonne National Laboratory where she is studying reactions important in X-ray bursts using radioactive ion beams. She also uses a variety of other facilities throughout the U.S. and abroad for her work, including the National Superconducting Cyclotron Laboratory at Michigan State and the Superconducting Linear Accelerator at Florida State, where she has led the installation of a 35-ton magnetic spectrograph supported by a Major Research Instrumentation Award from the National Science Foundation.

Vekhter & Newhauser Named Fellows

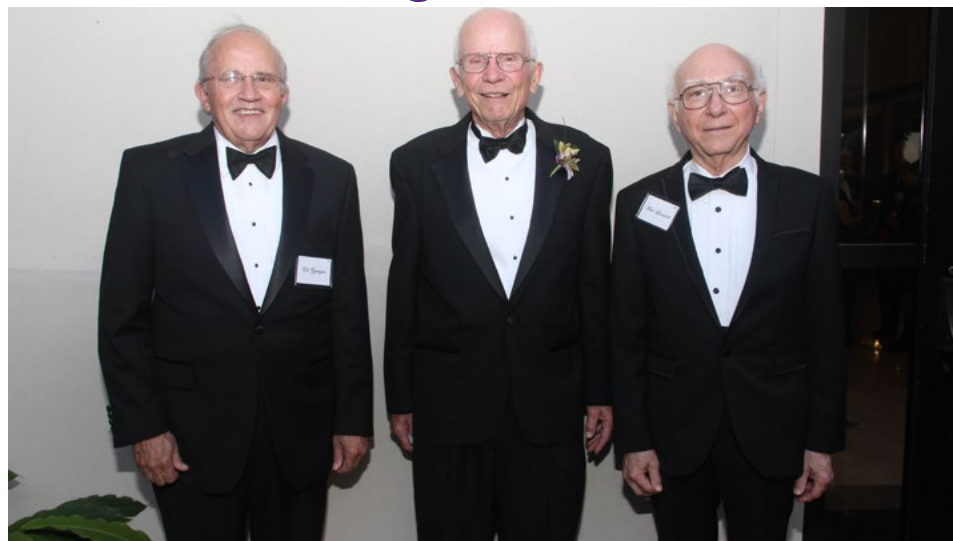
Ilya Vekhter has been named a Fellow of the APS "for important contributions to the theory of unconventional superconductors in the vortex state, including probes of order parameter symmetry."

<http://bit.ly/2bY5IMT>

Wayne Newhauser has been named a Fellow of the American Association of Physicists in Medicine.

<http://bit.ly/2cpEu7i>

A Trio of Distinguished Scientists



College of Science Hall of Distinction recipients Edward Zganjar (2015), William Hamilton (2016) and Arlo Landolt (2014)

William Hamilton named to College of Science Hall of Distinction

The LSU College of Science inducted four exceptional individuals into the Hall of Distinction on April 22, 2016, among them William O. Hamilton, LSU Professor Emeritus in Physics & Astronomy, and considered the father of gravitational physics at LSU. Over his career, Hamilton has made seminal contributions to low temperature experimental physics that have had major impacts in astronomy and cosmology. He was instrumental in attracting the Laser Interferometric Gravitational Wave Observatory (LIGO) facility to the State of Louisiana. His leadership established LSU at the forefront of the important and high priority area of gravitational research, an area of research currently a centerpiece of the Physics & Astronomy Department's research efforts. At LSU, Hamilton served on the Faculty Senate and Senate Executive Committee, as chair of the Graduate Council, on the departmental Steering Committee, and as Associate Dean of Academic Services. He is a Fellow of the American Physical Society, and his research helped lay the groundwork for the worldwide effort to detect gravitational waves using laser interferometric techniques.

Established in 2004, the College of Science Hall of Distinction

celebrates individuals who make significant contributions to science, business, academia, or government, as well as to their community. 2016 honorees were Charles Chappius, MD, Brigadier General, Louisiana Air National Guard and Distinguished LSU Alumnus, Class of 1974; William Daly, PhD, Emeritus Alumni Professor, LSU Department of Chemistry; Susan Murphy, PhD, H.E. Robbins Professor of Statistics & Professor of Psychiatry, University of Michigan, and Distinguished LSU Alumnus, Class of 1980; and Hamilton. To view a photo gallery, visit: www.phys.lsu.edu



College of Science Dean Cynthia Peterson and 2016 Hall of Distinction Inductee William Hamilton

Agullo, Deibel, Singh Receive NSF & DOE CAREER awards



Assistant Professor Ivan Agullo has received a five-year NSF Faculty Early Career Development, or CAREER, award to

support his research on "The Early Universe as a Window to Quantum Gravity"; Param Singh has received an NSF CAREER award to fund his work on "Explorations in Quantum Gravity: Cosmological and Black Hole Spacetimes"; and Catherine Deibel was named as one of 44 scientists to receive funding from the DOE Early Career Research Program for her proposal "Determining Astrophysical Reaction Rates for Classical Novae and X-ray Bursts via Indirect Methods."

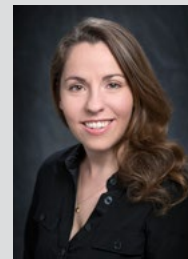
"This is a truly fascinating time for cosmology," said Agullo. "Recent observations have revealed remnants of physical processes that occurred a tiny

fraction of a second after the so-called 'Big Bang.' However, the theoretical tools we currently have to interpret the data are far from complete. A key difficulty is how to make Einstein's theory of gravity consistent with quantum mechanics. The NSF CAREER Award will provide the support I need to focus my energy on understanding these fundamental questions, and to integrate my research and educational activities by involving students at LSU, and the general public in this fascinating field."



Singh will work on understanding the resolution of singularities such as the Big Bang and inside black holes, using techniques of quantum gravity. In order to extract the physics of quantum gravitational spacetimes, Singh will use analytical, phenomenological and high performance computing tools.

"Understanding the physical implications of quantum gravity is vital to understanding the very first moments in the birth of our universe, the very last moments in a gravitational collapse and to overcome limitations of Einstein's theory of general relativity," Singh said.



Deibel is the first person at LSU to receive one of the highly competitive DOE awards. Her research, relies on state-of-the-art techniques for nuclear spectroscopy using both stable and radioactive ion beams to calculate the reaction rates of classical novae and Type I X-ray bursts, the most common stellar explosions in the Galaxy. Using these data, important reaction rates will be calculated accurately for the first time, eliminating key uncertainties in understanding classical novae and X-ray bursts.

Student News and Updates



Graduate student **Zach Edwards'** proposal (with Brad Schaefer and Zhichao Xue) for observing time with the Hubble Space Telescope (HST) was accepted. "The Stingray Nebula"

provides the unique opportunity to watch the ionization of a planetary nebula, a helium shell flash, and the evolution of the central star. The system has been evolving 'startlingly' fast, and has not been imaged for over 15 years. Edwards and his colleagues will use HST to track the rapid evolution of the system.

When he hasn't been working on software for the CALET cosmic ray experiment on the International Space Station, undergraduate **Craig Jones** has formed a



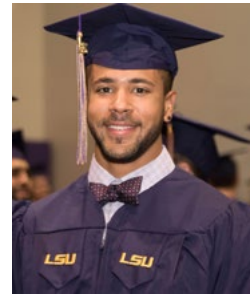
video game development company. <http://bit.ly/2acsAw1>



Medical physics PhD candidate **Joe Steiner** won second place in the LSU E. J. Ourso College of Business 4th Annual LSU Elevator Pitch Competition with his presentation on lowering the rate

of false positive prostate cancer screenings. <http://bit.ly/1Qyjc2N>

Physics major and Tiger Band member **Nigel Payne** was a "Featured Tiger", talking about being accepted into the Nuclear Propulsion Officer Candidate (NUPOC) program. View his video interview



here <http://bit.ly/2aDbBBn>

Alison Dreyfuss, PhD student in the theoretical nuclear physics group, was featured in a Lawrence Livermore National Lab Summer Student Spotlight. Read her interview at <http://1.usa.gov/1LTpXf>



Austin Baldwin was awarded an Astronaut



Foundation Scholarship. The Astronaut Scholarship Foundation, created by the six surviving Mercury 7 astronauts, was established to help the United

States retain its leadership in innovation by encouraging exceptional students to pursue advanced education and careers in STEM fields. Scholars are selected on the basis of initiative, creativity and academic achievement.

Erin Good Receives DOE NNSA Fellowship

The U.S. Department of Energy National Nuclear Security Administration has awarded a Stewardship Science Graduate Fellowship to PhD student Erin Good. The highly competitive DOE NNSA SSGF selects only five to six fellows each year. In addition to an enhanced stipend and covering university tuition and fees, the fellowship also allows Good to perform a summer practicum at one of DOE's national defense laboratories with the aim of developing the nation's nuclear workforce.



"Erin shows great promise as a young researcher in the field of nuclear physics," said Assistant Professor Catherine Deibel. "Despite being only a second year graduate student she has already made significant contributions to our research and I have no doubt she will be successful as an NNSA fellow and beyond." <http://bit.ly/1Nzbl0A>

Read the Reveille spotlight feature <http://bit.ly/1SAK3ck>

Students & Alumni in LIGO Discovery

After 40 years of meticulous calculations, instrument adjustments, and trial and error, three generations of scientists have helped provide a direct confirmation of Einstein's century-old General Theory of Relativity. Even before the Laser Interferometer Gravitational-Wave Observatories' groundbreaking Sept. 14 discovery, the University has played a key role as a major project collaborator. "[Louisiana] is one of only a couple places in the world where they can do this type of research," said graduate student Jonathan Cripe.

Read the Reveille article <http://bit.ly/2aswu2R>



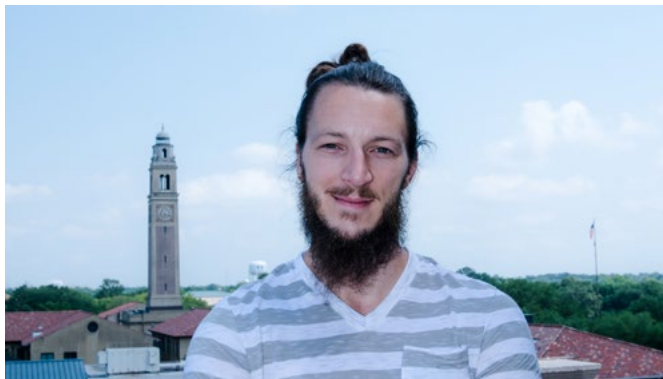
GRADUATE STUDENT SPOTLIGHT: CHRISTOPHER JOHNSON

Christopher Johnson exemplifies the Graduate Student Research Assistance (GSRA) program, supported by the Louisiana Space Consortium (LaSPACE). Chris has received consecutive GSRA awards supporting travel to collaborative meetings and scientific conferences, which led to invitations to participate in additional scientific meetings, thus increasing Chris's experience, professional network, and communication skills while presenting his work.

Chris shares some details about his research and advice for students looking to attend LSU Graduate School.

I am primarily interested in the physics that is involved with the evolution of black holes and white dwarfs and the objects that orbit them. A black hole is characterized as the end stage of a massive star that has collapsed in on itself after a supernova outburst so that nothing, not even light, can escape the immense gravitational pull. A white dwarf is referred to as the end stage of a low mass star, much like our own Sun. At this point, the star has collapsed in on itself to where, at the atomic level, the only thing that is overcoming the gravitational force inward is the compacted electrons occupying every facet of space in the stellar core. This is known as the electron degeneracy pressure and is the basis for degenerate matter.

I use photometry and spectroscopy of these systems to essentially "weigh the stars." That is, if we look at the brightness variations of a system over time, we can construct a light curve and infer a period for the system, ideally from eclipses or sinusoidal motion. Using this orbital period along with the radial velocity of the system given by the absorption spectral features and the Doppler shifts of these features, I apply Kepler's Laws of Motion and calculate a mass for the system. The mass is one of the most important parameters that can be measured for stellar systems, especially black holes, since there are only a handful of black holes confirmed out of the many, many billions of objects in the Universe. Understanding the mass distribution of these



systems allows us to infer how and when they formed, where they formed, and how they evolve over time. Many scientific teams have been working on these problems for 50 years and yet there are still more questions than answers concerning black holes.

I received my MS in Physics from LSU and will graduate with my PhD this summer. I have accepted a NASA-funded Postdoctoral Fellowship in the Science Mission Office at the Space Telescope Science Institute at Johns Hopkins University in Baltimore, Maryland beginning in the fall of 2016. I will be a data scientist analyzing large data sets from space telescopes, primarily the Hubble Space Telescope.

What have you enjoyed most about the graduate program in Physics & Astronomy at LSU?

I believe that the best part about the PhD program is that graduate students have the opportunity, and are encouraged, to travel and promote their own research at conferences and attend summer schools to gain further experience in their particular field of interest. The physics and astronomy community is very close-knit, so creating networks for collaborations and potential future employers is critical.

Posthumous Degrees Awarded to Anton Joe & Ishita Maity



Professors Mike Cherry and Jim Matthews Join LSU President F. King Alexander in presenting V.A. Victor and Elna Merin with Anton Joe's degree.

The College of Science honored two of its graduate students with degrees posthumously. Anton Joe, 25, and Ishita Maity, 28, both in the Department of Physics and Astronomy, unexpectedly passed away Sunday, April 26 2015 in Baton Rouge, Louisiana.

"We were deeply saddened to learn of the unfortunate and tragic accident involving Anton and Ishita," said Michael Cherry, department chair.

Anton was a student working with Parampreet Singh in the area of theoretical gravity, and Ishita was a student of Juhan Frank in theoretical astrophysics. Anton received his Ph.D. and Ashita her M.S. posthumous degrees at the Fall 2015 Commencement. Anton's father V.A. Victor and sister Elna Merin accepted the degree in his honor. Dr. Frank accepted Ishita's degree on her behalf.

Alumni News

Ravi Kopparapu (2006 PhD), assistant research scientist at NASA Goddard Space Flight Center/University of Maryland, returned to campus to present a colloquium on Habitable Zones and the Occurrence of Potential Habitable Planets in our Galaxy.

Yi Li (2013 PhD) is CEO of RNG Group Inc., also known as Renogy Solar. While still a student at LSU, Yi organized Renogy LLC with the help of the Business and Technology Center. For a few years, she operated the business out of a small warehouse at LBTC located off of GSRI Ave. The company has now moved to California, is selling internationally, and has increased revenue 20-fold since 2013.

Zach Byerly (2007 BS, 2011 MS & 2014 PhD) is working at LSU's CCT to predict the effects of large storms on the Louisiana coast. View the video <http://ow.ly/RVGsb>

Ashley Pagnotta (2012 PhD), Kathryn W. Davis Postdoctoral Fellow studying observational astrophysics at the American Museum of Natural History and faculty member in the Museum's Master of Arts in Teaching Program, recently published "The 2010 Eruption of the Recurrent Nova U Scorpii: The Multi-Wavelength Light Curve" together with Brad Schaefer, Arlo Landolt, James Clem et al. in The Astrophysical Journal. <http://arxiv.org/abs/1509.05431>



(l-to-r) Mike Cherry, undergraduate Craig Jones, and 1981 alumnus Thomas Harrington discuss the CALET research project at the Dean's Circle

Azadeh Keivani (2013 PhD) was featured in Physics Today. Azadeh is a postdoc with the Astrophysical Multimessenger Observatory Network at Penn State working on the IceCube neutrino detector under the ice in Antarctica. <http://sites.psu.edu/amon/2015/09/05/amon-in-physics-today/>

What are you doing with your physics degree?

We want to hear from YOU! Send updates to alumni@phys.lsu.edu or let us know if you would like to come to campus to give a "What I Did with My Physics Degree" talk to current undergraduate and graduate students.



Follow us on Facebook and Twitter to keep up to date on the latest news and events!

The Department hosted its first alumni tailgate on October 24, 2015. Photos from the event can be viewed at <http://bit.ly/20RT0Vq> Please mark your calendar for the 2016 Department of Physics & Astronomy Alumni Tailgate on Saturday, October 22 in front of Nicholson Hall in the Quad. Reconnect with fellow alumni and former professors and meet current students while enjoying jambalaya and LN₂ ice cream!



Join us for Physics & Astronomy ALUMNI TAILGATE Saturday, October 22 3-6 p.m.

Nicholson Hall
LSU Quadrangle



Meet current students
Enjoy jambalaya,
LN₂ ice cream &
science in the Quad

Join us for LSU Homecoming on Saturday, October 22 to reconnect with fellow alumni and former professors as we celebrate science and fall football.



Support your Alma Mater and Future Students

Private support has always been important in providing the margin of excellence for our students and faculty. In today's challenging economic times, LSU relies even more on our alumni and friends who make a vital investment in the future. Donations to the Department of Physics & Astronomy will be used to enhance our teaching program and facilitate scientific discoveries that shape the future.

With your support, we can continue to make a profound and lasting contribution to our students, our community, and the world.

How can you help?

You can make your tax-deductible gift to the LSU Department of Physics & Astronomy, by check. Please write the check to the "LSU Foundation," complete the form on this page, and note "LSU Department of Physics & Astronomy." Send the form with your contribution to:

John DiTusa, Chair
 Department of Physics & Astronomy
 Louisiana State University
 202 Nicholson Hall - Tower Drive
 Baton Rouge, LA 70803-4001

You can also donate online at

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A portion of all gifts is used to defray the costs of administering the funds. All gifts are tax-deductible, as prescribed by law.

The Department of Physics & Astronomy participates in several honorary and memorial funds and endowments, which benefit the educational process through the support of quality students, distinguished faculty, and educational/research facilities.

To support these funds, please note the name in the comments section on your check or in the online comments:

- Departmental Development Fund
- Joseph Callaway Memorial Fellowship Fund
- Ganesar Chanmugam Memorial Fellowship Fund
- Max Goodrich Distinguished Lectureship Series in Physics
- Horace C. Hearne, Jr. Institute for Theoretical Physics
- Kenneth R. Hogstrom Superior Graduate Student Scholarship Fund
- R. Greg Hussey Undergraduate Scholarship for Excellence in Physics
- Telescope Endowment Fund



(l-to-r) Dr. John DiTusa celebrates Spring 2016 Commencement with recent graduates on the LSU campus.



Please make your check payable to: "LSU Foundation" note "Physics & Astronomy" on the memo line.

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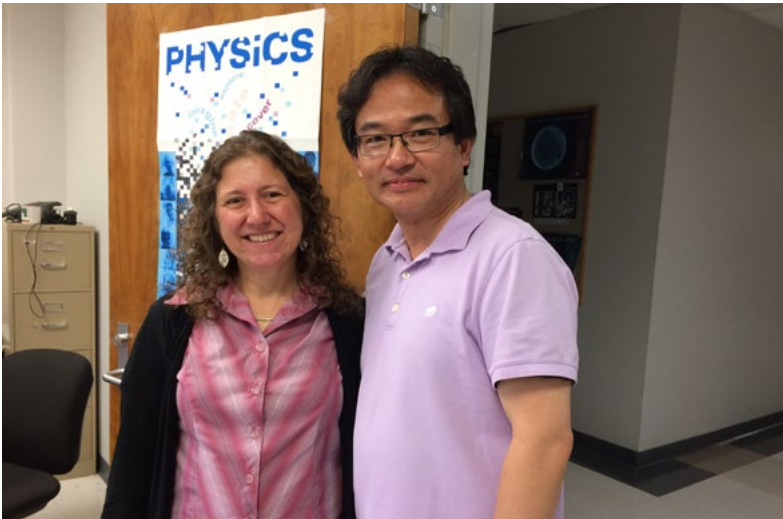
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Alumnus Kenny Geng Returns to Campus



Kenny Geng (PhD, 1994) visited Nicholson Hall recently with his daughter. They visited LIGO and New Orleans for the French Quarter Fest. On campus, they met with Bill Hamilton (Kenny's PhD advisor), Gabriela Gonzalez, and Mike Cherry. Kenny is currently ASIC Design Engineer at Microsemi in the San Francisco area, where he lives with his wife Wei Li (PhD, 1996), who is Sr. Director of Engineering Operations with ASML-Brion.

Let us know if you are planning a trip to campus. We would be delighted to give you a tour and help you reconnect with former professors. Email Mimi LaValle at mlavall@lsu.edu

1994 alumnus Kenny Geng visited with Gabriela Gonzalez to discuss and celebrate the detection of gravitational waves at LIGO.